**Environmental Monitoring
Report on Radiological Status
of the Ground Water Beneath
the Hanford Site
January-December 1974**

March 1976

Prepared for the Energy Research
and Development Administration
under Contract E(45-1):1830

Battelle
Pacific Northwest Laboratories

BNWL-1970

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

40
11-76
25 to NT 15
Plus Spring District

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Energy Research and Development Administration, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

PACIFIC NORTHWEST LABORATORY
operated by
BATTELLE
for the
U.S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
Under Contract E(45-1)-1330

Printed in the United States of America
Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22151
Price: Printed Copy ~~\$6.00~~, Microfiche \$2.25
6.50

ENVIRONMENTAL MONITORING REPORT
ON RADIOLOGICAL STATUS OF THE GROUND WATER
BENEATH THE HANFORD SITE
JANUARY-DECEMBER 1974

by

J.R. Raymond, Resources Systems Section
D.A. Myers, Environmental Evaluations Section
J.J. Fix, Environmental Evaluations Section
V.L. McGhan, Resources Systems Section
P.M. Schrotke, Resources Systems Section

March 1976

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Energy Research and Development Administration, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

Battelle
Pacific Northwest Laboratories
Richland, Washington 99352

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

fly

TABLE OF CONTENTS

LIST OF FIGURES	iii
LIST OF TABLES	iv
PREFACE	v
SUMMARY	1
INTRODUCTION	3
BACKGROUND SUMMARY	4
Plant Operations	4
Disposition of Wastes	4
Monitoring and Wells	6
Sampling and Analysis	7
EVALUATION OF GROUND-WATER SURVEILLANCE DATA	8
Radiological Impact	39
REFERENCES	42
APPENDIX A: GROSS BETA, TRITIUM AND NITRATE CONCENTRATIONS IN GROUND WATER	A-1
APPENDIX B: ROUTINE ANALYSES FOR MATERIALS OTHER THAN PRIMARY TRACERS	B-1
APPENDIX C: SPECIAL AND QUALITY ASSURANCE ANALYSES FOR VARIOUS WELLS	C-1
APPENDIX D: SPECTROCHEMICAL ANALYSES FOR VARIOUS WELLS SAMPLED NOVEMBER 1974	D-1
APPENDIX E: SUMMARY OF ¹²⁹ I ANALYSES OF HANFORD SITE WELL WATER	E-1

LIST OF FIGURES

1	Hanford Reservation	5
2	(Back Page Pocket)	
3	(Back Page Pocket)	
4	(Back Page Pocket)	
5	Gross Beta Concentration - Well 699-34-42	12
6	Gross Beta Concentration - Well 699-31-31	13
7	Gross Beta Concentration - Well 699-32-32	14
8	Gross Beta Concentration - Well 699-20-20	15
9	Tritium Concentration - Well 699-38-70	18
10	Tritium Concentration - Well 699-32-70	19
11	Tritium Concentration - Well 699-37-43	21
12	Tritium Concentration - Well 699-31-31	22
13	Tritium Concentration - Well 699-8-17	23
14	Tritium Concentration - Well 699-1-18	24
15	Tritium Concentration - Well 699-2-3	25
16	Tritium Concentration - Well 699-8-25	26
17	Tritium Concentration - Well 699-15-15A and B	27
18	Tritium Concentration - Well 699-42-12	29
19	Nitrate Concentration - Well 699-34-41	31
20	Nitrate Concentration - Well 699-26-15	32
21	Nitrate Concentration - Well 699-27-8	33
22	Nitrate Concentration - Well 699-15-15A and B	34
23	Nitrate Concentration - Well 699-10-E12	35

LIST OF TABLES

1	Lower Analytical Detection Limit and Applicable CG or DWS . . .	9
2	Numerical Data on the Routine Ground-Water Monitoring Program - CY-1974	10
3	Ruthenium-106 to ⁶⁰ Co Ratios for Selected Wells Southeast of 200 East Area - CY-1974 Data	16
4	Tritium and Nitrate Data for Confined and Unconfined Ground- Water Zones	38

PREFACE

This report is one of a series prepared annually to provide an evaluation of the status of ground-water contamination resulting from Hanford onsite discharges. This issue covers the data collected January through December 1974. The maps of the contamination plumes (and the data tables) are presented to allow comparison with previous report periods. The previous report in this series was BNWL-1860.¹

There are several changes in report format from the previous report. This report has one set of ground-water contaminant concentration maps (one each for Tritium (^3H), Total Beta (β_t) and Nitrate (NO_3^-) for calendar year 1974). The previous report contained two sets of concentration maps with one set representing the period January to June and the other set showing the July to December status. Because little change in ground-water contaminant concentration occurred throughout the year, one set of maps adequately represents the concentration and distribution of contaminants in the ground water for the calendar year.

