U-007-105.23

4984

WASTE MINIMIZATION AND GROUNDWATER SAMPLING EFFICIENCY: A NEW TECHNIQUE FOR PURGING GROUNDWATER MONITORING WELLS AT THE FERNALD ENVIRONMENTAL MANAGEMENT PROJECT OCTOBER 1993

12/17/93

DOE-FN/EPA
150
REPORT
OU5

-4984

WASTE MINIMIZATION AND GROUNDWATER SAMPLING EFFICIENCY:

A NEW TECHNIQUE FOR PURGING GROUNDWATER MONITORING WELLS AT THE FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

OCTOBER 1993

Prepared by

Fernald Environmental Restoration
Management Corporation
P.O. Box 398704
Cincinnati, Ohio 45239-8705

Prepared for

U.S. Department of Energy
P.O. Box 398705
Cincinnati, Ohio 45239-8705

Under Contract DE-AC05-860R21600

0001

-4984

WASTE MINIMIZATION AND GROUNDWATER SAMPLING EFFICIENCY:

A NEW TECHNIQUE FOR PURGING GROUNDWATER MONITORING WELLS AT THE FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

OCTOBER 1993

Prepared by

Fernald Environmental Restoration
Management Corporation
P.O. Box 398704
Cincinnati, Ohio 45239-8705

Prepared for

U.S. Department of Energy
P.O. Box 398705
Cincinnati, Ohio 45239-8705

Under Contract DE-AC05-860R21600

0002

Waste Minimization and Groundwater Sampling Efficiency: A New Technique for Purging Groundwater Monitoring Wells at the Fernald Environmental Management Project

ABSTRACT

Major emphasis is focused on the collection of representative groundwater samples with a novel technique that is both cost effective and minimizes the generation of waste waters. Recent extramural studies indicate more representative samples should and can be collected without prior well-volume exchange purging. Field experiments conducted at the Fernald Environmental Management Project (FEMP) demonstrate that under specific conditions of sampling, more representative groundwater samples can be obtained without removing the conventional 3-well-volumes from the well. The technique employs low purge rates (less than one liter per minute), dedicated bladder pumps with inlets located in the screened interval of the well, and maintaining isolation of the stagnant water column above the screened interval. If adopted, the proposed and now applied technique, herein called *micro-purging*, will save money and minimize waste over the groundwater monitoring life cycle at the FEMP.

INTRODUCTION

The mission of the Fernald Environmental Management Project (FEMP) is to remediate the environment of the Department of Energy (DOE) 1,050 acre complex and immediate areas impacted by contamination releases. Health and safety must be insured during remediation. Remediation of the FEMP groundwater will probably involve the greatest long-term commitment. Groundwater monitoring during this period will be vital to maintain vigilance of the restoration of impacted groundwaters and to assess the performance of remedial programs.

In support of the environmental restoration mission, the groundwater is routinely monitored now in as many as 200 of the 610 wells located on- and off the FEMP site. Groundwater transport has been identified as the primary pathway of concern for contamination from FEMP radioactive and nonradioactive pollutants. For example, it is now known that at least since 1981 (USGS 1985) elevated uranium has migrated offsite.

Unfortunately, to obtain groundwater samples, the past and present practice of sampling necessitates the discarding of voluminous quantities of waste waters. During a typical 3-month monitoring period, 90 to 110 monitoring wells are sampled and over 7,000 gallons of purge water are generated. Additionally tens of gallons of decontamination water are generated during the cleaning of

purging and sampling equipment. Contaminated sample waters must be carefully handled, stored, and treated prior to appropriate disposal. Because it is not known what the concentrations are until laboratory analyses are conducted, all waters must be handled and treated at much expense. Meanwhile the safety and health of groundwater monitoring crews and even laboratory analysts, are unnecessarily being subjected to handling and disposal of these potentially contaminated groundwaters.

Recent studies (e.g. Puls et al., 1992) have suggested that the past Technical Enforcement Guidance Document (USEPA, 1986) guidance for removal of three well volumes prior to sampling is unnecessary and that the most efficient sampling program should minimize waste waters. The current draft TEGD (USEPA, 1992) guidance is to determine the most efficient method based on local hydrogeologic conditions. Therefore, it is entirely the responsibility of a site program to develop an appropriate groundwater sampling methodology in concert with the regulatory oversight.

PURPOSE AND SCOPE OF INVESTIGATION

The purpose of the herein defined micro-purging experiment is to demonstrate that waste generation can be minimized and groundwater sampling efficiency and quality can be improved. This can be achieved by showing that representative groundwater samples can be obtained from a monitoring well <u>without</u> purging multiple well volumes and <u>without</u> monitoring indicator parameters for identifying well flow stabilization prior to sampling.

If groundwater samples could be obtained from the screened interval using dedicated equipment at flow rates that would prevent drawdown in the well and without disturbing the stagnant water column, then samples would be representative of the formation waters. Since flow from within the formation continues to flush the screened interval, it is therefore only necessary to sample that interval. Samples collected under these conditions should be analytically similar to samples collected after determining stabilization of indicator parameters after purging the conventional three well volumes.

COMPLIANCE RATIONALE

RCRA 40 CFR §265.92 requires that sample collection procedures be included in a sampling and analysis plan for groundwater monitoring. In 40 CFR §265.92, two references are provided that give broad guidance on the need to sample a representative interval of a monitoring well (USEPA, 1977; USEPA, 1979). Subsequent guidance by USEPA (1986) *suggested* well evacuation steps that included three purged well volumes for "higher yielding wells". "The procedure the owner/operator should use for well evacuation depends on the yield of the well (USEPA, 1986)". Gilham (1982) and Giddings (1983), for example, argued that the criteria for higher

yielding wells was vague and that adherence to three purged well volumes was indeed arbitrary, offering no assurance that all stagnant waters would be removed. USEPA (1986) did recognize that flow rates greater than 100 ml/min were excessive for the collection of volatile organics but provided no specific guidance for other analytes nor commented on sampling under natural flow conditions. Positive gas displacement bladder pumps and dedicated samplers were *recommended*, yet other sampling devices were not discouraged.

The Regional USEPA Superfund Groundwater Forum (USEPA, 1989) suggested low-flow pumping (equated herein as micro-purging). They proposed a flow rate based on the generic linear groundwater flow rate and open screen area. For many quiescent flow conditions they recommended 100 ml/min unless local hydraulic conditions warranted otherwise.

Further specific draft USEPA guidance (USEPA, 1992) does discuss the possibility of requiring little to no well purging prior to sample collection. USEPA further stated that purging should be below the recovery rate of a well and be performed with the pump intake near the top of the well screen. Although no specific purging device is recommended, "the use of bailers to purge monitoring wells generally should be avoided."

The above general compliance guidance emphasizes the need for representative samples with an awareness of waste minimization. In addition to the Pollution Control Act (1991) and standing DOE Orders (eg. 5400.1), Executive Order 12780 (1991) specifically mandates waste reduction. Micro-purging is expected to have regulatory compatibility and will significantly reduce monitoring well purge waters prior to sampling which will allow, in the case of RCRA constituents, the possibility of eliminating the collection, storage, and treatment of potentially hazardous waters from affected wells. In other groundwater monitoring programs at the FEMP, the significant reduction of shipments to and treatments at the general sump facility will be realized.

COST RATIONALE

Reduction in costs can be realized with positive effects on program efficiency if the micro-purging technique is adopted. This technique will eliminate the need for quality control rinsate samples since decontamination of sampling equipment is not required for dedicated equipment and in-line disposable filters. Additional cost reductions will be realized with the reduction of waste water collection and handling plus the elimination of labor and material costs associated with repeated use and decontamination of portable purging and sampling equipment. Estimated annual cost reduction equals $115,100 (Figure 1, Estimated Annual Cost Reduction: Replacing Standard Sampling Procedure With Micro-Purging).

Micro-purge sampling will require the installation of dedicated sampling equipment, incurring program expense. However, based on a typical quarterly sampling round of 99 wells, a preliminary cost analysis to recuperate capital outlays for this equipment has estimated a 1.1 year payback if the standard sampling procedure was replaced with the micro-purging technique (Figure 2, Payback Estimate: Standard Procedure Verses Micro-Purging). A present site advantage includes 90 monitoring wells equipped with viable dedicated bladder pump sampling equipment.

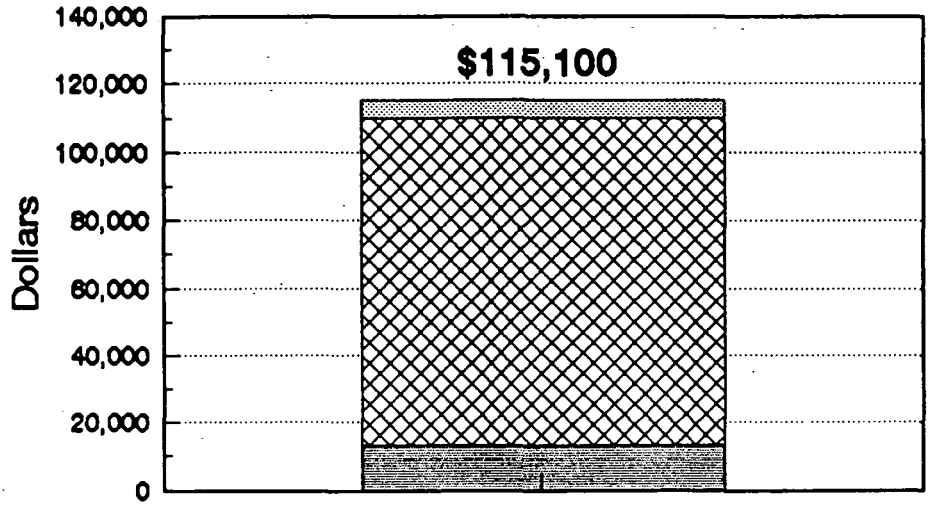
SUMMARY OF CURRENT WELL-PURGING PROCEDURE

The conventional multiple well volume purging technique is predicated on removal of the overlying water column prior to sampling the screened interval. This invariably causes disturbances in the well flow regime and equilibration times must be measured with indicator parameters.

Past and present purging and sampling practices at the FEMP employ the multible well volume purging technique. Current FEMP procedures advocate purging three or more well volumes prior to sampling with the insertion of purging devices into a well. Field parameters are measured (eg. pH) after the removal of each well volume. If field parameter measurements are within ± 10 percent after the removal of the three well volumes, the well is considered to be "sufficiently" purged (i.e., all stagnant water is considered removed and the remaining water is considered representative of the actual groundwater flowing into the screened interval). If the measurements are not within ± 10 percent, additional well volumes are purged until the parameters have stabilized.

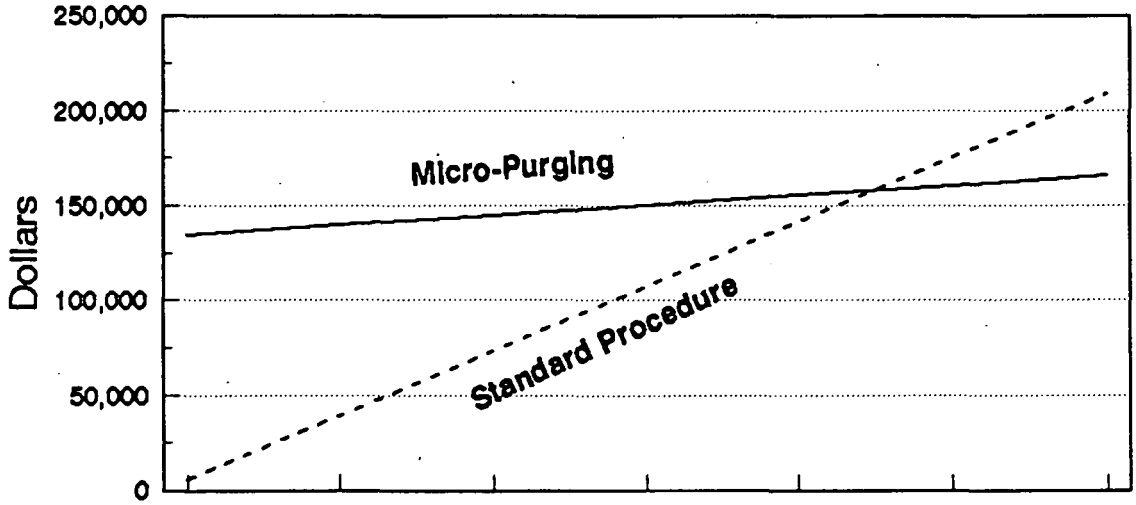
Current FEMP purging procedures can not completely evacuate the stagnant water column; can not suppress mixing and aeration between the overlying water column and the flow into the screened interval; nor establish short equilibration times. The counting of well volumes (Gilham, et al., 1985; Barcelona et al. 1983) should be limited to the earliest phases of a remedial investigation program when site-specific hydraulic conditions are unknown. Purging at low flow rates (Puls and Powell, 1992), with the pump intake within the screened interval in effect isolates the stagnant column of water in the well and negates the need for its removal. Special tracer studies (eg. Puls and Barcelona, 1993), beyond the scope of the FEMP field experiments herein, indicate that in many formations the water within the screened interval is chemically distinct from the overlying stagnant water column. Robin and Gillham (1987) and Keeley and Boateng (1987) also arrived at the same conclusion.

Figure 1
Estimated Annual Cost Reduction: Replacing Standard Sampling Procedure With Micro-Purging



ITEM	COST REDUCTION
Portable Equipment	$13,100
Rinsates	$96,900
Waste Water	$ 5,100

Figure 2
Payback Estimate
Standard Procedure Verses Micro-Purging



Years	0	0.25	0.5	0.75	1.0	1.25	1.5
——	$135,020	140,206	145,392	150,578	155,764	160,950	166,136
- - -	$ 5,900	39,826	73,752	107,678	141,604	175,530	209,456

MICRO-PURGING DESIGN

Principles

The micro-purging technique is predicated on not overturning the overlying water column and sampling only from the screened interval. In a practical sense this means that no drawdown is experienced during purging.

The intended objective of a quality groundwater sampling program is the acquisition of representative groundwater samples from a target geologic interval with the least amount of well flow disturbance (Puls and Powell, 1992). Groundwater flow under naturally induced gradients enter the well screen and must be sampled without overturning the water column above the screened interval. Naturally-occurring hydraulic gradients for the FEMP (≈ 0.0006) are sensitive to anthropogenic induced currents. These include thermal currents, chemical gradients (i.e. Sorbet coefficient), and transient vertical flow currents. Numerous studies indicate that the insertion of purging/sampling devices such as bailers, submersibles, et al., will disturb the sampling interval and may induce vertical gradients causing aeration and mixing. (eg. Unwin, 1986; Robin and Gillham, 1987; Puls and Barcelona, 1989b; Puls and Powell, 1992; Kearl, et al., 1992; Paul and Puls, 1992). In addition, observations through the use of a colloidal borescope (Kearl and Cronk, 1991) showed significant increases in turbidity from the insertion of equipment into the well.

If the overlying water column could be purged by simple well volume exchange, long equilibration times would be required. The natural flow entering the screen from a formation mixes with the equilibration of the overlying water column for some time interval. While indicator parameters for measuring the time of equilibration are helpful, they often do not equilibrate. Experiments by all investigators (see Puls and Barcelona, 1993 for a summary), including this work, demonstrate that the parameters vary between and within a site domain. In fact it can be shown (Puls and Barcelona, 1993) from tracer techniques that after so-called indicator parameters are "stabilized", thermal, chemical, and hydraulic interactions occur between the "assumed" stagnant overlying water column and the natural groundwaters flowing into the screened interval. Several days are required to establish complete equilibrium in the screened interval after small disturbances!

Recent studies (eg. Puls et al. 1992) used very low pumping rates (0.2 - 3.8 l/min) during purging, while many of the earlier recommendations (incorporated into USEPA guidance documentation (USEPA, 1986)), have been based on rates well in excess of this range. The pumping rate used during purging has been shown to

affect indicator parameters (Unwin, 1986; Pionke and Urban, 1987; Puls et al., 1992). Results suggest that the order of sensitivity and time for re-equilibration is directly related to pumping rate. The pumping rate used during purging (Puls and Powell, 1992) has been shown to affect equilibration of indicator parameters. Results suggest that the order of sensitivity and time for re-equilibration is directly related to pumping rates.

Because micro-purging best approximates natural formation flow into the screened interval, groundwater samples will be more representative irrespective of filtration. Puls et al, (1992) and Puls and Barcelona (1989b) have demonstrated, at several sites, marked decreases in sample variability. Sample quality is improved through reduced turbidity in samples and minimization of degassing and stripping effects. Sample accuracy and precision are improved as low flow pumping can eliminate mixing and dilution effects on the concentration of contaminants. The integrity of the filter pack is strengthened by reducing the stress and movement of fines into the well that result from high yield pumping.

Therefore, micro-purging can be adapted for use at the FEMP if the following requirements are satisfied:

- Dedicated sampling equipment, such as a bladder pump, that will not agitate or aerate the water, is installed in each routinely sampled well.
- Low flow rate purging (less than 1 l/min) is maintained.
- The static water level in each well remains "static" (no drawdown during purging and sampling).
- The inlet to the purging device is located within the screened interval of each well.
- If indicator parameters are used for quality control, then in-line measurement of field parameters should be obtained with an enclosed in-line flow-through cell (Barcelona et al., 1985).

Well Construction

The four monitoring wells used for the experiment are identified as numbers 2106, 2391, 3106, and 3391. Each well was installed by the same drilling (cable tool) and construction methods. Riser pipes and screens are made of 316 stainless steel. The screens in wells 2106 and 2391 straddle the water table where as the screens in wells 3106 and 3391 are set in the upper part of the Great Miami Aquifer (Table 1).

Table 1
Monitoring Well Details

Well	Total Depth (Ft)*	I.D. Dia. (In)	Static Water Level (Ft)*	Screen Length (Ft)	Top of Screen (Ft)*	Slot Size (In)	Install Date
2106	31.9	4	17.3	15	13.1	0.010	01/31/89
2391	25.1	4	12.4	15	8.4	0.010	03/05/90
3106	89.1	4	17.7	10	77.1	0.010	01/18/89
3391	74.7	4	12.2	10	63.0	0.010	05/15/90

* Measurements taken from ground level.

EQUIPMENT AND PROCEDURES

Equipment

Well purging and sampling were accomplished with dedicated bladder pumps (QED Model T-1200) installed in each well several months prior to the experiment. Each pump is made of fluoropolymer material and stainless steel with fluoropolymer material discharge tubing. Wells 3106 and 3391 have installed packers located approximately 1 foot above the top of the screen. Since the screened interval in wells 2106 and 2391 straddle the water table, no packers were installed in these wells.

Water quality parameters were measured and recorded using an in-line flow-through cell (QED Model FC1000). The flow-through cell contained probes for the measurement of pH, temperature, specific conductivity, and dissolved oxygen.

Fluctuations of the static water level were measured with an electronic water level meter (QED Model 6010E) that used compressed air to digitally display any fluctuations of 0.01 ft. A water level probe (QED Model 6000MSS) was used to confirm the readings from the meter and to measure the static water level of each well.

Field Procedure

Each well was sampled four times. Sampling occurred once a day, every three days, over a 12 day period. Duplicate samples were taken at the frequency of one per sampling day for a total of four duplicate samples and used as a check on the accuracy of the laboratory analysis. One duplicate sample was collected each day at a different well location.

On each of these four sampling days, a total of three sample sets were collected from each monitoring well. The first sample (micro-purge) was collected after 2-times the combined calculated volume of the bladder pump and discharge tubing was purged. The calculated 2-times tubing and pump volumes were 2.7 liters for wells 2106 and 2391, 7.5 liters for well 3106, and 6.5 liters for well 3391.

The second sample set was collected after one well volume was purged and the third set was collected after three well volumes were purged. For wells 2106 and 2391, one well volume was deemed the amount of water standing in the screened interval and the riser pipe. For wells 3106 and 3391, one well volume was considered the amount of water below each packer.

Each sample set contained six sample bottles for the analysis of:

Metals (Ca, Fe, Mg)	1-1 Liter Plastic
Metals (Dissolved Ca, Fe, Mg)	1-1 Liter Plastic
Phosphorus (Total)	1-500 ml Plastic
Fluoride and TDS	1-1 Liter Plastic
Alkalinity	1-500 ml Plastic
Uranium (Total U)	1-250 ml Plastic

All samples were analyzed at the FEMP laboratory (See Attachment B, Analytical Program). Filtered samples were obtained using in-line disposable filters (20 cm^2 acrylic copolymer, 0.45 micron).

Since the stagnant water column was not disturbed during purging and sampling, field parameters were not used as indicators for when to collect samples. However, field parameters (pH, temperature, specific conductivity, and dissolved oxygen) and water levels were monitored and recorded during purging and sampling. Readings were taken during the middle to end of the bladder pump discharge period and used to determine when or if stabilization had occurred. The criteria used to determine this were: ±0.1°C for temperature, ±0.1 pH units, ±10 μS/cm for specific conductivity, and ±0.1 ppm for dissolved oxygen for three consecutive readings taken at one minute intervals.

Purging rates were maintained at about 500 ml/min during purging prior to the collection of the micro-purge sample (500 ml/min purging rate was selected based upon previously cited references, site specific information, and equipment performance). Purging rates were then increased to maximum discharge rates for each pumping system. Purge rates were approximately 3.0 l/min for well 2106, 2.5 l/min for well 2391, and 2.0 l/min for wells 3106 and 3391. Packers in wells 3106 and 3391 were inflated after the collection of the micro-purge samples. The sampling histories of each well indicated that the water levels would not be affected at these purge rates. Water levels were monitored during purging to confirm this. For all sampling, purge rates were reduced to

between 100 and 200 ml/min (USEPA, 1989).

Statistical Analysis Procedure

To test the laboratory results of the ten analytical parameters, a null hypothesis (H_o) was used stating that there is no significant differences among the three sample sets: the micro-purge, the one well volume, and the three well volume purge. Rejection of the H_o would therefore suggest that for the given analytical parameter, at least one of the sampling sets differed from the other two.

To test the H_o, three statistical tests were performed: a parametric one-way and two-way Analysis of Variances (ANOVAs) and a nonparametric Kruskal-Wallis test. For the two parametric ANOVA tests, it was assumed that the data were normally distributed and displayed homogeneous variance (homoscedasticity).

RESULTS

Well Drawdown

Water levels for all four wells remained unchanged during each purging/sampling event. No measurable fluctuations were observed at any point during purging. Packers were inflated in wells 3106 and 3391 after each micro-purge sample set was collected to conform with standard purging practices (for sample comparison purposes). This isolated the standing water column from the screened interval.

Field Parameters

Field parameters (temperature, pH, specific conductivity, and dissolved oxygen) were monitored and recorded during each purging process (Attachment A). Although they were not used to determine when to sample, the time in which parameter stabilization was achieved was compared to when each micro-purge sample was taken. In the 16 sampling events, stabilization for all four parameters occurred only four times (25 percent) during three days at three different wells.

In all events, pH readings stabilized almost immediately and prior to the collection of each micro-purge sample set (Attachment A, Field Parameter Data and Charts). Temperature readings achieved stabilization in 13 of the 16 events and specific conductivity readings stabilized in 12 of the 16 events. Dissolved oxygen readings stabilized in only 6 of the 16 events.

After each micro-purge sample set was taken and purge rates were increased, a corresponding reaction was observed with both temperature and dissolved oxygen readings (Attachment A, Field Parameter Data and Charts, figures A-1 through A-16). Purge rate increases correlated with decreases in temperature and increases in

dissolved oxygen. No correlations were observed with pH and specific conductivity.

Groundwater Chemistry

The samples collected were analyzed at the FEMP's on-site laboratory for 12 selected parameters: Total Calcium, Filtered Calcium, Total Iron, Filtered Iron, Total Magnesium, Filtered Magnesium, Fluoride, Total Dissolved Solids, Phosphate, Alkalinity, and Total Uranium (Attachment B, Analytical Program). Detectable amounts were reported for all parameters except phosphate (See Attachment C, Analytical Data and Charts).

Analytical results for both total and dissolved iron were erratic. Orders of magnitude of up to 100 were obtained for both parameters. These results were not unexpected as water quality analysis for total and filtered iron have shown to be influenced by aeration from turbulence associated with sample transfer and filtering (Stolzenburg and Nichols, 1986).

Field duplicates were taken to document the precision of the sampling process. A Relative Percent Difference (RPD) performance requirement of 20 was used for each duplicate parameter. This is based upon the USEPA Contract Laboratory Program Statement of Work for Inorganic Analysis, Multi-Media Multi-Concentration ILM02.1, September 1991 (CLP SOW) and the Fernald Environmental Management Project Sitewide CERCLA Quality Assurance Project Plan, Volume II, Appendix G, Table G-2 (SCQ). The RPDs referenced in the CLP SOW and SCQ are only used for assessing analytical precision. Therefore, this is a rigorous standard.

Of the 40 field duplicate data points, only one exceeded the performance requirement. The Total Dissolved Solids duplicate for well 2391 had a RPD of 46.

Analytical Statistics

For the first of the three statistical tests used, a two-way Analysis of Variance (ANOVA) was utilized in order to compare the average of each of the three sampling sets across the four monitoring wells for each analytical parameter. Ten, two-way ANOVA computer programs were written using Statistical Analysis Software (SAS). The format for each computer program utilized the Proc ANOVA command if there were an equal number of sample sizes or the Proc GLM command if there were unequal sample sizes. Each of the ten SAS programs contained independent analytical laboratory results. An example of the SAS program for Alkalinity (mg/l) is shown in attachment D, Statistical Analysis Computer Codes and Tables.

Moreover, in the two-way ANOVA, three components were tested for each analytical parameter. The first component compared the averages of the three sampling sets. The second component compared the averages among the four monitoring wells. And finally, the third component combined the first and second components by measuring any interaction between the four monitoring wells and the three sampling sets.

As shown in Table D-1, two F-statistics and p-value results were recorded. The first value corresponds to the third component (Well*Method), representing any interaction that may be present between the monitoring well and the sampling set used. However, because all ten of the analytical parameters' p-values for Well*Method were significantly greater than 0.05, it was concluded that no interaction occurred.

The second F-statistic and p-value results in Table D-1, correspond to the first component described in the table as Method. This value was used to test the validity of the H_o: which states that there was no difference among the means of the three sampling sets. Once again, all of the ten analytical parameters had p-values greater than 0.05, meaning that the H_o could not be rejected.

The second analysis conducted to test the H_o involved using a one-way ANOVA. For each of the ten analytical parameters, four separate statistical computer programs were written using SAS. Each of the four computer programs correspond to the appropriate monitoring well: 2106, 3106, 2391, and 3391. The format for each computer program was identical except that each well number has its own analytical laboratory results. A total of forty (10 analytical parameters X 4 wells) computer programs were analyzed. An example of the SAS program for Total Calcium (ug/l) for well number 2391 is shown in Attachment D-2, Statistical Analysis Computer Codes and Tables.

The forty, one-way ANOVAs were performed to reduce any impact of spatial variability (e.g., differing levels of background or contamination levels) across the four monitoring wells. These one-way ANOVAs are also referred to as "simple effects" tests because they will detect differences in the three sampling sets at each well for each analytical parameter. It is quite different from the two-way ANOVA procedure which compared the three components mentioned above: the sampling set effects, monitoring well effects, and the sampling method and monitoring well interaction effects.

The two-way ANOVA in one aspect has less power than the one-way ANOVA tests because there is larger variability due to spatial differences. (Note this variability is reduced, however, by averaging it with a lesser variability associated with interaction. This can be done since the interaction is not significant). However, in another facet, it provides greater power by increasing

the sample sizes being compared (16 vs. 4). Moreover, the two-way ANOVA reduces the probability of observing one or two false positive results that would solely be due to random sampling error (uncertainty).

Results from the one-way ANOVAs are shown in Tables D-2a through D-11a, where the F-statistic, p-value and Mean Comparison values for each analytical parameter's well number are displayed. It was revealed that the H_0 was found to be true for thirty-nine out of the possible forty one-way Anova program at the 0.05 probability level. The one instance in which the H_0 was rejected involved the analytical parameter of Alkalinity for well number 2106. As shown in Table D-10a, this well had a F-statistic of 5.48 and a p-value of .0277. However, it should be noted that the H_0 for this well was rejected by a p-value difference of only .0223. Therefore, since forty ANOVA tests were performed at the 0.05 level of significance, there is reason to believe that the three mean sampling sets <u>are not</u> significantly different, but rather a false positive result has occurred.

Nevertheless, because the H_0 was rejected in this particular instance, more information was needed in order to determine which of the two mean pairs were significantly different. Because the ANOVA analysis (Proc GLM) did not provide this kind of information, a multiple comparisons procedure (MEANS METHOD TUKEY / DUNCAN) had to be added to the computer program (see Attachment D, Statistical Analysis Computer Codes and Tables).

The multiple comparisons procedures of Tukey and Duncan were very similar because they both provided a visual description about which mean pairs were significantly different as compared to the mean pairs which were not significantly different. When using multiple comparisons, means which were not significantly different were denoted by the same letter in the SAS output, while means which differ significantly were marked with different letters.

As revealed in Table D-10a, for the Alkalinity parameter for well number 2106, means 2x (micro-purge) and 3 (3 well volume purge) were found to differ significantly in both the Tukey and Duncan multiple comparison procedures.

Because the established assumption of homoscedasticity and normally distributed data could not be confirmed because of the relatively small sample sizes of the one-way ANOVA procedure, a nonparametric Kruskal-Wallis statistical test was also performed on all of the forty data sets. Although the Kruskal-Wallis analysis is a Chi Square approximation test, it is often referred to as a rank sum test because each group of data (three sampling sets) are combined and ranked in order from smallest to largest. Then, unlike the ANOVA where variability among each sampling set's mean is compared, with the Kruskal-Wallis test, each sampling set's median is

compared.

Moreover, with the Kruskal-Wallis test, the H_o states that there is no significant difference among the medians, while the H_a (alternative hypothesis) states that at least one median is significantly different. When evaluating the results of this statistical test, the Chi Square (χ^2) statistic and its p-value are analyzed. As shown in Tables D-2b through D-11b, the H_o was found to be true for all of the forty, nonparametric Kruskal-Wallis tests at the 0.05 probability level, meaning that there was no significant difference among the medians of the three sample sets.

DISCUSSION AND CONCLUSION

This experiment was conducted to determine the need to purge multiple well volumes from monitoring wells at the FEMP prior to sample collection. A comparison of analytical data from micro-purge sample sets to standard procedure sample sets have shown that the necessity to purge monitoring wells prior to representative sample collection does not exist. Based upon the two-way ANOVA, the one-way ANOVA, and the Kruskal-Wallis statistical results, it was concluded that there is no difference among the micro-purge sample set, the one well volume sample set, and the three well volume sample set.

Groundwater samples were obtained from the screened interval using dedicated equipment at flow rates that prevented drawdown in the well and did not disturb the stagnant water column. Under these conditions, samples collected are <u>analytically similar</u> to samples collected after determining stabilization of indicator parameters after purging the conventional three well volumes.

Representative samples can be collected from FEMP monitoring wells in the following manner: use dedicated bladder pumps with inlets located in the screened interval, purge a minimum of 2-times the calculated volume of the pump and discharge lines prior to sample collection, avoid disturbance of the stagnant water column, and determine a purge rate that will maintain a constant stagnant water level (less than 1 l/min).

Results of this experiment have shown that field parameter stabilization is not required to determine when to collect representative samples. These measurements are important, however, and should be collected to determine and confirm baseline site conditions. The use of an in-line flow-through cell that will isolate the analyzed sample from surface influences is recommended for the measurement of these parameters.

Since purging and sampling rates used should not affect the level of the stagnant water column, the use of packers is not necessary. Cost savings can be realized from the adoption of micro-purge

sampling. Labor hours saved from the elimination of purge water collection/transport and decontamination can be applied towards additional well sampling per day, thus increasing program efficiency. Rinsate sample requirements can be eliminated, which accounts for the largest percentage of realized cost savings. The use of disposal filters to avoid required decontamination of reusable filtering equipment is necessary to take advantage of this savings.

In conclusion, pending the approval of The Department of Energy and The Ohio Environmental Protection Agency, micro-purging should be adopted for use at the FEMP for the collection of representative groundwater samples. Advantages are: improved sample quality and cost savings through waste minimization and increased program efficiency.

REFERENCES

ASTM, 1992, ASTM Standards on Ground Water and Vadose Zone Investigations, ASTM, Philadelphia, 166 pp.

BARCELONA, M., Gibs, J., Helfrich, J., and Garske, E. 1985. Practical guide for ground-water sampling. Illinois State Water Survey, Champaign, Illinois, ISWS Contract Report 374.

McCABE, G.P. and Moore, D.S. 1989. Introduction to the Practice of Statistics, W.H. Freeman and Company, Purdue University, p.713-719.

FERMCO, 1992. FEMP Comprehensive Groundwater Monitoring Plan, November, 1992.

FERMCO, 1993. FEMP Groundwater Protection Management Program Plan, May, 1993

GIBS, J. and Imbrigotta, T.E. 1990. Well-purging criteria for sampling purgeable organic compounds. Groundwater, v. 28, p. 68-78.

GESCHUND, P.M. and Reynolds, M.D. 1987. Monodisperse ferrous phosphate colloids in an anoxic groundwater plume. J. Contam. Hydrol, v. 1, p. 309-317.

GIDDINGS, T. 1983. Bore-volume purging to improve monitoring well performance: an often mandated myth. Proceedings of the Third National Symposium on Aquifer Restoration and Ground Water Monitoring, May, National Water Well Association, p. 253-256.

GILLHAM, R.W., Robin, M.J., Barker, J.F., Cherry, J.A., 1983. Groundwater monitoring and sample bias, American Petroleum Institute Pub. 4367, 109 pp.

_____, 1985. Field evaluation of well purging procedures. American Petroleum Institute Pub. 4405, 206 pp.

KEARL, P., Cronk, T.A., and Little, C.A. 1991. Laboratory observations and measurements of colloidal velocity in a monitoring well. Water Resources Res.

_____ P., Korte, N., and Cronk, T. 1992. Suggested modifications to ground water sampling procedures based on observations from the colloidal borescope. Ground Water Monitoring Review, vol. 12, No. 2, pp. 155-161.

KEELEY, J.F. and Boateng, K. 1987. Monitoring well installation, purging, and sampling techniques, part I: conceptualizations. Groundwater, v. 25, p. 300-313.

MARSH, M.J. and Lloyd, J.W. 1980. Details of hydrochemical variations in flowing wells. Groundwater, v. 18, p. 366-373.

MEREDITH, D.V. and Brice, D. 1992. Limitations on the collection of representative samples from small diameter wells, Proceedings of the Sixth National Outdoor Action Conference on Groundwater Monitoring, May, Las Vegas, p. 429-439.

MILLER, G.D. 1982. Uptake and release of lead, chromium, and trace level volatile organics exposed to synthetic well-casing. The Second National Symposium on Aquifer Restoration and Ground Water Monitoring, May 1982, Columbus Ohio.

McCARTHY, J.F. and Wobber, F.J. 1986. Transport of contaminants in the subsurface; the role of organic and inorganic colloidal particles. Int. Series of Interactive Seminars, Summary Report, ORNL/M-349, Oak Ridge, Tennessee.

McDOWELL-BOYER, L.M., Hunt, J.R., and Sitar,N. 1986. Particle transport through porous media. Water Resources Res., v. 22, p. 1901-1921.

NACHT, S. 1983. Monitoring and sampling protocol considerations. Ground Water Monitoring Review, Summer, pp.23-29.

PAUL, C. J. and Puls, R.W. 1992. Comparison of ground-water sampling devices based on equilibration of water quality indicator parameters, National Groundwater Sampling Symposium Proceedings, November 30, 1992, p. 21-40.

PIONKE, H.B. and Urban, J.B. 1987. Sampling the chemistry of shallow aquifer systems: a case study. Groundwater Monitoring Review, Spring, p. 79-88.

PULS, P. and Powell, R. 1992. Acquisition of representative ground water quality samples of metals. Ground Water Monitoring Review. Vol. 12, No. 3, pp. 167-176.

_____, Clark, D.A., Bledsoe, B., Powell, R.M., and Paul, C.J. (in press) 1992. Metals in groundwater: sampling artifacts and reproducibility, Hazardous Waste & Hazardous Materials, 18 p.

_____, and Barcelona, M.J. 1989a. Ground water sampling for metals analyses, USEPA Superfund Groundwater Issue. EPA/540/4-89/001

_____1989b. Filtration of ground water samples for metals analysis, Hazardous Waste & Hazardous Materials, v.6, p.385-393.

ROBIN, M.J. and Gillham, 1987. Field evaluation for well purging procedures, Groundwater Monitoring Review, Fall, 1987,p. 85-93.

SCHULLER, R.M., Gibs, P., and Griffin, R.A. 1981. Recommended sampling procedures for monitoring wells. Groundwater Monitoring Review, Spring 1981, p. 42-46.

Stolzenburg, T. R.; Nichols, D. G. *Proceedings, 6th National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring;* National Water Well Association: Dubin, OH, 1986; p 216.

UNWIN, J.P. 1982. A Guide to Groundwater Sampling. National Council of the Paper Industry for Air and Stream Improvement Inc., Tech Bul. 362, New York.

_____, J.P. 1986. Investigations of techniques for purging groundwater monitoring wells an sampling groundwater for volatile organic compounds. Proceedings, ASTM Symposium on Field Methods for Ground Water Contamination Studies and Their Standardization, February, 1986, Cocoa Beach, Florida.

USDOE. Letter 0793-93. Proposal For Micro-Purging of Fernald Environmental Management Project Wells. 18p.

USEPA. 1977. Ground-water Monitoring at Solid Waste Disposal Facilities, EPA-530/SW-611.

_____. 1979. Methods for Chemical Analysis of Water and Waste, EPA-600/4-79-020.

_____. 1986. RCRA Technical Enforcement Guidance Document. OSWER-9950.1

_____. 1989 Regional USEPA Superfund Groundwater Forum

_____. April 1989, Guidance Document on the Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, EPA/530-SW-89-026.

_____. 1992. RCRA Ground-water Monitoring: Draft Technical Guidance

USGS, 1980. National Handbook of Recommended Methods for Water Data Acquisition, January, Reston, Virginia.

