**Radiological Status of the
Ground-Water Beneath the
Hanford Project
January-December 1978**

April 1979

**Prepared for the U.S. Department of Energy
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**Pacific Northwest Laboratory
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P. A. Eddy

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Prepared for U.S. Department of Energy under
Contract EY-76-C-06-1830

Pacific Northwest Laboratory
Richland, Washington 99352

SUMMARY

This report is one of a series prepared annually for the Department of Energy, to provide an evaluation of the status of ground-water contamination resulting from Hanford's onsite discharges.

Data collected during 1978 describe the movement of major plumes (β_t , 3_H , NO_3) that respond to the influences of ground-water flow, ionic dispersion and radioactive decay. The total beta plume continues to recede, with the exception of a beta source that is beginning to show up in the 300 Area, a result of minor spills and leaks which have occurred during the operating life of the 300 Area.

The tritium plume continues to expand and is mapped as having reached the Columbia River, although its contribution to the river cannot be distinguished from that attributable to atmospheric fallout. The plume now shows much the same configuration as in 1977. The nitrate plume shows general stability relative to its size with concentrations in the vicinity of the 100-H Area continuing to be high as a result of leaks from the evaporation facility.

The results of a study to determine the vertical distribution of contaminants in the Hanford ground-water system indicate that the majority of contaminants are stratified in the upper portions of the unconfined aquifer.

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INTRODUCTION

Surveillance of ground water on the Hanford Site is one facet of the comprehensive Environmental Monitoring Program designed to evaluate existing and potential pathways of exposure to contamination from site operations. The objectives of the ground-water monitoring program conducted by the Pacific Northwest Laboratory (PNL) for the U.S. Department of Energy (DOE), are to measure and report the concentration and distribution of radioactive and other chemical constituents in the ground water, and to determine movement and transport of contaminants with time and the impact of contamination on man's environs.

All routine ground-water samples for 1978 were taken by PNL's Environmental Evaluations section and were analyzed by the Technical Analysis Section. The U.S. Geological Survey, with the aid of the Geosciences Section of PNL, collected and comprehensively analyzed samples from specific wells. Program overview and coordination was provided by the Environmental Evaluations Section.

Rockwell Hanford Operations (RHO) is DOE's prime contractor for chemical processing and waste management activities on the Hanford Site. Rockwell Hanford Operations is responsible for operations within the site's 200 Areas, and conducts a comprehensive sampling and analysis program in these areas. With the exception of a few analyses, data from the RHO program are not included in this report.

BACKGROUND

Operations on the Hanford Site since 1944 have resulted in the disposal of large volumes of low-level liquid radioactive wastes and contaminated cooling water to the ground. Figure 1 shows the location and layout of the site. Most of the liquid wastes have been disposed of to the ground at the chemical separation areas (200 Areas) located on a plateau near the center of the site. Smaller amounts of wastes have been released at the reactor sites (100 Areas) located adjacent to the Columbia River, and at the laboratory and fuel fabrication area (300 Area). Only one reactor and its associated disposal facility (in the 100-N Area) are currently in operation. The disposal of liquid waste to the ground has been greatly reduced in the past several years because of the deactivation of all except the N Reactor at Hanford, the cessation of reactor fuel processing, and the improved treatment of several waste streams.

DISPOSITION OF WASTES

Liquid wastes disposed of to the ground percolate laterally and downward through 150 to 300 feet (50 to 100 m) of unconsolidated glaciofluvial and lacustrine sands, silts and gravel overlying the unconfined ground water. As the wastes move through this sedimentary material, adsorption and ion exchange reactions take place between the minerals in the sediments and the materials in the liquid waste. Some of the longer-lived and more hazardous radionuclides such as strontium-90 (^{90}Sr), cesium-137 (^{137}Cs), and plutonium-239 (^{239}Pu) have favorable ion exchange characteristics and are effectively removed from the liquid as it percolates downward through the unsaturated soil column. Other radionuclides such as ruthenium-106 (^{106}Ru), cobalt-60 (^{60}Co), technetium-99 (^{99}Tc), tritium (^3H), and nonradioactive materials such as nitrate (NO_3^-) have poor ion exchange characteristics and move through the unsaturated column at varying rates until they eventually enter the ground water. Once in the ground water, the contaminants move in a general down-gradient direction with the ground water. As the contaminants move in the ground water, their concentration is reduced by radioactive decay, ion exchange, diffusion and hydrodynamic dispersion.

FIGURE 1. The Hanford Site

During the past thirty-five years, the disposal of more than 160 billion gallons ($\sim 6 \times 10^{11}$ liters) of process cooling water and about eight billion gallons ($\sim 3 \times 10^{10}$ liters) of other liquid waste has changed the water table configuration. Ground-water mounds, created by the discharge of waste water, now exist near each of the chemical processing areas and in the 100-N reactor area. Ground-water levels have changed continuously over the years, depending upon variations in the volume and location of waste water discharged to the ground. The movement of the ground water and its associated contaminants has also changed with time, reflecting the variation in waste water discharge.

MONITORING AND WELLS

Over 700 cased monitoring wells (McGhan and Damschen 1977) have been drilled to water since the beginning of the disposal operations at the Hanford Site. These structures provide a means of obtaining water samples and conducting in-well investigations.

There are basically three aquifers which are monitored at the Hanford Site. The first or lowest is an aquifer in the consolidated basalt. When a well is drilled into this aquifer an artesian flow (water under greater than atmospheric pressure) is generally encountered, which causes the water level in the well to rise. The second aquifer is encountered by wells drilled into a semi-consolidated material overlying the basalt. This aquifer is also generally artesian. The third and probably the most important aquifer at the Hanford Site is the unconfined aquifer under atmospheric pressure which covers the artesian aquifers and the unconsolidated material near the surface. This aquifer appears to have most of the contaminants in it and is monitored far more heavily than the deeper aquifers. Wells are generally drilled a few tens of feet below the top of the aquifer and samples are taken from this bottom zone. Most of the wells drilled at Hanford are multipurpose structures; that is, they are used to obtain geological and hydrologic information before they become sampling structures.

In order to be a structure that will be useful in monitoring, a well should be perforated along its entire length below the water table to allow

the water in the aquifer to flow through the casing in a direction normal to the well at all depths. However, since the heterogeneity of the sediments beneath the Hanford Site prevents this, each well structure on the site must be evaluated individually as a monitoring facility.

For the 1978 routine ground-water monitoring program, 289 wells were used. From these, 1746 well-water samples were taken to provide 5250 analytical results for use in evaluating the effects of site operations on ground water. (These figures do not include other contractor monitoring efforts in the Hanford Site.)

SAMPLING AND ANALYSIS

Well-water samples are obtained routinely from throughout the Hanford Site. The frequency of sampling may be monthly, quarterly, semi-annually, or annually depending on the well location and constituents to be analyzed. Some ground-water samples are collected just under the water surface of the unconfined aquifer by lowering a glass bottle enclosed in a steel bail. When contamination appears in a project well, the highest concentration is usually observed at the surface of the water table (Eddy et al. 1978). Submersible sampling pumps have been installed in most key wells to obtain a more representative sample of the water in the aquifer adjacent to the well than is provided by a small-volume dipped sample. The submersible pump method prevents the possibility of cross contamination that may result from using a single bailer to sample several wells. At a few locations where appropriate well structures are available, samples are obtained from the confined aquifer zones. Some small diameter wells and piezometer tubes are sampled by the airlift method (Trescott and Pinder 1970).

Three substances, the radionuclides represented by total beta measurement (calculated as ^{106}Ru , ^3H , NO_3^-), are readily transported in ground water with little decrease in concentration from adsorption or ion exchange. They can also be detected in ground water in concentrations that are low relative to guidelines published in the Concentration Guides (CG) in Manual Chapter 0524 (U.S. Department Energy 1977), or in the State of Washington's drinking water regulations (40 CFR 141). Therefore, these substances are

used as primary tracers to monitor the movement of contaminated ground water. In addition, samples from selected wells are routinely analyzed at less frequent intervals for the radionuclides ^{90}Sr , ^{137}Cs , and ^{60}Co . Total alpha emission is also determined. Selected samples are analyzed by gamma spectrometry to identify the mixture of radionuclides present. Standard radiometric and chemical methods are used to analyze the routine ground-water samples.

Other radionuclides such as ^{129}I and ^{99}Tc have been detected in the ground water beneath the Hanford Site. These radionuclides also make excellent tracers of ground-water contamination and are used for this purpose to a limited extent, but they generally occur in very low concentrations. Ground-water from several wells is analyzed for chemical parameters in order to monitor broader changes in water quality. Analyses for uranium (^{238}U), fluoride (F^-) and total chromium (Cr) are made on selected ground-water samples in and adjacent to the 300 Area, because the fuel fabrication waste water disposed of at this site contains these contaminants.

EVALUATION OF GROUND-WATER SURVEILLANCE DATA

Radionuclide concentrations in the ground water beneath Hanford are evaluated in terms of their respective Concentration Guides (CGs) (U.S. Department of Energy 1977); radioactive materials are compared with drinking water regulations (DWR) promulgated by the EPA (40 CFR 141) as adopted by the State of Washington. The comparison between the actual concentration and the guidelines provides a conservative method of evaluating the potential significance of most waterborne materials. The CGs used in this report are those that apply to uncontrolled areas. Table 1 shows the detection limit and applicable CG or DWR for various materials analyzed under the routine ground-water monitoring program.

TABLE 1. Lower Analytical Detection Limit and Lowest Applicable Concentration Guides or Drinking Water Regulations

Analysis	Detection Limit ^(a)	CGs ^(a)
β_t (as ^{106}Ru)	0.08	NA ^(b)
Gross Alpha (as ^{239}Pu)	0.017	NA
^3H	1.0	3,000
^{60}Co	0.02	30
^{90}Sr	0.03	0.3
^{106}Ru	0.06	10
^{125}Sb	0.06	100
^{129}I	1×10^{-8}	0.06
^{131}I	0.01	0.3
^{137}Cs	0.02	20
U (Natural)	3.4	20,000 pCi/l
		<u>DWR</u>
NO_3^-	0.5 mg/l	45 mg/l
F^-	0.08 mg/l	1.8 mg/l
Cr^{6+}	3 mg/l	0 $\mu\text{g/l}$

(a) pCi/ml except where otherwise noted

(b) NA--Not Applicable. Significance of contaminations determined by specific radionuclide analysis.

At the beginning of each report section dealing with a major contaminant, a map shows the distribution of that contaminant. The isopleths on the maps show concentration zones rather than discrete contours because the data do not justify the additional detail. Data from waste disposal operations and resultant ground-water contamination in the 200 Areas are not included in this report. However, data from the 200 Areas were used to provide continuity in the maps.

Appendix A contains tabular analytical data for 1978 on the average, maximum and minimum concentrations of the primary tracers (gross beta activity, tritium and nitrate ion). The data on the average concentrations of the primary tracers were used to generate the isopleth maps.

Table 2 shows the number of wells sampled, the number of samples taken, and the number of analyses made as part of the 1978 ground-water monitoring program for each area of the Hanford Site. The data shown in Appendices A (the primary tracers) and B (other materials) were derived from analysis of the samples. The table does not account for any special samples taken.

TABLE 2. Numerical Data on the Routine Ground-Water Monitoring Program, 1978

<u>Area</u>	<u>Number of Wells Sampled</u>	<u>Number of Samples Taken</u>	<u>Number of Analyses Made</u>
100	28	128	344
200	21	84	252
300	28	112	672
600	<u>212</u>	<u>852</u>	<u>1908</u>
	289	1176	4352

GROSS BETA (β_t) CONCENTRATION IN THE GROUND WATER

Figure 2 shows the concentration and distribution of β_t contamination in Hanford's unconfined ground water. Appendix A contains data on the primary tracers for ground-water samples collected during 1978. The configuration of the β_t plume is static but the plume's general size has continued to recede slightly since the last reporting period. The plume now extends southeasterly from the 200-E Area for about 12.5 km (7.8 miles).

Concentrations in the main plume continued to be less than 1.0 pCi/mL. However, concentrations higher than 1.0 pCi/mL were noted in two small plumes adjacent to the southeast corner of the 200-W Area. Concentrations in the three major plumes are decreasing although the size of the plume near the 200-E Area is larger than it has been in the past several years. Figure 3 shows that gross beta concentrations at Well 6-34-42 have an apparent half life of about 1.3 years. Concentrations are currently near the detection limit of 0.08 pCi/mL. The nature of the concentration history indicates that this well is located in an area where ground-water flow is minimal, perhaps on the edge of an ancient channel of the Columbia River. Figure 4, a concentration history of Well 6-38-70, shows that gross beta concentration at this well has an apparent half life of 3.6 years. The continuing supply of gross beta-containing ground water past this site is reflected in Figure 4. Beta activity shown in this figure results from the cyclical nature of Hanford's plant operations. The peak in β_t concentrations occurred in early 1971 at a level of about 1.5 pCi/L, following the last operations in the 200-W Area. The level of contamination continues to decrease, with β_t contamination in Well 6-26-15 showing an apparent

FIGURE 3. Concentration History for Total Beta Activity in Well 6-34-42

FIGURE 4. Concentration History for Total Beta Activity in Well 6-38-70

half life midway between those of Wells 6-34-42 and 6-38-70. Well 6-26-15 is located near the extreme eastern edge of the gross beta plume. Gross beta concentrations at this site are expected to drop to less than detectable levels in the near future. Peaks in concentration histories can be used to determine travel times in the ground-water flow system. However, correlation of peaks and discharges is sometimes difficult because dispersion within the flow system tends to coalesce minor plumes from different release points and mask the true time of release.

In addition to the 200 Area plumes, contributors to the β_t contamination of ground water are evident in the 100-B, 100-D and 100-H Areas from past operations; they are evident in the 100-N Area from liquid waste disposal to the 1301-N trench; and in the 300 Area, from waste disposal facilities.

In 1973, the reporting of β_t was changed. The change is reflected by a lowering of the apparent detection level. Prior to 1973, all analyses for β_t were reported as $^{106}\text{Ru}/^{106}\text{Rh}$. Currently the values are reported strictly as

^{106}Ru . A further change was initiated in January, 1977. This action instituted gamma spectrum analysis in addition to β_t analysis for positive identification of those radionuclides contributing to the β_t plume.