The reporting units and lower concentration limits for the tritium and nitrate maps have been changed from the previous report. To provide consistency with one another, each parameter is now reported in ranges corresponding to 1-10%, 10-100% and >100% of its respective concentration guide or standard, except NO_3^- which is reported only in the upper two ranges. Previous reporting ranges have varied for each parameter. No change was made in the β_t reporting units or display limits.

An addition was made to the report to include data from a special study regarding the occurrence of Iodine-129 (^{129}I) in the ground water beneath the Hanford site.

ENVIRONMENTAL MONITORING REPORT ON RADIOLOGICAL
STATUS OF THE GROUND WATER BENEATH THE
HANFORD SITE

JANUARY-DECEMBER 1974

SUMMARY

Evaluation of β_t , ^3H and NO_3^- concentrations measured in well water sampled near the surface of the unconfined ground water during 1974 shows that zones of contamination extend in an easterly to south-easterly direction from 200-E Area, as has been observed in the past.¹ Tritium and NO_3^- ion concentrations above background were found along the Columbia River in the vicinity of the 100 Areas. A low ground-water mound showing uranium and nitrate ion concentrations above background continues to be observed in the 300 Area. Gross beta activity in the ground water beneath the 100 Areas was detectable only at the 100-N Area from effluent discharged to the 1301-N crib. A number of radionuclides, such as ^{106}Ru , ^{60}Co , ^{129}I , ^{137}Cs and ^{90}Sr , occur at various locations and are detectable in very low concentrations in the unconfined ground water external to the 200 Areas. In most cases, concentrations are several orders of magnitude below applicable CG's and are so close to the detection limit as to cast doubt of their existence based on a single analysis. Only in and adjacent to the 200 Areas does any radionuclide that was analyzed in CY-1974 occur in concentrations greater than 10% of the applicable CG for uncontrolled water use.

Nitrate ion concentrations greater than 100% of the Public Health Service (PHS) recommended drinking water standard of 45 mg/l continued to be observed in the ground water adjacent to the 200 Areas; in the vicinity of the 100-F and 300 Areas; and in the east-central part of the Hanford site (Wells 20-20, 26-15, and 32-22). Ground water from these zones is not consumed by human beings or other animals.

Configuration and concentration of ground-water contamination on the Hanford site has changed only slightly from the past reporting period.

No contamination attributable to Hanford operations was detected in the confined aquifer based on analyses of water samples from the limited number of wells available for sampling the confined aquifers.

INTRODUCTION

Surveillance of ground water on the Hanford site is one facet of a comprehensive Environmental Monitoring Program designed to evaluate existing and potential pathways of radiation exposure from project operations. Objectives of the Ground-Water Monitoring Program, conducted by Battelle-Northwest for ERDA, are to measure and report the concentration and distribution of radioactive and chemical constituents in the ground water, determine the movement and transport of contaminants with time, and to determine the impact on the environs.

All ground-water samples were taken by the Radiation Monitoring Section and were analyzed by the Technical Analysis Section as part of the Hanford Environmental Surveillance Program conducted by the Environmental Evaluations Section of Battelle-Northwest.

The Atlantic Richfield Hanford Company (ARHCO), ERDA's prime contractor for chemical processing and waste management activities on the Hanford site, has responsibility for operations within the 200 Areas. ARHCO conducts a Comprehensive Ground-Water Sampling and Analysis Program within the 200 Areas. Ground-water contamination data from the 200 Areas (chemical processing and waste management areas), except for analyses from a few wells primarily to determine source NO_3^- concentrations, are not included in this report.

BACKGROUND SUMMARY

PLANT OPERATIONS

Operations on the Hanford site since 1944 have resulted in ground disposal of large volumes of low-level and intermediate-level liquid radioactive wastes. Figure 1 shows the location and configuration of the site. Most of the liquid wastes have been disposed 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 associated disposal facility (100-N Area) is currently in operation. Ground disposal of liquid waste has been greatly reduced in the past several years due to the deactivation of all Hanford reactors (except N Reactor) with the resulting decrease in reactor fuel processing, coupled with improved treatment of several intermediate-level waste streams.