WEMCO, 1992. Sitewide CERCLA Quality Assurance Project Plan, Appendix K, July, 1992.

Attachment A

FIELD PARAMETER DATA AND CHARTS

Field Parameter Data

2106

12.6 C	6.85pH	1037uS	1.7ppm	6/3	11:01 AM
12.4 C	6.82pH	896.uS	1.5ppm	6/3	11:02 AM
12.0 C	6.78pH	785.uS	1.5ppm	6/3	11:03 AM
11.5 C	6.73pH	765.uS	1.3ppm	6/3	11:04 AM
11.6 C	6.69pH	763.uS	1.2ppm	6/3	11:05 AM
11.2 C	6.65pH	739.uS	1.0ppm	6/3	11:06 AM
11.2 C	6.63pH	738.uS	1.0ppm	6/3	11:07 AM
11.2 C	6.62pH	739.uS	1.0ppm	6/3	11:08 AM
11.3 C	6.61pH	743.uS	1.1ppm	6/3	11:09 AM
11.4 C	6.64pH	753.uS	1.1ppm	6/3	11:10 AM
11.4 C	6.67pH	746.uS	1.1ppm	6/3	11:11 AM
11.4 C	6.69pH	739.uS	0.9ppm	6/3	11:12 AM
11.3 C	6.70pH	743.uS	1.0ppm	6/3	11:13 AM
11.3 C	6.70pH	732.uS	0.9ppm	6/3	11:14 AM
11.2 C	6.71pH	738.uS	1.1ppm	6/3	11:15 AM
11.0 C	6.71pH	727.uS	0.8ppm	6/3	11:16 AM
10.9 C	6.72pH	732.uS	1.6ppm	6/3	11:17 AM
10.9 C	6.71pH	724.uS	0.8ppm	6/3	11:18 AM
10.9 C	6.64pH	738.uS	0.9ppm	6/3	11:19 AM
10.9 C	6.70pH	732.uS	1.6ppm	6/3	11:20 AM
10.8 C	6.71pH	732.uS	1.3ppm	6/3	11:21 AM
10.9 C	6.70pH	729.uS	2.3ppm	6/3	11:22 AM
10.9 C	6.75pH	727.uS	3.2ppm	6/3	11:23 AM
10.9 C	6.78pH	724.uS	3.5ppm	6/3	11:24 AM
10.7 C	6.81pH	736.uS	5.2ppm	6/3	11:25 AM
10.7 C	6.85pH	731.uS	6.7ppm	6/3	11:26 AM
10.6 C	6.88pH	735.uS	5.5ppm	6/3	11:27 AM
10.6 C	6.90pH	726.uS	6.1ppm	6/3	11:28 AM
10.6 C	6.92pH	735.uS	6.5ppm	6/3	11:29 AM
10.7 C	6.91pH	742.uS	4.6ppm	6/3	11:30 AM
10.6 C	6.93pH	739.uS	4.4ppm	6/3	11:31 AM
10.6 C	6.93pH	728.uS	5.5ppm	6/3	11:32 AM
10.6 C	6.97pH	721.uS	5.9ppm	6/3	11:33 AM
10.7 C	7.00pH	738.uS	5.5ppm	6/3	11:34 AM
10.6 C	7.01pH	733.uS	5.3ppm	6/3	11:35 AM
10.7 C	7.02pH	736.uS	5.8ppm	6/3	11:36 AM
10.6 C	7.02pH	721.uS	5.8ppm	6/3	11:37 AM
10.6 C	7.02pH	736.uS	4.7ppm	6/3	11:39 AM
10.6 C	7.01pH	742.uS	5.7ppm	6/3	11:40 AM
10.7 C	7.02pH	745.uS	4.9ppm	6/3	11:41 AM
10.6 C	7.02pH	726.uS	5.8ppm	6/3	11:42 AM
10.7 C	7.03pH	742.uS	5.5ppm	6/3	11:43 AM
10.6 C	7.02pH	736.uS	4.7ppm	6/3	11:44 AM
10.6 C	7.00pH	729.uS	4.5ppm	6/3	11:45 AM
10.6 C	7.00pH	736.uS	4.7ppm	6/3	11:46 AM
10.6 C	7.00pH	742.uS	4.5ppm	6/3	11:47 AM
10.6 C	6.99pH	743.uS	4.8ppm	6/3	11:48 AM
10.6 C	6.98pH	735.uS	5.4ppm	6/3	11:49 AM
10.6 C	6.99pH	745.uS	4.9ppm	6/3	11:50 AM
10.6 C	7.00pH	742.uS	5.2ppm	6/3	11:51 AM
10.6 C	7.00pH	746.uS	4.7ppm	6/3	11:52 AM

2106 Continued

10.6	C	7.00pH	742.uS	4.9ppm	6/3	11:53 AM
10.6	C	7.01pH	742.uS	4.2ppm	6/3	11:55 AM
10.6	C	7.01pH	745.uS	4.2ppm	6/3	11:57 AM
10.6	C	7.01pH	735.uS	4.7ppm	6/3	11:58 AM
10.6	C	7.01pH	742.uS	4.9ppm	6/3	11:59 AM
10.6	C	7.01pH	742.uS	5.2ppm	6/3	11:59 AM
10.7	C	7.01pH	745.uS	4.6ppm	6/3	11:59 AM
10.6	C	7.01pH	743.uS	4.2ppm	6/3	12:00 PM
10.6	C	7.00pH	742.uS	5.3ppm	6/3	12:02 PM
10.6	C	7.01pH	742.uS	4.4ppm	6/3	12:02 PM
10.6	C	7.00pH	742.uS	4.7ppm	6/3	12:03 PM
10.7	C	7.01pH	745.uS	4.2ppm	6/3	12:03 PM
10.7	C	7.01pH	731.uS	4.3ppm	6/3	12:04 PM
10.6	C	7.01pH	739.uS	4.5ppm	6/3	12:05 PM
10.7	C	7.00pH	739.uS	4.6ppm	6/3	12:07 PM
10.6	C	7.00pH	743.uS	4.9ppm	6/3	12:08 PM
10.7	C	7.00pH	750.uS	4.1ppm	6/3	12:09 PM

Field Parameter Data

2106

12.0 C	6.97pH	748.uS	4.9ppm	6/7 7:37 AM
11.0 C	7.03pH	687.uS	4.6ppm	6/7 7:41 AM
10.9 C	7.04pH	686.uS	4.0ppm	6/7 7:42 AM
10.8 C	7.03pH	682.uS	3.5ppm	6/7 7:43 AM
10.8 C	7.03pH	684.uS	3.7ppm	6/7 7:45 AM
10.8 C	7.03pH	679.uS	3.8ppm	6/7 7:46 AM
11.3 C	7.07pH	690.uS	3.7ppm	6/7 7:50 AM
11.4 C	7.10pH	693.uS	3.8ppm	6/7 7:52 AM
11.4 C	7.12pH	698.uS	3.4ppm	6/7 7:53 AM
11.3 C	7.14pH	693.uS	4.0ppm	6/7 7:55 AM
11.2 C	7.14pH	693.uS	3.7ppm	6/7 7:55 AM
11.1 C	7.15pH	688.uS	3.8ppm	6/7 7:59 AM
11.0 C	7.15pH	687.uS	3.9ppm	6/7 8:01 AM
11.0 C	7.15pH	686.uS	3.4ppm	6/7 8:02 AM
10.6 C	7.13pH	690.uS	2.0ppm	6/7 8:06 AM
10.6 C	7.13pH	684.uS	2.0ppm	6/7 8:07 AM
10.6 C	7.13pH	675.uS	1.4ppm	6/7 8:10 AM
10.5 C	7.13pH	668.uS	1.5ppm	6/7 8:10 AM
10.6 C	7.12pH	678.uS	1.8ppm	6/7 8:11 AM
10.6 C	7.13pH	670.uS	1.5ppm	6/7 8:12 AM
10.5 C	7.12pH	683.uS	1.7ppm	6/7 8:15 AM
10.5 C	7.12pH	670.uS	1.4ppm	6/7 8:16 AM
10.5 C	7.13pH	676.uS	1.5ppm	6/7 8:19 AM
10.5 C	7.13pH	675.uS	1.6ppm	6/7 8:22 AM
10.5 C	7.11pH	679.uS	1.5ppm	6/7 8:24 AM
10.5 C	7.09pH	672.uS	1.8ppm	6/7 8:27 AM
10.5 C	7.07pH	677.uS	1.5ppm	6/7 8:30 AM
10.5 C	7.09pH	676.uS	1.5ppm	6/7 8:32 AM
10.5 C	7.10pH	672.uS	1.5ppm	6/7 8:35 AM
10.5 C	7.10pH	672.uS	1.4ppm	6/7 8:37 AM
10.6 C	7.08pH	672.uS	1.5ppm	6/7 8:39 AM
10.5 C	7.08pH	668.uS	1.4ppm	6/7 8:40 AM
10.5 C	7.10pH	669.uS	1.5ppm	6/7 8:42 AM
10.5 C	7.09pH	669.uS	1.4ppm	6/7 8:44 AM

Field Parameter Data

2106

14.6 C	6.45pH	1180.uS	6.1ppm	6/11 7:02 AM
13.0 C	6.78pH	942.uS	6.4ppm	6/11 7:04 AM
12.7	6.89pH	762.uS	5.6ppm	6/11 7:06 AM
12.6 C	6.89pH	729.uS	5.7ppm	6/11 7:07 AM
11.7 C	6.86pH	712.uS	5.8ppm	6/11 7:08 AM
11.7 C	6.89pH	716.uS	5.4ppm	6/11 7:10 AM
11.2 C	6.92pH	705.uS	5.6ppm	6/11 7:12 AM
11.6 C	6.93pH	710.uS	5.1ppm	6/11 7:14 AM
11.7 C	6.95pH	716.uS	5.0ppm	6/11 7:14 AM
12.0 C	7.00pH	707.uS	4.7ppm	6/11 7:17 AM
11.9 C	7.04pH	708.uS	4.6ppm	6/11 7:19 AM
11.8 C	7.07pH	712.uS	4.9ppm	6/11 7:21 AM
11.6 C	7.05pH	717.uS	4.6ppm	6/11 7:22 AM
11.9 C	7.09pH	707.uS	5.2ppm	6/11 7:25 AM
11.3 C	7.10pH	712.uS	5.1ppm	6/11 7:28 AM
11.2 C	7.10pH	710.uS	5.1ppm	6/11 7:30 AM
10.9 C	7.11pH	705.uS	5.5ppm	6/11 7:33 AM
10.6 C	7.14pH	725.uS	5.7ppm	6/11 7:36 AM
10.7 C	7.16pH	726.uS	5.3ppm	6/11 7:38 AM
10.7 C	7.17pH	724.uS	5.7ppm	6/11 7:39 AM
10.6 C	7.18pH	725.uS	5.7ppm	6/11 7:41 AM
10.6 C	7.16pH	725.uS	5.1ppm	6/11 7:43 AM
10.7 C	7.18pH	726.uS	5.3ppm	6/11 7:45 AM
10.6 C	7.19pH	725.uS	5.2ppm	6/11 7:45 AM
10.7 C	7.20pH	729.uS	5.6ppm	6/11 7:47 AM
10.7 C	7.21pH	728.uS	5.0ppm	6/11 7:49 AM
10.6 C	7.23pH	729.uS	5.3ppm	6/11 7:51 AM
10.6 C	7.24pH	729.uS	5.3ppm	6/11 7:52 AM
10.7 C	7.25pH	729.uS	5.1ppm	6/11 7:55 AM
10.7 C	7.25pH	731.uS	5.1ppm	6/11 7:57 AM
10.6 C	7.26pH	725.uS	5.1ppm	6/11 7:58 AM
10.6 C	7.26pH	725.uS	5.9ppm	6/11 7:59 AM
10.6 C	7.25pH	724.uS	5.6ppm	6/11 7:59 AM
10.7 C	7.27pH	729.uS	5.6ppm	6/11 8:01 AM
10.6 C	7.26pH	729.uS	5.4ppm	6/11 8:03 AM
10.7 C	7.27pH	731.uS	5.6ppm	6/11 8:04 AM
10.7 C	7.26pH	724.uS	5.1ppm	6/11 8:06 AM
11.0 C	7.27pH	708.uS	5.1ppm	6/11 8:08 AM
11.1 C	7.28pH	709.uS	5.1ppm	6/11 8:10 AM
11.1 C	7.28pH	708.uS	5.7ppm	6/11 8:11 AM
11.1 C	7.26pH	709.uS	5.9ppm	6/11 8:12 AM

Field Parameter Data

2106

17.8 C	6.46pH	1740uS	7.0ppm	6/15 7:49 AM
14.7 C	7.08pH	1040uS	5.8ppm	6/15 7:51 AM
14.2 C	7.15pH	884.uS	5.4ppm	6/15 7:53 AM
12.6 C	7.22pH	762.uS	6.2ppm	6/15 7:55 AM
11.9 C	7.25pH	692.uS	5.4ppm	6/15 7:57 AM
11.7 C	7.26pH	693.uS	5.2ppm	6/15 7:58 AM
11.6 C	7.28pH	688.uS	5.0ppm	6/15 8:00 AM
11.7 C	7.29pH	688.uS	5.0ppm	6/15 8:01 AM
11.4 C	7.33pH	686.uS	5.2ppm	6/15 8:06 AM
11.6 C	7.34pH	684.uS	3.9ppm	6/15 8:12 AM
11.5 C	7.35pH	684.uS	3.9ppm	6/15 8:15 AM
11.3 C	7.33pH	679.uS	4.1ppm	6/15 8:19 AM
11.4 C	7.35pH	679.uS	3.8ppm	6/15 8:24 AM
11.4 C	7.37pH	680.uS	3.8ppm	6/15 8:29 AM
11.4 C	7.33pH	682.uS	3.5ppm	6/15 8:34 AM
11.6 C	7.31pH	690.uS	3.7ppm	6/15 8:39 AM
11.5 C	7.37pH	686.uS	3.5ppm	6/15 8:45 AM
11.5 C	7.39pH	686.uS	3.4ppm	6/15 8:49 AM
11.5 C	7.40pH	684.uS	3.4ppm	6/15 8:54 AM
11.6 C	7.42pH	683.uS	3.3ppm	6/15 8:59 AM
11.6 C	7.42pH	690.uS	3.6ppm	6/15 9:04 AM
11.4 C	7.43pH	686.uS	3.3ppm	6/15 9:09 AM
11.5 C	7.44pH	690.uS	3.5ppm	6/15 9:14 AM
11.5 C	7.45pH	695.uS	3.4ppm	6/15 9:19 AM
11.9 C	7.46pH	688.uS	3.3ppm	6/15 9:24 AM
11.8 C	7.47pH	685.uS	3.3ppm	6/15 9:29 AM
11.6 C	7.47pH	698.uS	3.4ppm	6/15 9:34 AM
11.0 C	7.47pH	693.uS	3.7ppm	6/15 9:36 AM
11.0 C	7.47pH	682.uS	4.7ppm	6/15 9:38 AM
10.9 C	7.48pH	679.uS	4.2ppm	6/15 9:40 AM
11.0 C	7.48pH	682.uS	4.3ppm	6/15 9:42 AM
10.9 C	7.49pH	680.uS	4.1ppm	6/15 9:45 AM
11.0 C	7.49pH	687.uS	5.0ppm	6/15 9:48 AM
11.0 C	7.47pH	687.uS	5.1ppm	6/15 9:51 AM
10.9 C	7.47pH	688.uS	4.8ppm	6/15 9:54 AM
10.9 C	7.45pH	683.uS	4.7ppm	6/15 9:57 AM
10.9 C	7.44pH	682.uS	4.4ppm	6/15 10:00 AM
10.9 C	7.43pH	684.uS	4.9ppm	6/15 10:04 AM
11.0 C	7.43pH	683.uS	4.8ppm	6/15 10:06 AM
11.0 C	7.42pH	680.uS	4.6ppm	6/15 10:08 AM
11.0 C	7.41pH	683.uS	4.8ppm	6/15 10:10 AM
11.0 C	7.41pH	682.uS	4.5ppm	6/15 10:11 AM
10.9 C	7.41pH	684.uS	4.7ppm	6/15 10:12 AM
11.0 C	7.40pH	693.uS	4.8ppm	6/15 10:14 AM
11.0 C	7.39pH	690.uS	4.6ppm	6/15 10:16 AM

Field Parameter Data

3106

13.4 C	7.76pH	702.uS	6.2ppm	6/11 8:29 AM
12.4 C	7.58pH	692.uS	4.4ppm	6/11 8:30 AM
12.3 C	7.53pH	689.uS	4.2ppm	6/11 8:31 AM
12.0 C	7.41pH	685.uS	3.6ppm	6/11 8:32 AM
12.0 C	7.33pH	680.uS	3.2ppm	6/11 8:34 AM
11.9 C	7.29pH	680.uS	1.6ppm	6/11 8:35 AM
11.9 C	7.27pH	676.uS	1.7ppm	6/11 8:37 AM
11.9 C	7.26pH	676.uS	1.2ppm	6/11 8:38 AM
11.9 C	7.25pH	676.uS	1.2ppm	6/11 8:40 AM
11.9 C	7.25pH	676.uS	1.1ppm	6/11 8:41 AM
11.9 C	7.25pH	676.uS	1.0ppm	6/11 8:43 AM
11.9 C	7.25pH	676.uS	1.0ppm	6/11 8:45 AM
11.9 C	7.25pH	677.uS	0.9ppm	6/11 8:46 AM
12.1 C	7.25pH	685.uS	1.1ppm	6/11 8:48 AM
11.9 C	7.25pH	681.uS	1.0ppm	6/11 8:51 AM
11.9 C	7.24pH	683.uS	0.9ppm	6/11 8:53 AM
11.9 C	7.24pH	681.uS	0.8ppm	6/11 8:55 AM
11.9 C	7.24pH	673.uS	1.3ppm	6/11 8:57 AM
11.8 C	7.23pH	671.uS	1.4ppm	6/11 8:58 AM
11.8 C	7.22pH	667.uS	1.3ppm	6/11 8:59 AM
11.8 C	7.22pH	680.uS	1.1ppm	6/11 9:00 AM
11.7 C	7.23pH	682.uS	1.0ppm	6/11 9:04 AM
11.6 C	7.24pH	680.uS	2.6ppm	6/11 9:06 AM
11.7 C	7.24pH	680.uS	2.1ppm	6/11 9:07 AM
11.7 C	7.24pH	680.uS	2.8ppm	6/11 9:08 AM
11.6 C	7.24pH	679.uS	3.0ppm	6/11 9:09 AM
11.6 C	7.25pH	678.uS	3.0ppm	6/11 9:11 AM
11.6 C	7.25pH	678.uS	2.1ppm	6/11 9:13 AM
11.6 C	7.25pH	671.uS	2.3ppm	6/11 9:14 AM
11.6 C	7.25pH	672.uS	1.8ppm	6/11 9:15 AM
11.6 C	7.26pH	676.uS	1.6ppm	6/11 9:17 AM
11.6 C	7.26pH	667.uS	1.5ppm	6/11 9:18 AM
11.6 C	7.26pH	667.uS	1.3ppm	6/11 9:21 AM
11.6 C	7.27pH	675.uS	1.4ppm	6/11 9:23 AM
11.5 C	7.27pH	676.uS	1.6ppm	6/11 9:25 AM
11.6 C	7.28pH	664.uS	1.6ppm	6/11 9:28 AM
11.6 C	7.29pH	667.uS	1.3ppm	6/11 9:30 AM
11.6 C	7.29pH	663.uS	1.3ppm	6/11 9:32 AM
11.6 C	7.30pH	675.uS	1.6ppm	6/11 9:34 AM
11.6 C	7.30pH	664.uS	1.5ppm	6/11 9:35 AM
11.6 C	7.31pH	668.uS	1.4ppm	6/11 9:38 AM
11.6 C	7.33pH	671.uS	1.4ppm	6/11 9:41 AM
11.6 C	7.33pH	667.uS	1.4ppm	6/11 9:42 AM
11.6 C	7.34pH	657.uS	1.4ppm	6/11 9:46 AM
11.5 C	7.34pH	653.uS	1.8ppm	6/11 9:48 AM
11.5 C	7.35pH	671.uS	1.6ppm	6/11 9:51 AM
11.5 C	7.36pH	658.uS	2.0ppm	6/11 9:53 AM
11.5 C	7.36pH	657.uS	2.3ppm	6/11 9:55 AM
11.5 C	7.36pH	657.uS	1.9ppm	6/11 9:55 AM
11.5 C	7.37pH	658.uS	2.0ppm	6/11 9:57 AM
11.5 C	7.38pH	663.uS	1.2ppm	6/11 9:59 AM
11.5 C	7.38pH	658.uS	1.1ppm	6/11 10:00 AM

Field Parameter Data

3106

12.9 C	7.26pH	661.uS	4.2ppm	6/3 12:33 PM
12.3 C	7.15pH	647.uS	3.4ppm	6/3 12:34 PM
12.3 C	7.12pH	644.uS	2.7ppm	6/3 12:34 PM
12.2 C	7.05pH	643.uS	1.6ppm	6/3 12:35 PM
12.0 C	7.00pH	641.uS	1.0ppm	6/3 12:37 PM
11.9 C	6.99pH	641.uS	0.9ppm	6/3 12:37 PM
11.9 C	6.98pH	644.uS	0.8ppm	6/3 12:38 PM
11.9 C	6.98pH	645.uS	0.8ppm	6/3 12:39 PM
12.1 C	6.98pH	651.uS	0.6ppm	6/3 12:41 PM
11.9 C	6.98pH	639.uS	1.1ppm	6/3 12:42 PM
12.0 C	6.98pH	639.uS	1.0ppm	6/3 12:43 PM
12.0 C	6.99pH	639.uS	1.0ppm	6/3 12:43 PM
12.1 C	6.99pH	640.uS	0.9ppm	6/3 12:44 PM
12.0 C	6.99pH	637.uS	1.0ppm	6/3 12:45 PM
12.2 C	6.99pH	643.uS	0.7ppm	6/3 12:47 PM
12.2 C	6.99pH	648.uS	0.6ppm	6/3 12:48 PM
12.2 C	6.99pH	649.uS	0.7ppm	6/3 12:49 PM
11.7 C	6.97pH	652.uS	1.5ppm	6/3 12:55 PM
11.8 C	7.01pH	660.uS	1.7ppm	6/3 12:58 PM
12.1 C	7.11pH	664.uS	3.7ppm	6/3 1:05 PM
11.7 C	7.14pH	661.uS	3.4ppm	6/3 1:21 PM
11.7 C	7.15pH	662.uS	5.1ppm	6/3 1:22 PM
11.7 C	7.15pH	665.uS	2.2ppm	6/3 1:23 PM
11.7 C	7.16pH	645.uS	5.3ppm	6/3 1:24 PM
11.6 C	7.17pH	653.uS	4.8ppm	6/3 1:26 PM
11.6 C	7.18pH	641.uS	4.9ppm	6/3 1:32 PM
11.7 C	7.18pH	652.uS	3.7ppm	6/3 1:32 PM
11.5 C	7.18pH	637.uS	3.6ppm	6/3 1:39 PM
11.6 C	7.19pH	641.uS	3.9ppm	6/3 1:43 PM
11.5 C	7.20pH	633.uS	4.0ppm	6/3 1:47 PM
11.6 C	7.20pH	638.uS	3.6ppm	6/3 1:49 PM
11.7 C	7.21pH	631.uS	3.9ppm	6/3 1:51 PM

Field Parameter Data

3106

11.9 C	7.15pH	689.uS	1.5ppm	6/7 8:55 AM
11.8 C	7.15pH	685.uS	1.3ppm	6/7 8:56 AM
11.8 C	7.14pH	688.uS	1.4ppm	6/7 8:58 AM
11.8 C	7.11pH	681.uS	1.1ppm	6/7 9:01 AM
11.7 C	7.11pH	697.uS	0.9ppm	6/7 9:03 AM
11.7 C	7.11pH	697.uS	0.9ppm	6/7 9:04 AM
11.7 C	7.12pH	697.uS	0.8ppm	6/7 9:06 AM
11.7 C	7.12pH	697.uS	0.8ppm	6/7 9:07 AM
11.7 C	7.12pH	695.uS	0.8ppm	6/7 9:10 AM
11.6 C	7.12pH	694.uS	0.6ppm	6/7 9:13 AM
11.7 C	7.07pH	690.uS	0.5ppm	6/7 9:21 AM
11.7 C	7.08pH	690.uS	0.6ppm	6/7 9:22 AM
11.6 C	7.04pH	687.uS	0.7ppm	6/7 9:27 AM
11.6 C	7.05pH	683.uS	0.7ppm	6/7 9:28 AM
11.5 C	7.04pH	660.uS	0.4ppm	6/7 9:30 AM
11.5 C	7.05pH	672.uS	0.3ppm	6/7 9:33 AM
11.5 C	7.04pH	675.uS	0.2ppm	6/7 9:35 AM
11.5 C	7.02pH	672.uS	0.2ppm	6/7 9:37 AM
11.5 C	7.02pH	664.uS	0.2ppm	6/7 9:38 AM
11.5 C	7.02pH	665.uS	0.3ppm	6/7 9:38 AM
11.5 C	7.01pH	672.uS	0.2ppm	6/7 9:40 AM
11.5 C	7.01pH	676.uS	0.2ppm	6/7 9:42 AM
11.5 C	7.01pH	675.uS	0.2ppm	6/7 9:44 AM
11.5 C	7.01pH	667.uS	0.2ppm	6/7 9:45 AM
11.5 C	7.00pH	671.uS	0.2ppm	6/7 9:46 AM
11.5 C	7.01pH	664.uS	0.2ppm	6/7 9:51 AM
11.5 C	7.04pH	671.uS	0.1ppm	6/7 9:54 AM
11.5 C	7.06pH	667.uS	0.1ppm	6/7 9:57 AM
11.5 C	7.06pH	680.uS	0.1ppm	6/7 9:59 AM
11.5 C	7.06pH	678.uS	0.1ppm	6/7 10:02 AM
11.5 C	7.06pH	680.uS	0.1ppm	6/7 10:05 AM
11.6 C	7.06pH	671.uS	0.2ppm	6/7 10:06 AM
11.5 C	7.05pH	675.uS	0.1ppm	6/7 10:08 AM
11.6 C	7.04pH	679.uS	0.1ppm	6/7 10:13 AM
11.6 C	7.03pH	687.uS	0.1ppm	6/7 10:17 AM
11.6 C	7.06pH	693.uS	0.1ppm	6/7 10:23 AM
11.5 C	7.06pH	686.uS	0.1ppm	6/7 10:24 AM
11.5 C	7.07pH	684.uS	0.1ppm	6/7 10:28 AM
11.6 C	7.07pH	688.uS	0.1ppm	6/7 10:29 AM
11.6 C	7.07pH	688.uS	0.1ppm	6/7 10:29 AM
11.6 C	7.08pH	671.uS	0.1ppm	6/7 10:31 AM
11.6 C	7.08pH	679.uS	0.1ppm	6/7 10:34 AM
11.5 C	7.08pH	678.uS	0.1ppm	6/7 10:35 AM
11.5 C	7.07pH	672.uS	0.1ppm	6/7 10:37 AM
11.5 C	7.05pH	688.uS	0.1ppm	6/7 10:39 AM
11.5 C	7.05pH	688.uS	0.1ppm	6/7 10:40 AM
11.6 C	7.05pH	688.uS	0.1ppm	6/7 10:42 AM
11.5 C	7.06pH	687.uS	0.1ppm	6/7 10:44 AM

Field Parameter Data

3106

12.8 C	7.59pH	657.uS	5.3ppm	6/15 10:31 AM
12.6 C	7.47pH	661.uS	4.7ppm	6/15 10:33 AM
13.1 C	7.46pH	662.uS	4.7ppm	6/15 10:34 AM
13.1 C	7.46pH	661.uS	3.9ppm	6/15 10:35 AM
13.5 C	7.46pH	664.uS	3.2ppm	6/15 10:38 AM
13.7 C	7.46pH	671.uS	3.4ppm	6/15 10:39 AM
13.6 C	7.46pH	672.uS	3.1ppm	6/15 10:40 AM
13.3 C	7.46pH	666.uS	2.9ppm	6/15 10:42 AM
13.0 C	7.46pH	664.uS	2.3ppm	6/15 10:43 AM
13.0 C	7.46pH	664.uS	2.0ppm	6/15 10:45 AM
13.0 C	7.46pH	664.uS	2.0ppm	6/15 10:45 AM
13.1 C	7.45pH	666.uS	2.0ppm	6/15 10:46 AM
13.2 C	7.45pH	671.uS	1.9ppm	6/15 10:48 AM
13.1 C	7.46pH	663.uS	1.5ppm	6/15 10:50 AM
13.5 C	7.46pH	667.uS	1.6ppm	6/15 10:51 AM
13.3 C	7.47pH	663.uS	1.4ppm	6/15 10:53 AM
13.2 C	7.47pH	667.uS	1.3ppm	6/15 10:54 AM
13.4 C	7.47pH	672.uS	1.2ppm	6/15 10:58 AM
13.3 C	7.47pH	671.uS	1.2ppm	6/15 11:00 AM
13.3 C	7.47pH	668.uS	1.2ppm	6/15 11:02 AM
13.1 C	7.47pH	664.uS	1.2ppm	6/15 11:03 AM
13.1 C	7.47pH	664.uS	1.3ppm	6/15 11:04 AM
13.2 C	7.47pH	664.uS	1.2ppm	6/15 11:05 AM
12.6 C	7.47pH	680.uS	1.3ppm	6/15 11:08 AM
12.4 C	7.46pH	685.uS	1.6ppm	6/15 11:10 AM
12.1 C	7.46pH	681.uS	1.0ppm	6/15 11:13 AM
12.0 C	7.45pH	681.uS	1.0ppm	6/15 11:14 AM
11.8 C	7.46pH	656.uS	1.8ppm	6/15 11:16 AM
11.9 C	7.46pH	655.uS	1.4ppm	6/15 11:18 AM
11.7 C	7.46pH	658.uS	1.3ppm	6/15 11:20 AM
11.7 C	7.47pH	657.uS	1.2ppm	6/15 11:22 AM
11.7 C	7.47pH	664.uS	0.8ppm	6/15 11:23 AM
11.8 C	7.47pH	647.uS	0.6ppm	6/15 11:25 AM
11.8 C	7.47pH	647.uS	0.6ppm	6/15 11:26 AM
11.6 C	7.47pH	654.uS	0.6ppm	6/15 11:27 AM
11.7 C	7.46pH	658.uS	0.3ppm	6/15 11:30 AM
11.7 C	7.47pH	641.uS	0.2ppm	6/15 11:32 AM
11.6 C	7.47pH	643.uS	0.2ppm	6/15 11:35 AM
11.7 C	7.47pH	653.uS	0.2ppm	6/15 11:37 AM
11.6 C	7.47pH	653.uS	0.2ppm	6/15 11:41 AM
11.7 C	7.47pH	668.uS	0.2ppm	6/15 11:44 AM
11.7 C	7.47pH	668.uS	0.3ppm	6/15 11:47 AM
11.6 C	7.47pH	661.uS	0.2ppm	6/15 11:52 AM
11.6 C	7.47pH	658.uS	0.2ppm	6/15 11:54 AM
11.7 C	7.47pH	646.uS	0.2ppm	6/15 11:56 AM
11.6 C	7.46pH	671.uS	0.3ppm	6/15 11:58 AM
11.5 C	7.46pH	657.uS	0.2ppm	6/15 11:59 AM
11.6 C	7.46pH	648.uS	0.2ppm	6/15 12:02 PM
11.5 C	7.46pH	661.uS	0.2ppm	6/15 12:03 PM

Field Parameter Data

3391

13.3 C	7.36pH	628.uS	3.3ppm	6/3 3:56 PM
12.8 C	7.29pH	627.uS	3.2ppm	6/3 3:57 PM
12.7 C	7.21pH	636.uS	2.7ppm	6/3 3:59 PM
12.5 C	7.18pH	637.uS	2.5ppm	6/3 4:00 PM
12.4 C	7.18pH	636.uS	2.4ppm	6/3 4:00 PM
12.4 C	7.17pH	636.uS	1.7ppm	6/3 4:01 PM
12.4 C	7.17pH	637.uS	2.1ppm	6/3 4:03 PM
12.5 C	7.17pH	636.uS	2.0ppm	6/3 4:04 PM
12.6 C	7.17pH	615.uS	2.0ppm	6/3 4:07 PM
12.6 C	7.16pH	643.uS	2.1ppm	6/3 4:09 PM
12.6 C	7.16pH	639.uS	2.0ppm	6/3 4:10 PM
12.4 C	7.14pH	627.uS	1.9ppm	6/3 4:13 PM
12.4 C	7.07pH	632.uS	1.6ppm	6/3 4:15 PM
12.5 C	7.11pH	632.uS	1.9ppm	6/3 4:19 PM
12.0 C	7.11pH	620.uS	1.1ppm	6/3 4:29 PM
12.0 C	7.11pH	631.uS	1.4ppm	6/3 4:29 PM
12.0 C	7.12pH	621.uS	1.1ppm	6/3 4:31 PM
12.0 C	7.13pH	622.uS	1.1ppm	6/3 4:31 PM
12.0 C	7.15pH	629.uS	0.8ppm	6/3 4:34 PM
12.0 C	7.16pH	629.uS	0.7ppm	6/3 4:36 PM
12.0 C	7.17pH	621.uS	0.9ppm	6/3 4:37 PM
12.0 C	7.17pH	624.uS	0.8ppm	6/3 4:37 PM
12.0 C	7.17pH	629.uS	0.8ppm	6/3 4:39 PM
12.0 C	7.18pH	597.uS	0.9ppm	6/3 4:39 PM
12.0 C	7.18pH	620.uS	0.7ppm	6/3 4:40 PM
12.0 C	7.18pH	623.uS	0.7ppm	6/3 4:40 PM
12.0 C	7.18pH	625.uS	0.9ppm	6/3 4:42 PM
12.0 C	7.19pH	628.uS	0.6ppm	6/3 4:43 PM
12.0 C	7.19pH	631.uS	0.7ppm	6/3 4:44 PM
12.0 C	7.22pH	610.uS	0.6ppm	6/3 4:51 PM
12.0 C	7.22pH	631.uS	0.5ppm	6/3 4:53 PM
12.0 C	7.23pH	652.uS	0.6ppm	6/3 4:55 PM
12.0 C	7.24pH	652.uS	0.5ppm	6/3 4:58 PM
12.0 C	7.25pH	634.uS	0.7ppm	6/3 5:01 PM

Field Parameter Data

3391

15.2 C	6.84pH	814.uS	1.4ppm	6/7 11:38 AM
13.8 C	7.04pH	693.uS	1.1ppm	6/7 11:39 AM
13.5 C	7.04pH	707.uS	0.9ppm	6/7 11:40 AM
13.7 C	7.06pH	711.uS	0.8ppm	6/7 11:42 AM
13.5 C	7.07pH	709.uS	0.7ppm	6/7 11:43 AM
13.0 C	7.09pH	700.uS	0.5ppm	6/7 11:45 AM
12.6 C	7.06pH	708.uS	0.3ppm	6/7 11:48 AM
12.7 C	7.07pH	712.uS	0.3ppm	6/7 11:49 AM
12.7 C	7.06pH	709.uS	0.3ppm	6/7 11:50 AM
12.8 C	7.07pH	694.uS	0.3ppm	6/7 11:52 AM
12.7 C	7.07pH	707.uS	0.2ppm	6/7 11:55 AM
12.7 C	7.09pH	708.uS	0.2ppm	6/7 11:58 AM
12.7 C	7.09pH	708.uS	0.2ppm	6/7 11:59 AM
12.7 C	7.10pH	707.uS	0.2ppm	6/7 12:00 PM
12.3 C	7.18pH	701.uS	0.1ppm	6/7 12:04 PM
12.2 C	7.18pH	689.uS	0.1ppm	6/7 12:06 PM
12.1 C	7.20pH	692.uS	0.1ppm	6/7 12:09 PM
12.2 C	7.21pH	693.uS	0.1ppm	6/7 12:11 PM
12.2 C	7.19pH	689.uS	0.1ppm	6/7 12:13 PM
12.1 C	7.23pH	689.uS	0.1ppm	6/7 12:15 PM
12.1 C	7.25pH	673.uS	0.1ppm	6/7 12:18 PM
12.1 C	7.24pH	672.uS	0.1ppm	6/7 12:19 PM
12.1 C	7.30pH	664.uS	0.2ppm	6/7 12:26 PM
12.1 C	7.29pH	669.uS	0.1ppm	6/7 12:26 PM
12.1 C	7.31pH	669.uS	0.1ppm	6/7 12:28 PM
12.2 C	7.33pH	681.uS	0.2ppm	6/7 12:35 PM
12.1 C	7.32pH	661.uS	0.1ppm	6/7 12:36 PM
12.2 C	7.33pH	684.uS	0.2ppm	6/7 12:41 PM
12.2 C	7.35pH	681.uS	0.1ppm	6/7 12:45 PM
12.2 C	7.35pH	680.uS	0.1ppm	6/7 12:47 PM
12.1 C	7.35pH	659.uS	0.1ppm	6/7 12:49 PM
12.1 C	7.35pH	677.uS	0.1ppm	6/7 12:50 PM
12.1 C	7.35pH	679.uS	0.3ppm	6/7 12:51 PM
12.2 C	7.35pH	677.uS	0.1ppm	6/7 12:53 PM
12.2 C	7.35pH	680.uS	0.2ppm	6/7 12:55 PM
12.2 C	7.35pH	678.uS	0.1ppm	6/7 12:58 PM