DEFINITION OF GROSS BETA CONTRIBUTORS

In 1976, a program to define the actual contributors to the gross beta plume was initiated. Well 6-34-42 (Figure 3) was selected for analysis because of its proximity to the 200-East Area plume. Initial analyses indicated the possible existence of minute concentrations of highly mobile radionuclides.

In an effort to determine whether gross beta contributors could be detected away from the major plume, three wells were selected for comprehensive radiochemical analysis. Data from three wells, 6-37-43, 6-31-31 and 6-26-15 (Figure 5), are shown in Table 3.

Additional data concerning ^{60}Co and ^{106}Ru were obtained during analysis for ^{129}I ; these data are presented in a later section of this report. The low

FIGURE 5. Concentration History for Total Beta Activity in Well 6-26-15

TABLE 3. Comprehensive Radiochemical Analysis of Three Wells

Well No.	²² Na	⁵⁴ Mn	⁶⁰ Co	⁶⁵ Zn	⁹⁵ Zr ⁹⁵ Nb	⁹⁵ Nb	¹⁰⁶ Ru	^{108m} Ag	^{110m} Ag	¹²⁵ Sb
699-26-15										
Filters	<0.0016	<0.0014	0.019	<0.0035	0.0030	0.0032	0.019	<0.0011	<0.0019	<0.0042
1st Anion Bed	<0.024	0.042	53.	0.15	0.060	0.037	1.57	<0.019	<0.050	<0.057
2nd Anion Bed	<0.0063	<0.0066	1.7	0.027	<0.017	<0.012	0.24	<0.0080	<0.0096	<0.014
1st Cation Bed	<0.0047	<0.0045	0.15	<0.017	<0.011	<0.0040	0.065	<0.0034	<0.0055	<0.010
2nd Cation Bed	<0.0059	<0.0070	0.075	<0.011	<0.0069	<0.0099	0.039	<0.0033	<0.0051	<0.0098
1st Al ₂ O ₃	<0.0014	<0.0016	0.014	<0.0045	<0.0039	<0.0031	0.027	<0.0016	<0.0013	<0.0064
2nd Al ₂ O ₃	<0.0014	<0.0029	0.012	<0.0025	<0.0039	<0.0015	0.022	<0.00097	<0.0014	<0.0030
3rd Al ₂ O ₃	<0.00091	<0.0014	0.0090	<0.0037	<0.0021	<0.0030	0.016	<0.00094	<0.0019	<0.0042
699-31-31										
Filters	<0.0018	<0.0028	0.074	<0.0037	<0.0017	<0.0020	0.011	<0.00091	<0.0019	<0.0056
1st Anion Bed	<0.015	<0.017	20.	0.094	0.038	0.024	2.77	<0.014	<0.028	<0.033
2nd Anion Bed	<0.0056	<0.013	1.74	<0.033	<0.011	<0.0062	0.44	<0.0080	<0.014	<0.015
1st Cation Bed	<0.0036	<0.0029	0.14	<0.014	<0.0094	<0.0058	0.036	<0.0025	<0.0041	<0.0076
2nd Cation Bed	<0.0079	<0.0050	0.064	<0.0090	<0.0052	<0.0055	0.037	<0.0028	<0.0038	<0.0080
1st Al ₂ O ₃	<0.0019	<0.0027	0.011	<0.0022	<0.0039	<0.0026	0.043	<0.0018	<0.0014	<0.0031
2nd Al ₂ O ₃	<0.0011	<0.0018	0.012	<0.0054	<0.0029	<0.0021	0.034	<0.00091	<0.0012	<0.0025
3rd Al ₂ O ₃	<0.0011	<0.0011	0.017	<0.0030	<0.0019	<0.0020	0.039	<0.00093	<0.0012	<0.0025
699-37-43										
Filters	<0.0014	<0.0018	0.020	<0.0024	<0.0017	<0.0026	<0.0093	<0.0017	<0.0021	<0.0039
1st Anion Bed	<0.0074	<0.0034	0.020	<0.019	<0.0072	<0.0069	0.15	<0.0060	<0.0060	<0.014
2nd Anion Bed	<0.0087	<0.0032	0.016	<0.0080	<0.0069	<0.0039	<0.033	<0.0032	<0.0043	<0.011
1st Cation Bed	<0.0046	<0.0035	<0.0038	<0.0086	<0.0070	<0.0075	<0.031	<0.0042	<0.0044	<0.012
2nd Cation Bed	<0.0038	<0.0051	<0.0057	<0.011	<0.0056	<0.0040	<0.033	<0.0041	<0.0058	<0.011
1st Al ₂ O ₃	<0.0018	<0.00092	<0.0043	<0.0025	<0.0031	<0.0024	<0.0094	<0.00088	<0.0015	<0.0028
2nd Al ₂ O ₃	<0.0013	<0.0022	<0.0039	<0.0031	<0.0020	<0.0011	<0.0084	<0.0011	<0.0029	<0.0036
3rd Al ₂ O ₃	<0.0013	<0.0017	<0.0059	<0.0039	<0.0044	<0.0016	<0.0093	<0.00088	<0.0016	<0.0027

TABLE 3. Comprehensive Radiochemical Analysis of Three Wells (contd)

Well No.	$^{126}\text{Sn}, ^{126}\text{Sb}$	^{134}Cs	^{137}Cs	^{144}Ce	^{152}Eu	^{154}Eu	^{155}Eu	$^{212}\text{Pb} (^{228}\text{Th})$	$^{214}\text{Pb} (^{226}\text{Ra})$
699-26-15									
Filters	<0.0020	<0.0016	0.0034	<0.011	<0.0036	0.011	<0.0068	0.029	0.0060
1st Anion Bed	<0.025 •	<0.035 •	0.053 •	0.19 •	<0.058 •	<0.24 •	<0.059	<0.0062	<0.0012
2nd Anion Bed	<0.0066	<0.018 •	<0.0078	<0.036	<0.015	<0.047	<0.034	<0.0050	<0.0012
1st Cation Bed	<0.0070	<0.0091	<0.0036	<0.033	<0.011	<0.024	<0.019	0.022 •	0.042 •
2nd Cation Bed	<0.0078	<0.0069	<0.0090	<0.029	<0.010	<0.048	<0.016	<0.0047	0.011
1st Al_2O_3	<0.0018	<0.0012	<0.0022	<0.015	<0.0032	<0.0064	<0.0044	<0.0014	<0.0018
2nd Al_2O_3	<0.0020	<0.0024	<0.0017	<0.0085	<0.0031	<0.0090	<0.0040	<0.0014	<0.0025
3rd Al_2O_3	<0.0014	<0.0017	<0.00094	<0.012	<0.0052	<0.013	<0.0039	<0.0031	<0.0023
699-31-31									
Filters	<0.0019	<0.0016	0.0069	<0.0084	<0.0031	<0.0073	<0.0052	0.010	0.0038
1st Anion Bed	<0.020	<0.034	0.031	0.074	<0.063	<0.14	<0.035	0.024	<0.0012
2nd Anion Bed	<0.0050	<0.0068	<0.0092	<0.033	<0.014	<0.045	<0.017	<0.0061	<0.0044
1st Cation Bed	<0.0057	<0.0069	<0.0058	<0.024	<0.0087	<0.034	<0.015	0.0081	0.023
2nd Cation Bed	<0.0028	<0.0055	<0.0074	<0.024	<0.0076	<0.022	<0.018	<0.0050	0.0090
1st Al_2O_3	<0.0011	<0.0007	<0.0013	<0.0072	<0.0027	<0.0047	<0.0046	<0.0013	<0.0022
2nd Al_2O_3	<0.0012	<0.0018	<0.0013	<0.0088	<0.0027	<0.011	<0.0041	<0.00078	<0.00051
3rd Al_2O_3	<0.0012	<0.0018	<0.0011	<0.0074	<0.0028	<0.0081	<0.0036	<0.000091	<0.0014
699-37-43									
Filters	<0.0013	<0.0030	<0.014	<0.0080	<0.0034	<0.0067	<0.0063	0.017	0.0094
1st Anion Bed	<0.0066	<0.0053	<0.0077	<0.035	<0.011	<0.069	<0.019	<0.0062	<0.0012
2nd Anion Bed	<0.0065	<0.0057	<0.0053	<0.0054	<0.010	<0.054	<0.017	<0.0084	<0.0078
1st Cation Bed	<0.0031	<0.0058	<0.0063	<0.032	<0.011	<0.028	<0.024	<0.0064	0.033
2nd Cation Bed	<0.0027	<0.0031	<0.0043	<0.030	<0.013	<0.024	<0.018	<0.0090	0.0054
1st Al_2O_3	<0.0016	<0.0009	<0.00091	<0.0077	<0.0049	<0.012	<0.0062	<0.0050	<0.0012
2nd Al_2O_3	<0.0011	<0.0012	<0.0013	<0.0077	<0.0051	<0.012	<0.0057	<0.0049	<0.0034
3rd Al_2O_3	<0.0016	<0.0017	<0.00095	<0.0082	<0.0029	<0.0082	<0.0037	<0.0026	<0.00055

levels shown for these radionuclides were attainable only through special analytical techniques, and corroborate the data obtained to define the gross beta contributors.

TRITIUM (^3H) CONCENTRATION IN THE UNCONFINED GROUND WATER

Because tritium enters the ground-water system as a part of the water molecule, it is carried along with the ground-water flow and remains almost unaffected by the geologic conditions that affect other radionuclides. Tritium, therefore, provides the most accurate and extensive overview of Hanford operations. Figure 6 shows the distribution of ^3H in the unconfined aquifer. Appendix A contains data concerning maximum, average and minimum concentrations for samples collected in 1978.

The configuration of the ^3H plume has changed somewhat in the past year. Concentrations of ^3H in Well 6-40-1 remain high and continue to indicate that the plume is nearing the Columbia River.

Tritium concentrations in wells within the plume show different responses dependent upon the geohydrology of the locale being monitored. Figure 7 shows a concentration history for Well 6-15-26. The apparent half life for ^3H in this well is about 10 years, slightly less than the actual half life. This rate of decay indicates that uncontaminated or at least less-contaminated water is reaching this well. Figure 8, a concentration history for Well-6-32-22, shows essentially the same thing; however, ground water containing slightly more elevated concentrations of ^3H is indicated by the apparent half life, which is greater than 12.3 years. The concentration history of ^3H in Well 6-26-15 (Figure 9) shows that, after peaking in 1969, concentrations of ^3H declined and reached an apparent equilibrium in about 1975. Ground-water flow in the vicinity of this well is such that concentrations are maintained near 1000 pCi/ml.

Figure 10 shows that the tritium concentration in Well 6-9-E2 dropped through mid-1972 and has been increasing since then. The increase in ^3H concentration in 6-9-E2 matches closely that shown in Well 6-2-3 (Figure 11), which has rising ^3H concentrations starting about 1966. These two wells

FIGURE 7. Concentration History for Tritium in Well 6-15-26

FIGURE 8. Concentration History for Tritium in Well 6-32-22

FIGURE 9. Concentration History for Tritium in Well 6-26-15

FIGURE 10. Concentration History for Tritium in Well 6-9-E2

FIGURE 11. Concentration History for Tritium in Well 6-2-3

are used to monitor the southernmost lobe of ^3H plume. Well 6-2-3 also illustrates the arrival of the plume at the well's location, beginning in the mid-1960's.

The combination of operational effects and hydrological events can be seen in Figure 12, which shows a concentration history for Well 6-87-55. This well is located about 1 mile (1.8 km) from N Reactor. The graph with its sinusoidal pattern illustrates a dynamic system which combines river flow, precipitation, reactor operations and geohydrology.

FIGURE 12. Concentration History for Tritium in Well 6-87-55

NITRATE (NO_3^-) CONCENTRATION IN THE UNCONFINED GROUND WATER

Figure 13 shows the concentration and distribution of NO_3^- in the ground water at Hanford. Appendix A contains data on the maximum, minimum and average concentrations. Data collected in 1978 indicate little aerial change in the nitrate plume. Zones of elevated nitrate concentration persist in the vicinity of the 200-E, 200-W, 100-D, 100-F, 100-H, 100-K, and 100-N Areas, and in the central portion of the main plume.

The concentration histories for Wells 1-H3-1 and 1-H4-3 (Figures 14 and 15) show marked increases in the level of NO_3^- concentration. Well 1-H4-3 was drilled specifically to monitor a solar evaporation facility used by United Nuclear Industries (UNI). The facility consists of a concrete structure previously used as a retention basin for the 100-H Reactor. The pond is currently used as a concentrator for wastes generated by UNI fuel fabrication activities in the 300 Area. Wastes placed in the basin normally contain copper, sodium, nitrate, and sulphate, with small amounts of other constituents such as chromium. The wastes do not contain radioactive materials other than

FIGURE 13. Nitrate Ion Distribution in Unconfined Ground Water

FIGURE 14. Concentration History for Nitrate in Well 1-H3-1

FIGURE 15. Concentration History for Nitrate in Well 1-H4-3

A decrease of nitrate concentration continues in Well 6-34-42 (Figure 16), where a cyclical pattern has developed. This pattern is the operational history of the 200-E Area. The very definite trend of increasing nitrate concentration observed in Well 6-17-5 (Figure 17), located north of the Washington Public Power Supply System projects, has reversed and decreasing concentrations of nitrate are now being observed. Maintenance work on this well and the installation of a sampling pump have eliminated much of the data scatter. The graph indicates the previous rapid increase in nitrate

FIGURE 17. Concentration History for Nitrate in Well 16-17-5

concentration at this site, indicative of the movement or expansion of the zone of high concentration within the central portion and the later decline as the main plume passes.

ADDITIONAL CONTAMINANTS IN THE GROUND WATER

Appendix B contains data from the routine analysis of materials other than the primary tracers. These materials include uranium, gross alpha emitters, and fluoride ion, all found primarily in the fuel fabrications area (300 Area). A special analysis was performed for iodine-129 (see next section). In addition, water samples from the first aquifer were analyzed and the temperature distribution of water in the unconfined third aquifer was mapped.

SPECIAL ANALYSES FOR IODINE-129

During 1978, samples were collected from ten wells for iodine-129 analysis. Selection of these wells was based on location, with preference given to those, away from a source of contamination, so that the degree and direction of movement of this radionuclide could be ascertained. Existing data were complemented by the additional information.

Analyses were performed using neutron activation techniques (ASTM 1978). This analytical technique allows a detection level of approximately 1×10^{-5} pico curies per liter ($1.7 \times 10^{-5}\%$ of the Concentration Guides). Table 4 shows the results of the analyses for 1976, 1977 and 1978. Figure 18 shows the locations of the sampling points.

TABLE 4. ^{129}I , ^{60}Co , and ^{106}Ru Concentrations

Well No.	Concentration, pCi/l		
	^{129}I	^{60}Co	^{106}Ru
699-8-17	0.12	12.0	0.4
699-15-26	0.52	11.0	0.37
699-20-20	2.8	27.0	0.52
699-32-72	1.6×10^{-3}	4.6×10^{-3}	1.9×10^{-3}
699-34-51	1.8×10^{-5}	6.6×10^{-4}	0.00
699-40-33	2.2×10^{-5}	0.00	0.00
699-41-23	3.0	14.0	0.86
699-42-12	0.49	15.0	0.34
699-45-42	15.0	9.0×10^{-5}	3.7×10^{-3}
699-54-57	1.6×10^{-3}	9.6×10^{-5}	0.00

FIGURE 18. Location of Sample Points for I-129 Analysis

Iodine-129 is of interest because of its long half life (10^7 years) and its mobility in the ground-water environment. Analyses made during 1975-1978 verify that ^{129}I follows the flow paths of the other major contaminants and its levels of concentration are reduced by diffusion and dispersion within the ground-water flow system. Past studies have shown that the majority of the ^{129}I is contained in the upper portions of the aquifer (Eddy et al. 1978). During 1978, no increase in ^{129}I concentrations attributable to ground-water transport was observed in Columbia River water. Iodine-129 concentrations attributable to worldwide fallout were determined to be about 5×10^{-4} pCi/l in the Columbia River (Houston and Blumer 1978).

THERMAL CONTAMINATION

Thermal features of aquifers are unique since warmer water tends to flow more rapidly than cooler water, displaying an apparent higher hydraulic conductivity.

Figure 19 shows the distribution of ground-water temperatures measured in January, 1979. The temperature ranges shown are the result of: 1) the natural

FIGURE 19. Distribution of Ground-Water Temperature Measured in January 1979

temperature of the unconfined aquifer (about 15°C for the Hanford Site); 2) changes caused by natural phenomena such as bank storage near the Columbia River and discharge upward of ground water from warmer, confined aquifers into the unconfined systems; and 3) superimposed temperature gradients caused by onsite operations.

The thermal plumes attributable to onsite operations are similar to the radionuclide plumes in shape and extent. The areas in which reactors have been shut down have large quantities of hot water resulting from both ground disposal and leakage from retention basins. Ground-water temperatures in the vicinity of the 100-B exceed 33°C.

The discharge of ground-water that has been thermally affected by plant operations has no noticeable effect on Columbia River temperatures since only minor amounts of heated water reach the river.

RADIOLOGICAL IMPACT

Ground-water transport of contaminants on the Hanford Site represents a potential pathway for exposure to radiation via water obtained from either 1) wells that tap the unconfined aquifer, or 2) the Columbia River, into which the unconfined aquifer discharges. The following discussion examines these potential pathways.

GROUND WATER

During 1978, drinking water on the Hanford Site was obtained from the unconfined aquifer at the Arid Lands Ecology (ALE) facility and the Fast Flux Test Facility (FFTF). Only the drinking water at ALE contains concentrations of radionuclides resulting solely from naturally-occurring radioactivity. The drinking water at FFTF contains elevated concentrations of ^3H from past waste disposal in the 200-East Area, as shown in Figure 6.

The impact on the total-body dose attributable to the ^3H in drinking water at FFTF (average 48,000 pCi/l) is estimated to be 0.6 mrem, based on an ingestion rate of 220 liters/year at 40 hrs/week. The 50-year dose commitment from ^3H is the same as the annual dose because of the relatively short biological half life of this radionuclide.

The concentrations of ^3H in FFTF drinking water are low compared to the guidelines in MC-0524.

COLUMBIA RIVER

Ground-water entering the Columbia River from the Hanford Site is diluted by a factor of about 1000 because of the difference between the river and ground-water flow rates. During 1978, the average Columbia River flow rate reported by the U.S. Geological Survey (Houston and Blumer 1978) was 117,500 cfs ($3328 \text{ m}^3/\text{sec}$). The flow rate from the unconfined aquifer (Myers 1978) was calculated to be about 100 cfs ($2.8 \text{ m}^3/\text{sec}$).

Tritium (^3H) may be observed at the farthest extreme boundaries of the contamination plume shown in Figure 6; this radionuclide would reach the river

in the greatest concentrations at the earliest time. Figure 20 provides a comparison of identical analyses performed on samples taken upstream and downstream from the Hanford Site. The figure reveals no apparent significant difference between upstream and downstream concentrations of ^3H . The Columbia River transports approximately 42,000 Ci of ^3H attributable to worldwide fallout (annual flow of 10^{14} l x ~ 420 pCi/l). Tritium discharges from N Reactor during 1978 contributed an additional $\sim 0.7\%$ (330 pCi/l), (Greager 1979) but this contribution is not distinguishable from the variability resulting in fallout levels.

Looking at the distributions of other radionuclides shown in Figure 20, no difference between upstream and downstream concentrations is apparent except for those observed for ^{60}Co . The ^{60}Co is attributable to routine past reactor operations (i.e., for 1978, the $0.96 \text{ m}^3/\text{sec}$ released into the Columbia River's average flow of 117,500 cfs ($3328 \text{ m}^3/\text{sec}$) would result in an average annual concentration of 0.009 pCi/l). The other radionuclides shown in Figure 20 are from worldwide fallout (^{90}Sr and ^{106}Ru) and natural causes (^{40}K and U)(Greager 1979).

FIGURE 20. Upstream and Downstream Concentration of Radionuclides in Columbia River Water

QUALITY CONTROL

The PNL program for quality control measures was initiated in 1974 and reaches all phases of the ground-water monitoring program. The extensive effort to insure that samples are representative of the aquifer system beneath the site includes: 1) well maintenance; 2) visual and geophysical inspection; and 3) installation of sampling pumps. In addition, blind and duplicate samples are analyzed by the PNL Technical Analysis Laboratory. Analysis of ground-water samples by the U.S. Geological Survey has been continued. These programs have shown that data received as part of the routine monitoring program are within the analytical limits of accuracy. The historical analytical record for each well further confirms the representativeness of the data collected each year.

In addition to providing quality assurance, the program with the U.S. Geological Survey provides data on the chemistry of Hanford ground-water. These data, including wet chemical and spectrographic analysis, represent background information that is useful in assessing trends of effects of plant operations. The results of the analyses made in 1978 are shown in Appendix C. These analyses indicate that the quality of the ground-water beneath the Hanford Site is comparable to that of other ground-waters found in eastern Washington. No changes in basic chemistry are evident that indicate chemical contamination from Hanford sources other than the results of the leak at the 183H Solar Evaporator Facility and changes caused by process waste disposal in the 300 Area.

At the laboratory level the documentation of laboratory instrument calibrations and all laboratory procedures is required. Documentation of field instrument calibration also is being implemented.

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APPENDIX A

APPENDIX A

Total Beta, Tritium, Nitrate Concentrations in the
Ground-Water (unconfined aquifer), Taken
March 22, 1979 at 6:26:32

(PNL Wells)(Calendar Year 1978)

WELL NO.			TOTAL BETA (PCI/ML) -----	TRITIUM (PCI/ML) -----	NITRATE (MG/L) -----
1	83	1	MAX AVE MIN	1.20E+00*	
1	83	2P	MAX AVE MIN	<1.10E+00*	<5.00E-01*
1	83	2Q	MAX AVE MIN	<1.13E+00*	<5.00E-01*
1	84	1	MAX AVE MIN	3.80E+01*	4.07E+00*
1	84	4	MAX AVE MIN	8.70E+02*	2.50E+00* 2.20E+00*
1	89	1	MAX AVE MIN	1.80E+00*	3.80E+00*
1	02	5	MAX AVE MIN	2.47E+01*	6.63E+01*
1	05	12	MAX AVE MIN	7.83E-02*	2.37E+00* 2.43E+01*
1	08	3	MAX AVE MIN	<7.50E-02*	6.03E+00* 4.15E+00*
1	F5	1	MAX AVE MIN	<7.40E-01*	1.83E+00*
1	F5	3	MAX AVE MIN	<8.50E-01*	6.25E+00*

WELL NO,			TOTAL BETA (PCI/ML) *****	TRITIUM (PCI/ML) *****	NITRATE (MG/L) *****	
1	F5	4	MAX AVE MIN	1.08E+02*	2.22E+00*	
1	F5	6	MAX AVE MIN	<7.40E-01*	<5.00E-01*	
1	F7	1	MAX AVE MIN	1.01E+00*	5.77E+01*	
1	F8	1	MAX AVE MIN	2.53E+01*	7.57E+01*	
1	F8	2	MAX AVE MIN	1.10E+01*	3.73E+01*	
1	H3	1	MAX AVE MIN	1.10E+01*	6.87E+01*	
1	H4	3	MAX AVE MIN	1.50E+00 9.63E-01 5.90E-01	6.70E+00 5.65E+00 4.80E+00	8.40E+03 4.81E+03 2.10E+03
1	K	11	MAX AVE MIN	4.23E+01*	6.33E+00*	
1	K	19	MAX AVE MIN	4.75E+00*	2.93E+00*	
1	K	20	MAX AVE MIN	2.10E+00*	1.05E+00*	
1	K	22	MAX AVE MIN	3.77E+00*	8.20E-01*	
1	N	3	MAX AVE MIN	7.77E-01*	5.20E+01*	
1	N	4	MAX AVE MIN	1.22E-01*	5.47E+01*	4.80E+00*
1	N	6	MAX AVE MIN	3.57E-01*	5.67E+01*	
1	N	14	MAX AVE MIN	5.50E-01*	5.33E+01*	1.20E+01*
1	N	15	MAX AVE MIN	2.23E-01*	5.53E+01*	1.09E+01*

WELL NO.				TOTAL BETA (PCI/ML)	TRITIUM (PCI/ML)	NITRATE (MG/L)
				-----	-----	-----
3	1	1	MAX	<7.50E-02		
			AVE	<7.50E-02		9.60E+00*
			MIN	<7.50E-02		
3	1	2	MAX			
			AVE	<7.50E-02*		9.80E+00*
			MIN			
3	1	3	MAX	<7.50E-02		
			AVE	<7.50E-02		1.21E+01*
			MIN	<7.50E-02		
3	1	4	MAX			
			AVE	<7.50E-02*		1.02E+01*
			MIN			
3	1	5	MAX	<7.50E-02	<1.20E+00	
			AVE	<7.50E-02	<8.92E-01	
			MIN	<7.50E-02	<5.30E-01	
3	1	6	MAX	<7.50E-02		1.80E+01
			AVE	<7.50E-02		9.46E+00
			MIN	<7.50E-02		1.00E+00
3	3	1	MAX	<7.50E-02		2.00E+01
			AVE	<7.50E-02		7.49E+00
			MIN	<7.50E-02		2.10E+00
3	3	2	MAX	<7.50E-02		1.10E+01
			AVE	<7.50E-02		5.67E+00
			MIN	<7.50E-02		<5.00E-01
3	3	3	MAX	1.30E-01		7.60E+00
			AVE	8.00E-02		4.92E+00
			MIN	<7.50E-02		<5.00E-01
3	3	8	MAX	2.20E+00		1.60E+01
			AVE	4.20E-01		1.16E+01
			MIN	<7.50E-02		7.60E+00
3	3	9	MAX	1.30E-01		4.00E+01
			AVE	7.96E-02		1.62E+01
			MIN	<7.50E-02		6.30E+00
3	3	10	MAX	<7.50E-02		2.70E+01
			AVE	<7.50E-02		1.47E+01
			MIN	<7.50E-02		4.30E+00
3	3	11	MAX	<7.50E-02		1.60E+01
			AVE	<7.50E-02		1.10E+01
			MIN	<7.50E-02		8.40E+00
3	4	1	MAX	<7.50E-02		1.20E+01
			AVE	<7.50E-02		8.23E+00
			MIN	<7.50E-02		6.10E+00
3	4	5	MAX			
			AVE	<7.50E-02*		3.20E+00*
			MIN			

WELL NO.	TOTAL BETA (PCI/ML)	TRITIUM (PCI/ML)	NITRATE (MG/L)
	-----	-----	-----
3 4 7	MAX AVE MIN	<7.50E-02 <7.50E-02 <7.50E-02	1.50E+01 1.16E+01 8.70E+00
3 4 9	MAX AVE MIN	<7.50E-02 <7.50E-02 <7.50E-02	1.70E+01 1.10E+01 3.30E+00
3 4 10	MAX AVE MIN	<7.50E-02 <7.50E-02 <7.50E-02	1.60E+01 1.27E+01 9.60E+00
3 5 1	MAX AVE MIN	<7.50E-02*	1.37E+01*
3 6 1	MAX AVE MIN	<7.50E-02*	1.27E+01*
3 8 1	MAX AVE MIN	<7.50E-02*	3.73E+00*
3 8 2	MAX AVE MIN	<7.50E-02*	8.77E+00*
3 8 3	MAX AVE MIN	<7.50E-02*	2.73E+00*
6 S31 1P	MAX AVE MIN		<1.11E+00* 6.67E-01*
6 S30E15A	MAX AVE MIN		9.13E+00*
6 S29 E12	MAX AVE MIN		1.30E+01*
6 S27 E14	MAX AVE MIN	<7.50E-02*	1.40E+01 1.25E+01 8.90E+00
6 S19 E13	MAX AVE MIN		9.83E+00*
6 S19 11	MAX AVE MIN		3.30E+01*
DISC NAME 6 S18 E2AP DOES NOT MATCH INPUT NAME 6 S18 E2B			
6 S14 20	MAX AVE MIN		5.20E-01*