Field Parameter Data

3391

17.1	C	6.75pH	1760.uS	6.7ppm	6/11 10:57 AM
15.2	C	7.04pH	980.uS	6.4ppm	6/11 10:58 AM
13.5	C	7.11pH	749.uS	4.8ppm	6/11 11:00 AM
13.0	C	7.12pH	705.uS	3.8ppm	6/11 11:01 AM
13.0	C	7.19pH	697.uS	3.2ppm	6/11 11:04 AM
13.3	C	7.22pH	702.uS	3.1ppm	6/11 11:05 AM
12.8	C	7.23pH	685.uS	2.4ppm	6/11 11:08 AM
12.8	C	7.25pH	684.uS	2.2ppm	6/11 11:09 AM
12.7	C	7.27pH	699.uS	2.3ppm	6/11 11:11 AM
12.7	C	7.28pH	699.uS	1.3ppm	6/11 11:12 AM
12.7	C	7.27pH	695.uS	1.4ppm	6/11 11:14 AM
12.8	C	7.27pH	685.uS	1.7ppm	6/11 11:15 AM
12.8	C	7.27pH	684.uS	1.7ppm	6/11 11:17 AM
12.4	C	7.26pH	685.uS	1.2ppm	6/11 11:20 AM
12.8	C	7.27pH	685.uS	1.1ppm	6/11 11:23 AM
12.6	C	7.32pH	697.uS	0.9ppm	6/11 11:26 AM
12.4	C	7.32pH	685.uS	1.2ppm	6/11 11:28 AM
12.2	C	7.30pH	684.uS	1.6ppm	6/11 11:30 AM
12.2	C	7.25pH	681.uS	0.9ppm	6/11 11:32 AM
12.1	C	7.27pH	679.uS	1.3ppm	6/11 11:33 AM
12.1	C	7.30pH	673.uS	0.2ppm	6/11 11:36 AM
12.2	C	7.33pH	680.uS	0.2ppm	6/11 11:38 AM
12.1	C	7.35pH	677.uS	0.3ppm	6/11 11:40 AM
12.2	C	7.36pH	679.uS	0.2ppm	6/11 11:41 AM
12.1	C	7.38pH	672.uS	0.2ppm	6/11 11:43 AM
12.1	C	7.38pH	671.uS	0.2ppm	6/11 11:45 AM
12.1	C	7.39pH	672.uS	0.2ppm	6/11 11:47 AM
12.1	C	7.40pH	676.uS	0.2ppm	6/11 11:49 AM
12.1	C	7.41pH	669.uS	0.2ppm	6/11 11:51 AM
12.1	C	7.42pH	660.uS	0.2ppm	6/11 11:55 AM
12.0	C	7.44pH	663.uS	0.1ppm	6/11 11:59 AM
12.1	C	7.44pH	665.uS	0.2ppm	6/11 12:01 PM
12.1	C	7.45pH	671.uS	0.2ppm	6/11 12:03 PM
12.0	C	7.45pH	664.uS	0.3ppm	6/11 12:05 PM
12.1	C	7.46pH	667.uS	0.2ppm	6/11 12:06 PM
12.1	C	7.46pH	669.uS	0.2ppm	6/11 12:08 PM
12.1	C	7.47pH	664.uS	0.2ppm	6/11 12:09 PM
12.0	C	7.47pH	661.uS	0.2ppm	6/11 12:12 PM
12.0	C	7.47pH	667.uS	0.2ppm	6/11 12:12 PM
12.1	C	7.48pH	668.uS	0.2ppm	6/11 12:13 PM
12.1	C	7.48pH	663.uS	0.2ppm	6/11 12:16 PM
12.1	C	7.49pH	667.uS	0.2ppm	6/11 12:19 PM
12.1	C	7.49pH	643.uS	0.2ppm	6/11 12:20 PM

Field Parameter Data

3391

18.3 C	6.86pH	1720uS	8.3ppm	6/15 12:51 PM
16.2 C	7.22pH	1100uS	6.3ppm	6/15 12:52 PM
15.2 C	7.32pH	887.uS	3.4ppm	6/15 12:54 PM
14.8 C	7.36pH	730.uS	3.5ppm	6/15 12:55 PM
14.4 C	7.39pH	704.uS	3.8ppm	6/15 12:57 PM
14.3 C	7.40pH	692.uS	3.1ppm	6/15 12:58 PM
13.8 C	7.41pH	666.uS	2.2ppm	6/15 1:00 PM
13.6 C	7.41pH	681.uS	1.7ppm	6/15 1:02 PM
13.7 C	7.42pH	681.uS	1.6ppm	6/15 1:03 PM
13.9 C	7.43pH	667.uS	1.5ppm	6/15 1:04 PM
13.4 C	7.45pH	672.uS	1.5ppm	6/15 1:06 PM
13.1 C	7.46pH	667.uS	1.3ppm	6/15 1:09 PM
13.0 C	7.46pH	667.uS	1.1ppm	6/15 1:10 PM
13.0 C	7.47pH	667.uS	1.0ppm	6/15 1:12 PM
13.1 C	7.48pH	672.uS	1.0ppm	6/15 1:14 PM
13.1 C	7.48pH	672.uS	1.0ppm	6/15 1:14 PM
13.2 C	7.49pH	677.uS	1.1ppm	6/15 1:15 PM
12.4 C	7.50pH	672.uS	1.2ppm	6/15 1:18 PM
12.3 C	7.52pH	676.uS	0.6ppm	6/15 1:21 PM
12.3 C	7.52pH	672.uS	0.5ppm	6/15 1:23 PM
12.3 C	7.53pH	677.uS	0.5ppm	6/15 1:27 PM
12.1 C	7.54pH	667.uS	0.7ppm	6/15 1:28 PM
12.1 C	7.54pH	672.uS	0.5ppm	6/15 1:29 PM
12.1 C	7.55pH	680.uS	0.5ppm	6/15 1:34 PM
12.1 C	7.55pH	679.uS	0.5ppm	6/15 1:36 PM
12.1 C	7.56pH	679.uS	0.4ppm	6/15 1:39 PM
12.1 C	7.56pH	680.uS	0.8ppm	6/15 1:41 PM
12.0 C	7.56pH	673.uS	0.6ppm	6/15 1:43 PM
12.0 C	7.56pH	672.uS	0.6ppm	6/15 1:45 PM
12.1 C	7.56pH	676.uS	0.3ppm	6/15 1:47 PM
12.0 C	7.57pH	680.uS	0.4ppm	6/15 1:50 PM
12.0 C	7.57pH	677.uS	0.3ppm	6/15 1:52 PM
12.1 C	7.58pH	676.uS	0.5ppm	6/15 1:55 PM
12.0 C	7.58pH	681.uS	0.4ppm	6/15 1:59 PM
12.1 C	7.58pH	677.uS	0.3ppm	6/15 2:00 PM
12.0 C	7.59pH	681.uS	0.2ppm	6/15 2:03 PM
12.0 C	7.59pH	673.uS	0.3ppm	6/15 2:06 PM
12.0 C	7.59pH	676.uS	0.3ppm	6/15 2:08 PM
12.1 C	7.59pH	677.uS	0.2ppm	6/15 2:10 PM
12.0 C	7.59pH	676.uS	0.2ppm	6/15 2:11 PM

Field Parameter Data

2391

12.5 C	6.81pH	776.uS	1.4ppm	6/3	5:25 PM
12.4 C	6.87pH	773.uS	1.4ppm	6/3	5:26 PM
12.4 C	6.94pH	785.uS	1.2ppm	6/3	5:28 PM
12.3 C	6.99pH	786.uS	1.1ppm	6/3	5:30 PM
12.2 C	7.01pH	777.uS	1.0ppm	6/3	5:32 PM
12.1 C	7.01pH	776.uS	0.9ppm	6/3	5:34 PM
12.1 C	7.01pH	776.uS	0.9ppm	6/3	5:35 PM
12.0 C	7.01pH	781.uS	0.8ppm	6/3	5:37 PM
12.0 C	7.02pH	781.uS	0.7ppm	6/3	5:38 PM
12.1 C	7.03pH	777.uS	0.7ppm	6/3	5:39 PM
12.1 C	7.02pH	777.uS	0.7ppm	6/3	5:40 PM
12.1 C	7.04pH	776.uS	0.7ppm	6/3	5:40 PM
12.1 C	7.04pH	777.uS	0.7ppm	6/3	5:42 PM
12.1 C	7.04pH	773.uS	0.7ppm	6/3	5:42 PM
11.9 C	6.91pH	776.uS	0.8ppm	6/3	5:49 PM
11.9 C	6.90pH	777.uS	0.8ppm	6/3	5:51 PM
12.0 C	6.91pH	776.uS	0.9ppm	6/3	5:52 PM
11.9 C	6.92pH	768.uS	0.8ppm	6/3	5:55 PM
11.9 C	6.92pH	772.uS	0.7ppm	6/3	5:55 PM
11.9 C	6.92pH	769.uS	0.7ppm	6/3	5:55 PM
11.9 C	6.92pH	769.uS	0.8ppm	6/3	5:56 PM
11.9 C	6.93pH	776.uS	0.8ppm	6/3	5:57 PM
11.9 C	6.92pH	773.uS	0.9ppm	6/3	6:00 PM
11.9 C	6.93pH	781.uS	0.8ppm	6/3	6:01 PM
11.9 C	6.94pH	761.uS	0.8ppm	6/3	6:01 PM
11.9 C	6.93pH	781.uS	0.8ppm	6/3	6:02 PM
11.9 C	6.93pH	782.uS	0.8ppm	6/3	6:02 PM
11.9 C	6.92pH	773.uS	1.0ppm	6/3	6:05 PM
11.9 C	6.92pH	782.uS	0.8ppm	6/3	6:05 PM
11.9 C	6.91pH	781.uS	0.8ppm	6/3	6:06 PM
11.9 C	6.92pH	776.uS	0.9ppm	6/3	6:07 PM
11.9 C	6.94pH	770.uS	0.7ppm	6/3	6:07 PM
11.9 C	6.94pH	764.uS	0.9ppm	6/3	6:07 PM
11.9 C	6.94pH	766.uS	0.8ppm	6/3	6:10 PM
11.9 C	6.98pH	786.uS	0.7ppm	6/3	6:17 PM
11.8 C	6.99pH	786.uS	0.9ppm	6/3	6:19 PM
11.8 C	6.98pH	774.uS	0.9ppm	6/3	6:19 PM
11.8 C	6.99pH	785.uS	0.9ppm	6/3	6:20 PM
11.8 C	6.99pH	786.uS	0.8ppm	6/3	6:22 PM
11.8 C	7.00pH	789.uS	1.0ppm	6/3	6:22 PM
11.8 C	7.02pH	785.uS	1.1ppm	6/3	6:24 PM
11.8 C	7.01pH	785.uS	1.2ppm	6/3	6:24 PM
11.8 C	7.08pH	789.uS	1.1ppm	6/3	6:26 PM
11.8 C	7.09pH	790.uS	1.2ppm	6/3	6:27 PM
11.8 C	7.10pH	789.uS	1.1ppm	6/3	6:28 PM
11.9 C	7.10pH	786.uS	1.1ppm	6/3	6:28 PM
11.8 C	7.10pH	786.uS	1.1ppm	6/3	6:29 PM
11.8 C	7.11pH	789.uS	1.1ppm	6/3	6:29 PM
11.8 C	7.10pH	786.uS	1.0ppm	6/3	6:30 PM

Field Parameter Data

2391

14.5 C	7.97pH	732.uS	2.2ppm	6/7 1:17 PM
14.2 C	7.69pH	731.uS	1.8ppm	6/7 1:18 PM
13.9 C	7.53pH	731.uS	1.5ppm	6/7 1:19 PM
13.5 C	7.39pH	742.uS	1.5ppm	6/7 1:22 PM
13.4 C	7.36pH	744.uS	1.2ppm	6/7 1:22 PM
13.3 C	7.35pH	745.uS	1.3ppm	6/7 1:23 PM
13.2 C	7.33pH	746.uS	1.1ppm	6/7 1:24 PM
13.2 C	7.31pH	742.uS	0.9ppm	6/7 1:25 PM
12.4 C	7.27pH	745.uS	0.9ppm	6/7 1:29 PM
12.7 C	7.26pH	743.uS	0.7ppm	6/7 1:33 PM
12.3 C	7.26pH	743.uS	1.1ppm	6/7 1:35 PM
12.1 C	7.26pH	746.uS	0.8ppm	6/7 1:36 PM
12.2 C	7.26pH	743.uS	0.8ppm	6/7 1:41 PM
12.1 C	7.26pH	741.uS	1.0ppm	6/7 1:44 PM
12.1 C	7.27pH	745.uS	1.0ppm	6/7 1:47 PM
12.2 C	7.27pH	745.uS	0.9ppm	6/7 1:48 PM
12.0 C	7.28pH	740.uS	1.2ppm	6/7 1:49 PM
12.1 C	7.27pH	741.uS	1.1ppm	6/7 1:51 PM
12.1 C	7.28pH	735.uS	1.0ppm	6/7 1:51 PM
12.0 C	7.28pH	741.uS	0.8ppm	6/7 1:55 PM
12.1 C	7.29pH	745.uS	0.9ppm	6/7 1:57 PM
12.1 C	7.29pH	748.uS	1.2ppm	6/7 2:00 PM
12.0 C	7.29pH	743.uS	1.0ppm	6/7 2:02 PM
12.0 C	7.29pH	743.uS	0.9ppm	6/7 2:02 PM
12.0 C	7.30pH	743.uS	1.0ppm	6/7 2:07 PM
12.1 C	7.30pH	747.uS	1.1ppm	6/7 2:11 PM
12.0 C	7.30pH	740.uS	1.0ppm	6/7 2:17 PM
12.0 C	7.30pH	741.uS	1.1ppm	6/7 2:21 PM
12.0 C	7.30pH	741.uS	1.0ppm	6/7 2:24 PM
12.0 C	7.30pH	741.uS	1.0ppm	6/7 2:26 PM
12.0 C	7.31pH	740.uS	1.1ppm	6/7 2:28 PM
12.0 C	7.30pH	747.uS	1.1ppm	6/7 2:29 PM
12.0 C	7.31pH	743.uS	1.1ppm	6/7 2:30 PM
12.0 C	7.31pH	747.uS	1.1ppm	6/7 2:32 PM
12.0 C	7.31pH	745.uS	1.2ppm	6/7 2:34 PM
11.9 C	7.31pH	748.uS	1.1ppm	6/7 2:36 PM

Field Parameter Data

2391

14.3 C	7.79pH	804.uS	7.0ppm	6/11 12:34 PM
13.6 C	7.53pH	758.uS	2.9ppm	6/11 12:35 PM
13.0 C	7.40pH	740.uS	1.2ppm	6/11 12:37 PM
12.9 C	7.36pH	740.uS	1.1ppm	6/11 12:40 PM
12.7 C	7.35pH	752.uS	0.9ppm	6/11 12:42 PM
12.7 C	7.35pH	754.uS	0.8ppm	6/11 12:44 PM
12.7 C	7.35pH	758.uS	0.7ppm	6/11 12:45 PM
12.7 C	7.35pH	758.uS	0.9ppm	6/11 12:47 PM
12.5 C	7.35pH	752.uS	0.9ppm	6/11 12:49 PM
12.2 C	7.34pH	753.uS	0.8ppm	6/11 12:53 PM
12.5 C	7.34pH	754.uS	0.7ppm	6/11 12:55 PM
12.4 C	7.34pH	758.uS	0.7ppm	6/11 12:59 PM
12.2 C	7.35pH	753.uS	1.4ppm	6/11 1:02 PM
12.1 C	7.34pH	753.uS	0.9ppm	6/11 1:04 PM
12.0 C	7.35pH	753.uS	1.0ppm	6/11 1:07 PM
12.0 C	7.35pH	752.uS	1.0ppm	6/11 1:09 PM
12.0 C	7.35pH	752.uS	1.0ppm	6/11 1:09 PM
12.0 C	7.35pH	753.uS	1.1ppm	6/11 1:10 PM
11.9 C	7.35pH	745.uS	1.1ppm	6/11 1:12 PM
12.0 C	7.35pH	754.uS	1.2ppm	6/11 1:13 PM
11.9 C	7.35pH	753.uS	1.3ppm	6/11 1:16 PM
12.0 C	7.35pH	758.uS	1.3ppm	6/11 1:19 PM
11.9 C	7.35pH	762.uS	1.5ppm	6/11 1:23 PM
12.0 C	7.35pH	765.uS	1.5ppm	6/11 1:26 PM
11.9 C	7.35pH	754.uS	1.3ppm	6/11 1:27 PM
12.0 C	7.35pH	765.uS	1.4ppm	6/11 1:29 PM
12.0 C	7.35pH	766.uS	1.7ppm	6/11 1:32 PM
12.0 C	7.35pH	768.uS	1.8ppm	6/11 1:33 PM
11.9 C	7.35pH	761.uS	1.9ppm	6/11 1:34 PM
12.0 C	7.35pH	762.uS	1.6ppm	6/11 1:36 PM
11.9 C	7.35pH	772.uS	1.8ppm	6/11 1:37 PM
11.9 C	7.35pH	761.uS	1.9ppm	6/11 1:38 PM
11.9 C	7.35pH	765.uS	1.9ppm	6/11 1:40 PM
11.9 C	7.35pH	765.uS	1.9ppm	6/11 1:41 PM
11.9 C	7.35pH	762.uS	1.8ppm	6/11 1:42 PM
11.9 C	7.35pH	762.uS	1.9ppm	6/11 1:42 PM

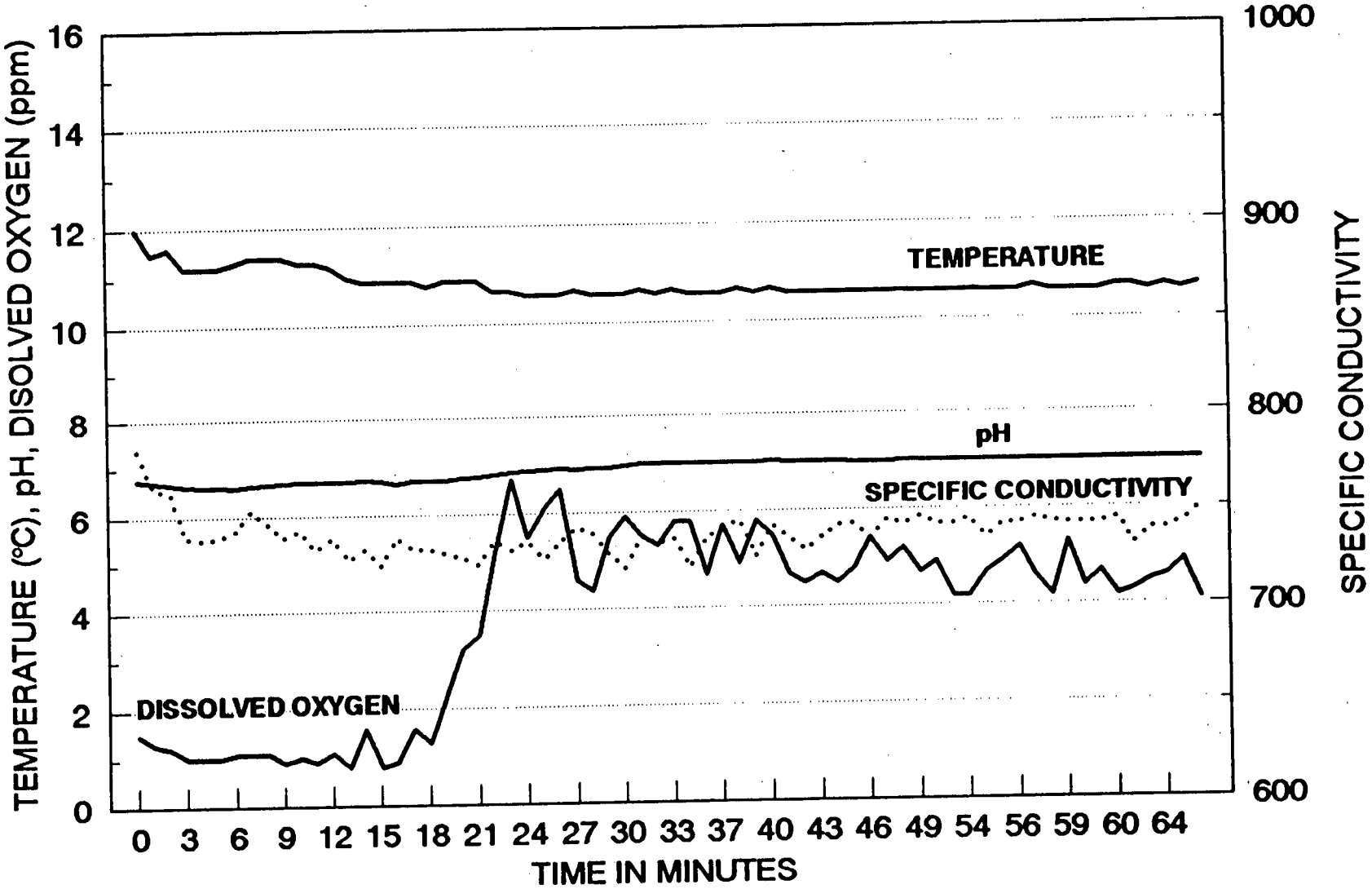
Field Parameter Data

2391

17.5 C	7.78pH	1720uS	5.7ppm	6/15 2:23 PM
15.4 C	7.62pH	1200uS	4.9ppm	6/15 2:24 PM
13.9 C	7.49pH	836.uS	2.5ppm	6/15 2:27 PM
13.4 C	7.46pH	767.uS	1.6ppm	6/15 2:29 PM
13.2 C	7.44pH	741.uS	1.3ppm	6/15 2:31 PM
13.1 C	7.44pH	733.uS	1.1ppm	6/15 2:33 PM
13.0 C	7.44pH	733.uS	1.1ppm	6/15 2:33 PM
12.5 C	7.43pH	741.uS	2.4ppm	6/15 2:35 PM
12.3 C	7.42pH	747.uS	1.4ppm	6/15 2:37 PM
12.2 C	7.41pH	727.uS	2.2ppm	6/15 2:40 PM
12.0 C	7.41pH	725.uS	0.9ppm	6/15 2:42 PM
12.0 C	7.40pH	736.uS	0.8ppm	6/15 2:46 PM
12.0 C	7.41pH	743.uS	0.7ppm	6/15 2:48 PM
11.9 C	7.41pH	745.uS	0.9ppm	6/15 2:50 PM
12.0 C	7.41pH	747.uS	1.0ppm	6/15 2:51 PM
12.0 C	7.41pH	753.uS	0.8ppm	6/15 2:53 PM
12.0 C	7.42pH	752.uS	0.8ppm	6/15 2:57 PM
12.0 C	7.42pH	754.uS	0.9ppm	6/15 3:00 PM
11.9 C	7.42pH	758.uS	0.8ppm	6/15 3:03 PM
12.0 C	7.42pH	761.uS	1.2ppm	6/15 3:06 PM
12.0 C	7.42pH	762.uS	1.0ppm	6/15 3:08 PM
12.0 C	7.42pH	765.uS	1.0ppm	6/15 3:12 PM
11.9 C	7.42pH	765.uS	1.0ppm	6/15 3:14 PM
11.9 C	7.42pH	766.uS	1.2ppm	6/15 3:16 PM
11.9 C	7.42pH	766.uS	1.4ppm	6/15 3:18 PM
11.9 C	7.42pH	765.uS	1.1ppm	6/15 3:19 PM
12.0 C	7.43pH	766.uS	1.2ppm	6/15 3:20 PM
11.9 C	7.42pH	768.uS	1.5ppm	6/15 3:21 PM
11.9 C	7.43pH	769.uS	1.4ppm	6/15 3:22 PM

Figure A-1

WELL 2016



JUNE 3, 1993

0039

-4984

Figure A-2

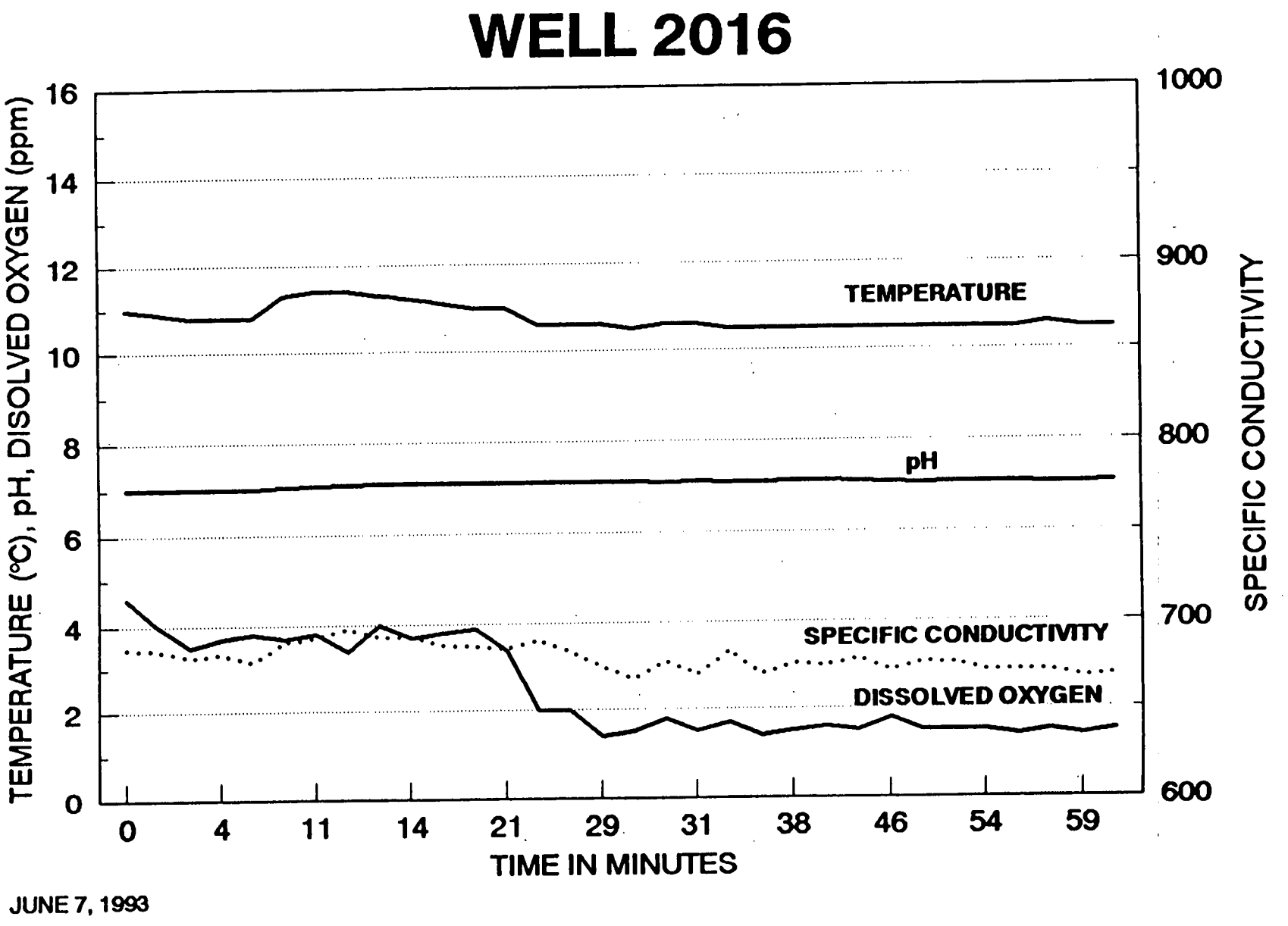
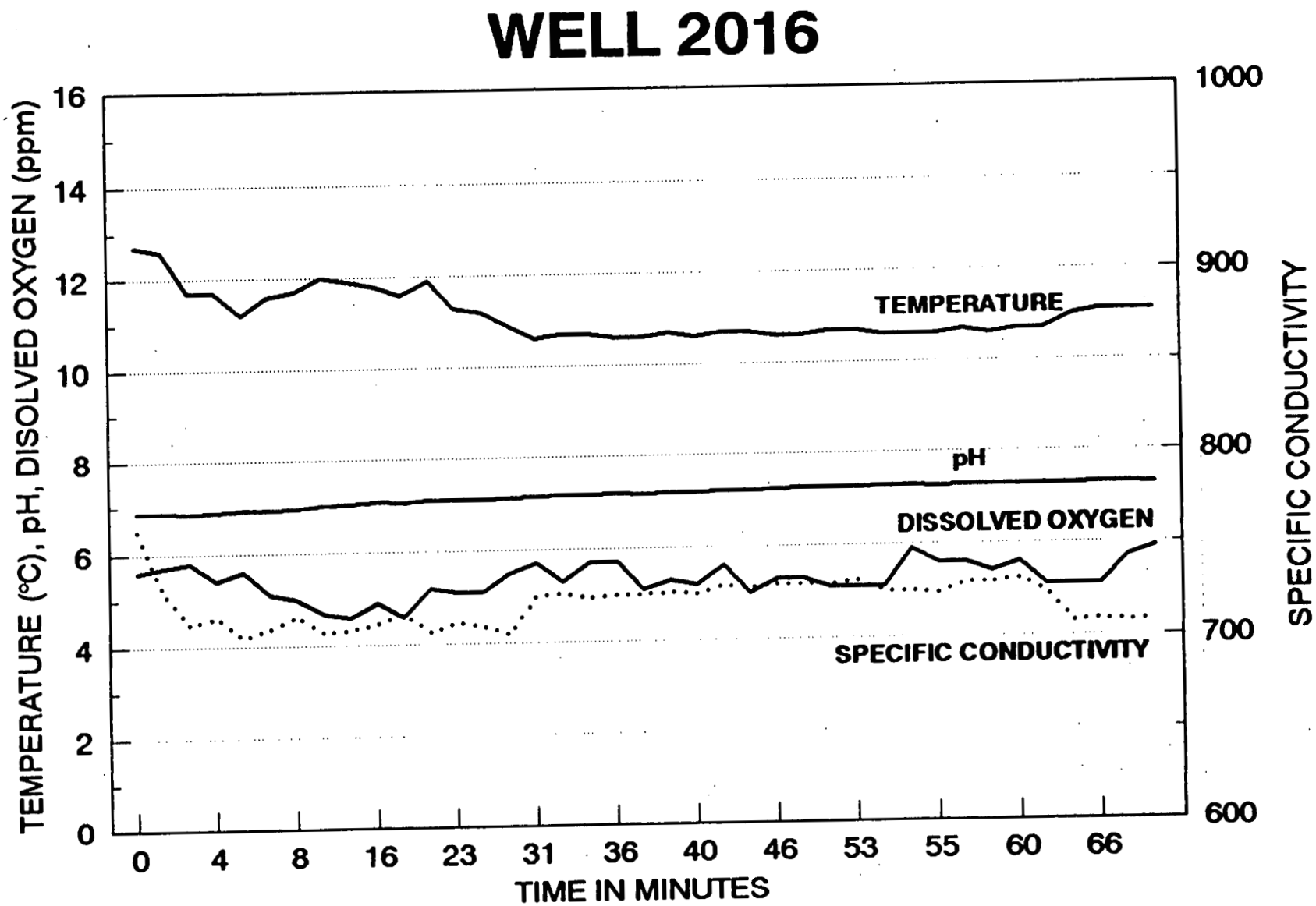
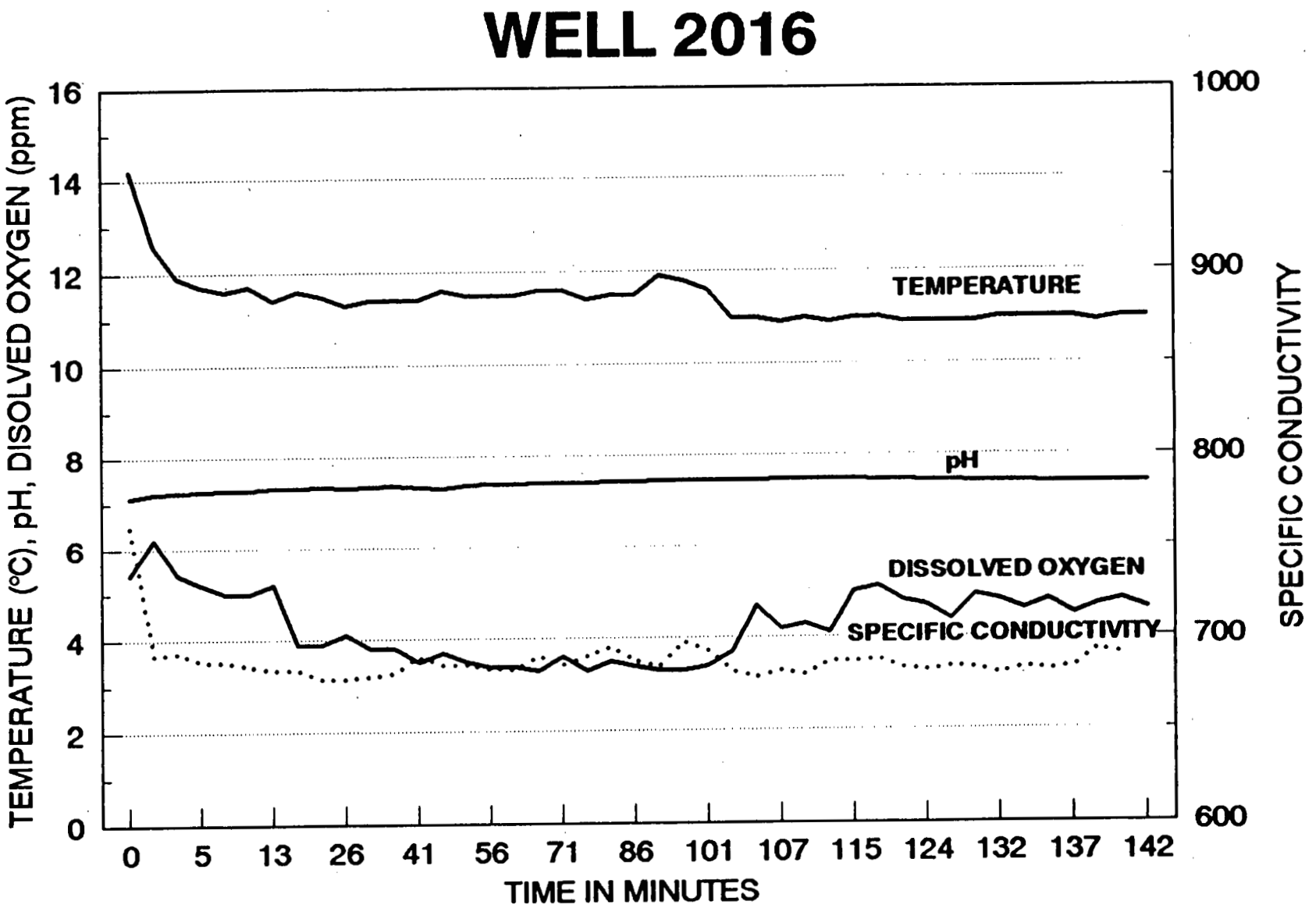

WELL 2016
TEMPERATURE (°C), pH, DISOLVED OXYGEN (ppm)
16
14
12
10
8
6
4
2
0
1000
900
800
700
600
SPECIFIC CONDUCTIVITY
TEMPERATURE
pH
SPECIFIC CONDUCTIVITY
DISSOLVED OXYGEN
0
4
11
14
21
29
31
38
46
54
59
TIME IN MINUTES
JUNE 7, 1993