WELL NO.		TOTAL BETA (PCI/ML) -----	TRITIUM (PCI/ML) -----	NITRATE (MG/L) -----
6 312 3	MAX AVE MIN		7.23E+00*	5.13E+00*
6 312 29	MAX AVE MIN			5.10E+00 2.25E+00 <5.00E-01
6 311E12A	MAX AVE MIN		<1.23E+00*	8.75E+00*
6 311E12AP	MAX AVE MIN		<1.43E+00*	9.50E+00*
6 38 19	MAX AVE MIN		<1.23E+00*	2.33E+00*
6 36E14A	MAX AVE MIN		<1.50E+00*	8.65E+00*
6 36 E48	MAX AVE MIN		1.37E+01*	9.20E+00*
6 36 E40	MAX AVE MIN		1.57E+01*	1.02E+01*
6 33 E12	MAX AVE MIN		<1.01E+00*	4.75E+00*
6 33 25	MAX AVE MIN		2.37E+00*	<5.00E-01*
6 31 75	MAX AVE MIN	<7.50E-02*	3.80E+01*	<5.00E-01*
6 30 8	MAX AVE MIN	<7.50E-02 <7.50E-02 <7.50E-02	7.20E+01 5.62E+01 1.40E+01	8.60E+00 4.83E+00 <5.00E-01
6 30 7	MAX AVE MIN	<7.50E-02*	3.60E+01*	7.10E+00*
6 1 18	MAX AVE MIN		1.57E+02*	1.83E+01*
6 2 3	MAX AVE MIN	<7.50E-02*	1.20E+02 1.05E+02 9.30E+01	2.50E+01 2.17E+01 1.80E+01

WELL NO.		TOTAL BETA (PCI/ML) -----	TRITIUM (PCI/ML) -----	NITRATE (MG/L) -----
6	2 33A	MAX AVE MIN	8.55E+00*	1.20E+00*
6	3 45	MAX AVE MIN	<1.39E+00*	5.40E+00 3.08E+00 8.00E-01
6	4 E6	MAX AVE MIN	<1.00E+00*	4.30E+00*
6	8 17	MAX AVE MIN	<7.50E-02*	1.97E+02* 1.94E+01*
6	8 25	MAX AVE MIN	<7.50E-02*	1.27E+02* 2.10E+01*
6	8 32	MAX AVE MIN	2.90E+00*	7.50E-01*
6	9 E2	MAX AVE MIN	1.45E+00*	<5.00E-01*
6	10 E12	MAX AVE MIN	1.30E+00*	1.07E+01*
6	13 1A	MAX AVE MIN	<7.50E-02*	6.80E+02 3.01E+02 1.20E+01 1.40E+01 6.75E+00 <5.00E-01
6	13 1B	MAX AVE MIN	2.67E+02*	7.07E+00*
6	14 E6P	MAX AVE MIN	<1.24E+00*	<5.00E-01*
6	14 E6Q	MAX AVE MIN	<1.23E+00*	<5.00E-01*
6	14 E6R	MAX AVE MIN	<1.26E+00*	<5.00E-01*
6	14 E6S	MAX AVE MIN	<1.07E+00*	<5.00E-01*
6	14 E6T	MAX AVE MIN	1.04E+01*	5.25E+00*

WELL NO.		TOTAL BETA (PCI/ML)	TRITIUM (PCI/ML)	NITRATE (MG/L)
		-----	-----	-----
6 14 38	MAX AVE MIN	<7.50E-02*	2.10E+00 1.31E+00 <6.30E-01	<5.00E-01 <5.00E-01 <5.00E-01
6 15 158	MAX AVE MIN	<7.50E-02*	3.76E+00*	1.19E+01*
6 13 26	MAX AVE MIN	<7.50E-02*	3.30E+02*	2.77E+01*
6 17 5	MAX AVE MIN	<7.50E-02*	<1.35E+00*	3.30E+01*
6 19 43	MAX AVE MIN		9.63E+00*	6.03E+00*
6 19 47A	MAX AVE MIN		<1.33E+00*	5.30E+01*
6 19 58	MAX AVE MIN			<5.00E-01*
6 19 88	MAX AVE MIN			1.10E+00 9.53E-01 7.00E-01
6 20 E5A	MAX AVE MIN		1.10E+00*	2.70E+00*
6 20 E5P	MAX AVE MIN		<1.21E+00*	<5.00E-01*
6 20 E5Q	MAX AVE MIN		<1.09E+00*	<5.00E-01*
6 20 E5R	MAX AVE MIN		<1.22E+00*	7.53E-01*
6 20 E12	MAX AVE MIN		<1.19E+00*	<5.00E-01*
6 20 E12P	MAX AVE MIN		1.21E+00*	<5.00E-01*
6 20 20	MAX AVE MIN	9.17E-02*	7.47E+02*	4.73E+01*

WELL NO.		TOTAL BETA (PCI/ML) -----	TRITIUM (PCI/ML) -----	NITRATE (MG/L) -----
6 20 39	MAX AVE MIN		<1.02E+00*	<5.00E-01*
6 22 70	MAX AVE MIN		1.03E+01*	9.10E+00*
6 24 1P	MAX AVE MIN		<1.18E+00*	<5.00E-01*
6 24 1Q	MAX AVE MIN		<1.07E+00*	<5.00E-01*
6 24 1R	MAX AVE MIN		<1.12E+00*	<5.00E-01*
6 24 1S	MAX AVE MIN		<1.37E+00*	<5.00E-01*
6 24 1T	MAX AVE MIN		1.23E+00*	<5.00E-01*
6 24 33	MAX AVE MIN	<7.50E+02*	2.30E+02*	2.17E+01*
6 24 46	MAX AVE MIN		<9.23E-01*	<5.00E-01*
6 25 55	MAX AVE MIN		1.83E+00*	1.15E+01*
6 25 70	MAX AVE MIN		7.05E+00*	3.40E+01*
6 26 15	MAX AVE MIN	1.47E-01*	1.01E+03*	5.00E+01*
6 26 69	MAX AVE MIN			<5.00E-01*
6 27 8	MAX AVE MIN	2.30E-01 1.75E-01 1.30E-01	9.40E+02 9.10E+02 8.80E+02	5.40E+01 5.00E+01 4.60E+01
6 28 40	MAX AVE MIN	<7.50E+02*	8.50E+01 3.47E+01 9.90E+00	1.30E+01 1.14E+01 9.50E+00

WELL NO.		TOTAL BETA (PCI/ML)	TRITIUM (PCI/ML)	NITRATE (MG/L)
		-----	-----	-----
6 28 40P	MAX AVE MIN		2.10E+00*	<5.00E+01*
6 29 78	MAX AVE MIN		<1.20E+00 <1.02E+00 <7.70E-01	2.30E+00 2.08E+00 1.90E+00
6 31 31	MAX AVE MIN	<7.50E-02*	1.30E+03 1.13E+03 1.00E+03	4.33E+01*
6 31 31P	MAX AVE MIN		1.20E+03 8.25E+02 1.10E+00	4.70E+01 2.33E+01 <5.00E+01
6 31 31Q	MAX AVE MIN		6.90E+00*	<5.00E+01*
6 31 53B	MAX AVE MIN		<1.10E+00*	5.20E+00*
6 31 65	MAX AVE MIN		1.10E+00 8.18E-01 <5.70E-01	2.20E+00 9.25E-01 <5.00E-01
6 32 22	MAX AVE MIN	1.33E+01*	1.27E+03*	6.60E+01*
6 32 42	MAX AVE MIN		4.87E+02*	5.75E+00*
6 32 43	MAX AVE MIN		1.33E+02*	1.70E+01*
6 32 62	MAX AVE MIN		1.96E+00*	2.60E+01*
6 32 70	MAX AVE MIN	<7.50E-02*	4.40E+02 2.50E+02 1.60E+02	1.90E+01 1.58E+01 1.40E+01
6 32 72	MAX AVE MIN		1.50E+02 1.40E+02 1.30E+02	8.80E+00 3.23E+00 <5.00E-01
6 32 77	MAX AVE MIN	<7.50E-02 <7.50E-02 <7.50E-02	2.90E+00 1.45E+00 <6.10E-01	4.00E+01 3.10E+01 2.20E+01
6 33 42	MAX AVE MIN	<7.50E-02*	2.83E+02*	1.53E+01*

WELL NO.		TOTAL BETA (PCI/ML) -----	TRITIUM (PCI/ML) -----	NITRATE (MG/L) -----
6 33 56	MAX AVE MIN	<7.50E-02*	<9.70E-01*	8.33E+00*
6 34 39A	MAX AVE MIN	<7.50E-02*	5.97E+02*	3.03E+01*
6 34 42	MAX AVE MIN	<7.50E-02*	4.55E+02*	3.00E+01*
6 34 51	MAX AVE MIN	<7.50E-02*	1.88E+00*	8.20E+00*
6 35 9	MAX AVE MIN	<7.50E-02*	1.19E+02*	1.95E+01*
6 35 66	MAX AVE MIN	<7.50E-02 <7.50E-02 <7.50E-02	8.60E+02 7.56E+02 6.40E+02	2.30E+01 2.16E+01 2.10E+01
6 35 70	MAX AVE MIN	1.20E+01 8.88E-02 <7.50E-02	7.80E+03 7.37E+03 6.90E+03	3.60E+01 2.75E+01 2.10E+01
6 35 78	MAX AVE MIN	<7.50E-02 <7.50E-02 <7.50E-02	1.00E+00 8.40E-01 <7.60E-01	1.90E+00 1.13E+00 <5.00E-01
6 36 46P	MAX AVE MIN		<8.60E-01*	<5.00E-01*
6 36 46Q	MAX AVE MIN		1.36E+00*	7.00E-01*
6 36 61A	MAX AVE MIN			2.60E+01 1.70E+01 1.30E+01
6 36 93	MAX AVE MIN		<1.00E+00*	6.00E-01*
6 37 43	MAX AVE MIN	<7.50E-02*	6.90E+01*	1.20E+01*
6 37 82A	MAX AVE MIN		<7.20E-01 <6.45E-01 <5.90E-01	5.30E+01 4.88E+01 4.40E+01
6 38 65	MAX AVE MIN		5.30E+01*	5.77E+01*

WELL NO.		TOTAL BETA (PCI/ML)	TRITIUM (PCI/ML)	NITRATE (MG/L)
		-----	-----	-----
6 38 70	MAX AVE MIN	2.60E-01*	3.20E+01*	2.97E+02*
6 39 39	MAX AVE MIN	<7.50E-02*	<9.20E+01*	<5.00E+01*
6 39 79	MAX AVE MIN	47.50E-02 <7.50E-02 <7.50E-02	<1.20E+00 <9.65E+01 <5.70E+01	1.20E+00 1.00E+00 6.20E+01
6 40 1	MAX AVE MIN		1.70E+02*	2.40E+01*
6 40 33A	MAX AVE MIN		3.77E+01*	1.30E+00*
6 40 62	MAX AVE MIN		1.90E+01 8.55E+00 3.90E+00	1.70E+01 1.60E+01 1.50E+01
6 41 23	MAX AVE MIN	8.33E-02*	7.90E+02*	7.27E+01*
6 42 12A	MAX AVE MIN	<7.50E-02*	3.27E+02*	2.83E+01*
6 43 88	MAX AVE MIN		<1.40E+00 <8.70E+01 <5.80E+01	2.30E+01 1.10E+01 7.50E+01
6 44 64	MAX AVE MIN		<1.10E+00 <9.45E+01 <8.30E+01	1.80E+01 1.50E+01 1.40E+01
6 45 42	MAX AVE MIN	47.50E-02 <7.50E-02 <7.50E-02	3.20E+02 3.17E+02 3.00E+02	5.30E+00 3.75E+00 <5.00E+01
6 45 69	MAX AVE MIN	<7.50E-02*	<9.03E+01*	2.70E+01*
6 46 21	MAX AVE MIN	<7.50E-02*	1.93E+01*	8.87E+02*
6 47 35A	MAX AVE MIN		<9.80E+01 <7.93E+01 <5.90E+01	<5.00E+01 <5.00E+01 <5.00E+01
6 47 46	MAX AVE MIN	<7.50E-02*	<1.00E+00 <8.35E+01 <6.50E+01	1.60E+01 1.11E+01 1.20E+00

WELL NO.		TOTAL BETA (PCI/ML) -----	TRITIUM (PCI/ML) -----	NITRATE (MG/L) -----
6 47 60	MAX	2.30E-01	5.70E+00	2.40E+01
	AVE	1.14E-01	3.02E+00	2.08E+01
	MIN	<7.50E-02	<6.40E-01	1.70E+01
6 48 71	MAX		<1.30E+00	2.30E+01
	AVE		<9.25E-01	1.25E+01
	MIN		<6.70E-01	8.60E-01
6 49 55	MAX	<7.50E-02	<1.00E+00	1.00E+01
	AVE	<7.50E-02	<8.50E-01	6.50E+00
	MIN	<7.50E-02	<6.90E-01	4.50E+00
6 49 57	MAX	1.10E+00	1.60E+02	1.80E+02
	AVE	9.93E-01	1.50E+02	1.50E+02
	MIN	8.80E-01	1.40E+02	1.40E+02
6 49 79	MAX		<2.10E+00	4.10E+01
	AVE		<1.17E+00	3.90E+01
	MIN		<5.40E-01	3.80E+01
6 50 208	MAX		3.20E+01	2.20E+00
	AVE	<7.50E-02*	6.08E+00	1.62E+00
	MIN		<5.90E-01	<5.00E-01
6 50 30	MAX		<1.30E+00	5.60E+00
	AVE		<9.33E-01	3.03E+00
	MIN		<6.10E-01	<5.00E-01
6 50 42	MAX		1.10E+00	<5.00E-01
	AVE		8.65E-01	<5.00E-01
	MIN		<7.30E-01	<5.00E-01
6 50 53	MAX	1.80E-01	3.70E+00	5.10E+01
	AVE	1.41E-01	1.63E+00	3.73E+01
	MIN	<7.50E-02	<7.80E-01	2.30E+01
6 50 85	MAX		<1.40E+00	2.10E+01
	AVE		<1.00E+00	1.70E+01
	MIN		<7.10E-01	1.10E+01
6 51 63	MAX		<1.20E+00	4.50E+00
	AVE		<9.58E-01	2.43E+00
	MIN		<7.80E-01	<5.00E-01
6 51 75	MAX		<1.50E+00	<5.00E-01
	AVE		<9.78E-01	<5.00E-01
	MIN		<5.80E-01	<5.00E-01
6 53 35	MAX		<8.70E-01	<5.00E-01
	AVE		<7.90E-01	<5.00E-01
	MIN		7.00E-01	<5.00E-01
6 53 47	MAX		<8.30E-01	<5.00E-01
	AVE		<7.20E-01	<5.00E-01
	MIN		<5.80E-01	<5.00E-01

WELL NO.		TOTAL BETA (PCI/ML)	TRITIUM (PCI/ML)	NITRATE (MG/L)
		-----	-----	-----
6 53 55A	MAX		<1.48E+00	<5.00E-01
	AVE		<9.05E-01	<5.02E-01
	MIN		<3.43E-01	<5.04E-01
6 53 103	MAX		<1.92E+00	<5.00E-01
	AVE		<1.42E+00	<5.00E-01
	MIN		<7.70E-01	<5.00E-01
6 54 34	MAX		<8.08E-01	<5.00E-01
	AVE		<7.15E-01	<5.00E-01
	MIN		<6.60E-01	<5.00E-01
6 54 37A	MAX		1.10E+00	<5.00E-01
	AVE		9.33E-01	<5.00E-01
	MIN		<7.52E-01	<5.00E-01
6 54 42	MAX			<5.00E-01
	AVE		<9.05E-01*	<5.00E-01
	MIN			<5.00E-01
6 54 45	MAX		<9.10E-01	<5.00E-01
	AVE		<8.23E-01	<5.00E-01
	MIN		<6.50E-01	<5.00E-01
6 54 57	MAX		<1.20E+00	9.40E-01
	AVE		<8.55E-01	6.10E-01
	MIN		<6.80E-01	<5.00E-01
6 55 40	MAX		<1.30E+00	<5.00E-01
	AVE		<9.62E-01	<5.00E-01
	MIN		<6.90E-01	<5.00E-01
6 55 44	MAX		<1.50E+00	<5.00E-01
	AVE		<1.22E+00	<5.00E-01
	MIN		<5.80E-01	<5.00E-01
6 55 50C	MAX		<1.00E+00	<5.00E-01
	AVE	<7.50E-02*	<8.22E-01	<5.00E-01
	MIN		<6.20E-01	<5.00E-01
6 55 72	MAX		<1.60E+00	<5.00E-01
	AVE		<1.15E+00	<5.00E-01
	MIN		<8.90E-01	<5.00E-01
6 55 76	MAX			2.20E+00
	AVE	<7.50E-02*	<1.00E+00*	9.96E-01
	MIN			<5.00E-01
6 55 89	MAX			8.00E-01
	AVE			6.30E-01
	MIN			<5.00E-01
6 57 25A	MAX		<1.50E+00	2.60E+00
	AVE		<1.13E+00	1.75E+00
	MIN		<6.40E-01	6.10E-01
6 57 29	MAX			
	AVE		1.62E+00*	7.73E-01*
	MIN			
6 57 83	MAX			1.70E+00
	AVE			1.22E+00
	MIN			6.90E-01

WELL NO.		TOTAL BETA (PCI/ML) -----	TRITIUM (PCI/ML) -----	NITRATE (MG/L) -----
6 59 32	MAX AVE MIN		1.90E+00 1.27E+00 9.30E-01	1.70E+00 8.00E-01 <5.00E-01
6 59 58	MAX AVE MIN		3.70E+00 2.74E+00 2.20E+00	6.60E-01 5.32E-01 <5.00E-01
6 60 32	MAX AVE MIN		1.30E+00 9.45E-01 <5.70E-01	1.22E+00 7.48E-01 <5.00E-01
6 60 57	MAX AVE MIN		3.10E+00 1.85E+00 1.30E+00	<5.00E-01 <5.00E-01 <5.00E-01
6 60 60	MAX AVE MIN		1.40E+00 1.03E+00 7.80E-01	7.10E+00 2.15E+00 <5.00E-01
6 61 37	MAX AVE MIN			1.60E+00 9.50E-01 <5.00E-01
6 61 41	MAX AVE MIN		<8.40E-01*	8.60E-01*
6 61 62	MAX AVE MIN		5.00E+00 4.05E+00 3.20E+00	3.10E+00 2.00E+00 1.40E+00
6 62 31	MAX AVE MIN			<5.00E-01 <5.00E-01 <5.00E-01
6 62 43F	MAX AVE MIN		1.63E+00*	1.01E+00*
6 63 25A	MAX AVE MIN		<1.10E+00 <8.75E-01 <6.00E-01	7.40E+00 4.93E+00 2.70E+00
6 63 51	MAX AVE MIN		<1.09E+00*	7.67E-01*
6 63 55	MAX AVE MIN		2.10E+00 1.44E+00 9.40E-01	<5.00E-01 <5.00E-01 <5.00E-01
6 63 58	MAX AVE MIN		3.10E+00 1.80E+00 1.30E+00	6.70E-01 5.43E-01 <5.00E-01
6 63 90	MAX AVE MIN	<7.50E-02*	<1.50E+00 <1.15E+00 <9.80E-01	3.30E+00 2.08E+00 <5.00E-01

WELL NO.		TOTAL BETA (PCI/ML)	TRITIUM (PCI/ML)	NITRATE (MG/L)
		-----	-----	-----
6 64 27	MAX AVE MIN		<8.90E-01*	2.27E+00*
6 64 62	MAX AVE MIN		2.50E+00 2.03E+00 1.80E+00	8.00E-01 6.55E-01 5.80E-01
6 65 22	MAX AVE MIN		<6.80E-01*	8.40E+00*
6 65 38	MAX AVE MIN		<6.10E-01*	<5.00E-01*
6 65 50	MAX AVE MIN	1.00E-01*	7.00E+00 3.00E+00 1.40E+00	9.30E-01 7.30E-01 5.60E-01
6 65 59	MAX AVE MIN		2.33E+00*	5.20E-01*
6 65 72	MAX AVE MIN		1.30E+00 9.45E-01 4.70E-01	5.40E+00 4.78E+00 4.30E+00
6 65 83	MAX AVE MIN		1.80E+00 1.31E+00 9.50E-01	2.30E+00 1.60E+00 4.50E-01
6 66 38	MAX AVE MIN			<5.20E-01*
6 66 39	MAX AVE MIN			<5.00E-01 <5.20E-01 <5.20E-01
6 66 58	MAX AVE MIN		3.00E+00 2.30E+00 1.60E+00	7.70E-01 6.27E-01 5.20E-01
6 66 64	MAX AVE MIN		1.50E+00 1.23E+00 8.20E-01	8.90E-01 7.80E-01 5.80E-01
6 66 103	MAX AVE MIN		<8.15E-01*	<5.00E-01*

WELL NO.		TOTAL BETA (PCI/ML) -----	TRITIUM (PCI/ML) -----	NITRATE (MG/L) -----
6 67 51	MAX AVE MIN		1,70E+00*	6,90E-01*
6 67 86	MAX AVE MIN		1,70E+00 1,40E+00 1,20E+00	1,30E+00 9,90E-01 7,70E-01
6 67 86R	MAX AVE MIN		<1,18E+00*	2,03E+00*
6 67 86S	MAX AVE MIN		<9,97E-01*	5,20E+01*
6 67 98	MAX AVE MIN		<1,60E+00 <1,08E+00 <8,70E-01	3,60E+00 2,67E+00 1,70E+00
6 68 105	MAX AVE MIN		<5,30E-01*	7,95E-01*
6 69 38	MAX AVE MIN		<1,20E+00 <9,18E-01 <5,50E-01	3,90E+01 1,03E+01 <5,30E-01
6 70 68	MAX AVE MIN		1,40E+00*	6,80E-01*
6 71 30	MAX AVE MIN		<1,33E+00*	1,60E+01*
6 71 52	MAX AVE MIN		2,10E+00*	2,23E+00*
6 71 77	MAX AVE MIN		<9,80E-01*	6,80E-01*
6 72 73	MAX AVE MIN		<1,01E+00*	1,10E+00*
6 72 88	MAX AVE MIN		1,00E+01 9,05E+00 7,60E+00	3,40E+00 1,85E+00 1,00E+00
6 72 92	MAX AVE MIN		7,90E+00*	2,60E+00*
6 72 98	MAX AVE MIN		2,80E+00*	<5,00E-01*

WELL NO.	TOTAL BETA (PCI/ML) -----	TRITIUM (PCI/ML) -----	NITRATE (MG/L) -----
6 73 61 MAX AVE MIN		<8.20E-01*	2.30E+00*
6 74 44 MAX AVE MIN		<1.70E+00 <1.16E+00 <5.40E-01	<5.00E-01 <5.00E-01 <5.00E-01
6 74 60 MAX AVE MIN		<1.60E+00*	1.60E+00*
6 77 36 MAX AVE MIN		<1.70E+00 <1.16E+00 <5.90E-01	2.20E+02 2.02E+02 1.82E+02
6 77 54 MAX AVE MIN			3.77E+00*
6 78 62 MAX AVE MIN			3.10E+00*
6 80 435 MAX AVE MIN			2.09E+00*
6 81 58 MAX AVE MIN		<1.14E+00*	<5.00E-01*
6 83 47 MAX AVE MIN		<1.60E+00*	
6 84 35A0 MAX AVE MIN		<1.00E+00*	<5.00E-01*
6 87 55 MAX AVE MIN		6.97E+01*	1.17E+01*
6 89 35 MAX AVE MIN			6.90E+00*
6 90 45 MAX AVE MIN		2.35E+01*	<5.00E-01*
6 96 49 MAX AVE MIN		2.37E+01*	7.33E-01*
6 97 43 MAX AVE MIN		9.30E+00*	3.90E+00*

WELL NO.		TOTAL BETA (PCI/ML) -----	TRITIUM (PCI/ML) -----	NITRATE (MG/L) -----
6 101 408	MAX AVE MIN		<1.30E+00*	<5.00E-01*
6 HAN 6	MAX AVE MIN		5.13E+00*	2.83E+00*
6 HAN 9	MAX AVE MIN		<1.60E+00*	3.60E+00*
6 HAN 19	MAX AVE MIN		<0.30E+01*	3.37E+00*
6 HAN 24	MAX AVE MIN		<1.15E+00*	3.92E+01*

APPENDIX B

Total Alpha, Strontium, Cesium, Cobalt, Uranium, Ruthenium, Chromium and Fluoride Concentrations
in the Ground-Water Unconfined Aquifer, Calendar Year 1978.

WELL NO. DATE	TOTAL ALPHA (PCI/ML)	STRONTIUM (PCI/ML)	CESIUM (PCI/ML)	COBALT (PCI/ML)	URANIUM (PCI/ML)	RUTHENIUM (PCI/ML)	CHROMIUM (MG/L)	FLUORIDE (MG/L)
1 05 12 02-JUN-78 06-NOV-78						1.00E-01 1.70E-01		
1 H4 3 17-JAN-78 28-FEB-78 27-MAR-78 02-JUN-78 23-JUN-78 12-JUL-78 25-SEP-78 11-OCT-78 06-NOV-78			<1.00E-02	1.20E-02	1.10E-02 1.70E-02 2.50E-02 1.50E-02 3.56E-01 3.29E-01 2.05E-01	1.40E-01	3.30E+00 4.40E+00 1.50E+00 2.90E+00 6.40E+00 1.20E+01 4.10E+00 4.20E+00 4.80E+00	1.00E-01 4.10E-01 3.00E-01 8.00E-01 8.50E-01 9.00E-01 1.30E-01 1.30E-01 1.00E-01
1 K 11 17-MAY-78 06-NOV-78				2.10E-02 1.30E-02		1.30E-01		
1 N 3 02-MAR-78 17-MAY-78 06-NOV-78		2.90E-01 2.20E-01		1.30E-01 1.00E-01 1.30E-01		1.00E+00 6.40E-01		
1 N 4 02-MAR-78 17-MAY-78 06-NOV-78		7.70E-03 5.10E-03		7.00E-02 9.30E-02 8.00E-02		2.30E-01 2.80E-01		
1 N 6 02-MAR-78 17-MAY-78 06-NOV-78		1.00E-02 1.20E-02		1.30E-01 1.10E-01 1.60E-01		6.00E-01 3.40E-01		

WELL NO. DATE	TOTAL ALPHA (PCI/ML)	STRONTIUM (PCI/ML)	CESIUM (PCI/ML)	COBALT (PCI/ML)	URANIUM (PCI/ML)	RUTHENIUM (PCI/ML)	CHROMIUM (MG/L)	FLUORIDE (MG/L)
1 N 14 02-MAR-78 17-MAY-78 06-NOV-78		7.37E-02 6.70E-02		1.90E-01 2.50E-01		9.00E-01 5.00E-01		
1 N 15 02-MAR-78 17-MAY-78 06-NOV-78		1.30E-02 1.50E-02		1.40E-01 9.80E-02 1.20E-01		3.10E-01 1.20E-01 2.60E-01		
3 1 1 12-JAN-78 24-MAR-78 12-JUN-78 12-SEP-78			<1.00E-02	<1.00E-02	1.50E-02 1.40E-02 6.80E-03	2.40E-01	7.90E-03 1.50E-02 1.90E-02 1.20E-02	6.80E-01 7.20E-01 6.50E-01 8.20E-01
3 1 2 24-MAR-78 12-JUN-78 12-SEP-78				1.40E-02	6.90E-03 6.90E-03 8.90E-03	1.00E-01	3.60E-02 1.70E-02 1.20E-02	6.20E-01 4.80E-01 8.20E-01
3 1 3 12-JAN-78 27-MAR-78 12-JUN-78 12-SEP-78			<1.20E-02 <1.00E-02	<1.00E-02	1.00E-02 1.30E-02 1.20E-02	1.90E-01 1.00E-01	7.90E-03 1.40E-02 5.80E-03 3.00E-03	5.50E-01 6.80E-01 5.00E-01 8.50E-01
3 1 4 12-JAN-78 24-MAR-78 20-JUN-78 15-SEP-78				1.50E-02	6.90E-03 6.90E-03 6.80E-03		5.80E-03 6.20E-03 1.20E-02 3.00E-03	4.60E-01 7.80E-01 5.20E-01 5.00E-01
3 1 5 04-JAN-78 03-FEB-78 24-MAR-78 26-APR-78				1.50E-02	6.90E-03 1.20E-02	2.00E-01	6.80E-03 4.40E-03 8.60E-03 1.20E-02	4.30E-01 5.30E-01 4.10E-01 3.00E-01