Figure A-3



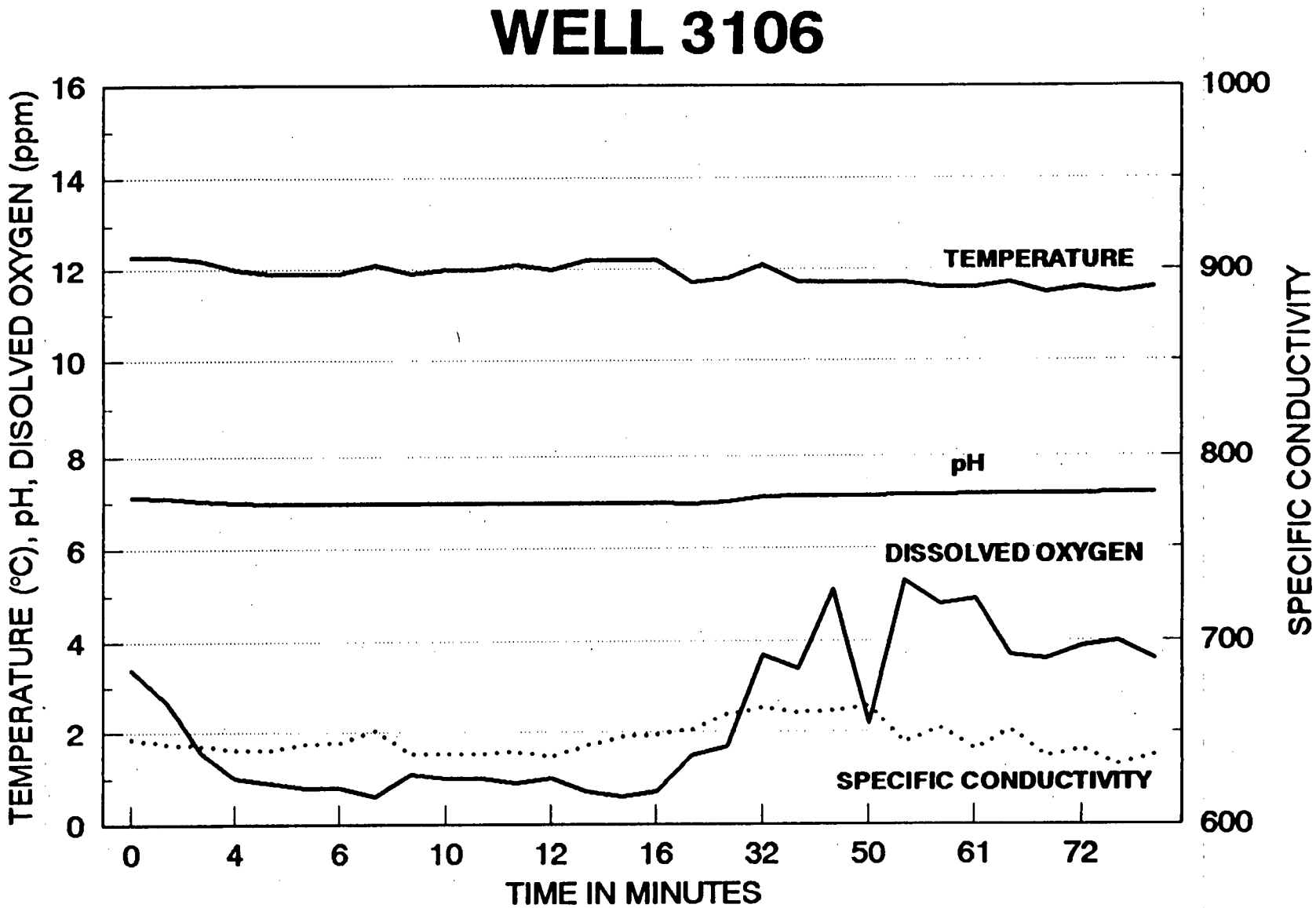
JUNE 11, 1993

Figure A-4



JUNE 15, 1993

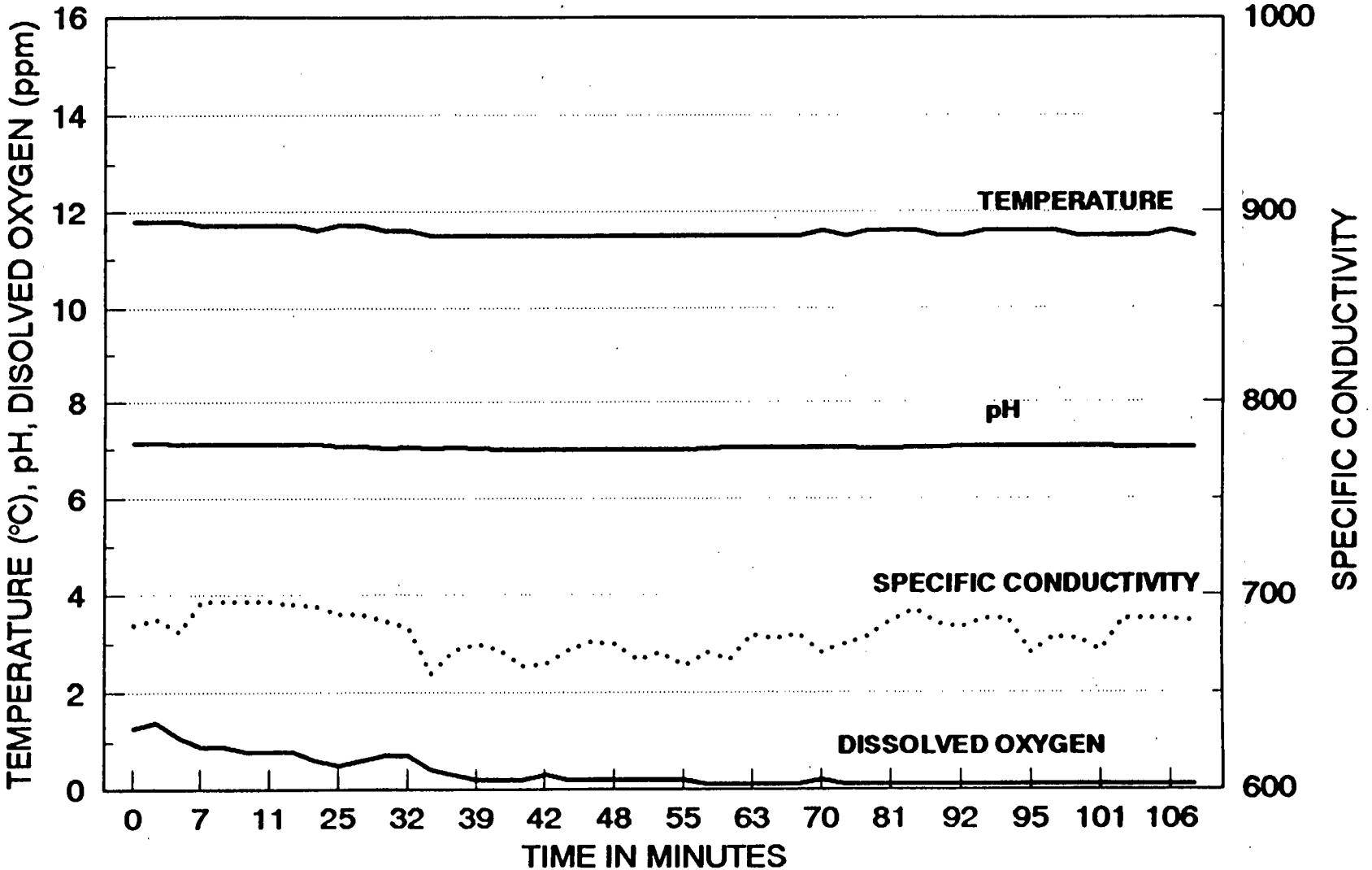
Figure A-5



JUNE 3, 1993

Figure A-6

WELL 3106



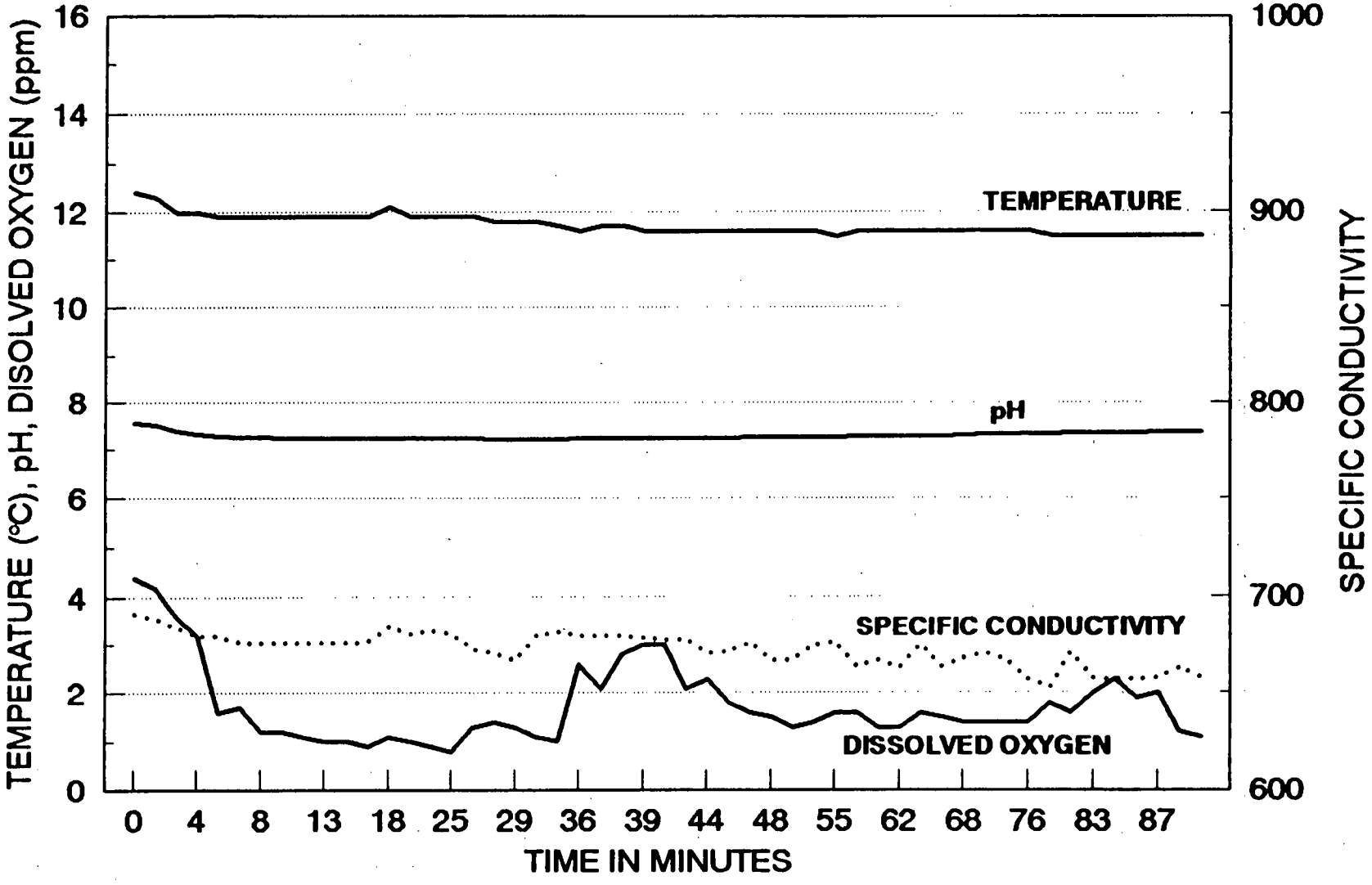
JUNE 7, 1993

0044

-4984

Figure A-7

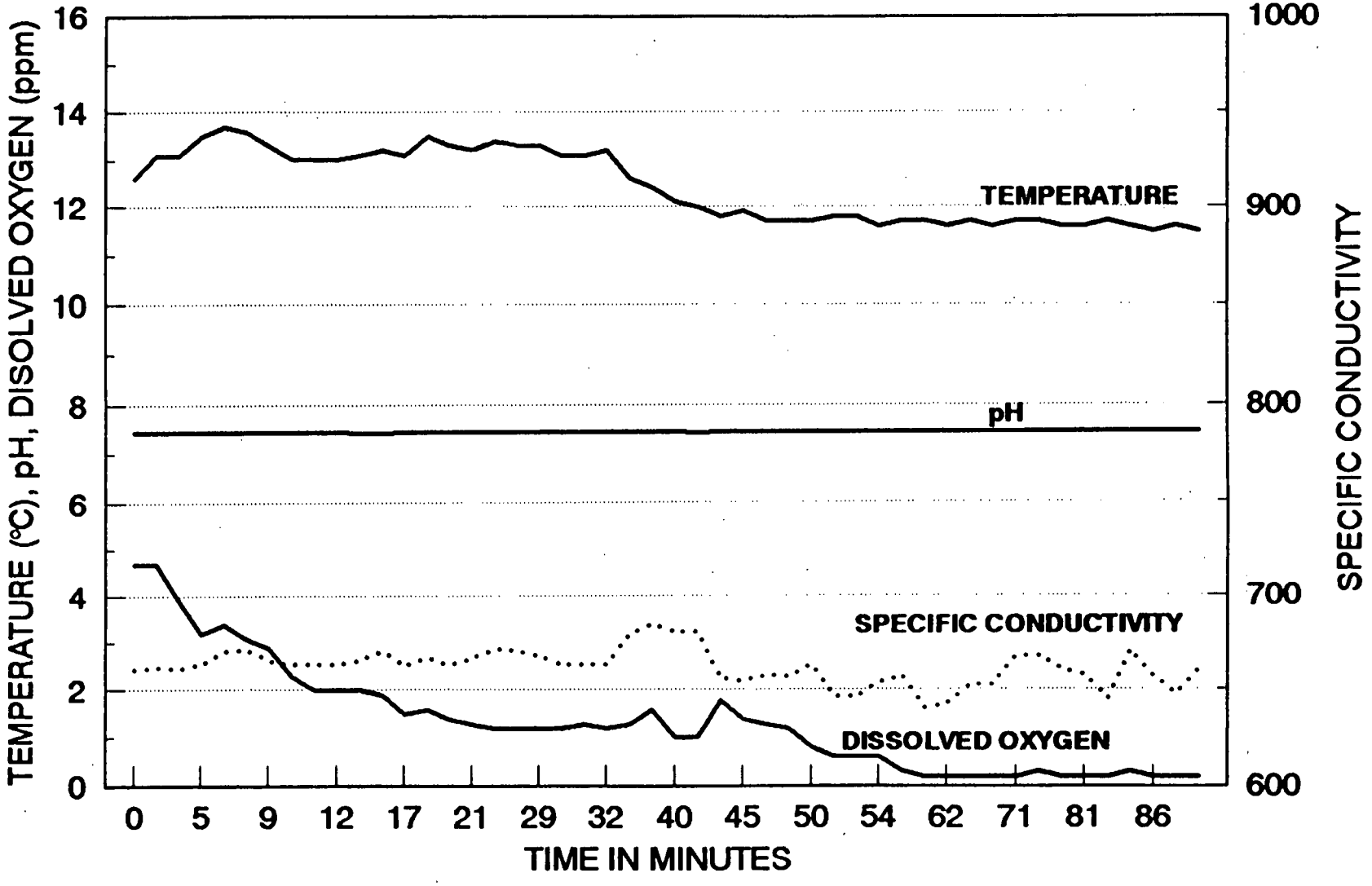
WELL 3106



JUNE 11, 1993

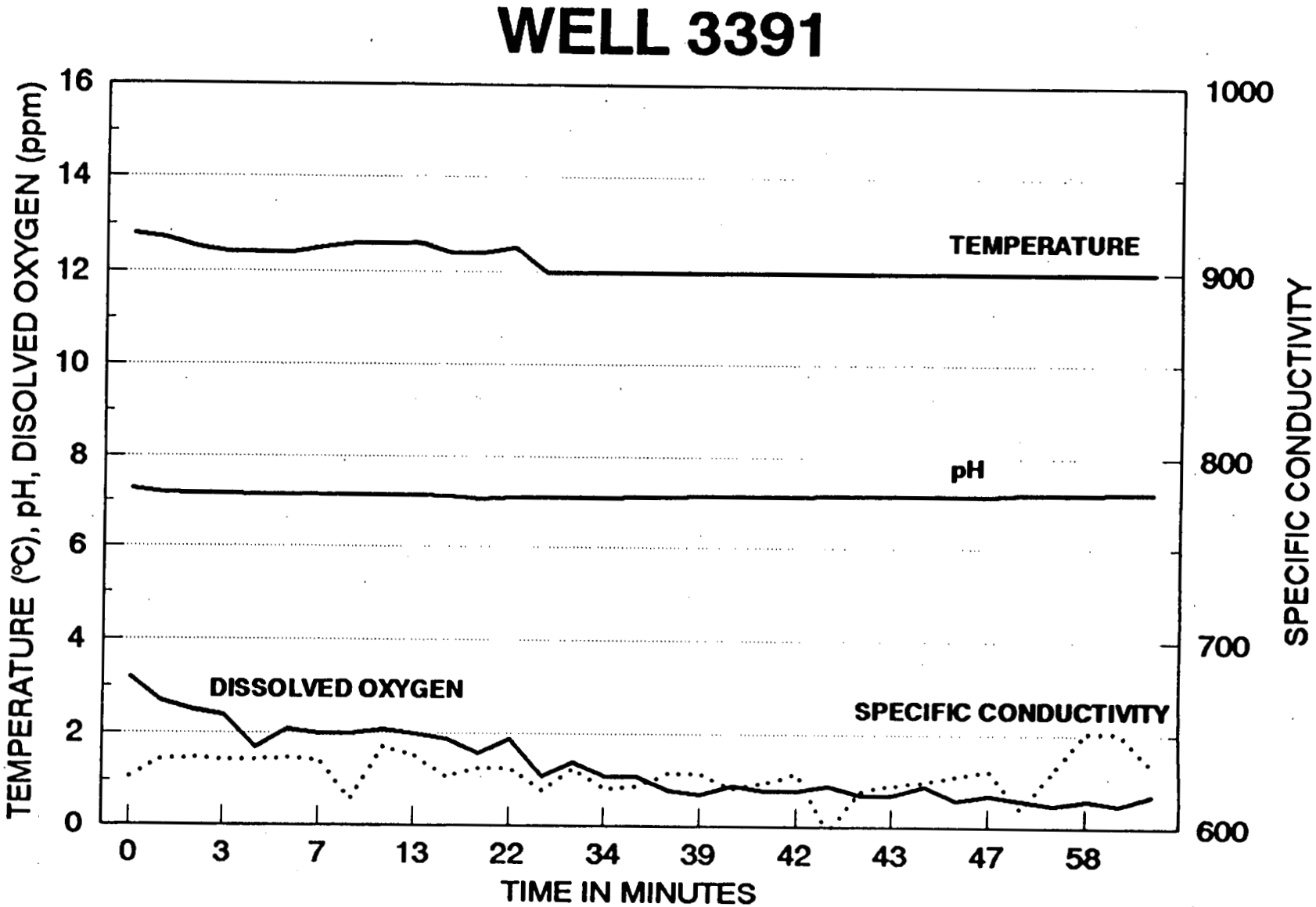
Figure A-8

WELL 3106



JUNE 15, 1993

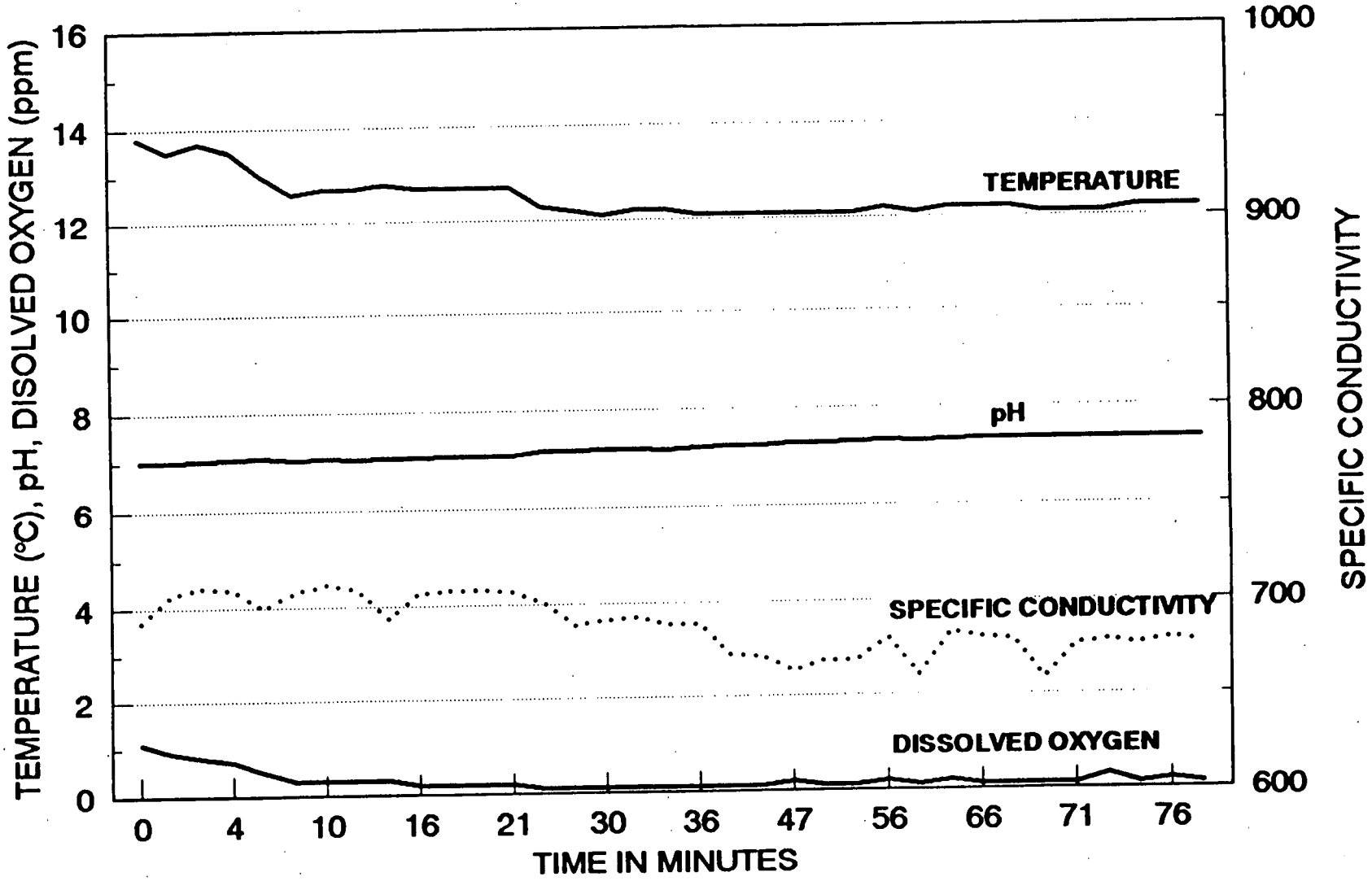
Figure A-9



JUNE 3, 1993

Figure A-10

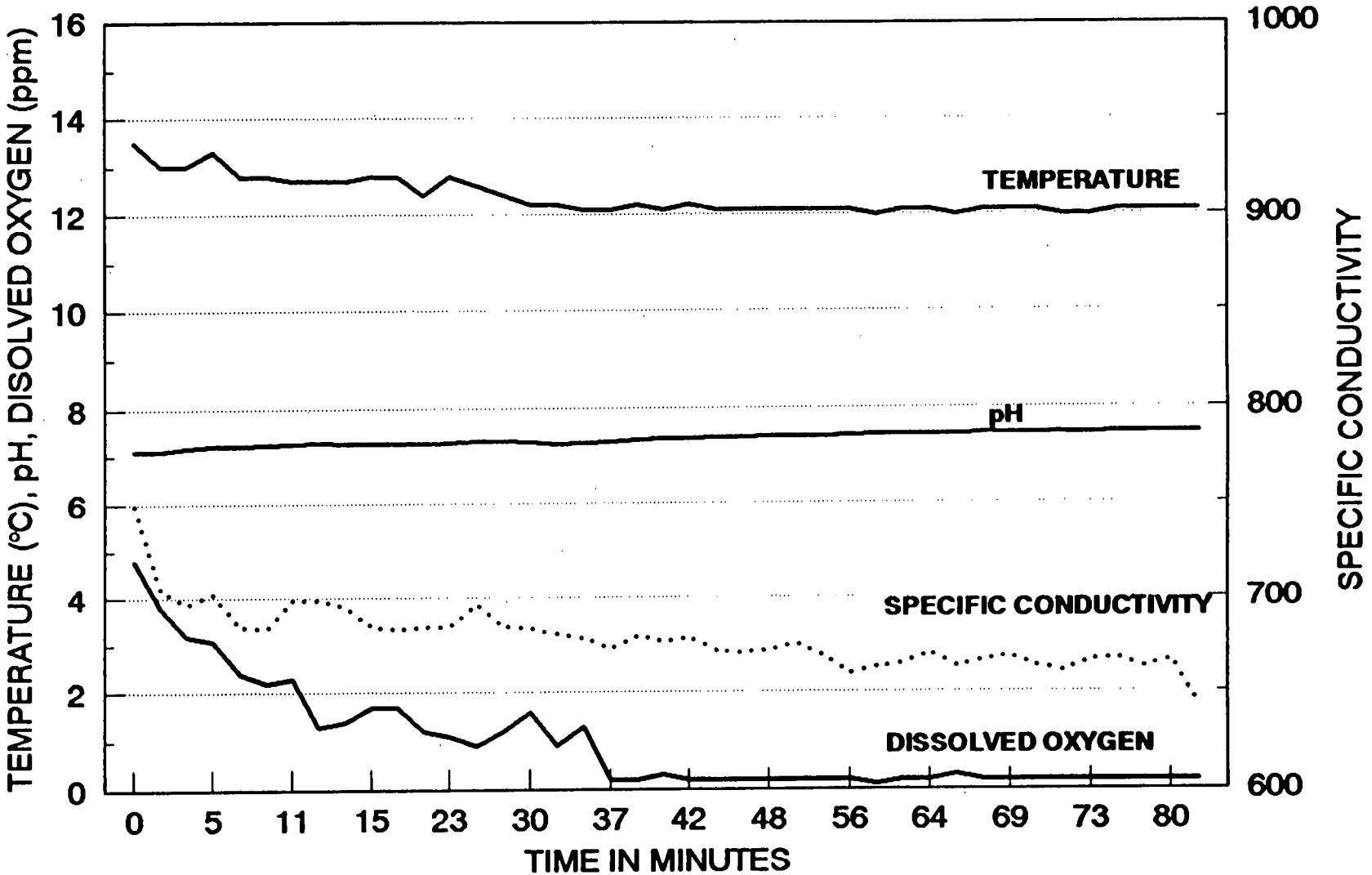
WELL 3391



JUNE 7, 1993

Figure A-11

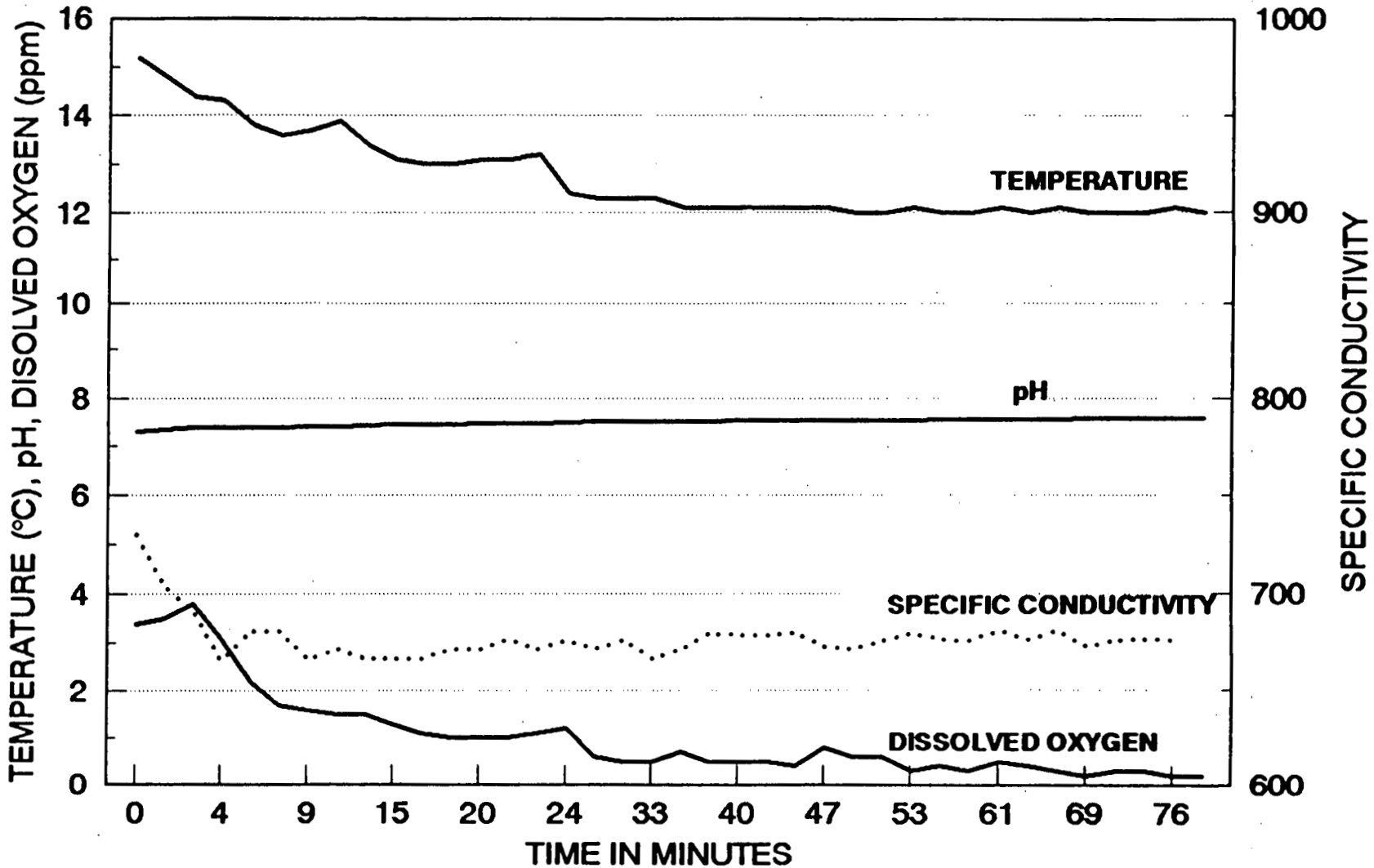
WELL 3391



JUNE 11, 1993

Figure A-12

WELL 3391



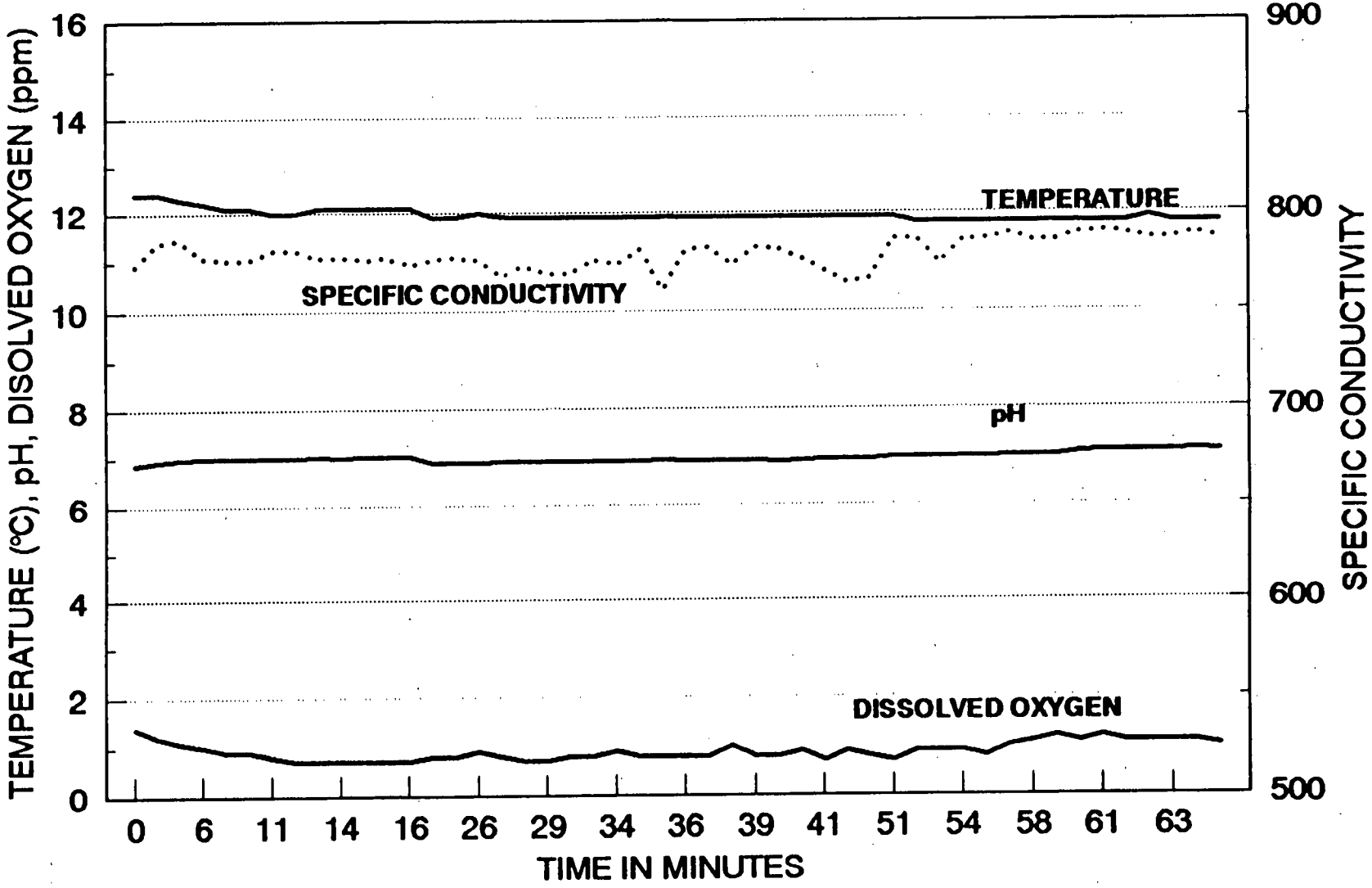
JUNE 15, 1993

0050

-4084

Figure A-13

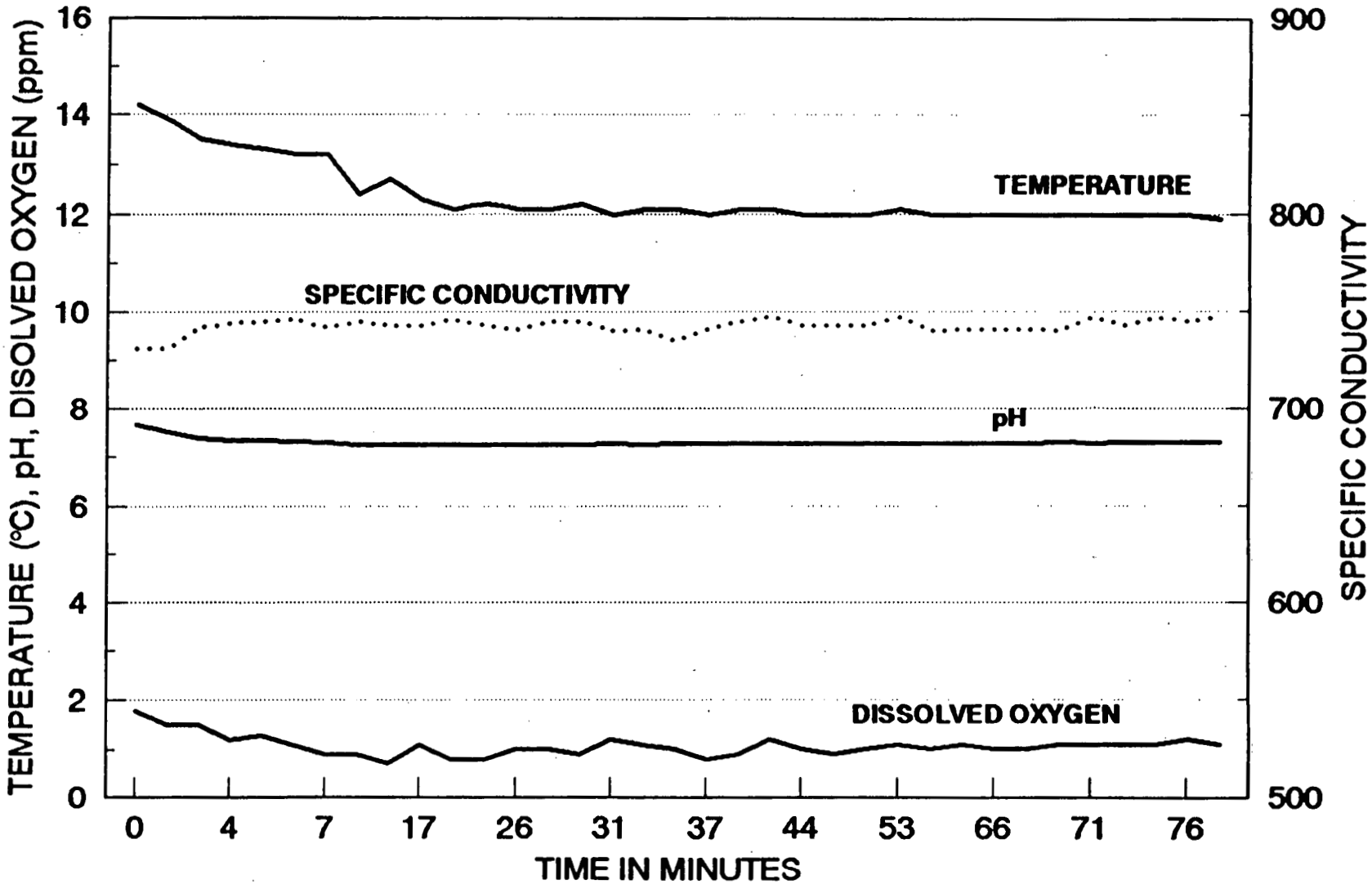
WELL 2391



JUNE 3, 1993

Figure A-14

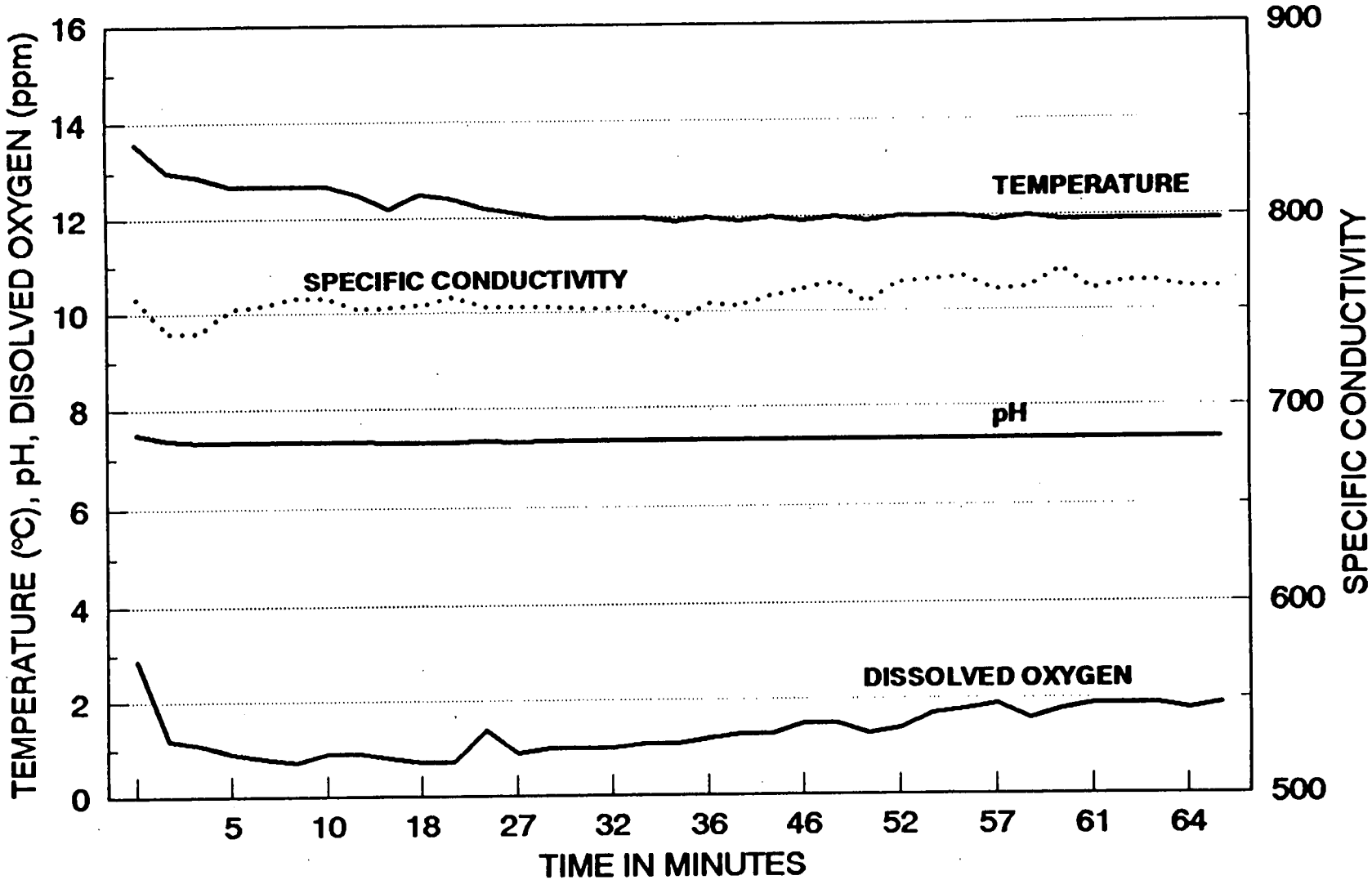
WELL 2391



JUNE 7, 1993

Figure A-15

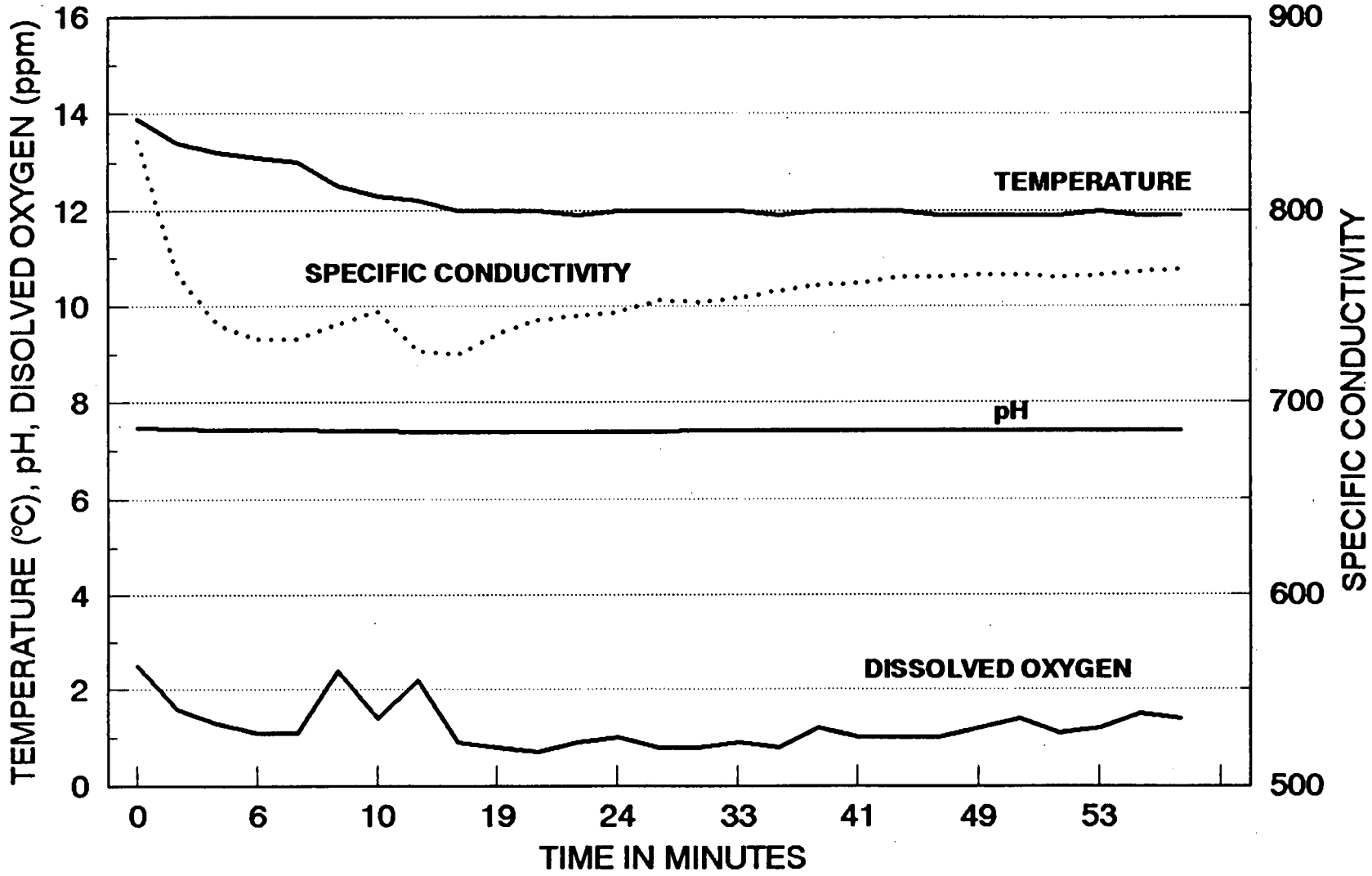
WELL 2391



JUNE 11, 1993

Figure A-16

WELL 2391



JUNE 15, 1993

Attachment B

ANALYTICAL PROGRAM

DATE: 06/02/93

ANALYTICAL PROGRAM 8 - CHEMICAL PARAMETERS DATA USE: MICRO-PURGE EXPERIMENT SAMPLES SHIPPED TO ON-SITE LABORATORIES			
PARAMETER	HOLDING TIME *	CHEMICAL PRESERVATIVE	CONTAINER(s) REQUIRED
METALS (TOTAL) Calcium, Iron, Magnesium	6 months	HNO_3, pH < 2	1 - 1 Liter Plastic
METALS (DISSOLVED)** Calcium, Iron, Magnesium	6 months	HNO_3, pH < 2	1 - 1 Liter Plastic
FLUORIDE	28 days	NONE	1 - 1 Liter Plastic
Total Dissolved Solids	07 days	NONE	
PHOSPHATES (TOTAL)	28 days	H_2SO_4, pH < 2	1 - 500 ml Plastic
ALKALINITY***	14 days	NONE	1 - 500 ml Plastic
TOTAL URANIUM	06 months	HNO_3, pH < 2	1 - 250 ml Plastic