WELL NO. DATE	TOTAL ALPHA (PCI/ML)	STRONTIUM (PCI/ML)	CESIUM (PCI/ML)	COBALT (PCI/ML)	URANIUM (PCI/ML)	RUTHENIUM (PCI/ML)	CHROMIUM (MG/L)	FLUORIDE (MG/L)
3 1 5								
16-MAY-78				1.80E-02	9.60E-03		1.10E-02	6.20E-01
12-JUN-78					9.60E-03		1.10E-02	1.10E+00
11-JUL-78				1.60E-02	<6.90E-03		2.60E-02	1.00E+00
07-AUG-78					<6.90E-03		1.40E-02	6.50E-01
15-SEP-78					<6.90E-03		6.20E-03	4.30E-01
13-OCT-78					<6.90E-03		<3.00E-03	3.50E-01
08-NOV-78					<6.90E-03	1.50E-01	9.30E-03	5.30E-01
28-NOV-78					<6.90E-03		7.40E-03	1.60E-01
3 1 6								
12-JAN-78							3.60E-03	4.60E-01
08-MAR-78			<1.00E-02	<1.00E-02	1.00E-02	8.20E-02	1.10E-02	4.50E-01
24-MAR-78				1.80E-02	1.50E-02		3.70E-02	4.10E-01
26-APR-78					9.60E-03		1.70E-02	4.20E-01
16-MAY-78					1.10E-02		9.20E-03	5.50E-01
20-JUN-78					<6.90E-03		2.70E-02	5.70E-01
11-JUL-78				1.30E-02	<6.90E-03		2.40E-02	5.60E-01
07-AUG-78					<6.90E-03		2.20E-02	6.80E-01
15-SEP-78					<6.90E-03			
13-OCT-78				2.00E-02	1.00E-02	1.60E-01	4.50E-03	4.00E-01
08-NOV-78				2.70E-02	9.60E-03	1.50E-01	<3.00E-03	5.40E-01
28-NOV-78					<6.90E-03		1.00E-02	1.30E-01
3 3 1								
04-JAN-78	8.90E-02						<3.00E-03	5.80E-01
03-FEB-78	7.50E-02						5.00E-03	7.30E-01
01-MAR-78	7.00E-02		<1.50E-02	1.20E-02	3.40E-02		<3.00E-03	4.60E-01
24-MAR-78	8.20E-02				4.10E-02		4.60E-02	7.20E-01
25-APR-78	7.90E-02				4.30E-02		<3.00E-03	1.00E+00
16-MAY-78	5.10E-02				2.80E-02		5.10E-03	7.20E-01
20-JUN-78					2.40E-02		1.10E-02	7.20E-01
11-JUL-78	4.90E-02				2.60E-02		3.10E-02	5.50E-01
07-AUG-78	4.20E-02				2.20E-02		4.40E-03	6.50E-01
12-SEP-78	2.00E-02				1.00E-02		1.40E-02	7.50E-01
13-OCT-78	3.20E-02				1.70E-02		<3.00E-03	4.20E-01
08-NOV-78	3.80E-02				2.00E-02		<3.00E-03	3.50E-01
28-NOV-78	2.70E-02				1.40E-02		<3.00E-03	3.70E-01
3 3 2								
12-JAN-78							1.60E-01	3.40E-01

WELL NO. DATE	TOTAL ALPHA (PCI/ML)	STRONTIUM (PCI/ML)	CESIUM (PCI/ML)	COBALT (PCI/ML)	URANIUM (PCI/ML)	RUTHENIUM (PCI/ML)	CHROMIUM (MG/L)	FLUORIDE (MG/L)
3 3 2								
02-FEB-78	3.10E-02						1.60E-01	4.10E-01
01-MAR-78	2.90E-02		<2.00E-02	3.00E-02	1.50E-02	2.00E-01	5.30E-02	2.00E-01
22-MAR-78	2.80E-02				1.50E-02		1.20E-01	3.00E-01
26-APR-78	2.90E-02				1.60E-02		2.40E-01	2.60E-01
16-MAY-78	3.20E-02				1.70E-02		1.80E-01	4.00E-01
20-JUN-78					1.80E-02		1.20E-02	4.00E-01
11-JUL-78	2.20E-02				1.20E-02		3.20E-02	3.60E-01
07-AUG-78	2.20E-02				1.20E-02		6.70E-03	4.10E-01
14-SEP-78	2.00E-02				1.00E-02		5.90E-03	3.90E-01
08-NOV-78	<1.70E-02				<6.90E-03		<3.00E-03	2.40E-01
28-NOV-78	<1.70E-02				<6.90E-03		<3.00E-03	2.60E-01
3 3 3								
04-JAN-78	<1.70E-02						<3.00E-03	3.00E-01
02-FEB-78	<1.70E-02						5.40E-02	3.90E-01
01-MAR-78	<1.70E-02		<1.50E-02	3.00E-02	<6.90E-03	1.70E-01	5.60E-02	2.50E-01
23-MAR-78	1.70E-02				8.90E-03		1.70E-01	3.20E-01
26-APR-78	2.30E-02				1.20E-02		6.80E-02	4.50E-01
16-MAY-78	1.80E-02				9.60E-03		7.10E-02	8.00E-01
20-JUN-78					1.00E-02		2.70E-02	3.60E-01
11-JUL-78	2.10E-02				1.10E-02		3.10E-02	3.90E-01
07-AUG-78	1.90E-02				1.00E-02		2.20E-02	4.20E-01
14-SEP-78	<1.70E-02				<6.00E-03		5.70E-03	3.50E-01
08-NOV-78	<1.70E-02				<6.90E-03		9.30E-03	2.70E-01
28-NOV-78	<1.70E-02				8.90E-03		6.10E-03	1.70E-01
3 3 6								
30-MAR-78					<6.90E-03		<3.00E-03	2.00E-01
3 3 8								
04-JAN-78	3.60E-02	6.16E-02	<1.50E-02	<1.00E-02		1.00E-01	<3.00E-03	6.80E-01
07-FEB-78	4.10E-02	1.20E-01					4.70E-03	7.50E-01
01-MAR-78	4.20E-02	1.12E-01	<1.50E-02	1.80E-02	2.10E-02	1.20E-01	7.20E-03	5.70E-01
05-APR-78					1.50E-02		5.10E-03	6.60E-01
26-APR-78	4.00E-02	1.03E-01			2.20E-02		7.00E-03	6.00E-01
16-MAY-78	3.60E-02	6.70E-01		1.50E-02	1.90E-02	8.00E-02	7.10E-03	7.00E-01
12-JUN-78	3.10E-02				1.70E-02		9.50E-03	8.00E-01
11-JUL-78	2.90E-02				1.50E-02		1.30E-02	5.50E-01
07-AUG-78	3.10E-02	1.77E-01			1.70E-02		2.10E-02	6.00E-01
14-SEP-78	4.70E-02	1.40E-01			2.50E-03		<3.00E-03	6.00E-01

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WELL NO. DATE	TOTAL ALPHA (PCI/ML)	STRONTIUM (PCI/ML)	CESIUM (PCI/ML)	COBALT (PCI/ML)	URANIUM (PCI/ML)	RUTHENIUM (PCI/ML)	CHROMIUM (MG/L)	FLUORIDE (MG/L)
3 3 8 15-NOV-78 28-NOV-78	3.50E-02			2.82E-01	2.30E-02 1.60E-02		<3.00E-03 <3.00E-03	3.30E-01 2.20E-01
3 3 9 04-JAN-78 07-FEB-78 01-MAR-78 24-MAR-78 26-APR-78 16-MAY-78 19-JUN-78 11-JUL-78 07-AUG-78 14-SEP-78 13-OCT-78 08-NOV-78 28-NOV-78	4.60E-02 3.50E-02 5.30E-02 4.60E-02 4.70E-02 5.70E-02 5.50E-02 5.00E-02 5.00E-02 3.30E-02 4.20E-02 3.80E-02	<2.10E-03 <2.30E-03 <5.29E-04 <9.19E-04 <6.14E-04 	<1.50E-02	2.30E-02	2.70E-02 2.50E-02 2.60E-02 3.10E-02 3.00E-02 2.90E-02 2.60E-02 2.70E-02 1.70E-02 2.20E-02 2.00E-02	2.30E-01	<3.00E-03 <3.00E-03 <3.00E-03 9.20E-03 3.70E-03 <3.00E-03 5.10E-03 1.20E-02 6.70E-03 <3.00E-03 <3.00E-03 <3.00E-03 <3.00E-03	7.30E-01 9.50E-01 7.20E-01 1.10E-01 6.00E-01 3.40E-01 9.50E-01 8.80E-01 1.20E-01 6.50E-01 6.42E-01 5.70E-01 4.50E-01
3 3 10 04-JAN-78 07-FEB-78 01-MAR-78 24-MAR-78 26-APR-78 16-MAY-78 19-JUN-78 11-JUL-78 07-AUG-78 14-SEP-78 13-OCT-78 08-NOV-78 28-NOV-78	3.70E-02 4.70E-02 4.60E-02 4.10E-02 4.60E-02 5.00E-02 6.20E-02 6.10E-02 8.20E-02 4.10E-02 7.10E-02 9.00E-02	<2.90E-03 3.60E-03 <1.10E-03 <4.50E-04 <2.95E-04 	<1.50E-02	1.50E-02	2.40E-02 2.30E-02 2.60E-02 2.60E-02 2.70E-02 3.20E-02 3.20E-02 4.10E-02 4.90E-02 3.80E-02 4.60E-02		3.00E-03 <3.00E-03 4.20E-03 5.10E-03 8.60E-03 4.90E-03 5.80E-03 8.50E-03 6.20E-03 <3.00E-03 <3.00E-03 <3.00E-03 <3.00E-03	7.00E-01 8.20E-01 6.70E-01 5.50E-01 5.00E-01 7.00E-01 7.00E-01 7.30E-01 8.50E-01 6.80E-01 5.30E-01 4.90E-01 3.50E-01
3 3 11 04-JAN-78 07-FEB-78 01-MAR-78 24-MAR-78 26-APR-78 16-MAY-78	4.20E-02 5.10E-02 4.50E-02 4.80E-02 4.60E-02 4.70E-02	9.50E-03 7.00E-03 2.66E-03 5.32E-03 2.70E-03	<1.50E-02	1.40E-02	2.30E-02 2.60E-02 2.60E-02 2.60E-02		5.30E-03 8.50E-03 8.10E-03 1.50E-02 7.40E-03 1.10E-02	5.80E-01 7.50E-01 5.40E-01 4.20E-01 5.50E-01 7.20E-01

WELL NO. DATE	TOTAL ALPHA (PCI/ML)	STRONTIUM (PCI/ML)	CESIUM (PCI/ML)	COBALT (PCI/ML)	URANIUM (PCI/ML)	RUTHENIUM (PCI/ML)	CHROMIUM (MG/L)	FLUORIDE (MG/L)
3 3 11 19-JUN-78 07-AUG-78	2.70E+02				1.90E+02 1.50E+02		9.20E+03 4.80E+03	6.00E+01 6.00E+01
3 4 1 11-JAN-78 08-MAR-78 23-MAR-78 26-APR-78 16-MAY-78 19-JUN-78 11-JUL-78 07-AUG-78 14-SEP-78 13-OCT-78 08-NOV-78 28-NOV-78			<1.20E+02	1.90E+02 1.70E+02 3.00E+02	6.90E+03 6.90E+03 8.90E+03 6.90E+03 6.90E+03 7.50E+03 1.40E+02 1.20E+02 1.50E+02 1.30E+02 1.30E+02	3.00E+01 1.20E+01	2.20E+02 1.50E+01 1.20E+01 9.20E+02 7.50E+02 9.90E+02 2.70E+02 43.00E+03 43.00E+03 9.30E+03 2.20E+02	4.10E+01 3.70E+01 3.20E+01 3.00E+01 4.00E+01 4.20E+01 4.10E+01 3.90E+01 4.50E+01 3.30E+01 3.30E+01 2.70E+01
3 4 5 27-MAR-78 20-JUN-78 07-AUG-78					1.20E+02 1.00E+02		5.40E+03 9.90E+02	7.50E+01 4.20E+01
3 4 7 04-JAN-78 07-FEB-78 01-MAR-78 24-MAR-78 26-APR-78 16-MAY-78 20-JUN-78 11-JUL-78 07-AUG-78 14-SEP-78 13-OCT-78 08-NOV-78 28-NOV-78	9.20E+02 6.50E+02 6.20E+02 6.50E+02 6.80E+02 5.60E+02 5.50E+02 4.40E+02 4.10E+02 5.90E+02 5.90E+02 6.10E+02	<1.27E+03 <3.31E+04	<1.50E+02	2.10E+02	3.30E+02 3.40E+02 3.40E+02 3.10E+02 2.90E+02 3.00E+02 2.30E+02 4.80E+03 3.10E+02 3.10E+02 3.30E+02		7.90E+03 8.50E+03 6.20E+03 1.20E+02 3.40E+02 9.20E+03 1.50E+02 2.20E+02 1.30E+02 43.00E+03 4.40E+03 4.90E+03 5.00E+03	6.50E+01 8.30E+01 6.50E+01 7.50E+01 5.00E+01 1.50E+00 5.50E+01 6.50E+01 8.00E+01 7.20E+01 6.50E+01 6.20E+01 3.80E+01
3 4 9 04-JAN-78	5.30E+02	<1.80E+03	<1.20E+02	1.60E+02		9.00E+02	6.10E+03	7.00E+01

WELL NO. DATE	TOTAL ALPHA (PCI/ML)	STRONTIUM (PCI/ML)	CESIUM (PCI/ML)	COBALT (PCI/ML)	URANIUM (PCI/ML)	RUTHENIUM (PCI/ML)	CHROMIUM (MG/L)	FLUORIDE (MG/L)
3 4 9								
07-FEB-78	4.40E+02	<2.10E+03					9.10E+03	8.50E+01
01-MAR-78	5.00E+02	<4.53E+04	<1.50E+02	1.40E+02	2.60E+02		4.70E+03	6.40E+01
24-MAR-78	5.00E+02				2.70E+02		5.40E+03	4.00E+01
26-APR-78	6.40E+02	<6.62E+04			3.40E+02		2.30E+02	5.00E+01
16-MAY-78	7.00E+02	<1.11E+03			3.70E+02		6.20E+03	7.20E+01
19-JUN-78					3.70E+02		1.40E+02	6.00E+01
11-JUL-78	4.40E+02				2.40E+02		1.40E+02	6.00E+01
07-AUG-78	4.50E+02				2.40E+02		1.60E+02	7.00E+01
14-SEP-78	2.10E+02				1.10E+02		<3.00E+03	8.00E+01
13-OCT-78	1.00E+02				9.60E+03		<3.00E+03	4.50E+01
08-NOV-78	5.00E+02				3.10E+02		<3.00E+03	3.80E+01
28-NOV-78	4.30E+02				2.30E+02		<3.00E+03	2.20E+01
3 4 10								
04-JAN-78	5.20E+02	<1.50E+03					4.70E+03	7.30E+01
07-FEB-78	5.80E+02	2.90E+03					7.40E+03	9.00E+01
01-MAR-78	4.70E+02	<7.22E+04	<1.50E+02	2.70E+02	2.40E+02	1.60E+01	6.20E+03	6.70E+01
24-MAR-78	4.60E+02				2.40E+02		1.30E+02	6.00E+01
26-APR-78	6.00E+02	<8.26E+04			3.30E+02		9.80E+03	5.50E+01
16-MAY-78		<2.50E+03	1.06E+03	<3.84E+03		<2.39E+01		
16-MAY-78		<7.73E+04						
19-JUN-78					3.00E+02		6.60E+03	6.20E+01
11-JUL-78	5.00E+02				2.60E+02		1.70E+02	6.50E+01
07-AUG-78	3.70E+02				2.00E+02		5.90E+03	9.50E+01
14-SEP-78	3.60E+02				1.90E+02		3.20E+03	6.40E+01
08-NOV-78	6.80E+02				3.60E+02		<3.00E+03	4.90E+01
28-NOV-78	7.40E+02				3.90E+02		5.00E+03	4.10E+01
3 5 1								
11-JAN-78			<1.20E+02	2.10E+02			7.90E+03	2.90E+01
23-MAR-78				1.70E+02	<6.90E+03		2.50E+02	3.10E+01
20-JUN-78					<6.90E+03		1.60E+02	3.50E+01
14-SEP-78				2.50E+02	<6.80E+03		<3.00E+03	3.60E+01
3 6 1								
11-JAN-78			<1.20E+02	2.90E+02		1.40E+01	5.00E+03	3.00E+01
23-MAR-78				1.30E+02	<6.90E+03		7.80E+03	6.00E+01
20-JUN-78					<6.90E+03		6.60E+03	2.80E+01
12-SEP-78					<6.80E+03		6.70E+03	3.00E+01

WELL NO. DATE	TOTAL ALPHA (PCI/ML)	STRONTIUM (PCI/ML)	CESIUM (PCI/ML)	COBALT (PCI/ML)	URANIUM (PCI/ML)	RUTHENIUM (PCI/ML)	CHROMIUM (MG/L)	FLUORIDE (MG/L)
3 8 1 11-JAN-78 23-MAR-78 20-JUN-78 12-SEP-78					<6.90E-03 <6.90E-03 <6.80E-03		<3.00E-03 7.10E-03 <3.00E-03 <3.00E-03	3.00E-01 3.40E-01 3.20E-01 3.80E-01
3 8 2 11-JAN-78 27-MAR-78 20-JUN-78 12-SEP-78			<1.00E-02	<1.00E-02	<6.90E-03 <6.90E-03 <6.80E-03	9.00E-02	5.80E-03 8.60E-03 7.40E-03 <3.00E-03	3.40E-01 3.20E-01 3.90E-01 4.20E-01
3 8 3 11-JAN-78 24-MAR-78 20-JUN-78 12-SEP-78				1.70E-02 3.00E-02	<6.90E-03 <6.90E-03 <6.80E-03		4.70E-03 1.10E-02 5.80E-03 <3.00E-03	3.60E-01 3.40E-01 7.00E-01 3.50E-01
6 830E15A 11-JAN-78 21-MAR-78 21-JUN-78 12-SEP-78					<6.90E-03 <6.90E-03 <6.80E-03		7.40E-03 1.30E-02 1.20E-02 <3.00E-03	1.20E-01 1.80E-01 1.40E-01 1.80E-01
6 829 E12 11-JAN-78 21-MAR-78 21-JUN-78 12-SEP-78					<6.90E-03 <6.90E-03 <6.80E-03			2.60E-01 3.00E-01 2.80E-01 3.40E-01
6 827 E14 11-JAN-78 08-MAR-78 21-MAR-78 26-APR-78 17-MAY-78 21-JUN-78 11-JUL-78 07-AUG-78					<6.90E-03 <6.90E-03 <6.90E-03 <6.90E-03 <6.90E-03 <6.90E-03 <6.90E-03 <6.90E-03	1.40E-01	5.80E-03 5.60E-03 6.20E-03 1.20E-02 1.30E-02 1.00E-02 1.80E-02 <3.00E-03	2.60E-01 2.30E-01 3.40E-01 3.10E-01 3.90E-01 2.60E-01 2.60E-01 2.90E-01

WELL NO. DATE	TOTAL ALPHA (PCI/ML)	STRONTIUM (PCI/ML)	CESIUM (PCI/ML)	COBALT (PCI/ML)	URANIUM (PCI/ML)	RUTHENIUM (PCI/ML)	CHROMIUM (MG/L)	FLUORIDE (PG/L)
6 327 E14 15-SEP-78 12-OCT-78 02-NOV-78 29-NOV-78					<6,80E-03 <6,90E-03 <6,90E-03 <6,90E-03		<3,00E-03 <3,00E-03 <3,00E-03 <3,00E-03	2,40E-01 2,80E-01 1,90E-01 1,12E-01
6 319 E13 12-JAN-78 21-MAR-78 20-JUN-78 12-SEP-78					<6,90E-03 <6,90E-03 <6,80E-03			3,60E-01 3,20E-01 3,50E-01 4,12E-01
6 36 E48 21-MAR-78 26-SEP-78					<6,90E-03 <6,80E-03			
6 56 E40 21-MAR-78 21-JUN-78 19-SEP-78					<6,90E-03 <6,90E-03 <6,80E-03			
6 30 8 20-SEP-78				2,10E-02				
6 30 7 06-JAN-78 21-MAR-78			<1,50E-02	<1,40E-02 1,30E-02		1,60E-01		
6 2 3 06-JAN-78 21-MAR-78 25-SEP-78	<1,70E-02			1,20E-02 1,40E-02				
6 8 17 21-MAR-78				2,00E-02				

B-10

WELL NO. DATE	TOTAL ALPHA (PCI/ML)	STRONTIUM (PCI/ML)	CESIUM (PCI/ML)	COBALT (PCI/ML)	URANIUM (PCI/ML)	RUTHENIUM (PCI/ML)	CHROMIUM (MG/L)	FLUORIDE (MG/L)
6 13 1A 13-JAN-78 19-APR-78			<1.50E+02	<1.50E+02		2.50E+01 1.00E+01		
6 15 26 23-MAR-78 21-SEP-78				3.40E+02 3.60E+02				
6 17 5 13-JAN-78 28-MAR-78			<1.50E+02	2.20E+02 1.80E+02		1.00E+01		
6 19 88 17-MAY-78								3.00E+01
6 20 20 05-JAN-78 21-MAR-78 20-SEP-78				2.80E+02 3.70E+02 3.50E+02				
6 20 39 05-JUL-78				4.60E+02		1.40E+01		
6 24 33 05-JAN-78 22-MAR-78 20-SEP-78				1.60E+02 1.50E+02 2.80E+02				
6 26 15 13-JAN-78 22-MAR-78 21-SEP-78			<1.50E+02	5.40E+02 5.50E+02 3.60E+02		2.60E+01 8.20E+02		
6 27 8 13-JAN-78 28-MAR-78			<1.50E+02	5.70E+02 7.60E+02		3.32E+01		

B-12

WELL NO. DATE	TOTAL ALPHA (PCI/ML)	STRONTIUM (PCI/ML)	CESIUM (PCI/ML)	COBALT (PCI/ML)	URANIUM (PCI/ML)	RUTHENIUM (PCI/ML)	CHROMIUM (MG/L)	FLUORIDE (MG/L)
6 27 8 18-APR-78 15-SEP-78				8.10E+02 6.80E+02		1.90E+01		
6 28 40 03-FEB-78			<1.20E+02	2.40E+02				
6 31 31 08-MAR-78 19-APR-78			<1.10E+02	2.80E+02 5.20E+02		1.50E+01		
6 31 31P 22-MAR-78				3.30E+02				
6 32 22 17-JAN-78 23-MAR-78 19-APR-78			<1.40E+02	4.10E+02 6.10E+02 6.70E+02		3.00E+01		
6 32 43 18-JAN-78			<1.00E+02	2.80E+02				
6 32 62 13-JUL-78	<1.70E+02							
6 32 70 26-JAN-78 18-APR-78 24-APR-78 11-OCT-78			<1.30E+02	<1.20E+02 2.70E+02 1.30E+02		9.30E+02		
6 32 72 26-JAN-78 13-JUL-78			<1.70E+02	2.40E+02 1.60E+02		1.70E+01		

WELL NO. DATE	TOTAL ALPHA (PCI/ML)	STRONTIUM (PCI/ML)	CESIUM (PCI/ML)	COBALT (PCI/ML)	URANIUM (PCI/ML)	RUTHENIUM (PCI/ML)	CHROMIUM (MG/L)	FLUORIDE (MG/L)
6 32 77 31-JAN-78 13-JUL-78 12-OCT-78			<1,00E-02	1,60E-02 1,50E-02 2,10E-02		1,10E-01		
6 33 42 18-JAN-78 20-APR-78 22-SEP-78			<1,00E-02	1,90E-02 2,90E-02 2,80E-02		8,20E-02 1,20E-01		
6 33 56 18-JAN-78 27-MAR-78 05-JUL-78			<1,20E-02	1,30E-02 1,50E-02 4,00E-02		1,20E-01		
6 34 39A 17-JAN-78 21-SEP-78			<1,50E-02	<1,50E-02		2,90E-01 9,00E-02		
6 34 42 18-JAN-78			<1,00E-02	4,20E-02		8,00E-02		
6 35 9 13-JAN-78 28-MAR-78			<1,30E-02	2,40E-02 1,80E-02		1,10E-01		
6 35 66 18-APR-78 13-JUL-78 11-OCT-78	<7,50E-02			2,90E-02 1,80E-02 2,80E-02				
6 35 70 26-JAN-78 24-APR-78 13-JUL-78 11-OCT-78			<1,50E-02	<1,50E-02 3,00E-02 2,50E-02 2,30E-02		2,30E-01 4,00E-01 1,60E-01		

B-14

WELL NO, DATE	TOTAL ALPHA (PCI/ML)	STRONTIUM (PCI/ML)	CESIUM (PCI/ML)	COBALT (PCI/ML)	URANIUM (PCI/ML)	RUTHENIUM (PCI/ML)	CHROMIUM (MG/L)	FLUORIDE (MG/L)
-----	-----	-----	-----	-----	-----	-----	-----	-----
6 35 78 31-JAN-78 24-APR-78 24-JUL-78 12-OCT-78			<1,50E+02	2,00E+02 1,30E+02 1,20E+02 2,20E+02		2,20E+01 9,00E+02 1,00E+01		
6 36 06P 03-FEB-78			<1,40E+02	2,40E+02				
6 36 06Q 03-FEB-78			<1,40E+02	1,40E+02				
6 37 43 17-JAN-78			<1,50E+02	<1,50E+02		2,40E+01		
6 38 65 13-JUL-78				2,10E+02				
6 38 70 13-JUL-78 11-OCT-78	2,20E+01			1,30E+02				
6 39 39 01-FEB-78			<1,00E+02	2,70E+02				
6 39 79 31-JAN-78 24-JUL-78			<1,00E+02	<1,50E+02 1,40E+02		8,90E+02		
6 40 1 13-JAN-78			<1,00E+02	<1,00E+02		1,30E+01		
6 40 33A 17-JAN-78			<1,00E+02	<1,00E+02		1,90E+01		

WELL NO. DATE	TOTAL ALPHA (PCI/ML)	STRONTIUM (PCI/ML)	CESIUM (PCI/ML)	COBALT (PCI/ML)	URANIUM (PCI/ML)	RUTHENIUM (PCI/ML)	CHROMIUM (MG/L)	FLUORIDE (MG/L)
6 41 23 17-JAN-78 25-SEP-78			<1,50E+02	<1,50E+02 2,60E+02		2,80E+01		
6 42 124 13-JAN-78 25-SEP-78			<1,60E+02	2,80E+02 3,60E+02		3,60E+01 1,00E+01		
6 44 64 31-JAN-78 24-APR-78			<1,50E+02	2,20E+02 1,80E+02		2,10E+01		
6 45 42 01-FEB-78 02-OCT-78			<1,50E+02	<1,50E+02 2,10E+02		2,20E+01		
6 45 69 31-JAN-78			<1,50E+02	<1,50E+02		2,00E+01		
6 46 21 18-APR-78				2,70E+02				
6 47 46 12-JUL-78				1,50E+02				
6 47 60 31-JAN-78 17-APR-78 12-OCT-78			<1,00E+02	<1,00E+02 2,90E+02 6,70E+02		0,50E+02		
6 49 55 17-APR-78 18-APR-78 12-JUL-78 12-OCT-78				1,80E+02 3,30E+02 1,70E+02 3,40E+02				

WELL NO. DATE	TOTAL ALPHA (PCT/ML)	STRONTIUM (PCI/ML)	CESIUM (PCI/ML)	COBALT (PCI/ML)	URANIUM (PCI/ML)	RUTHENIUM (PCI/ML)	CHROMIUM (MG/L)	FLUORIDE (MG/L)
6 47 57 31-JAN-78 17-APR-78 21-JUL-78 12-OCT-78			<1.20E+02	3.20E+01 3.60E+01 3.90E+01 3.20E+01		2.00E-01 1.30E-01		
6 50 53 17-APR-78 12-JUL-78 12-OCT-78				2.50E+02 1.70E+02 5.10E+02		 1.20E-01		
6 55 50C 02-FEB-78 18-APR-78 21-JUL-78			<1.40E+02	<1.20E+02 3.40E+02 1.60E+02				
6 59 76 18-APR-78				2.90E+02				
6 63 90 18-APR-78				2.20E+02				
6 65 50 18-APR-78				2.90E+02				
6 66 103 18-MAY-78						1.50E-01		