NOTE: ALL SAMPLES LISTED ABOVE ARE KEPT COOL TO 4°C AS A METHOD OF PRESERVATION.

* Holding times taken from the Sitewide CERCLA QAPJP (SCQ)

** Metals (Dissolved) sample is filtered in the field.

*** Alkalinity samples will be dropped off at the Water Treatment Plant.

The four wells to be sampled are 2391, 3391, 2106, and 3106.
Collect three samples per well:

1. After 2x pump/line purge.
2. After one well volume.
3. After three well volume.

All four wells will be sampled each of the following days:

June 3, 7, 11, and 15.

One field duplicate should be sampled per day in the following sequence:

June 3 well 2106 after one well volume
June 7 well 3106 after three well volume
June 11 well 2391 after 2x pump/line purge
June 15 well 3391 after 2x pump/line purge

Attachment C

ANALYTICAL DATA AND CHARTS

ANALYTICAL DATA

Table C-1
Total Calcium (ug/L)

DATE	2106	3106	3391	2391	VOL
6/03/93	99,840	93,720	103,100	103,700	2X
	101,100[1]	91,630	100,600	130,700	1
	100,000	90,900	97,860	111,700	3
6/07/93	95,950	92,070	100,100	98,090	2X
	93,330	92,390	105,800	94,870	1
	95,670	94,200[2]	101,800	99,190	3
6/11/93	91,210	88,140	95,040	97,870[3]	2X
	91,090	84,870	91,100	100,100	1
	96,200	87,670	92,650	105,600	3
6/15/93	98,260	92,650	97,870[4]	97,120	2X
	92,840	90,860	94,730	99,180	1
	92,040	90,830	94,760	101,200	3

DUPLICATES:

					AVERAGE
06/03/93 - WELL 2106	@ 1	104,100	&	98,180	101,100[1]
06/07/93 - WELL 3106	@ 3	93,540	&	94,860	94,200[2]
06/11/93 - WELL 2391	@ 2x	97,540	&	98,200	97,870[3]
06/15/93 - WELL 3391	@ 2x	95,830	&	99,910	97,870[4]

ANALYTICAL DATA

Table C-2
Filtered Calcium (ug/L)

DATE	2106	3106	3391	2391	VOL
6/03/93	97,020	94,120	96,780	103,500	2X
	98,490[1]	91,620	104,000	105,400	1
	?	92,770	99,470	104,400	3
6/07/93	96,750	93,520	103,500	100,800	2X
	95,120	94,060	110,000	101,300	1
	97,370	95,170[2]	106,900	100,100	3
6/11/93	86,270	86,410	90,620	98,200[3]	2X
	93,600	85,350	93,140	97,620	1
	89,160	87,510	89,870	104,600	3
6/15/93	93,000	93,130	94,360[4]	98,330	2X
	91,760	92,530	92,360	99,520	1
	92,890	92,300	90,700	94,850	3

DUPLICATES:

					AVERAGE
06/03/93 - WELL 2106	@ 1	98,400	&	98,580	98,490[1]
06/07/93 - WELL 3106	@ 3	96,030	&	94,310	95,170[2]
06/11/93 - WELL 2391	@ 2x	97,370	&	99,020	98,200[3]
06/15/93 - WELL 3391	@ 2x	95,110	&	93,600	94,360[4]

ANALYTICAL DATA

Table C-3
Total Iron (ug/L)

DATE	2106	3106	3391	2391	VOL
6/03/93	<100.0 (34.4)	<100.0 (9.7)	2130	5359	2X
	<100.0 (10.3)[1]	<100.0 (13.5)	2427	11,950	1
	<100.0 (5.5)	<100.0 (6.3)	2207	2399	3
6/07/93	<100.0 (<5)	<100.0 (9.4)	100.9	2713	2X
	<100.0 (5.1)	<100.0 (30.1)	105.9	<100.0 (35.2)	1
	<100.0 (25.7)	<100.0 (<5)[2]	<100.0 (82.5)	1786	3
6/11/93	1854	<100.0 (16.5)	2353	884[3]	2X
	<100.0 (18.7)	<100.0 (7.3)	1817	129.1	1
	327.4	<100.0 (5.3)	1922	1976	3
6/15/93	185.1	<100.0 (<5)	2140[4]	3947	2X
	<100.0 (85.1)	<100.0 (5.0)	2501	9006	1
	<100.0 (30.7)	<100.0 (<5.0)	1945	<100.0 (72.4)	3

DUPLICATES:

			AVERAGE
06/03/93 - WELL 2106 @ 1	<100.0 (8.0)	& <100.0 (12.6)	<100.0 (10.3)[1]
06/07/93 - WELL 3106 @ 3	<100.0 (<5)	& <100.0 (<5)	<100.0 (<5)[2]
06/11/93 - WELL 2391 @ 2x	827	& 940.2	884[3]
06/15/93 - WELL 3391 @ 2x	2096	& 2185	2140[4]

Table C-4
Filtered Iron (ug/L)

DATE	2106	3106	3391	2391	VOL
6/03/93	<100.0 (<5)	<100.0 (10.6)	1880	<100.0 (12.2)	2X
	<100.0 (8.4)[1]	<100.0 (14.7)	1895	<100.0 (20.4)	1
	?	<100.0 (18.2)	2011	<100.0 (43.0)	3
6/07/93	<100.0 (<5)	<100.0 (<5)	1153	1800	2X
	<100.0 (<5)	<100.0 (<5)	669.5	2217	1
	<100.0 (<5)	<100.0 (14.0)[2]	438.8	1951	3
6/11/93	<100.0 (14.3)	<100.0 (9.6)	1800	150.4[3]	2X
	1100	<100.0 (38.5)	2037	555.5	1
	<100.0 (5.9)	<100.0 (14.6)	1883	<100.0 (<5)	3
6/15/93	<100.0 (8.8)	<100.0 (<5.0)	1880[4]	104.5	2X
	<100.0 (<5.0)	<100.0 (<5.0)	1887	109.4	1
	<100.0 (22.2)	<100.0 (<5.0)	1857	1121	3

DUPLICATES:

			AVERAGE
06/03/93 - WELL 2106 @ 1	<100.0 (9.9)	& <100.0 (7.0)	<100.0 (8.4)[1]
06/07/93 - WELL 3106 @ 3	<100.0 (11.1)	& <100.0 (16.8)	<100.0 (14.0)[2]
06/11/93 - WELL 2391 @ 2x	147.7	& 153.2	150.4[3]
06/15/93 - WELL 3391 @ 2x	1875	& 1884	1880[4]

ANALYTICAL DATA

Table C-5
Total Magnesium (ug/L)

DATE	2106	3106	3391	2391	VOL
6/03/93	24,760	23,150	25,890	28,720	2X
	25,220[1]	22,600	25,130	38,040	1
	24,960	22,300	24,270	31,310	3
6/07/93	23,930	22,870	27,860	24,430	2X
	23,270	22,980	29,510	23,500	1
	23,840	23,300[2]	28,430	25,030	3
6/11/93	23,220	21,480	23,630	26,700[3]	2X
	22,550	20,440	22,370	27,140	1
	24,110	21,600	22,850	28,760	3
6/15/93	24,050	22,790	24,360[4]	26,730	2X
	22,780	22,280	23,380	27,380	1
	22,630	22,280	23,410	28,000	3

DUPLICATES:

						AVERAGE
06/03/93 -	WELL 2106	@ 1	25,910	&	24,530	25,220[1]
06/07/93 -	WELL 3106	@ 3	23,170	&	23,420	23,300[2]
06/11/93 -	WELL 2391	@ 2x	26,630	&	26,770	26,700[3]
06/15/93 -	WELL 3391	@ 2x	23,840	&	24,880	24,360[4]

Table C-6
Filtered Magnesium (ug/L)

DATE	2106	3106	3391	2391	VOL
6/03/93	24,200	23,330	24,260	28,450	2X
	24,480[1]	22,520	26,100	29,060	1
	?	22,700	24,800	28,740	3
6/07/93	24,120	23,380	28,590	25,100	2X
	23,740	23,290	30,490	25,350	1
	24,270	23,510[2]	29,490	25,010	3
6/11/93	21,290	20,860	22,630	26,740[3]	2X
	23,860	20,770	22,820	26,740	1
	21,630	21,500	22,190	28,420	3
6/15/93	22,720	22,860	23,420[4]	27,030	2X
	22,530	22,630	23,110	27,490	1
	22,700	22,640	22,670	26,200	3

DUPLICATES:

					AVERAGE
06/03/93 - WELL 2106	@ 1	24,590	&	24,380	24,480[1]
06/07/93 - WELL 3106	@ 3	23,750	&	23,270	23,510[2]
06/11/93 - WELL 2391	@ 2x	26,550	&	26,930	26,740[3]
06/15/93 - WELL 3391	@ 2x	23,500	&	23,340	23,420[4]

Table C-7
Fluoride (mg/L)

DATE	2106	3106	3391	2391	VOL
6/03/93	0.25	0.13	0.18	0.12	2X
	0.25[1]	0.27	0.13	0.12	1
	0.24	0.13	0.18	0.12	3
6/07/93	0.27	0.15	0.13	0.15	2X
	0.25	0.13	0.14	0.15	1
	0.28	0.14[2]	0.14	0.15	3
6/11/93	0.26	0.14	0.14	0.14[3]	2X
	0.24	0.14	0.15	0.13	1
	0.26	0.15	0.15	0.13	3
6/15/93	0.24	0.13	0.14[4]	0.13	2X
	0.25	0.14	0.15	0.13	1
	0.26	0.13	0.14	0.13	3

DUPLICATES:

					AVERAGE
06/03/93 - WELL 2106	@ 1	0.24	&	0.26	0.25[1]
06/07/93 - WELL 3106	@ 3	0.14	&	0.15	0.14[2]
06/11/93 - WELL 2391	@ 2x	0.14	&	0.14	0.14[3]
06/15/93 - WELL 3391	@ 2x	0.14	&	0.14	0.14[4]

ANALYTICAL DATA

Table C-8
Total Dissolved Solids (mg/L)

DATE	2106	3106	3391	2391	VOL
6/03/93	386	515	390	566	2X
	394[1]	428	382	484	1
	404	442	390	489	3
6/07/93	453	467	519	406	2X
	422	391	514	394	1
	451	394[2]	509	393	3
6/11/93	288	438	237	373[4]	2X
	329	439	249	395	1
	338	426	313	408	3
6/15/93	354	456	483[4]	516	2X
	365	516	617	439	1
	475	494	535	420	3

DUPLICATES:

					AVERAGE
06/03/93 - WELL 2106	@ 1	391	&	398	394[1]
06/07/93 - WELL 3106	@ 3	396	&	391	394[2]
06/11/93 - WELL 2391	@ 2x	346	&	400	373[3]
06/15/93 - WELL 3391	@ 2x	372	&	594	483[4]

ANALYTICAL DATA

Table C-9
Phosphate (mg/L)

DATE	2106	3106	3391	2391	VOL
6/03/93	<1	<1	<1	<1	2X
	<1[1]	<1	<1	<1	1
	<1	<1	<1	<1	3
6/07/93	<1	<1	<1	<1	2X
	<1	<1	<1	<1	1
	<1	<1[2]	<1	<1	3
6/11/93	<1	<1	<1	<1[3]	2X
	<1	<1	<1	<1	1
	<1	<1	<1	<1	3
6/15/93	<1	<1	<1[4]	<1	2X
	<1	<1	<1	<1	1
	<1	<1	<1	<1	3

DUPLICATES:

					AVERAGE
06/03/93 - WELL 2106	@ 1	<1	&	<1	<1[1]
06/07/93 - WELL 3106	@ 3	<1	&	<1	<1[2]
06/11/93 - WELL 2391	@ 2x	<1	&	<1	<1[3]
06/15/93 - WELL 3391	@ 2x	<1	&	<1	<1[4]

ANALYTICAL DATA

Table C-10
Alkalinity (mg/L)

DATE	2106	3106	3391	2391	VOL
6/03/93	261	248	262	274	2X
	276[1]	256	266	290	1
	286	254	266	294	3
6/07/93	254	254	284	266	2X
	264	250	290	270	1
	276	254[2]	288	264	3
6/11/93	254	252	272	293[3]	2X
	264	256	264	290	1
	274	254	258	294	3
6/15/93	256	254	273[4]	286	2X
	258	262	272	290	1
	262	258	268	292	3

DUPLICATES:

						AVERAGE
06/03/93 - WELL 2106	@ 1	276	&	276		276[1]
06/07/93 - WELL 3106	@ 3	256	&	252		254[2]
06/11/93 - WELL 2391	@ 2x	294	&	292		293[3]
06/15/93 - WELL 3391	@ 2x	272	&	274		273[4]

ANALYTICAL DATA

Table C-11
Total Uranium (ug/L)

DATE	2106	3106	3391	2391	VOL
6/03/93	51.1	1.1	<0.2	0.7	2X
	51.2[1]	1.1	0.2	0.9	1
	50.6	0.9	<0.2	1.2	3
6/07/93	48.9	1.2	0.9	<0.2	2X
	49.9	1.1	1.0	0.2	1
	50.8	1.1[2]	1.1	0.2	3
6/11/93	50.4	1.3	<0.2	0.9[3]	2X
	51.4	1.2	0.2	1.0	1
	50.5	1.1	0.3	1.1	3
6/15/93	50.6	1.2	0.2[4]	0.9	2X
	50.6	1.2	0.2	0.9	1
	53.6	1.2	?	1.1	3

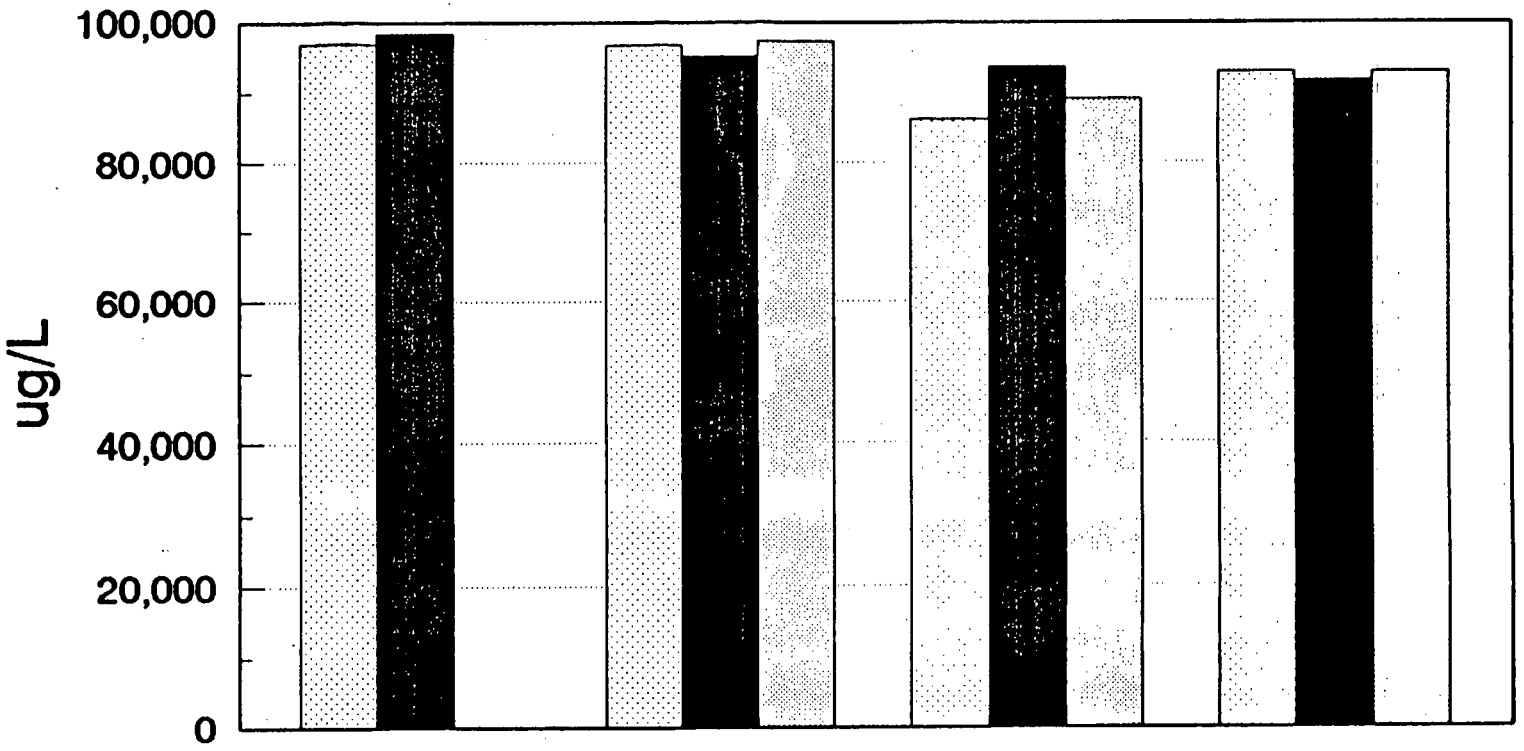
DUPLICATES:

					AVERAGE
06/03/93 - WELL 2106	@ 1	51.0	&	51.3	51.2[1]
06/07/93 - WELL 3106	@ 3	1.1	&	1.1	1.1[2]
06/11/93 - WELL 2391	@ 2x	0.9	&	0.9	0.9[3]
06/15/93 - WELL 3391	@ 2x	0.2	&	0.2	0.2[4]

Figure C-1

CALCIUM (FILTERED)

WELL 2106

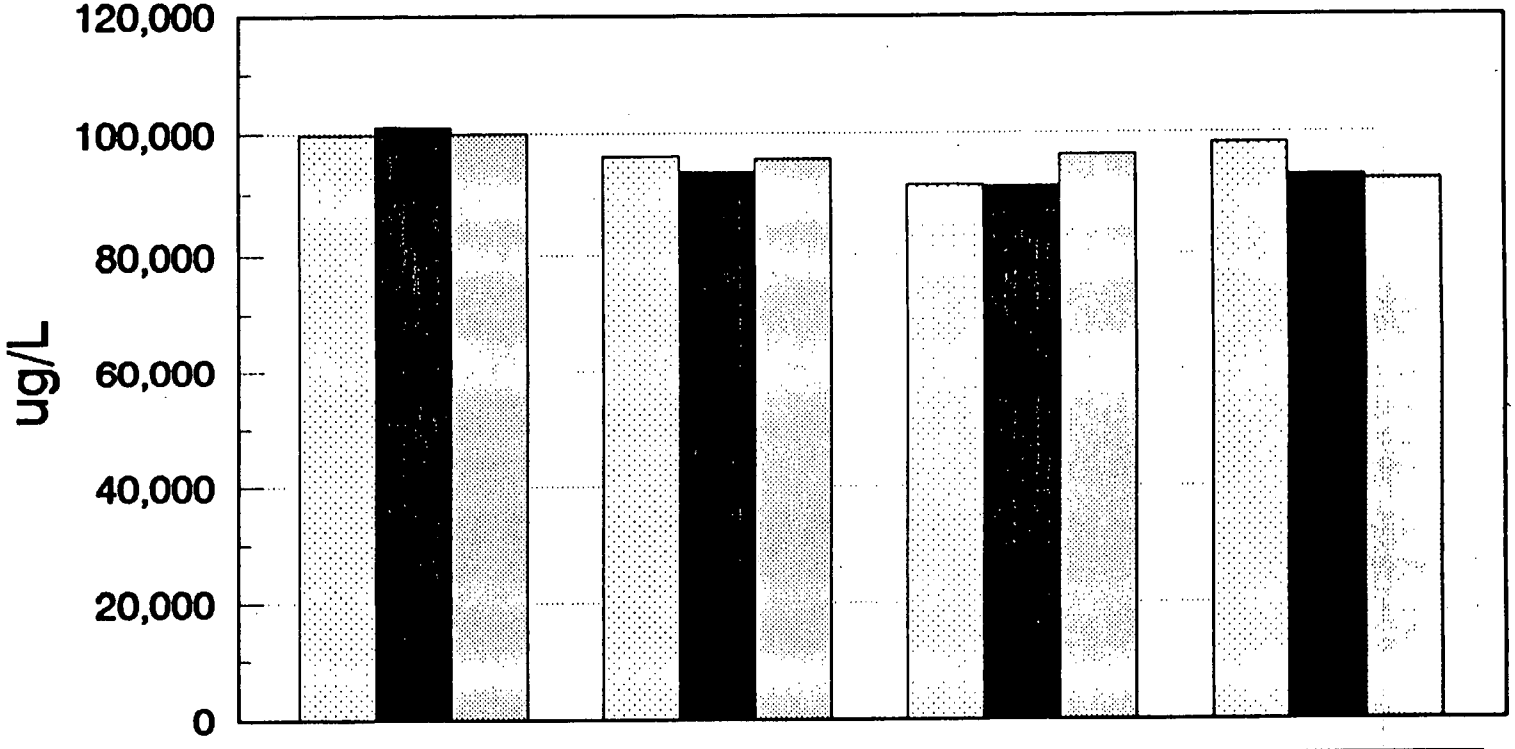


DATE	6/03/93	6/07/93	6/11/93	6/15/93
2X LINE	97,020	96,750	86,270	93,000
1 WELL VOLUME	98,490	95,120	93,600	91,760
3 WELL VOLUMES		97,370	89,160	92,890

Figure C-2

CALCIUM (TOTAL)

WELL 2106

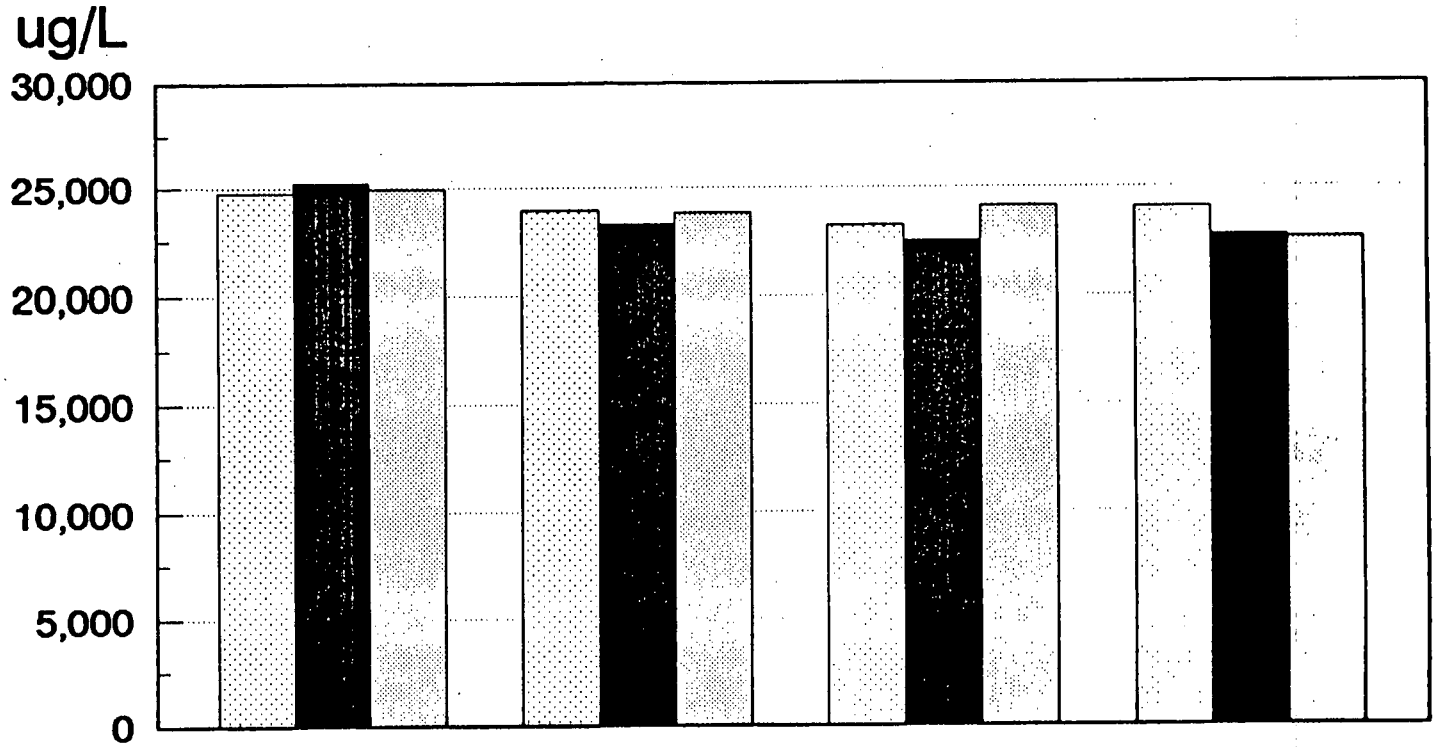


DATE	6/03/93	6/07/93	6/11/93	6/15/93
2X LINE	99,840	95,950	91,210	98,260
1 WELL VOLUME	101,100	93,330	91,090	92,840
3 WELL VOLUMES	100,000	95,670	96,200	92,040

Figure C-3

MAGNESIUM (TOTAL)

WELL 2106

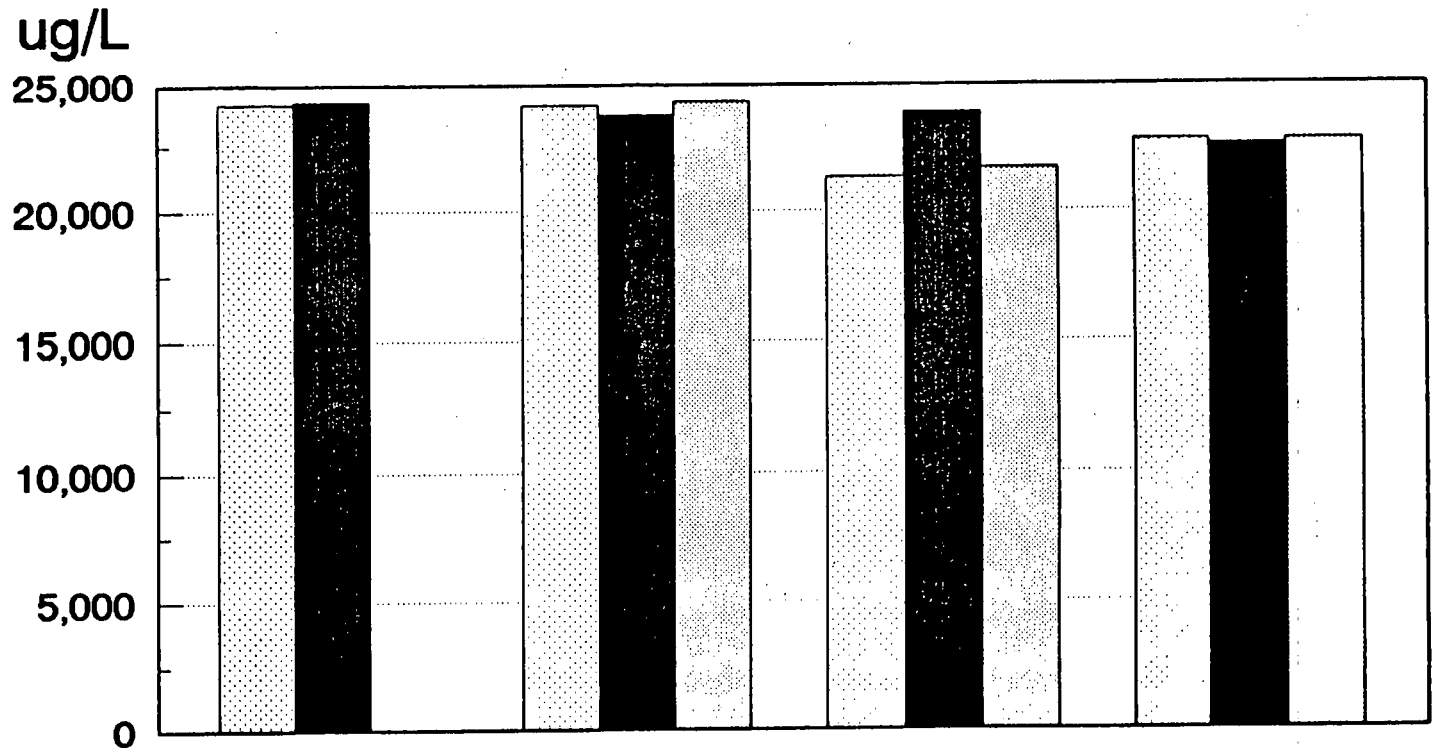


DATE	6/03/93	6/07/93	6/11/93	6/15/93
2X LINE	24,760	23,930	23,220	24,050
1 WELL VOLUME	25,220	23,270	22,550	22,780
3 WELL VOLUMES	24,960	23,840	24,110	22,630

Figure C-4

MAGNESIUM (FILTERED)

WELL 2106

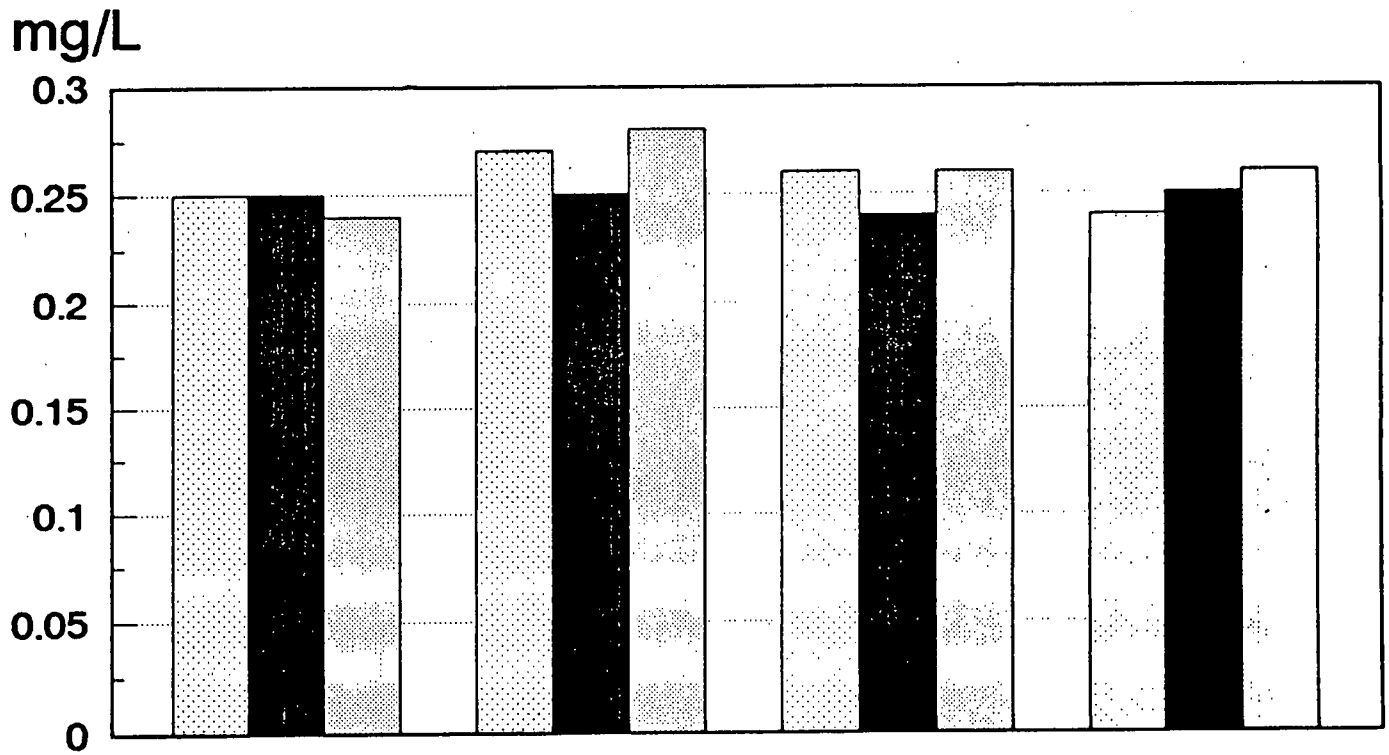


DATE	6/03/93	6/07/93	6/11/93	6/15/93
2X LINE	24,200	24,120	21,290	22,720
1 WELL VOLUME	24,280	23,740	23,860	22,530
3 WELL VOLUMES		24,270	21,630	22,700

Figure C-5

FLUORIDE

WELL 2106

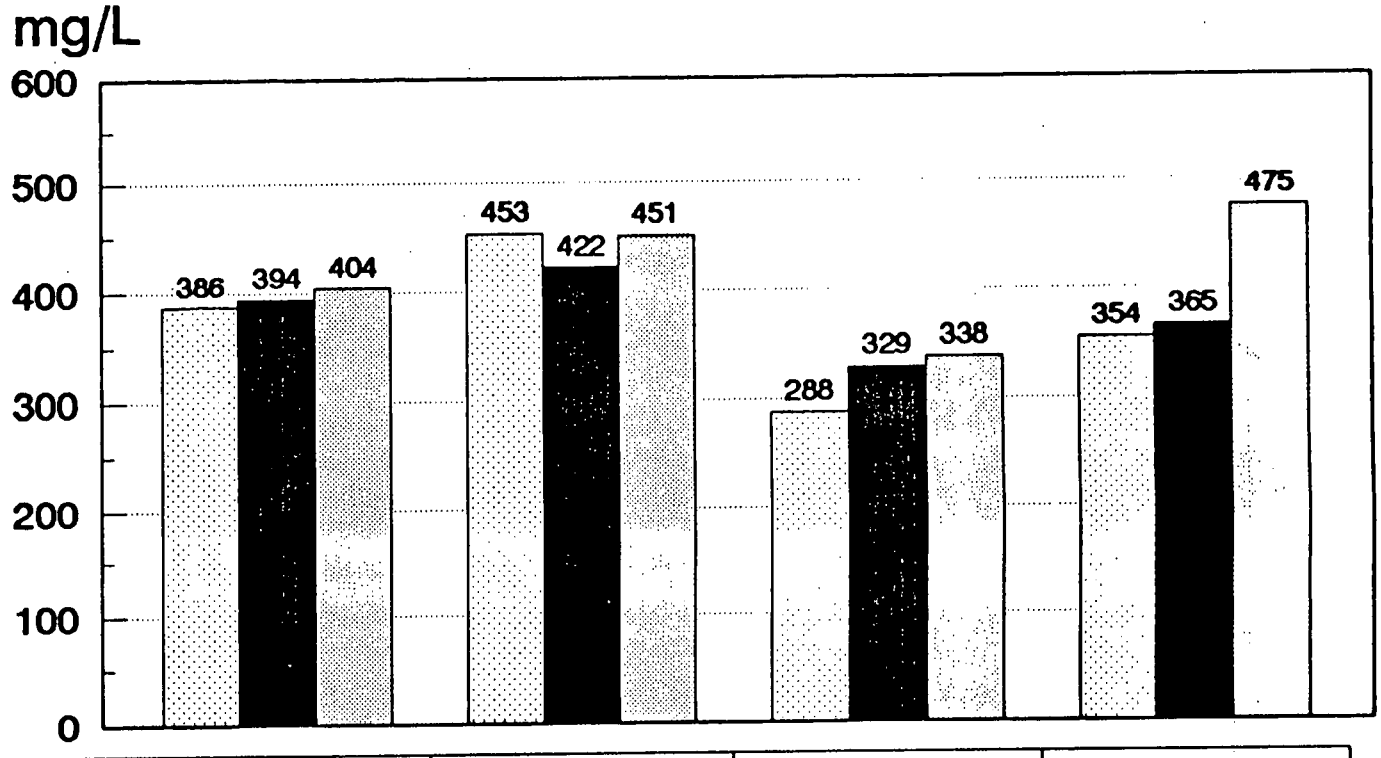


DATE	6/03/93	6/07/93	6/11/93	6/15/93
2X LINE	0.25	0.27	0.26	0.24
1 WELL VOLUME	0.25	0.25	0.24	0.25
3 WELL VOLUMES	0.24	0.28	0.26	0.26

Figure C-6

TOTAL DISSOLVED SOLIDS

WELL 2106



DATE	6/03/93	6/07/93	6/11/93	6/15/93
2X LINE	386	453	288	354
1 WELL VOLUME	394	422	329	365
3 WELL VOLUMES	404	451	338	475

Figure C-7

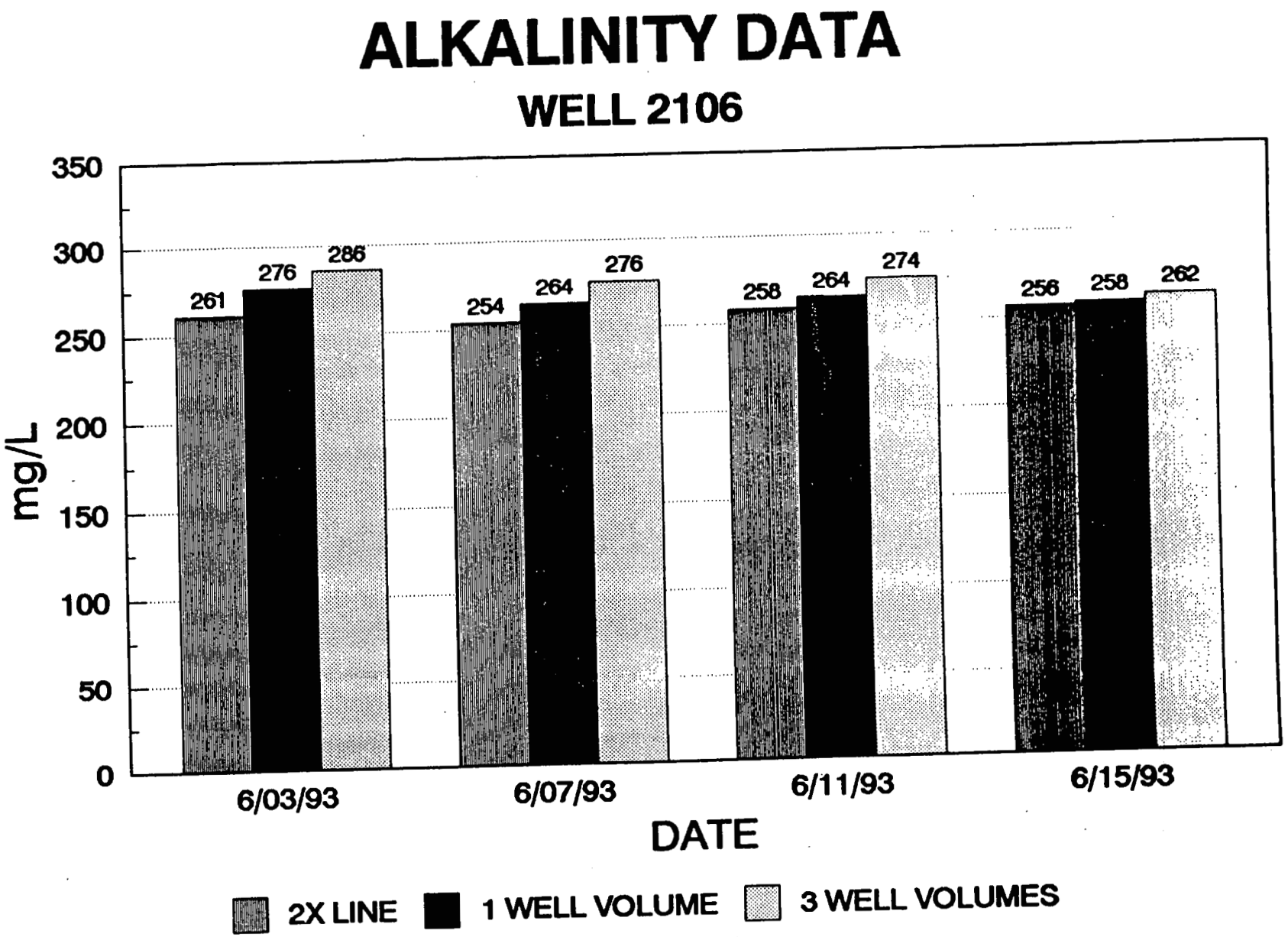
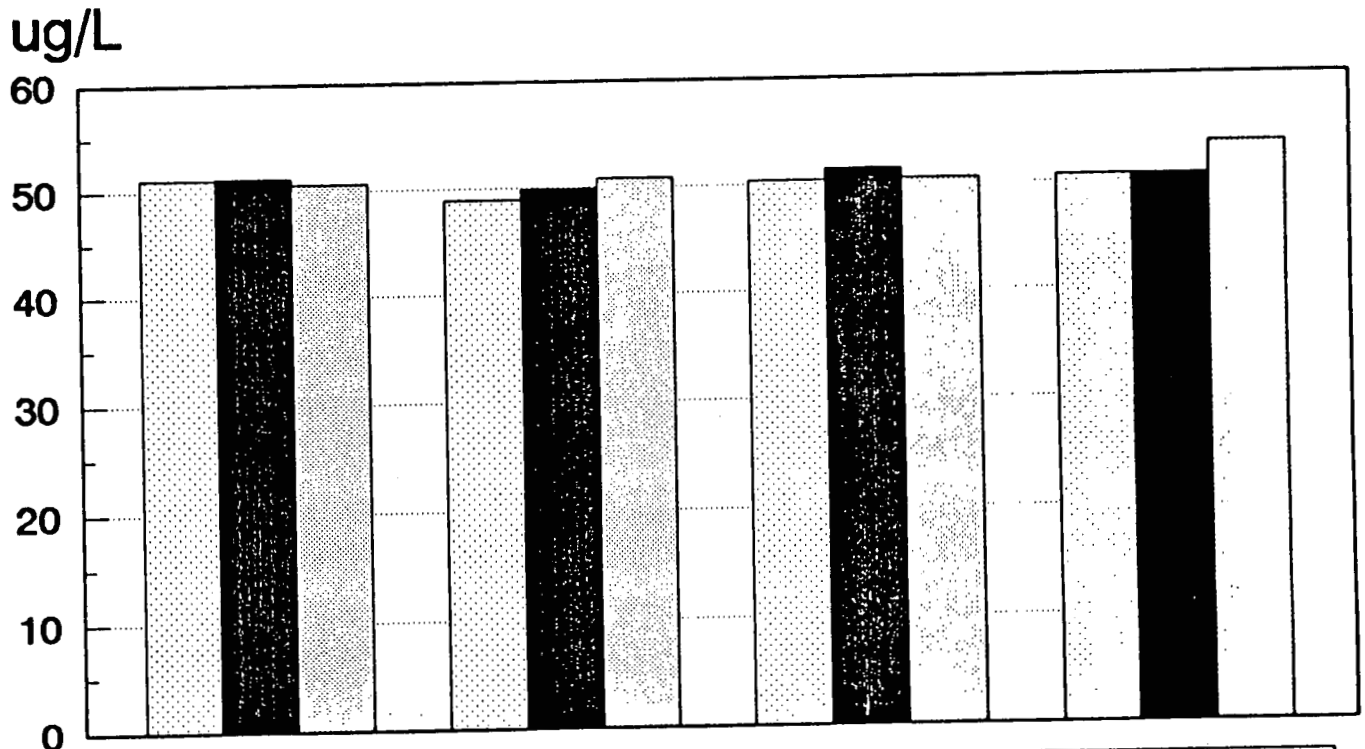

ALKALINITY DATA
WELL 2106
mg/L
350
300
250
200
150
100
50
0
261
276
286
254
264
276
258
264
274
256
258
262
6/03/93
6/07/93
6/11/93
6/15/93
DATE
2X LINE
1 WELL VOLUME
3 WELL VOLUMES

Figure C-8

URANIUM (TOTAL)

WELL 2106

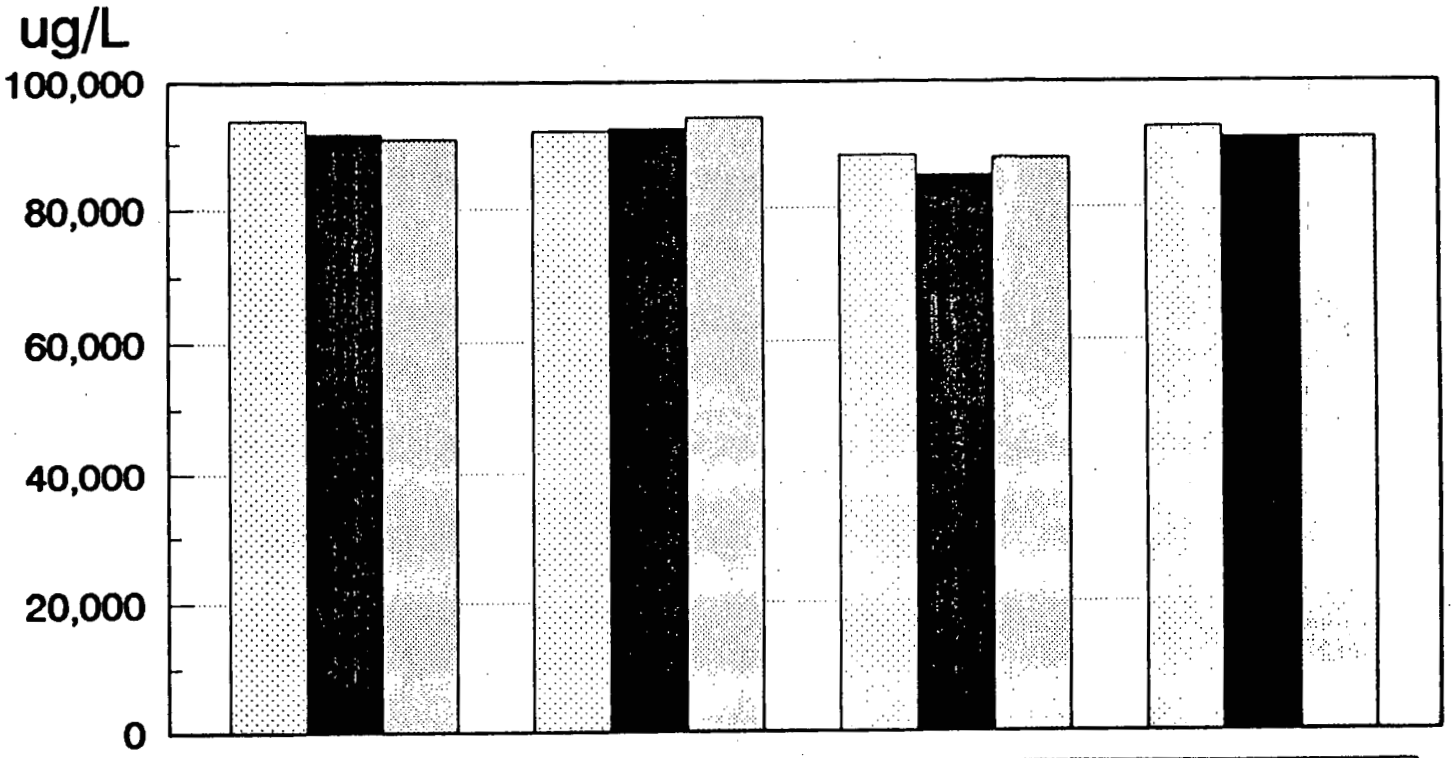


DATE	6/03/93	6/07/93	6/11/93	6/15/93
2X LINE	51.1	48.9	50.4	50.6
1 WELL VOLUME	51.2	49.9	51.4	50.6
3 WELL VOLUMES	50.6	50.8	50.5	53.6

Figure C-9

CALCIUM (TOTAL)

WELL 3106

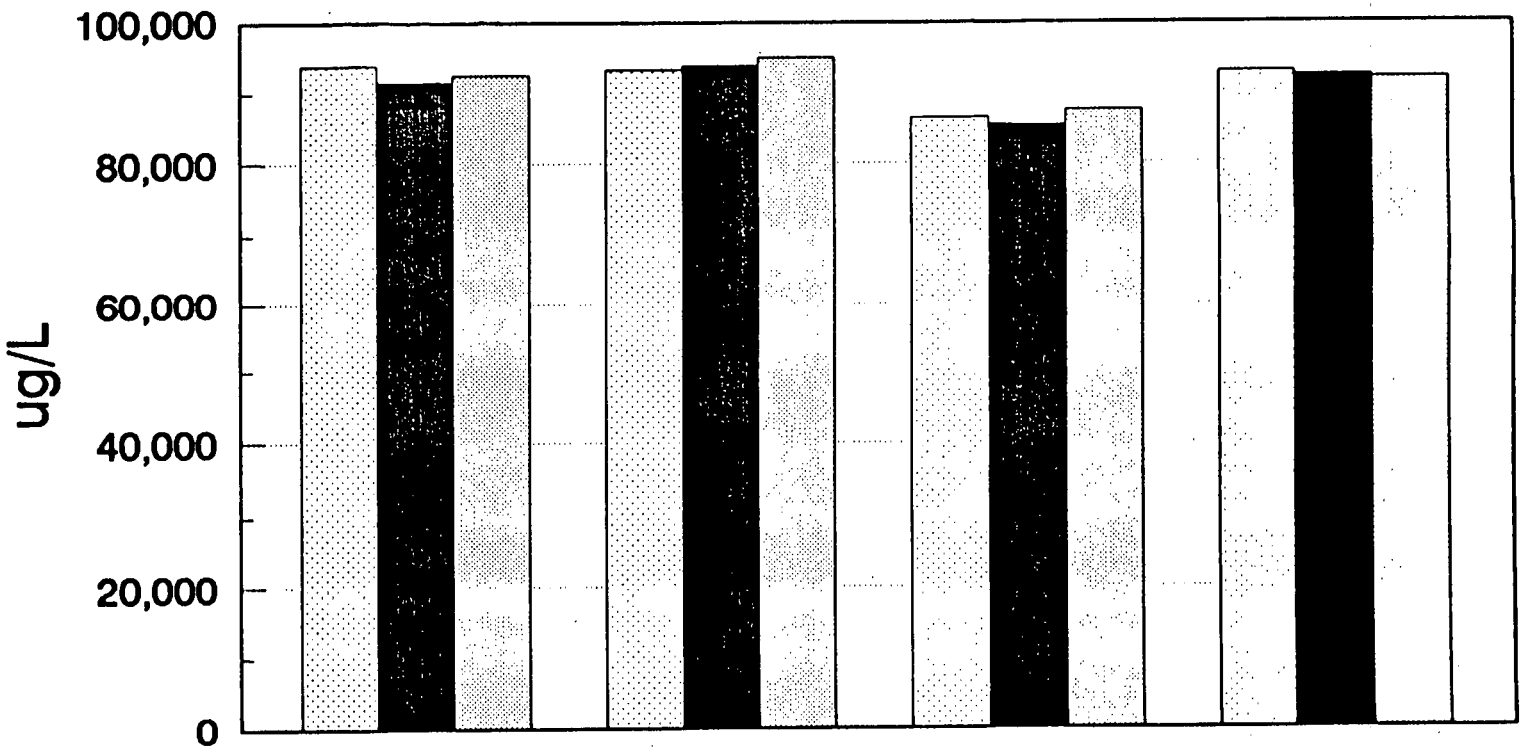


DATE	6/03/93	6/07/93	6/11/93	6/15/93
2X LINE	93,720	92,070	88,140	92,650
1 WELL VOLUME	91,630	92,390	84,870	90,860
3 WELL VOLUMES	90,900	94,200	87,670	90,830

Figure C-10

CALCIUM (FILTERED)

WELL 3106

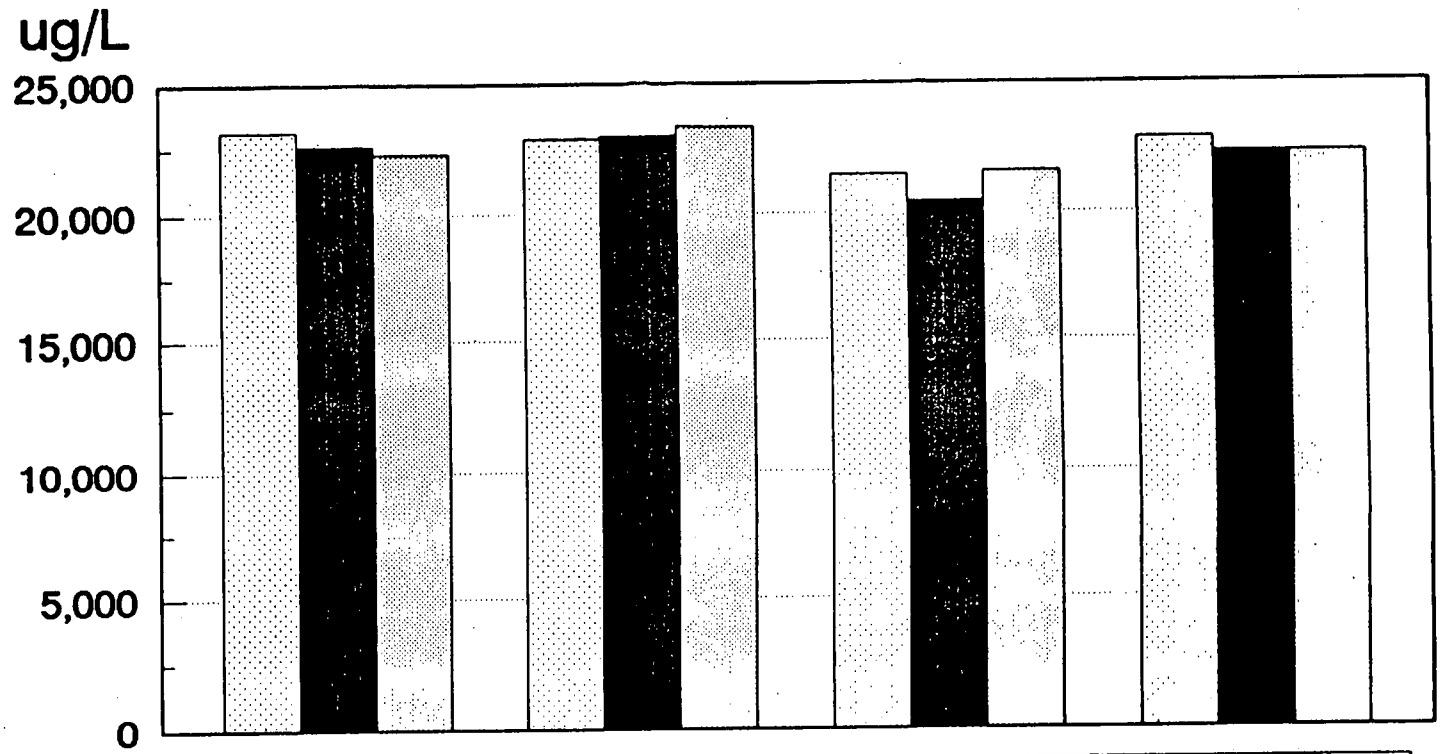


DATE	6/03/93	6/07/93	6/11/93	6/15/93
2X LINE	94,120	93,520	86,410	93,130
1 WELL VOLUME	91,620	94,060	85,350	92,530
3 WELL VOLUMES	92,770	95,170	87,510	92,300

Figure C-11

MAGNESIUM (TOTAL)

WELL 3106

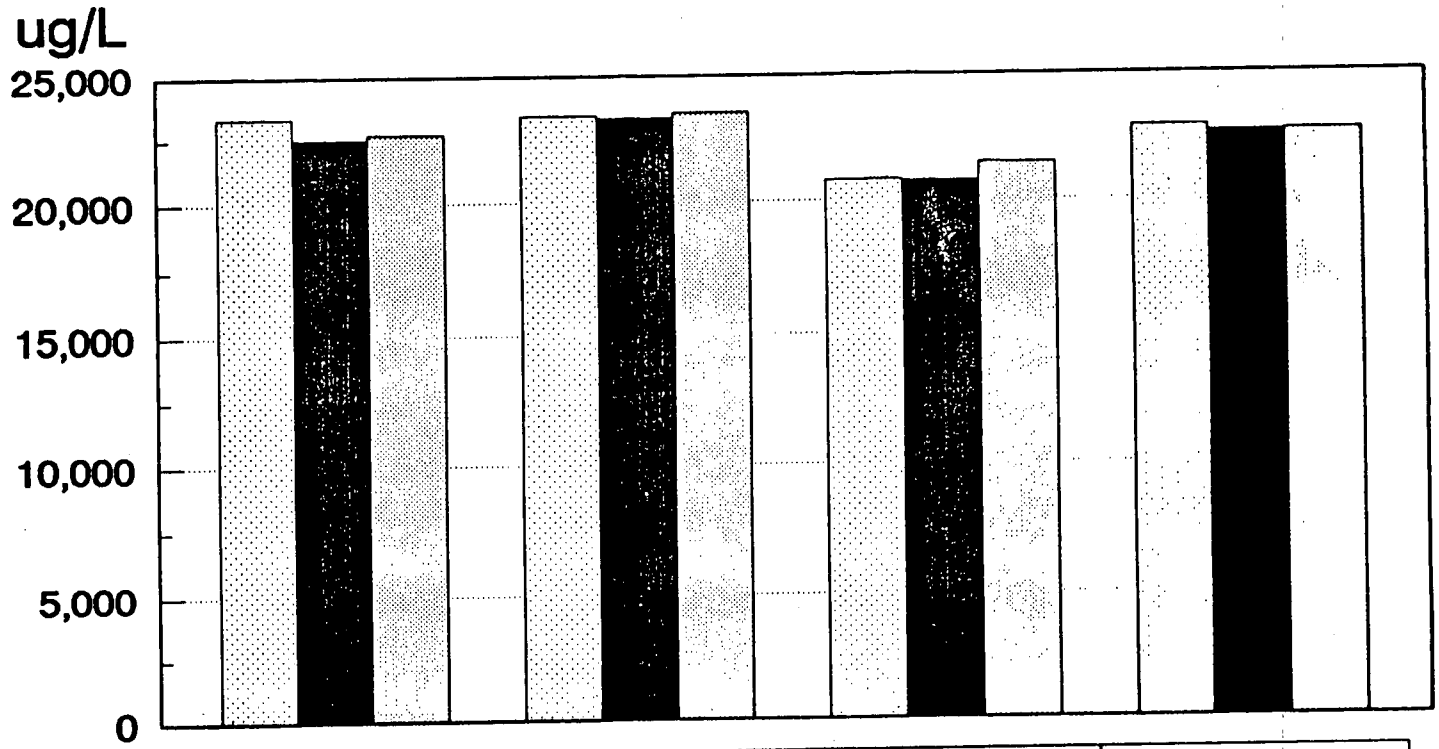


DATE	6/03/93	6/07/93	6/11/93	6/15/93
2X LINE	23,150	22,870	21,480	22,790
1 WELL VOLUME	22,600	22,980	20,440	22,280
3 WELL VOLUMES	22,300	23,300	21,600	22,280

Figure C-12

MAGNESIUM (FILTERED)

WELL 3106

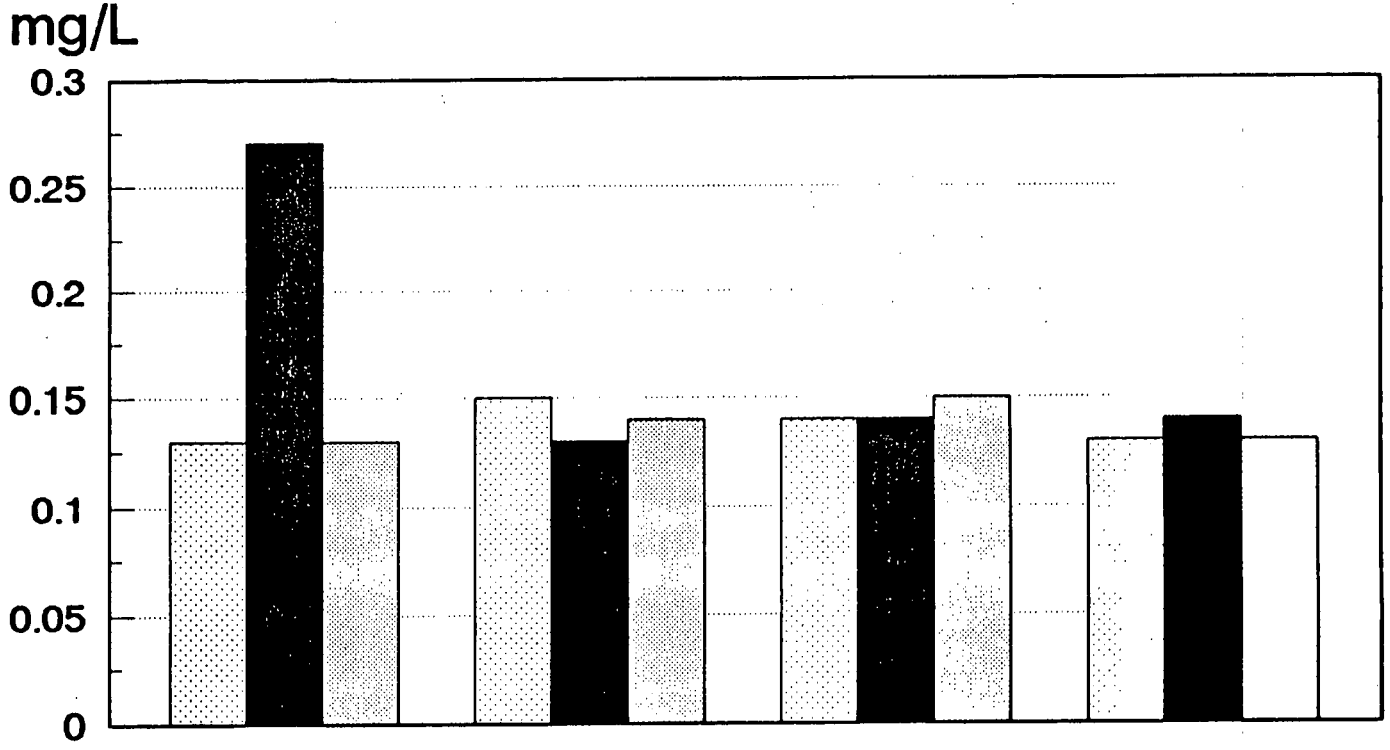


DATE	6/03/93	6/07/93	6/11/93	6/15/93
2X LINE	23,330	23,380	20,860	22,860
1 WELL VOLUME	22,520	23,290	20,770	22,630
3 WELL VOLUMES	22,700	23,510	21,500	22,640

Figure C-13

FLUORIDE

WELL 3106

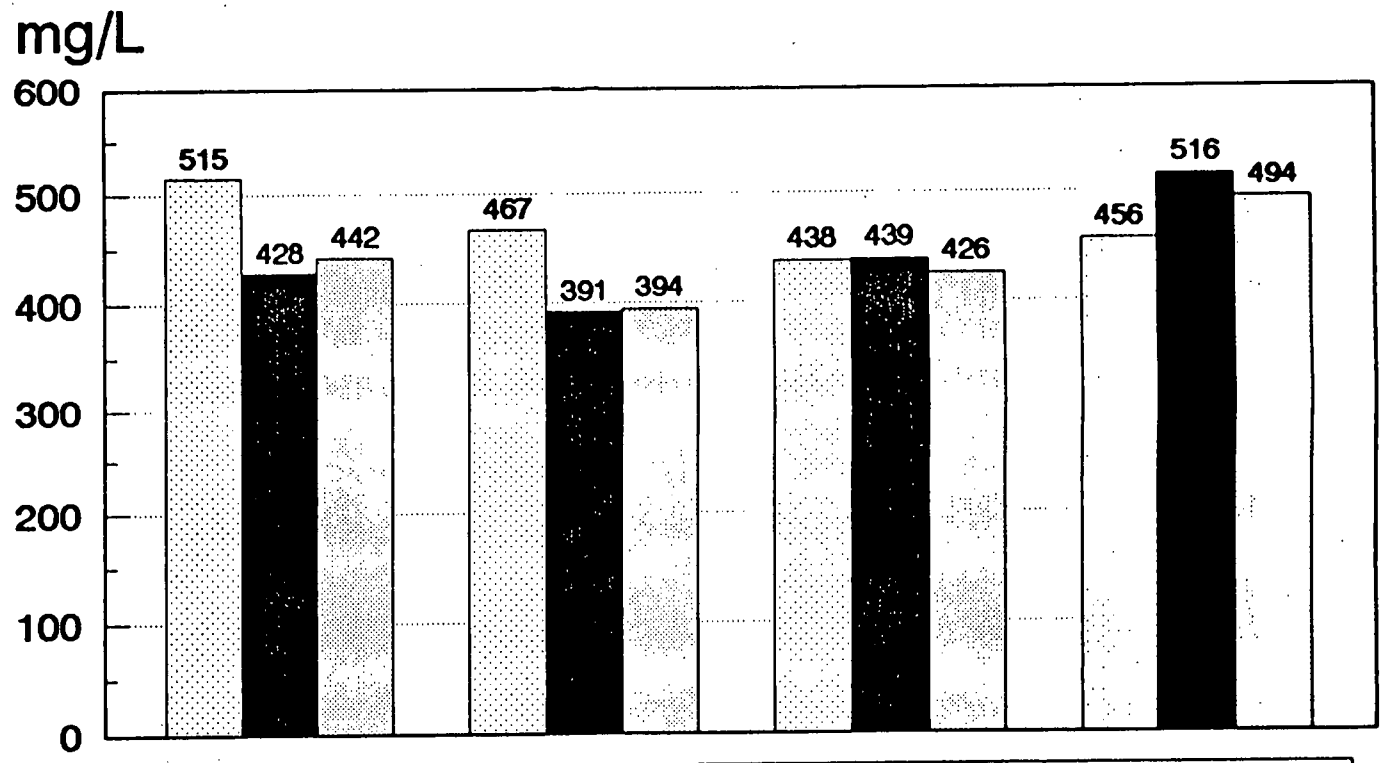


DATE	6/03/93	6/07/93	6/11/93	6/15/93
2X LINE	0.13	0.15	0.14	0.13
1 WELL VOLUME	0.27	0.13	0.14	0.14
3 WELL VOLUMES	0.13	0.14	0.15	0.13

Figure C-14

TOTAL DISSOLVED SOLIDS

WELL 3106

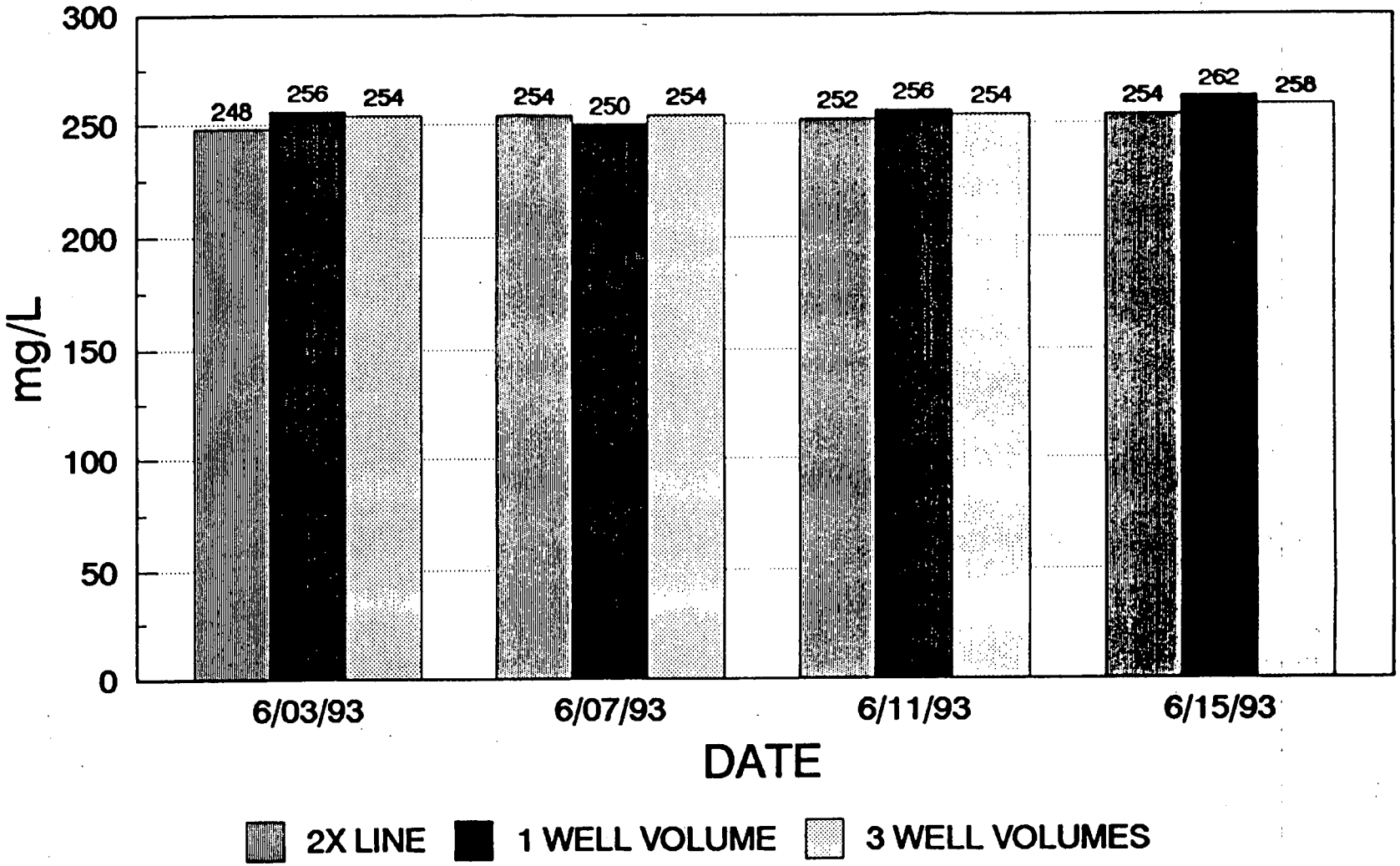


DATE	6/03/93	6/07/93	6/11/93	6/15/93
2X LINE	515	467	438	456
1 WELL VOLUME	428	391	439	516
3 WELL VOLUMES	442	394	426	494