APPENDIX C

Chemical and Spectrographic Analyses from Various Wells Sampled

Constituents	Units	699-63-90	699-46-21	699-55-50C	699-27-8	699-35-66	699-49-55
ALK, TOT (As CaCO_3)	mg/l	120	120	110	120	140	57
Aluminum	mg/l	70	70	50	70	70	130
Antimony	mg/l	30	30	30	30	30	30
Arsenic	mg/l	4	5	6	9	4	11
Barium	mg/l	10	50	7	50	30	30
Beryllium	mg/l	<1	<1	1	<1	1	<1
Bicarbonate	mg/l	150	150	130	150	170	59
Bismuth	mg/l	<1,000	<1,000	<1,000	1,000	<1,000	<1,000
Boron	mg/l	10	10	10	30	10	30
Bromide	mg/l	0.1	0.1	0.1	0.1	0.1	0.2
Cadmium	mg/l	3	3	1	1	1	1
Calcium	mg/l	36	40	29	54	43	62
Carbonate	mg/l	0	0	0	0	0	5
Chloride	mg/l	9.1	12	2.7	11	11	25
Chromium	mg/l	50	50	50	50	50	50
Chromium Hexavalent	mg/l	0	0	0	9	21	9
Cobalt	mg/l	5	5	5	5	5	5
Color	mg/l	1	1	1	1	3	2
Copper	mg/l	0	0	0	0	0	0
Cyanide	mg/l	0.00	0.00	0.00	0.02	0.00	0.00
Fluoride	mg/l	0.4	0.5	0.2	0.3	0.4	0.5
Gallium	mg/l	30	30	30	30	30	30
Germanium	mg/l	70	70	50	50	70	50
Hardness Noncarb	mg/l	20	43	2	55	21	130
Hardness Total	mg/l	140	170	110	90	160	190
Iodide	mg/l	0.00	0.01	0.00	0.01	0.01	0.00
Iron	mg/l	10	10	5	10	5	7
Iron Ferrous	mg/l	10	30	10	0	0	-
Lead	mg/l	30	30	30	30	30	30
Lithium	mg/l	7	10	5	10	7	7
Magnesium	mg/l	13	16	8.2	13	13	7.7
Manganese	mg/l	1	3	1	1	30	5
Molybdenum	mg/l	10	10	10	10	10	30
Nickel	mg/l	50	50	50	50	50	50
Nitrate	mg/l	1.29	2.8	0.16	12.1	5.6	3.7
pH Field		7.8	8.0	7.9	7.9	7.8	9.4
pH Lab		7.9	7.9	8.0	7.9	7.9	8.7
Potassium	mg/l	4.7	4.9	4.7	6.7	5.9	12
Residue Calc Sum	mg/l	218	255	151	252	242	395
Residue Ton/Aft	mg/l	0.28	0.33	0.19	0.41	0.35	0.52
Residue 180C	mg/l	205	243	139	302	256	391
Residue Tot Fil 105C	mg/l	300	350	190	390	360	460
SAR		0.4	0.7	0.3	0.6	0.7	1.4
Selenium	mg/l	1	1	0	2	1	12
Silica	mg/l	42	33	23	34	38	29
Silver	mg/l	10	10	10	10	10	10
Sodium	mg/l	31	21	6.0	20	20	42
Sodium Percent		14	21	10	13	21	32
Sp. Conductance Fld.		320	338	230	450	400	612
Sp. Conductance Lab.		323	398	256	472	404	588
Strontium	mg/l	100	300	100	300	100	300
Sulfate	mg/l	25	54	10	43	27	150
Tin	mg/l	70	70	50	70	50	50
Titanium	mg/l	5	5	5	5	5	5
Turbidity	JTU	-	1	1	-	25	20
Vanadium	mg/l	30	10	10	10	30	10
Water Temp	°C	17.4	17.2	16.4	16.4	21.2	17.6
Zinc	mg/l	5	5	5	30	5	5
Zirconium	mg/l	5	5	5	5	5	5
Cesium-137	pCi/l	2	2	0	-	2	2
Cobalt-60	pCi/l	1	1	1	50	1	1
Gross B.D.CS-137	pCi/l	4.4	7.5	5.2	110	11	13
Gross B.D.SR-90	pCi/l	3.7	6.4	4.5	36	9.1	4.5
Gross Alpha U-NAT	pCi/l	3.1	7.3	1.7	2.1	8.2	0.2
Tritium	pCi/l	480	21,200	480	1,300,000	950,000	480
Strontium-90	pCi/l	0.4	0.4	0.4	0.4	0.4	0.4

Constituents	Units	699-13-1A	699-14-38	699-33-56	699-50-288	699-50-8	699-32-22	699-34-51
ALK.TOT (As CaCO_3)	mg/L	130	140	170	130	130	110	160
Aluminum	ug/L	70	70	70	70	70	100	100
Antimony	ug/L	<30	<30	<30	30	<30	<30	<30
Arsenic	ug/L	14	4	6	7	5	5	6
Barium	ug/L	52	70	70	50	50	50	50
Beryllium	ug/L	<1	1	<1	<1	<1	<1	<1
Bicarbonate	mg/L	160	170	210	160	160	130	200
Bismuth	ug/L	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000
Boron	ug/L	30	30	30	10	30	30	30
Bromide	mg/L	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Cadmium	ug/L	3	3	3	3	3	3	3
Calcium	mg/L	33	34	47	31	42	50	50
Carbonate	mg/L	0	0	0	0	0	0	0
Chloride	mg/L	7.7	4.2	7.3	8.4	11	14	8.2
Chromium	ug/L	50	<50	<50	<50	50	<50	<50
Chromium Hexavalent	ug/L	0	0	6	5	7	5	5
Cobalt	ug/L	<5	<5	5	<5	<5	<5	<5
Color	-	5	5	4	1	1	2	1
Copper	ug/L	0	0	0	0	0	0	0
Cyanide	mg/L	0.00	0.00	0.00	0.00	0.00	0.02	0.03
Fluoride	mg/L	0.4	0.5	0.5	0.6	0.4	0.4	0.5
Gallium	ug/L	<30	30	30	30	30	<30	<30
Germanium	ug/L	50	70	70	70	70	70	70
Hardness Moncarb	mg/L	5	0	3	0	23	81	23
Hardness Total	mg/L	140	130	180	120	150	190	190
Iodide	mg/L	0.00	0.01	0.00	0.01	0.01	0.01	0.00
Iron	ug/L	<5	50	7	<5	<5	10	10
Iron Ferrous	ug/L	10	20	10	10	10	0	0
Lead	ug/L	<30	30	<30	<30	<30	<30	30
Lithium	ug/L	10	10	10	10	10	7	10
Magnesium	mg/L	13	11	14	11	12	14	15
Manganese	ug/L	1	70	3	1	1	5	3
Molybdenum	ug/L	10	10	30	30	12	10	10
Nickel	ug/L	50	<50	50	<50	50	<50	<50
Nitrate	mg/L	2.0	0.00	2.4	0.72	3.0	16.5	2.4
pH Field	-	7.8	7.8	7.8	7.8	8.0	7.9	7.8
pH Lab	-	7.8	7.8	7.9	7.8	7.8	7.8	7.7
Potassium	mg/L	6.5	6.0	6.0	4.2	6.9	6.9	5.9
Residue Calc Sum	mg/L	232	224	278	221	255	273	286
Residue Ton/Aft	-	0.31	0.27	0.36	0.28	0.34	0.44	0.38
Residue 1800	mg/L	225	202	261	203	251	180	278
Residue Tot Fil 1050	mg/L	280	220	380	290	370	430	380
SAR	-	0.8	0.6	0.8	0.9	0.8	1.0	0.7
Selenium	ug/L	1	0	2	1	2	1	3
Silica	mg/L	36	47	42	37	37	30	40
Silver	ug/L	<70	10	<10	10	10	<10	10
Sodium	mg/L	22	17	24	22	22	30	21
Sodium Percent	-	25	21	22	27	23	25	19
Sp. Conductance Fld.	-	348	300	430	290	390	526	424
Sp. Conductance Lab	-	352	315	427	327	397	512	434
Strontium	ug/L	300	100	300	300	300	300	300
Sulfate	mg/L	39	20	33	28	45	61	47
Tin	ug/L	<50	70	100	70	70	70	100
Titanium	ug/L	5	5	5	<5	5	5	<5
Turbidity	NTU	0	2	4	1	0	2	0
Vanadium	ug/L	10	10	30	30	10	10	30
Water Temp	°C	17.4	19.0	21.2	19.2	18.2	18.4	21.1
Zinc	ug/L	5	5	100	300	5	5	<5
Zirconium	ug/L	5	5	5	5	5	5	5
Cesium-137	pCi/L	2	2	<2	2	2	2	<2
Cobalt-60	pCi/L	1	1	<1	1	5	70	<1
Gross B.D.CS-137	pCi/L	3.1	3.4	6.9	4.6	16	160	6.0
Gross B.D.SR-90	pCi/L	7.1	3.3	5.8	3.9	12	130	5.1
Gross Alpha U-NA	ug/L	11	1.4	7.8	4.9	4.1	5.1	8.5
Tritium	pCi/L	170,000	480	<480	480	73,000	1,400,000	<480
Strontium-90	pCi/L	0.4	0.4	<0.4	<0.4	<0.4	0.4	0.4

Constituents	Units	699-33-42	699-28-43	699-31-31	699-32-70	699-55-76	199-08-3	699-65-50
AEK,TOT (As CaCO_3)	mg/l	110	140	110	110	46	70	110
Aluminum	ug/l	50	70	70	50	50	50	70
Antimony	ug/l	<30	30	<30	20	<30	<30	<30
Arsenic	ug/l	6	7	9	5	2	4	14
Barium	ug/l	30	50	50	30	50	70	10
Beryllium	ug/l	<1	<1	<1	<1	<1	<1	<1
Bicarbonate	mg/l	140	170	140	140	56	95	140
Bismuth	ug/l	<1,000	<1,000	1,300	1,300	<1,000	<1,000	1,000
Boron	ug/l	30	30	30	10	10	7	30
Bromide	mg/l	0.1	0.1	0.1	0.1	0.5	0.1	0.1
Cadmium	ug/l	3	3	3	3	1	3	3
Calcium	mg/l	38	46	43	37	41	46	26
Carbonate	mg/l	0	0	0	0	0	0	0
Chloride	mg/l	14	7.5	10	13	21	11	6.3
Chromium	ug/l	50	<50	<50	50	50	100	<50
Chromium hexavalent	ug/l	3	3	5	55	2	290	0
Cobalt	ug/l	<5	5	<5	5	5	<5	<5
Color	ug/l	4	1	1	1	2	2	1
Copper	ug/l	0	0	0	0	0	0	0
Cyanide	mg/l	0.01	0.00	0.01	0.00	0.00	0.00	0.00
Fluoride	mg/l	3.7	0.5	0.7	1.5	0.4	0.2	1.0
Gallium	ug/l	<30	30	30	30	30	<30	<30
Germanium	ug/l	70	70	70	50	30	30	50
Hardness Noncarb	mg/l	34	25	46	27	30	74	0
Hardness Total	mg/l	150	150	160	140	140	140	100
Iodide	mg/l	0.00	0.01	0.00	0.01	0.01	0.00	0.00
Iron	ug/l	30	13	10	7	5	3	30
Iron Ferrous	ug/l	10	10	0	0	0	0	10
Lead	ug/l	30	30	30	<30	<30	30	<30
Lithium	ug/l	10	7	7	5	5	5	7
Magnesium	mg/l	13	12	13	12	3.1	6.9	9.2
Manganese	ug/l	10	1	3	2	100	30	1
Molybdenum	ug/l	10	30	30	30	10	10	10
Nickel	ug/l	<50	50	50	50	50	<50	<50
Nitrate	mg/l	6.0	3.0	11.2	4.2	0.37	3.3	0.32
pH Field		7.5	7.9	7.9	7.7	8.5	7.8	3.0
pH Lab		7.6	7.9	7.5	7.8	8.0	7.8	8.1
Potassium	mg/l	6.4	6.7	7.2	4.5	5.9	5.0	5.4
Residue Calc Sum	mg/l	261	270	269	222	212	206	188
Residue Ton/Aft		0.37	0.36	0.41	0.30	0.29	0.29	0.23
Residue 180C	mg/l	273	267	299	223	206	210	171
Residue Tot Fil 105C	mg/l	370	360	400	330	260	270	260
SAR		1.0	0.8	1.0	0.7	0.5	0.2	0.8
Selenium	ug/l	2	3	1	3	3	1	0
Silica	mg/l	39	35	42	43	3.8	39	37
Silver	ug/l	<10	10	10	<10	<10	<10	<10
Sodium	mg/l	29	23	30	13	14	5.2	19
Sodium Percent		29	22	28	01	18	7	27
Sp. Conductance Fld.		415	418	454	340	350	320	272
Sp. Conductance Lab		429	416	454	351	352	314	276
Strontium	ug/l	100	300	300	100	100	300	100
Sulfate	mg/l	52	55	54	55	35	51	15
Tin	ug/l	70	50	70	70	50	100	50
Titanium	ug/l	<5	5	5	5	5	5	5
Turbidity	NTU	2	1	1	1	150	2	1
Vanadium	ug/l	30	10	30	30	10	10	30
Water Temp	°C	19.7	19.2	20.5	20.3	17.7	32.5	17.7
Zinc	ug/l	5	5	5	5	5	5	5
Zirconium	ug/l	5	5	5	5	5	5	5
Cesium-137	pCi/l	2	<2	2	2	2	2	2
Cobalt-60	pCi/l	20	1	10	1	1	1	<1
Gross B,D,CS-137	pCi/l	41	12	52	5.5	5.5	270	5.6
Gross B,D,SR-90	pCi/l	35	3.8	52	5.3	5.3	13	4.7
Gross Alpha U-NAT	ug/l	14	7.3	5.5	1.9	2.1	3.1	3.1
Tritium	pCi/l	310,000	13,000	1,100,000	200,000	480	7,000	2,500
Strontium-90	pCi/l	<0.4	0.4	0.4	0.4	0.4	2.9	<0.4

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