Figure C-15

ALKALINITY DATA

WELL 3106



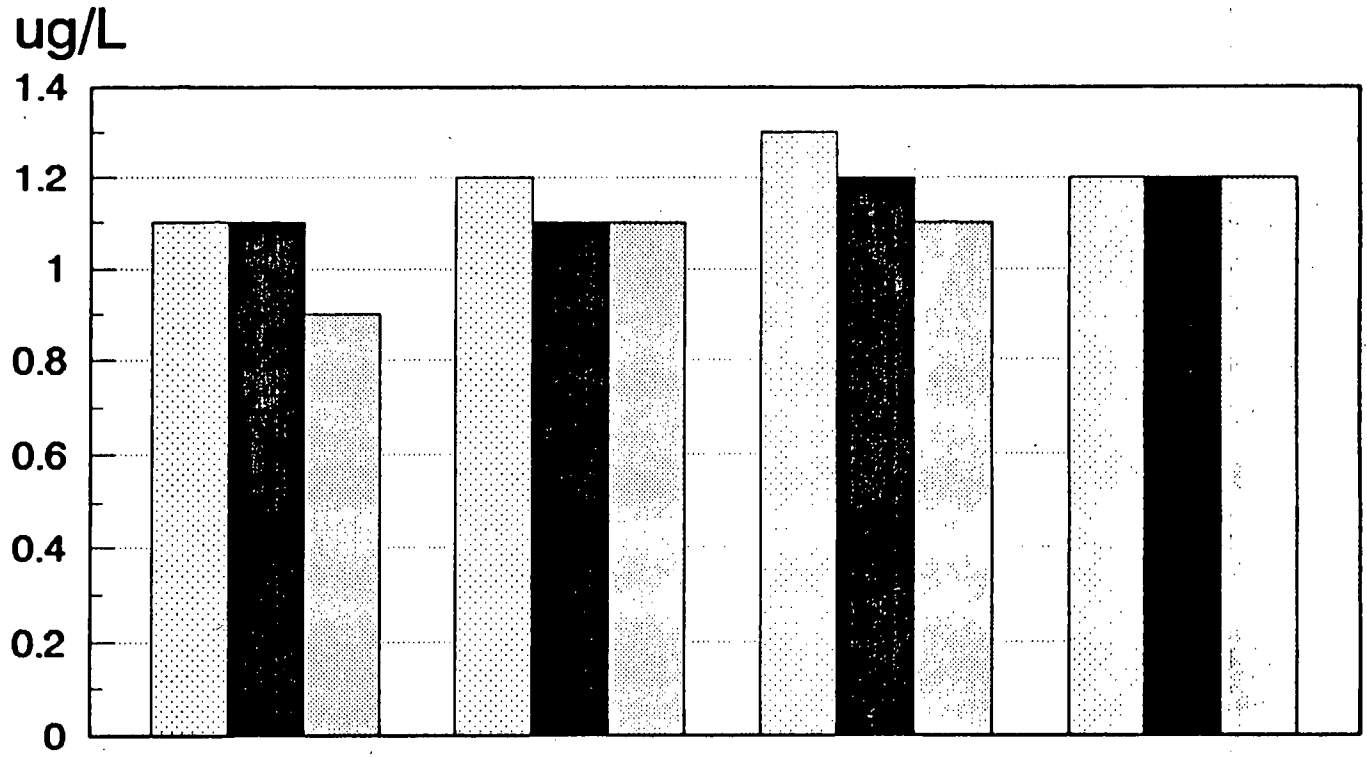
-4984

0083

Figure C-16

URANIUM (TOTAL)

WELL 3106

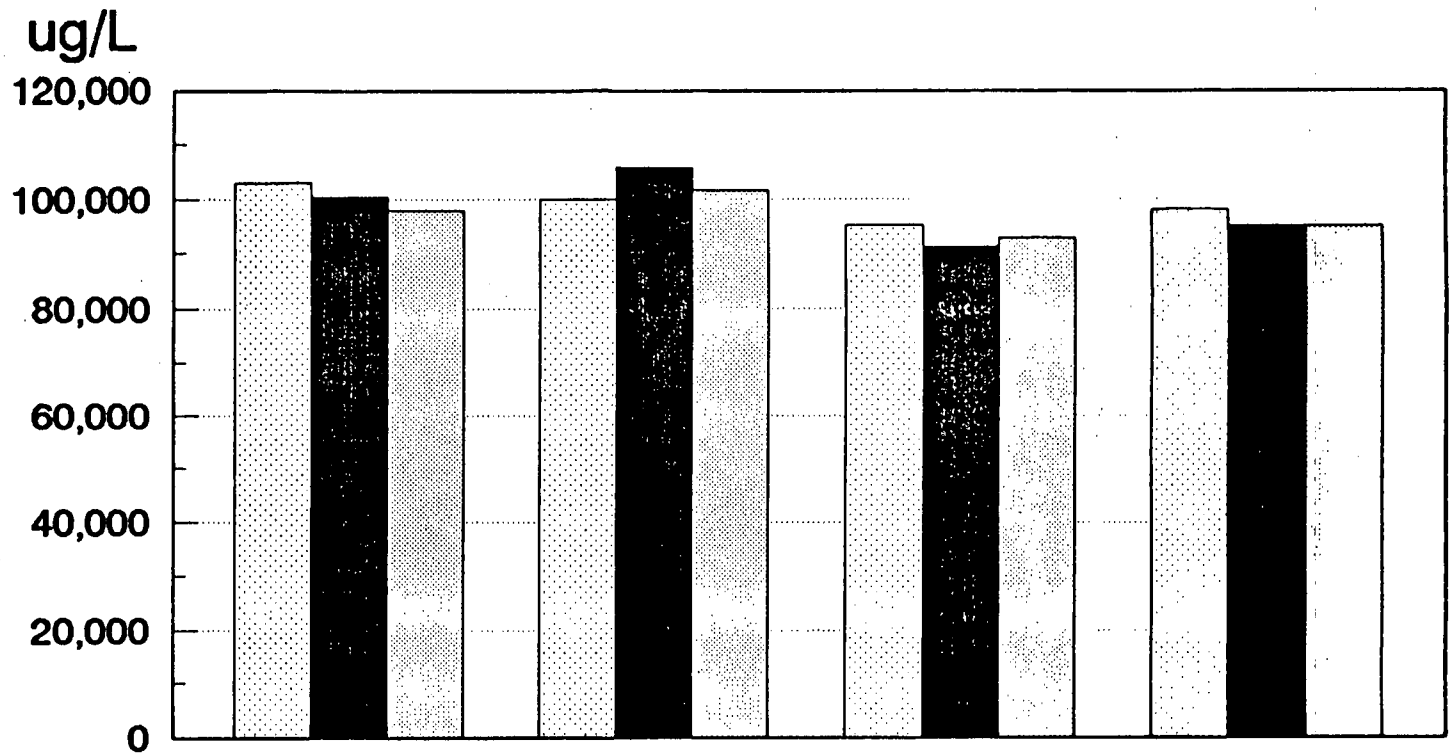


DATE	6/03/93	6/07/93	6/11/93	6/15/93
2X LINE	1.1	1.2	1.3	1.2
1 WELL VOLUME	1.1	1.1	1.2	1.2
3 WELL VOLUMES	0.9	1.1	1.1	1.2

Figure C-17

CALCIUM (TOTAL)

WELL 3391

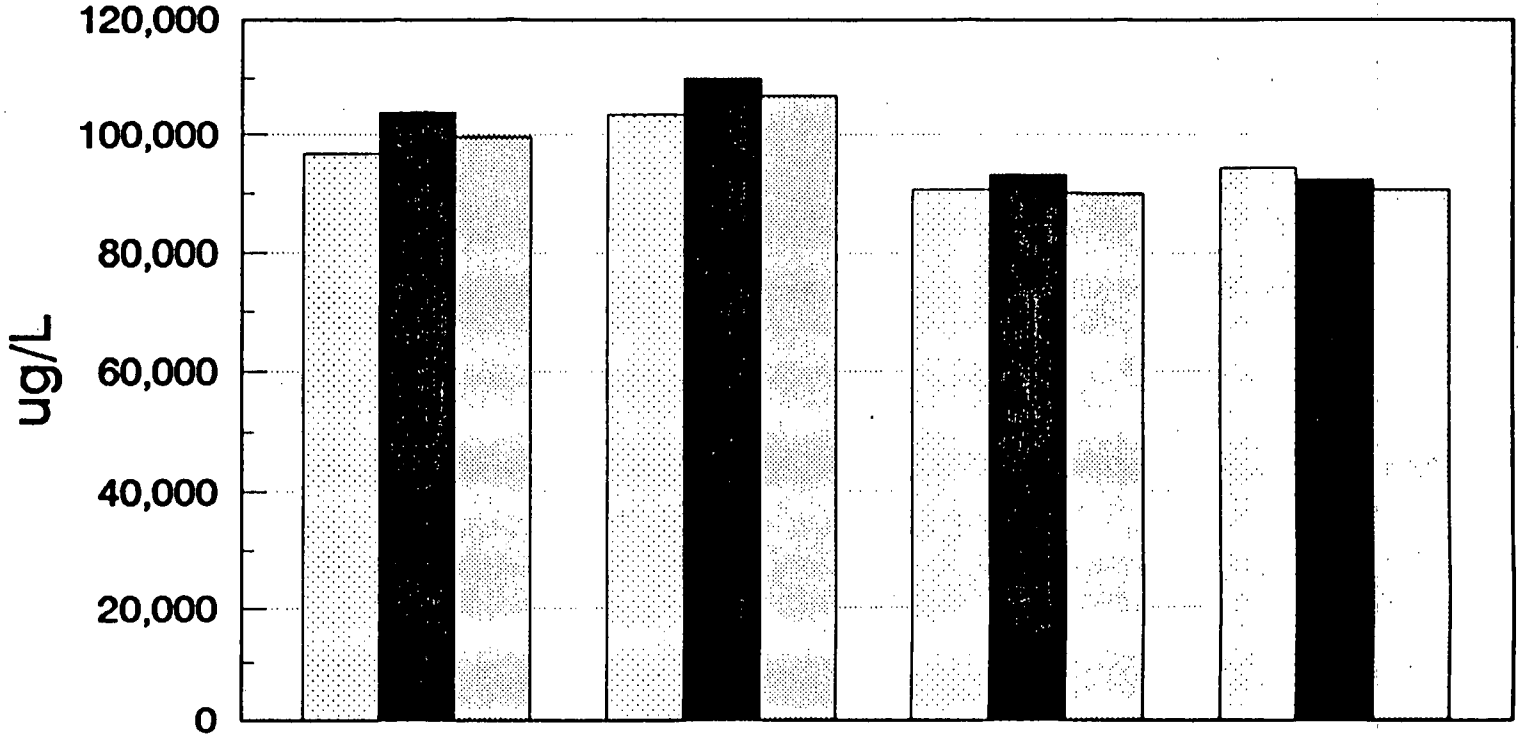


DATE	6/03/93	6/07/93	6/11/93	6/15/93
2X LINE	103,100	100,100	95,040	97,870
1 WELL VOLUME	100,600	105,800	91,100	94,730
3 WELL VOLUMES	97,860	101,800	92,650	94,760

Figure C-18

CALCIUM (FILTERED)

WELL 3391

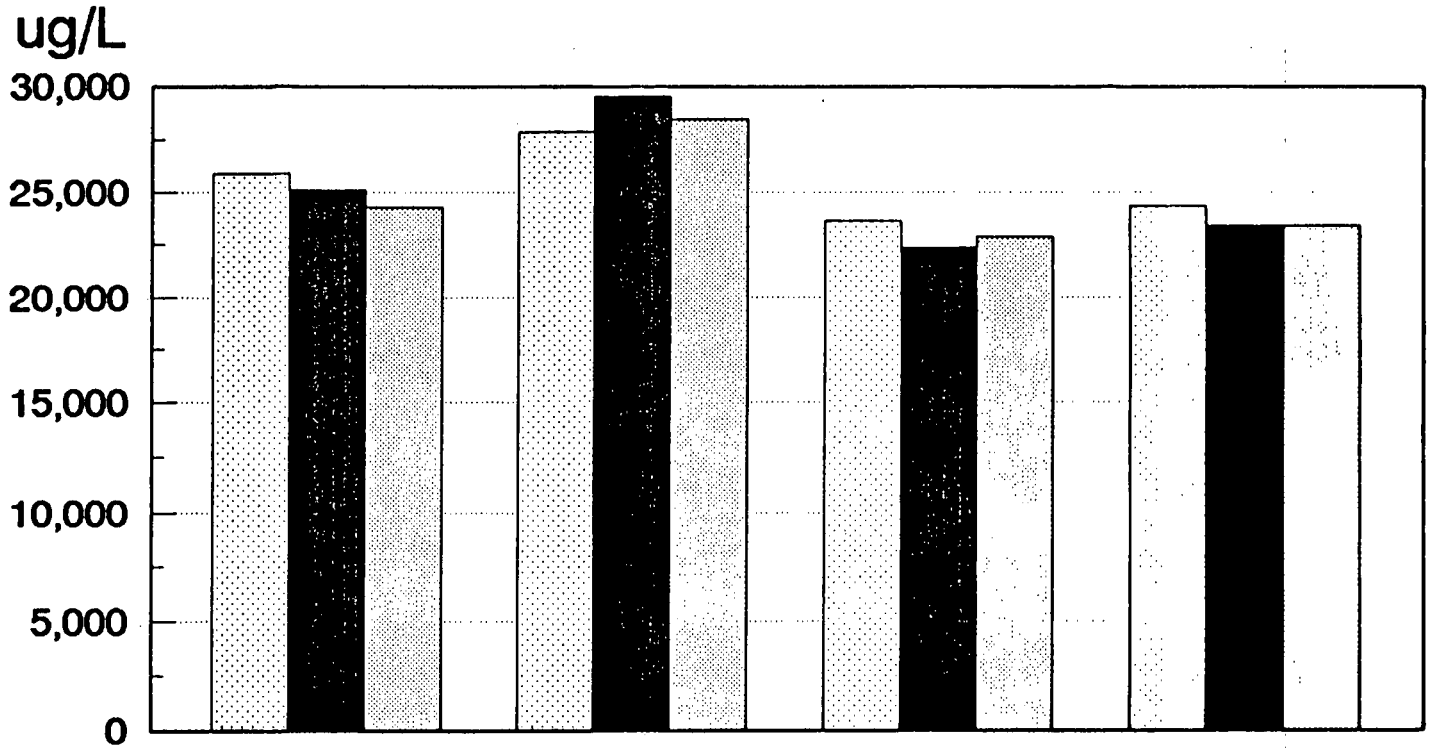


DATE	6/03/93	6/07/93	6/11/93	6/15/93
2X LINE	96,780	103,500	90,620	94,360
1 WELL VOLUME	104,000	110,000	93,140	92,360
3 WELL VOLUMES	99,470	106,900	89,870	90,700

Figure C-19

MAGNESIUM (TOTAL)

WELL 3391

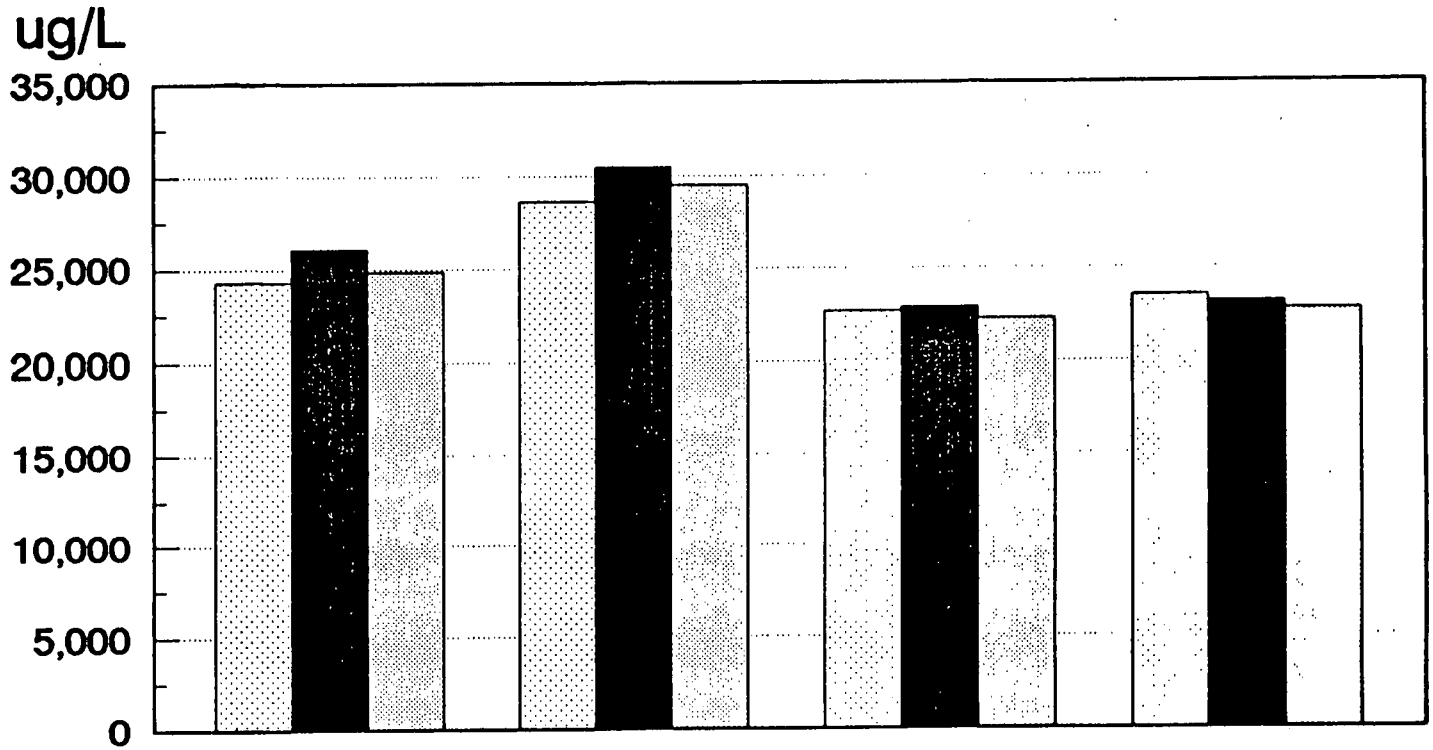


DATE	6/03/93	6/07/93	6/11/93	6/15/93
2X LINE	25,890	27,860	23,630	24,360
1 WELL VOLUME	25,130	29,510	22,370	23,380
3 WELL VOLUMES	24,270	28,430	22,850	23,410

Figure C-20

MAGNESIUM (FILTERED)

WELL 3391

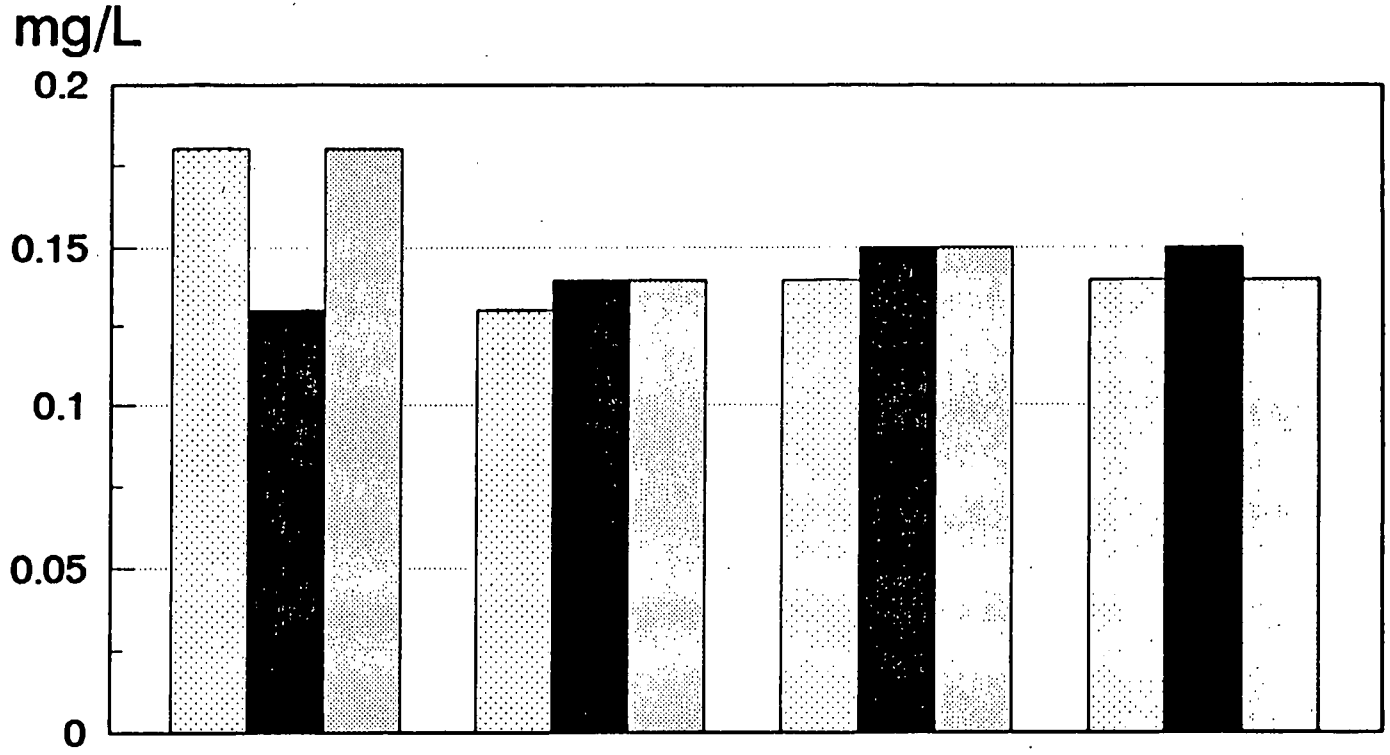


DATE	6/03/93	6/07/93	6/11/93	6/15/93
2X LINE	24,260	28,590	22,630	23,420
1 WELL VOLUME	26,100	30,490	22,820	23,110
3 WELL VOLUMES	24,800	29,490	22,190	22,670

Figure C-21

FLUORIDE

WELL 3391

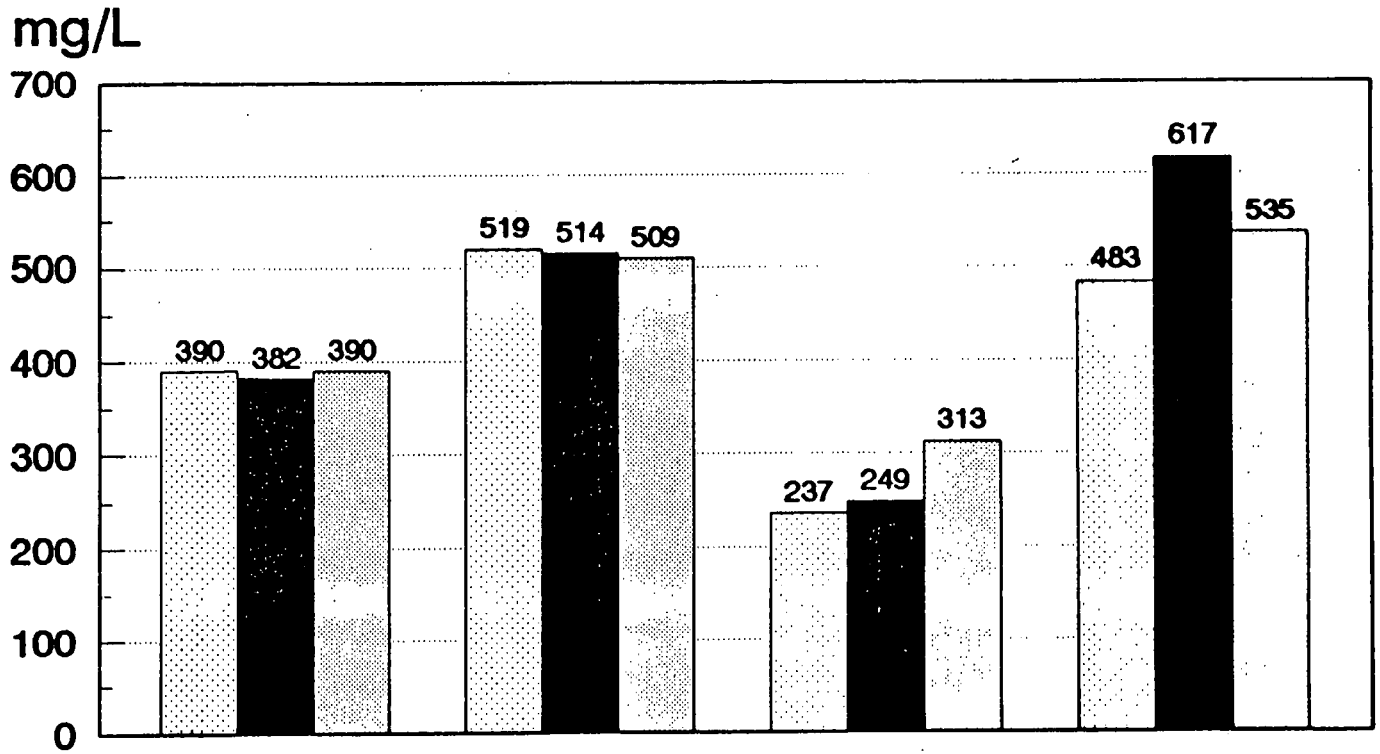


DATE	6/03/93	6/07/93	6/11/93	6/15/93
2X LINE	0.18	0.13	0.14	0.14
1 WELL VOLUME	0.13	0.14	0.15	0.15
3 WELL VOLUMES	0.18	0.14	0.15	0.14

Figure C-22

TOTAL DISSOLVED SOLIDS

WELL 3391



DATE	6/03/93	6/07/93	6/11/93	6/15/93
2X LINE	390	519	237	483
1 WELL VOLUME	382	514	249	617
3 WELL VOLUMES	390	509	313	535

Figure C-23

ALKALINITY DATA

WELL 3391

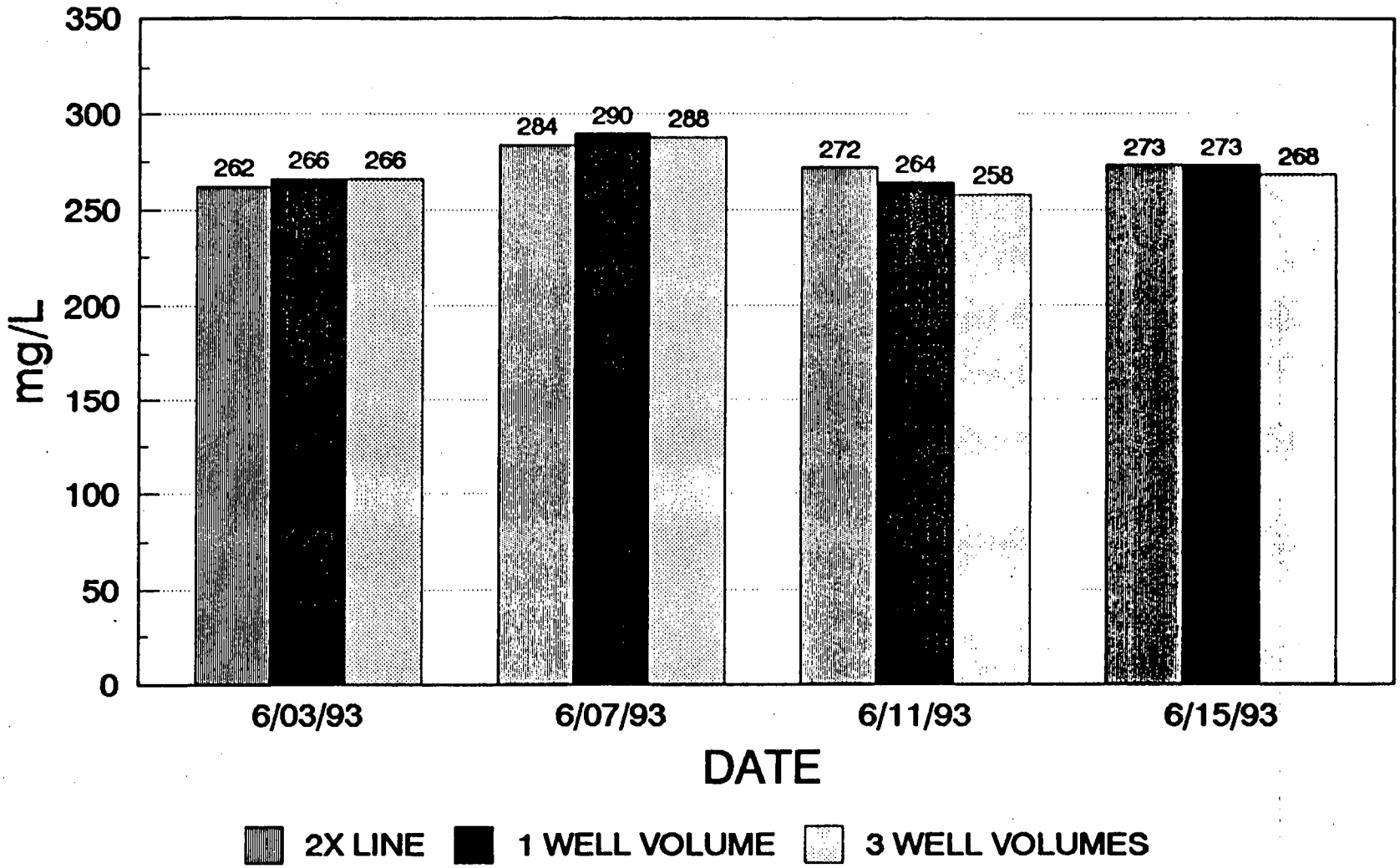
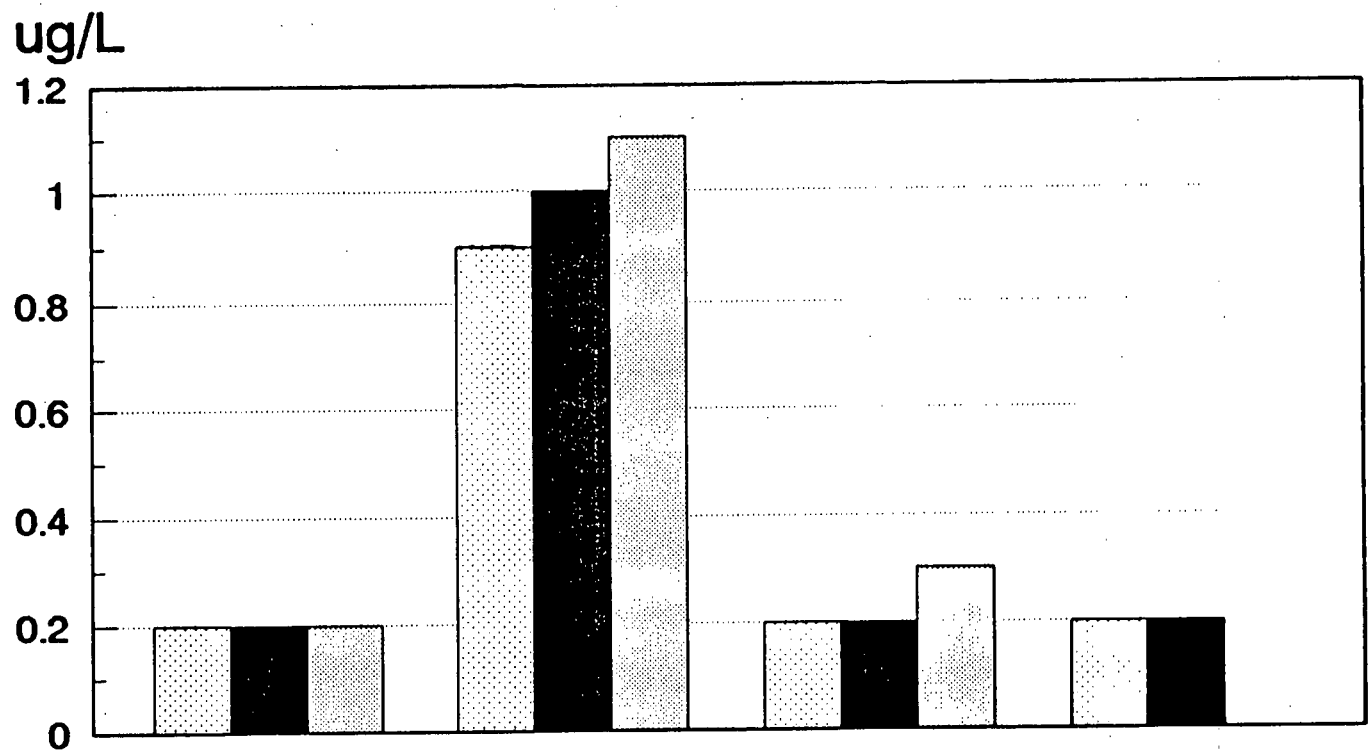


Figure C-24

URANIUM (TOTAL)

WELL 3391

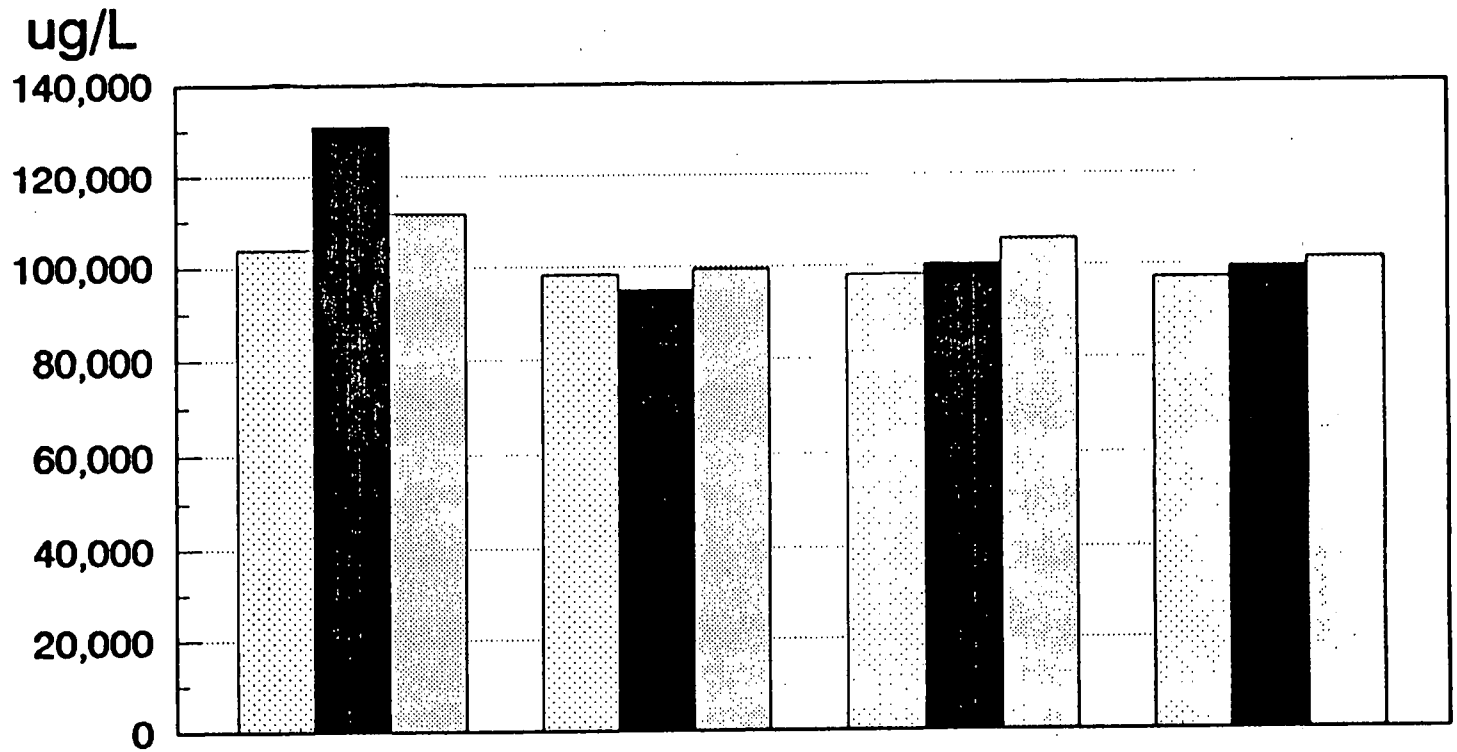


DATE	6/03/93	6/07/93	6/11/93	6/15/93
2X LINE	0.2	0.9	0.2	0.2
1 WELL VOLUME	0.2	1.0	0.2	0.2
3 WELL VOLUMES	0.2	1.1	0.3	

Figure C-25

CALCIUM (TOTAL)

WELL 2391

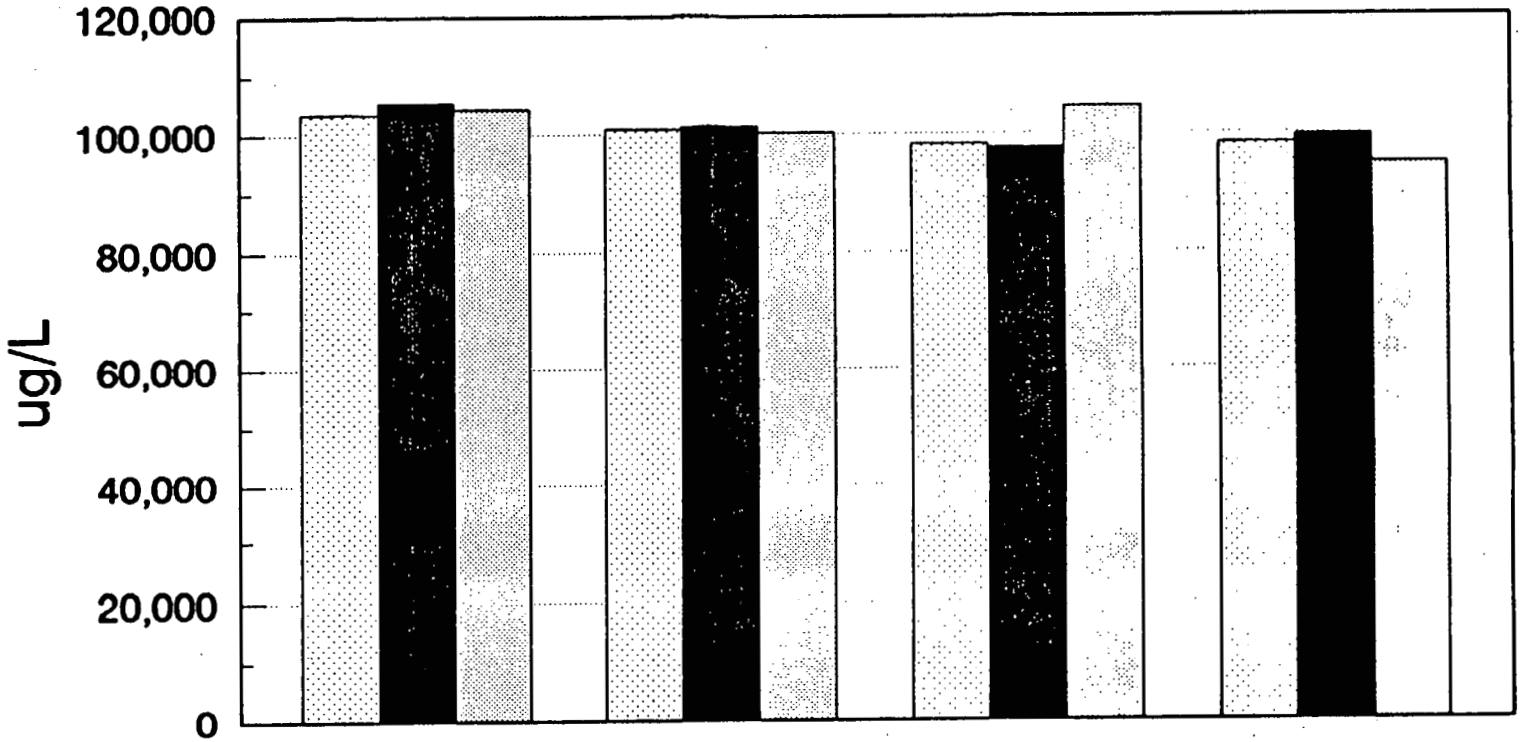


DATE	6/03/93	6/07/93	6/11/93	6/15/93
2X LINE	103,700	98,090	97,870	97,120
1 WELL VOLUME	130,700	94,870	100,100	99,180
3 WELL VOLUMES	111,700	99,190	105,600	101,200

Figure C-26

CALCIUM (FILTERED)

WELL 2391

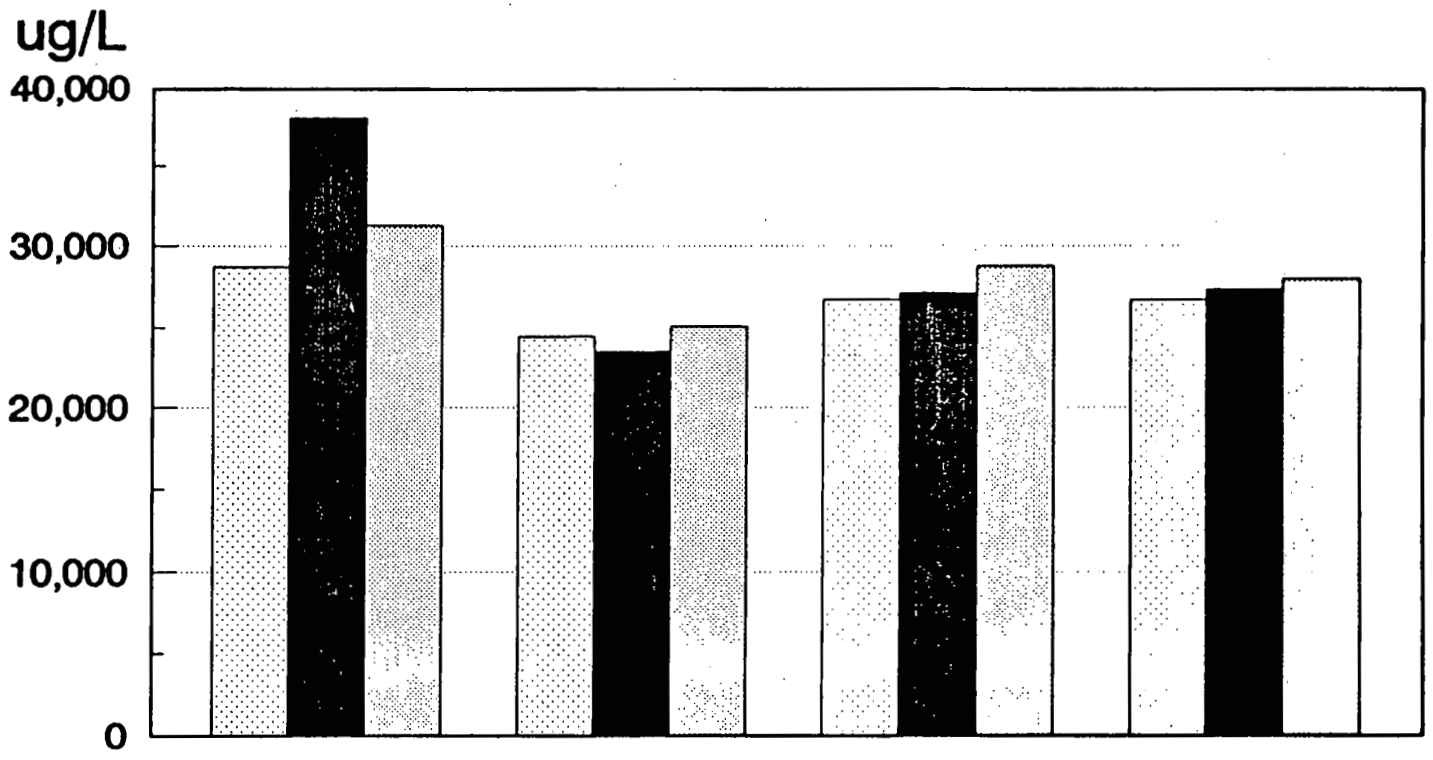


DATE	6/03/93	6/07/93	6/11/93	6/15/93
2X LINE	103,500	100,800	98,200	98,330
1 WELL VOLUME	105,400	101,300	97,620	99,520
3 WELL VOLUMES	104,400	100,100	104,600	94,850

Figure C-27

MAGNESIUM (TOTAL)

WELL 2391

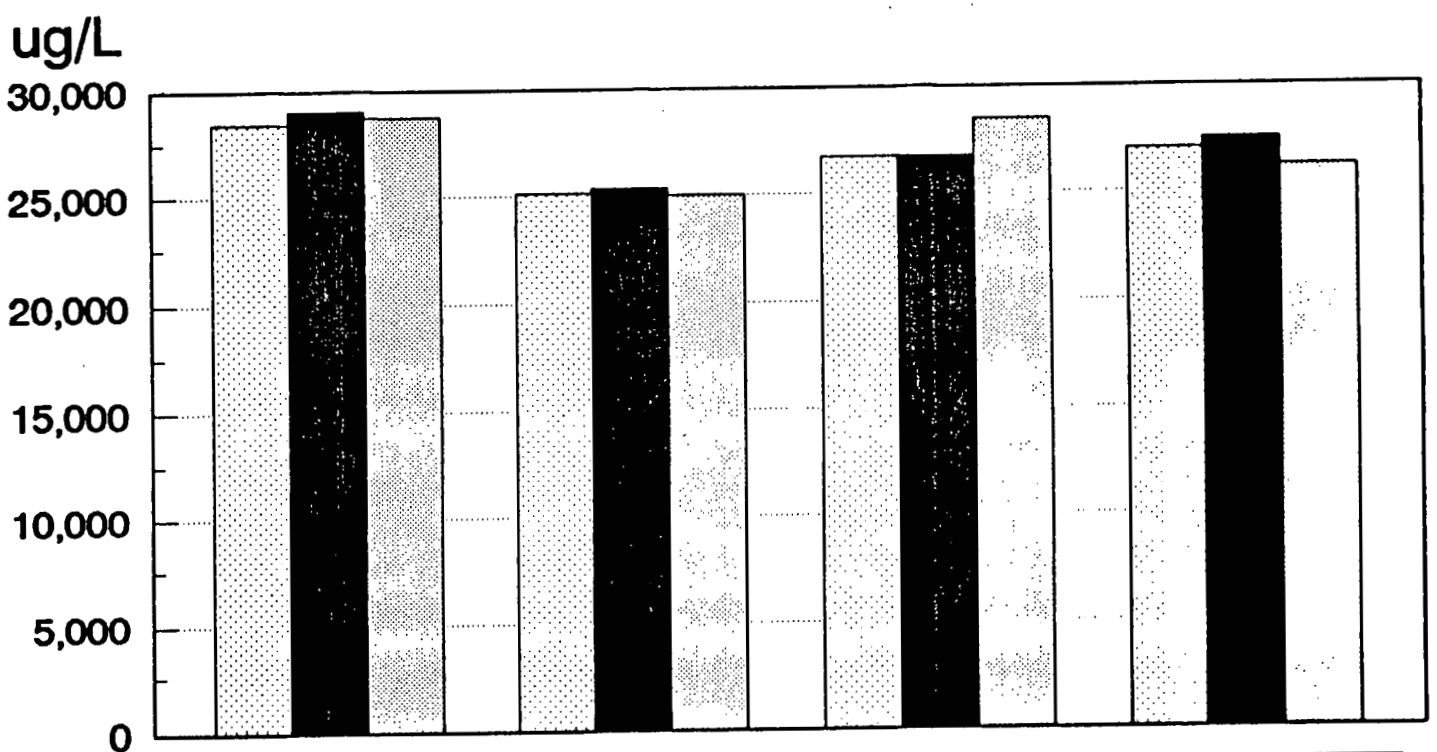


DATE	6/03/93	6/07/93	6/11/93	6/15/93
2X LINE	28,720	24,430	26,700	26,730
1 WELL VOLUME	38,040	23,500	27,140	27,380
3 WELL VOLUMES	31,310	25,030	28,760	28,000

Figure C-28

MAGNESIUM (FILTERED)

WELL 2391

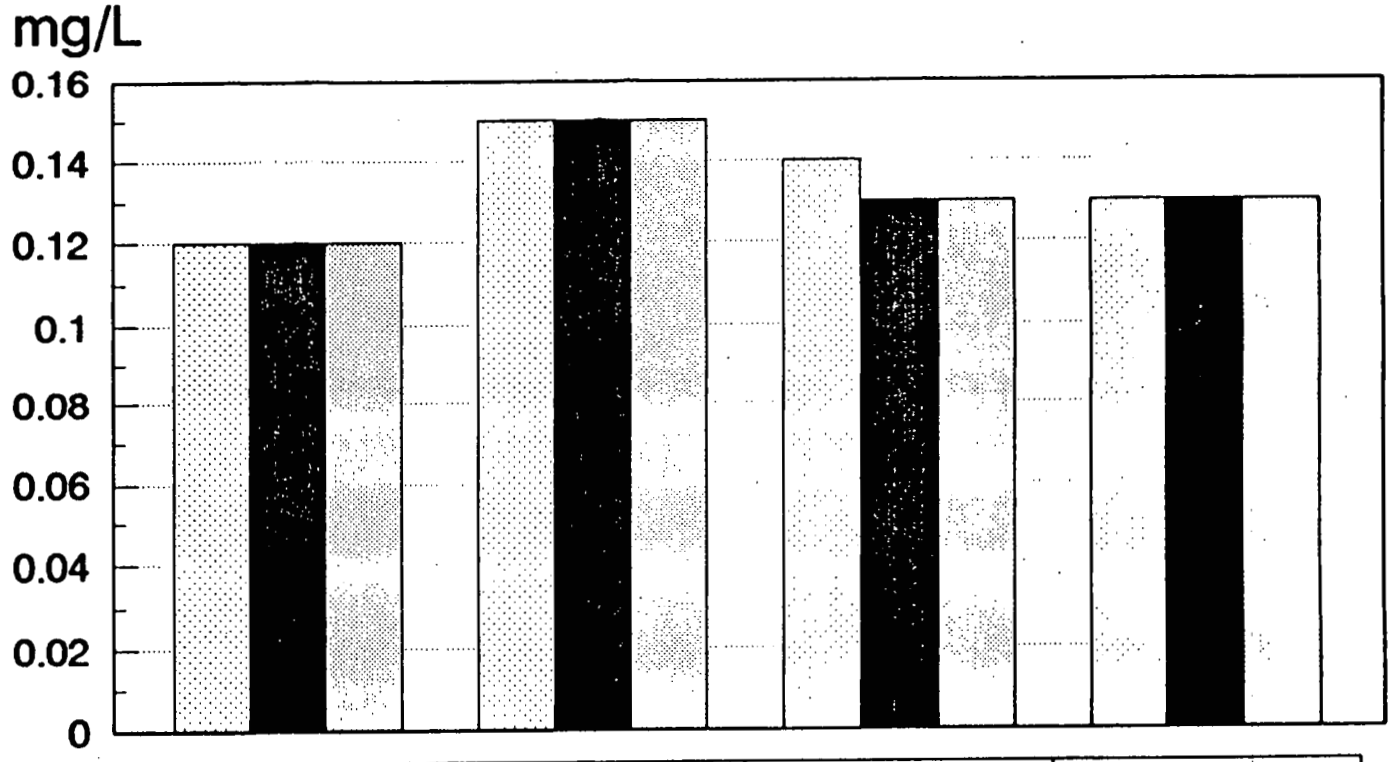


DATE	6/03/93	6/07/93	6/11/93	6/15/93
2X LINE	28,450	25,100	26,740	27,030
1 WELL VOLUME	29,060	25,350	26,740	27,490
3 WELL VOLUMES	28,740	25,010	28,420	26,200

Figure C-29

FLUORIDE

WELL 2391

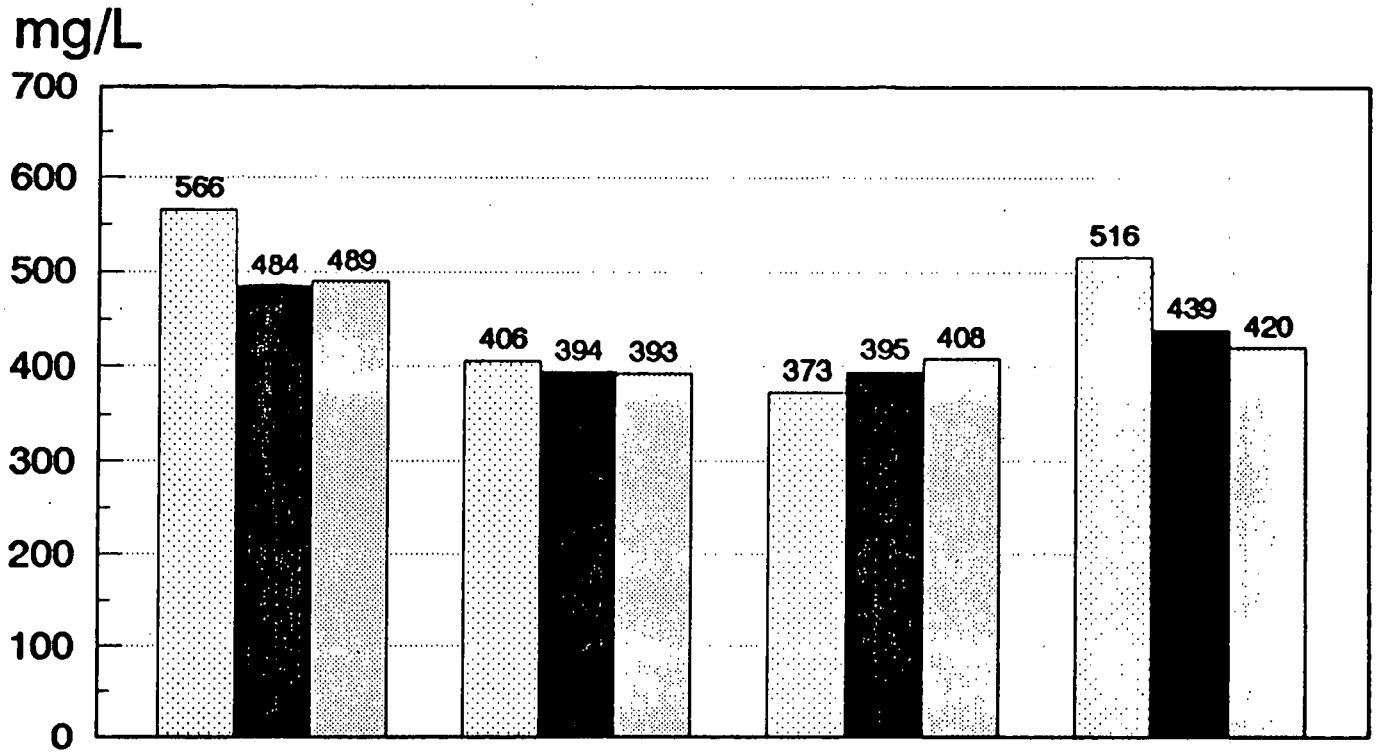


DATE	6/03/93	6/07/93	6/11/93	6/15/93
2X LINE	0.12	0.15	0.14	0.13
1 WELL VOLUME	0.12	0.15	0.13	0.13
3 WELL VOLUMES	0.12	0.15	0.13	0.13

Figure C-30

TOTAL DISSOLVED SOLIDS

WELL 2391



DATE	6/03/93	6/07/93	6/11/93	6/15/93
2X LINE	566	406	373	516
1 WELL VOLUME	484	394	395	439
3 WELL VOLUMES	489	393	408	420

Figure C-31

ALKALINITY DATA

WELL 2391

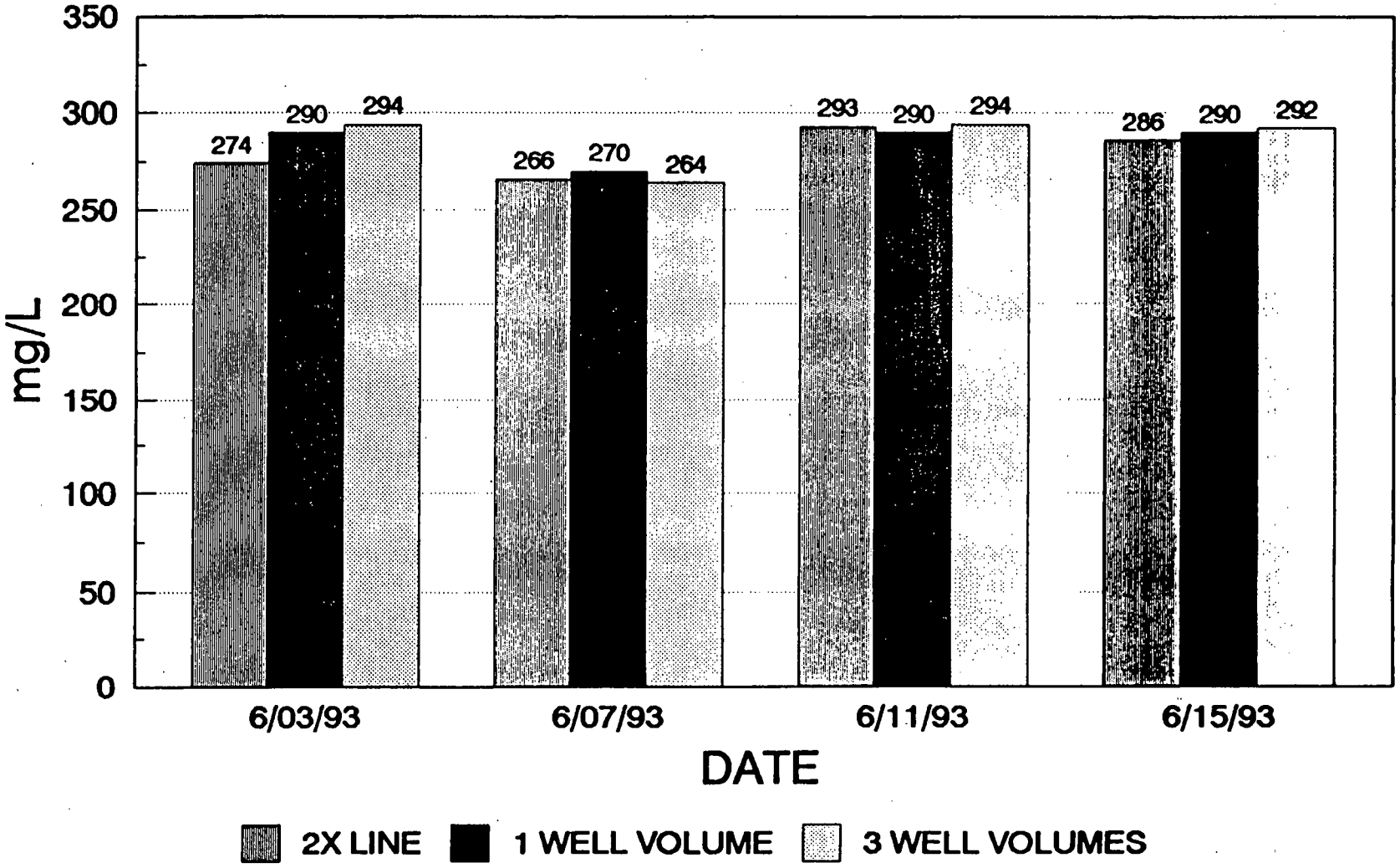
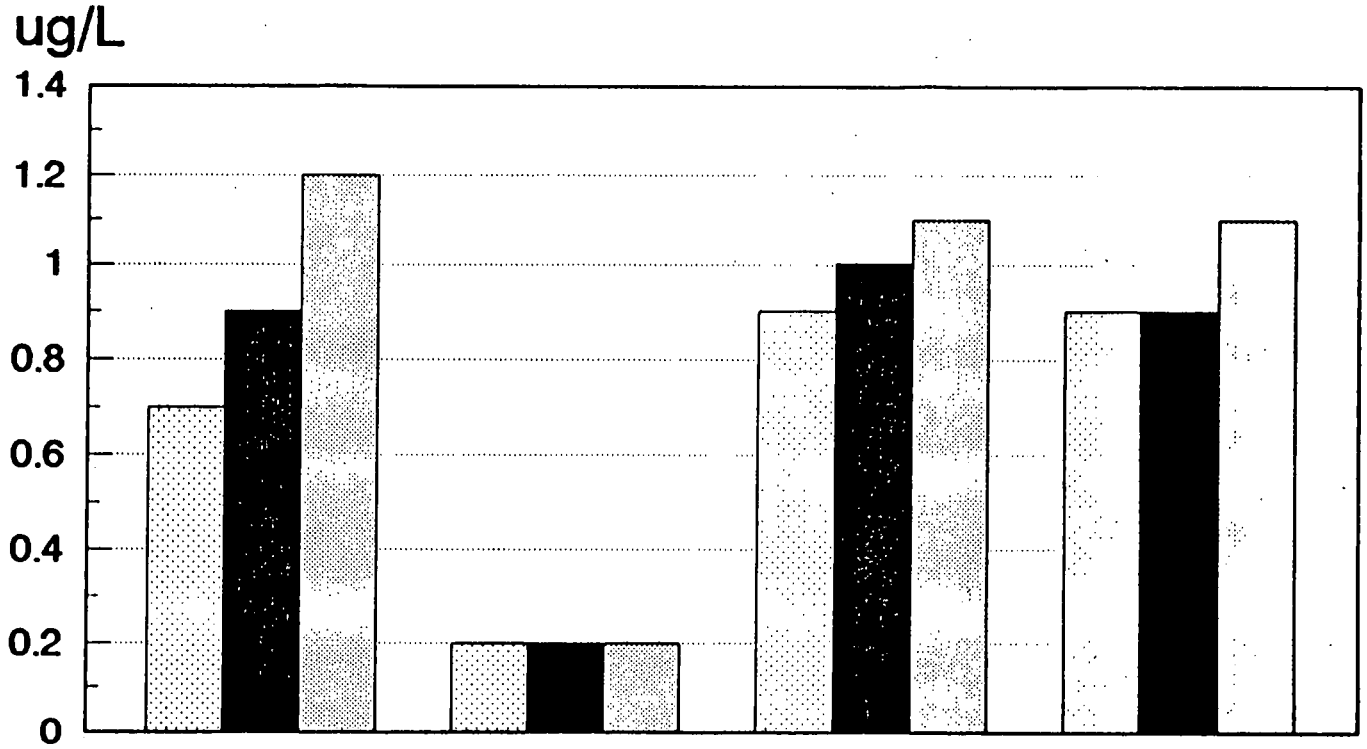


Figure C-32

URANIUM (TOTAL)

WELL 2391



DATE	6/03/93	6/07/93	6/11/93	6/15/93
2X LINE	0.7	0.2	0.9	0.9
1 WELL VOLUME	0.9	0.2	1.0	0.9
3 WELL VOLUMES	1.2	0.2	1.1	1.1

Attachment D

STATISTICAL ANALYSIS COMPUTER CODES AND TABLES

Attachment D-1: SAS Computer Program for Alkalinity (mg/l)

```
OPTIONS LS = 80;
TITLE 'MICRO-PURGE TWO-WAY ANOVA STATISTICAL TEST FOR ALKALINITY (mg/l)';
DATA;
INPUT METHOD WELLNO AMOUNT;
LINES;
1  21  276
1  21  264
1  21  264
1  21  258
2  21  261
2  21  254
2  21  258
2  21  256
3  21  286
3  21  276
3  21  274
3  21  262
1  31  256
1  31  250
1  31  256
1  31  262
2  31  248
2  31  254
2  31  252
2  31  254
3  31  254
3  31  254
3  31  254
3  31  258
1  33  266
1  33  290
1  33  264
1  33  272
2  33  262
2  33  284
2  33  272
2  33  273
3  33  266
3  33  288
3  33  258
3  33  268
1  23  290
1  23  270
1  23  290
1  23  290
2  23  274
2  23  266
2  23  293
2  23  286
3  23  294
3  23  264
3  23  294
3  23  292
;
RUN;
PROC ANOVA;
      CLASS METHOD WELLNO;
      MODEL AMOUNT = METHOD WELLNO METHOD*WELLNO;
      MEANS METHOD WELLNO / TUKEY DUNCAN;
RUN;
PROC ANOVA;
      CLASS METHOD WELLNO;
      MODEL AMOUNT = METHOD WELLNO;
RUN;
```

Attachment D-2: SAS Computer Program for Total Calcium (ug/l) for Well Number 2391

```
OPTIONS LS = 80;
TITLE 'MICRO-PURGE PARAMETRIC STATISTICAL RESULTS FOR TOTAL CALCIUM
(ug/l)';
TITLE2 'WELL NUMBER 2391';
DATA;
INPUT METHOD AMOUNT;
LINES;
1 130700
1 94870
1 100100
1 99180
2 103700
2 98090
2 97870
2 97120
3 111700
3 99190
3 105600
3 101200
;
RUN;
PROC GLM;
      CLASS METHOD;
      MODEL AMOUNT = METHOD;
      MEANS METHOD / TUKEY DUNCAN;
RUN;
```

Table D-1: Micro-purge Two-Way ANOVA Statistical Results

Analytical Parameter	# of Anal.	F-Stat. (Well* Method)	P-Value (Well* Method)	Concl.	F-Stat. (Method)	P-Value (Method)	Concl.
Alkalinity (mg/l)	48	.84	.5489	No inter-action	1.79	.1787	Fail to reject the H_o
Filtered Calcium (ug/l)	47	.19	.9787	No inter-action	.29	.7480	Fail to reject the H_o
Filtered Iron (ug/l)	47	.13	.9909	No inter-action	.16	.8548	Fail to reject the H_o
Filtered Magnesium (ug/l)	47	.10	.9958	No inter-action	.20	.8194	Fail to reject the H_o
Fluoride (mg/l)	48	.98	.4540	No inter-action	.14	.8680	Fail to reject the H_o
Total Calcium (ug/l)	48	.56	.7609	No inter-action	.05	.9496	Fail to reject the H_o
Total Dissolved Solids (mg/l)	48	.33	.9177	No inter-action	.04	.9589	Fail to reject the H_o
Total Iron (ug/l)	48	.91	.5003	No inter-action	.98	.3850	Fail to reject the H_o
Total Magnesium (ug/l)	48	.36	.8988	No inter-action	.05	.9555	Fail to reject the H_o
Total Uranium (ug/l)	47	.76	.6078	No inter-action	1.29	.2851	Fail to reject the H_o

Table D-2a
One-Way ANOVA Statistical Results for Total Calcium (ug/l)

WELL #	# OF ANAL.	F-STATISTIC	P-VALUE	CONCLUSION	VOL.	MEAN
2106	12	.23	.8026	Fail to reject the H_o	2x	96,315.00
					1	94,590.00
					3	95,978.00
3106	12	.35	.7112	Fail to reject the H_o	2x	91,645.00
					1	89,938.00
					3	90,900.00
3391	12	.22	.8051	Fail to reject the H_o	2x	99,028.00
					1	98,058.00
					3	96,768.00
2391	12	.51	.6157	Fail to reject the H_o	2x	99,195.00
					1	106,213.00
					3	104,423.00

Table D-2b
Kruskal-Wallis Statistical Results for Total Calcium (ug/l)

WELL #	# OF ANAL.	X^2-STATISTIC	P-VALUE	CONCLUSION
2106	12	.46	.7939	Fail to reject the H_o
3106	12	1.08	.5836	Fail to reject the H_o
3391	12	.81	.6677	Fail to reject the H_o
2391	12	.51	.6189	Fail to reject the H_o

Table D-3a
One-Way ANOVA Statistical Results for Filtered Calcium (ug/l)

WELL #	# OF ANAL.	F-STATISTIC	P-VALUE	CONCLUSION	VOL.	MEAN
2106	11	.18	.8383	Fail to reject the H_o	2x	93,260.00
					1	94,743.00
					3	93,140.00
3106	12	.10	.9041	Fail to reject the H_o	2x	91,795.00
					1	90,890.00
					3	91,938.00
3391	12	.27	.7690	Fail to reject the H_o	2x	96,315.00
					1	99,875.00
					3	96,735.00
2391	12	.06	.9409	Fail to reject the H_o	2x	100,208.00
					1	100,960.00
					3	100,988.00

Table D-3b
Kruskal-Wallis Statistical Results for Filtered Calcium (ug/l)

WELL #	# OF ANAL.	X^2-STATISTIC	P-VALUE	CONCLUSION
2106	11	.35	.8401	Fail to rejcet the H_o
3106	12	.81	.6677	Fail to reject the H_o
3391	12	.73	.6939	Fail to reject the H_o
2391	12	.27	.8741	Fail to reject the H_o

Table D-4a
One-Way ANOVA Statistical Results for Total Iron (ug/l)

WELL #	# OF ANAL.	F-STATISTIC	P-VALUE	CONCLUSION	VOL.	MEAN
2106	12	.96	.4178	Fail to reject the H_o	2x	519.00
					1	53.00
					3	97.00
3106	12	1.76	.2262	Fail to reject the H_o	2x	9.53
					1	13.97
					3	4.15
3391	12	.03	.9697	Fail to reject the H_o	2x	1681.00
					1	1712.70
					3	1539.10
2391	12	.99	.4087	Fail to reject the H_o	2x	3226
					1	5280
					3	1558

Table D-4b
Kruskal-Wallis Statistical Results for Total Iron (ug/l)

WELL #	# OF ANAL.	X^2-STATISTIC	P-VALUE	CONCLUSION
2106	12	.50	.7788	Fail to reject the H_o
3106	12	3.63	.1630	Fail to reject the H_o
3391	12	.81	.6677	Fail to reject the H_o
2391	12	1.19	.5509	Fail to reject the H_o

Table D-5a
One-Way ANOVA Statistical Results for Filtered Iron (ug/l)

WELL #	# OF ANAL.	F-STATISTIC	P-VALUE	CONCLUSION	VOL.	MEAN
2106	11	.82	.4727	Fail to reject the H_o	2x	7.00
					1	278.40
					3	10.20
3106	12	.62	.5604	Fail to reject the H_o	2x	6.30
					1	14.55
					3	12.33
3391	12	.05	.9536	Fail to reject the H_o	2x	1678.30
					1	1622.10
					3	1547.50
2391	12	.09	.9175	Fail to reject the H_o	2x	516.80
					1	725.60
					3	779.40

Table D-5b
Kruskal-Wallis Statistical Results for Filtered Iron (ug/l)

WELL #	# OF ANAL.	X^2-STATISTIC	P-VALUE	CONCLUSION
2106	11	.06	.9713	Fail to reject the H_o
3106	12	1.61	.4465	Fail to reject the H_o
3391	12	1.66	.4361	Fail to reject the H_o
2391	12	.27	.8741	Fail to reject the H_o

Table D-6a
One-Way ANOVA Statistical Results for Total Magnesium (ug/l)

WELL #	# OF ANAL.	F-STATISTIC	P-VALUE	CONCLUSION	VOL.	MEAN
2106	12	.34	.7176	Fail to reject the H_o	2x	23,990.00
					1	23,455.00
					3	23,885.00
3106	12	.32	.7310	Fail to reject the H_o	2x	22,572.00
					1	22,075.00
					3	22,370.00
3391	12	.07	.9301	Fail to reject the H_o	2x	25,435.00
					1	25,098.00
					3	24,740.00
2391	12	.36	.7078	Fail to reject the H_o	2x	26,645.00
					1	29,015.00
					3	28,275.00

Table D-6b
Kruskal-Wallis Statistical Results for Total Magnesium (ug/l)

WELL #	# OF ANAL.	X^2-STATISTIC	P-VALUE	CONCLUSION
2106	12	.73	.6939	Fail to reject the H_o
3106	12	.55	.7596	Fail to reject the H_o
3391	12	.73	.6939	Fail to reject the H_o
2391	12	1.38	.5004	Fail to reject the H_o

Table D-7a
One-Way ANOVA Statistical Results for Filtered Magnesium (ug/l)

WELL #	# OF ANAL.	F-STATISTIC	P-VALUE	CONCLUSION	VOL.	MEAN
2106	11	.43	.6660	Fail to reject the H_o	2x	23,082.50
					1	23,652.50
					3	22,866.70
3106	12	.11	.8994	Fail to reject the H_o	2x	22,607.50
					1	22,302.50
					3	22,587.50
3391	12	.10	.9065	Fail to reject the H_o	2x	24,725.00
					1	25,630.00
					3	24,788.00
2391	12	.05	.9527	Fail to reject the H_o	2x	26,830.00
					1	27,160.00
					3	27,093.00

Table D-7b
Kruskal-Wallis Statistical Results for Filtered Magnesium (ug/l)

WELL #	# OF ANAL.	X^2-STATISTIC	P-VALUE	CONCLUSION
2106	11	.35	.8401	Fail to reject the H_o
3106	12	1.50	.4724	Fail to reject the H_o
3391	12	.50	.7788	Fail to reject the H_o
2391	12	.18	.9124	Fail to reject the H_o

Table D-8a
One-Way ANOVA Statistical Results for Fluoride (mg/l)

WELL #	# OF ANAL.	F-STATISTIC	P-VALUE	CONCLUSION	VOL.	MEAN
2106	12	1.04	.3935	Fail to reject the H_o	2x	.26
					1	.25
					3	.26
3106	12	.91	.4371	Fail to reject the H_o	2x	.14
					1	.17
					3	.14
3391	12	.32	.7351	Fail to reject the H_o	2x	.15
					1	.14
					3	.15
2391	12	.05	.9499	Fail to reject the H_o	2x	.14
					1	.13
					3	.13

Table D-8b
Kruskal-Wallis Statistical Results for Fluoride (mg/l)

WELL #	# OF ANAL.	X^2-STATISTIC	P-VALUE	CONCLUSION
2106	12	1.94	.3792	Fail to reject the H_o
3106	12	.52	.7720	Fail to reject the H_o
3391	12	.67	.7166	Fail to reject the H_o
2391	12	.13	.9380	Fail to reject the H_o

Table D-9a
One-Way ANOVA Statistical Results for
Total Dissolved Solids (mg/l)

WELL #	# OF ANAL.	F-STATISTIC	P-VALUE	CONCLUSION	VOL.	MEAN
2106	12	.76	.4936	Fail to reject the H_o	2x	370.25
					1	377.50
					3	417.00
3106	12	.56	.5886	Fail to reject the H_o	2x	469.00
					1	443.50
					3	439.00
3391	12	.08	.9272	Fail to reject the H_o	2x	407.25
					1	440.50
					3	436.75
2391	12	.47	.6376	Fail to reject the H_o	2x	465.25
					1	428.00
					3	427.25

Table D-9b
Kruskal-Wallis Statistical Results for
Total Dissolved Solids (ug/l)

WELL #	# OF ANAL.	X^2-STATISTIC	P-VALUE	CONCLUSION
2106	12	1.42	.4909	Fail to reject the H_o
3106	12	1.42	.4909	Fail to reject the H_o
3391	12	.18	.9124	Fail to reject the H_o
2391	12	.27	.8741	Fail to reject the H_o

Table D-10a
One-Way ANOVA Statistical Results for Alkalinity (mg/l)

WELL #	# OF ANAL.	F-STATISTIC	P-VALUE	CONCLUSION	VOL.	MEAN
2106	12	5.48	.0277	Reject the H_o. Well volumes 2x and 3 are significantly different	2x	257.25
					1	265.50
					3	274.50
3106	12	1.44	.2857	Fail to reject the H_o	2x	252.00
					1	256.00
					3	255.00
3391	12	.09	.9177	Fail to reject the H_o	2x	272.75
					1	273.00
					3	270.00
2391	12	.29	.7529	Fail to reject the H_o	2x	279.75
					1	285.00
					3	286.00

Table D-10b
Kruskal-Wallis Statistical Results for Alkalinity (mg/l)

WELL #	# OF ANAL.	X^2-STATISTIC	P-VALUE	CONCLUSION
2106	12	6.83	.0329	Reject the H_o
3106	12	3.28	.1941	Fail to reject the H_o
3391	12	.38	.8279	Fail to reject the H_o
2391	12	1.53	.4661	Fail to reject the H_o

Table D-11a
One-Way ANOVA Statistical Results for Total Uranium (ug/l)

WELL #	# OF ANAL.	F-STATISTIC	P-VALUE	CONCLUSION	VOL.	MEAN
2106	12	1.07	.3843	Fail to reject the H_o	2x	50.25
					1	50.78
					3	51.38
3106	12	1.84	.2140	Fail to reject the H_o	2x	1.20
					1	1.15
					3	1.08
3391	11	.14	.8690	Fail to reject the H_o	2x	.38
					1	.40
					3	.53
2391	12	.34	.7218	Fail to reject the H_o	2x	.68
					1	.75
					3	.90

Table D-11b
Kruskal-Wallis Statistical Results for Total Uranium (ug/l)

WELL #	# OF ANAL.	X^2-STATISTIC	P-VALUE	CONCLUSION
2106	12	1.44	.4860	Fail to reject the H_o
3106	12	2.86	.2391	Fail to reject the H_o
3391	11	1.41	.4935	Fail to reject the H_o
2391	12	2.72	.2567	Fail to reject the H_o