DISPOSITION OF WASTES

Liquid wastes disposed to the ground percolate laterally and downward through the 150 to 300 feet of unconsolidated glaciofluvial and lacustrine sands, silts and gravel overlying the ground-water table. As the wastes move through the sedimentary earth materials, adsorption and ion exchange reactions take place between the minerals in the sediments and the materials in the waste water. 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 water. Some 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^-) do not have good ion exchange characteristics and move through the ground at varying rates to eventually enter the ground water. When the contaminants enter the water table, they move in a general down gradient direction with the ground water. As the radionuclides move in the ground water, their concentration is reduced by radioactive decay, ion exchange, diffusion and hydrodynamic dispersion.

FIGURE 1 Hanford Site

Disposal of more than 130 billion gallons of process cooling water and about 8 billion gallons of intermediate-level radioactive waste over the past 30 years has profoundly changed the water table. Ground-water mounds have been created near each of the chemical processing areas and in the 100-N reactor area from discharge of waste water. Ground-water levels have changed continuously over the years, depending upon variations in volumes and locations of waste water discharged to the ground. Movement of the ground water and associated contaminants also have changed with time reflecting the variation in waste water discharge.

MONITORING AND WELLS

Over 700 cased monitoring wells have been drilled to water since the beginning of disposal operations at Hanford. The structures provide access for obtaining water samples and for conducting in-well investigations. Some of the wells are drilled to basalt bedrock, others are drilled to the first semi pervious layer below the water table, and still others are drilled only a few tens of feet below the water table in the unconfined aquifer. Most of the wells were drilled as multipurpose structures to obtain geologic and hydrologic information as well as water quality data.

To provide an ideal structure for monitoring purposes, a well should be perforated throughout its length below the water table and the water in the aquifer should flow through the casing normal to the well at all depths. However, since the heterogeneity of the sediments beneath the Hanford site prevent this, each well structure must be evaluated individually as a monitoring facility.

Two hundred fifty wells were used in the 1974 routine Ground-Water Monitoring Program; 895 well water samples were taken to provide 1953 analytical results for use in evaluating the status of contamination in the ground water. These figures do not include ARHCO's monitoring efforts in the 200 Areas. Sampling frequency varies from bimonthly to semiannually, depending on well location and the analyzed constituent.

SAMPLING AND ANALYSIS

Sampling is generally scheduled on a quarterly basis. Most of the ground-water samples are collected near the water surface of the unconfined aquifer by lowering a glass bottle enclosed in a steel bail into the water. Usually, when contamination appears in a project well, the highest concentration is observed at the surface of the water table. A study is being made to define vertical stratification of contaminants in the ground water. At a few locations where appropriate well structures are available, samples are obtained from the confined aquifer zones. Submersible sampling pumps are being installed in 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 radionuclides represented by gross beta (β_t) measurement (calculated as ^{106}Ru) and ^3H , as well as NO_3^- ion are readily transported in the ground water with little decrease in concentration due to adsorption or ion exchange. They also can be detected in low concentrations in the ground water relative to their respective concentration guides (CG)² or drinking water standards (DWS).³ Therefore, these substances are used as primary tracers to monitor the movement of contaminated ground water. In addition to gross beta, ^3H , and NO_3^- , 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 ray spectrometry. Ground water from several wells is analyzed for chemical parameters to monitor broader changes in water quality. Analyses for uranium (^{238}U), fluoride (F^-) and chromium ion (Cr^{+6}) are done on selected ground-water samples in and adjacent to the 300 Area because the fuel fabrication waste water disposed at this site contains these contaminants. Standard radiometric and chemical methods are used to analyze the routine ground-water samples.

EVALUATION OF GROUND-WATER SURVEILLANCE DATA

Radionuclides represented by β_t analysis (calculated as ^{106}Ru), ^3H and NO_3^- are readily transported in the ground water and can easily and cost-effectively be detected in low concentrations. Since these substances are the ground-water contaminants that appear in the highest concentration from waste disposal operations on the Hanford site they are utilized as the primary tracers in assessing ground-water contamination. Well water analyses are obtained frequently from throughout the Hanford site. Other radionuclides, such as ^{129}I and ^{99}Tc , have been detected in the ground water beneath the Hanford site. These radionuclides also would make excellent tracers of ground-water contamination, but they generally occur in very low concentrations and require difficult and costly analytical procedures.

Analyses under the routine Ground-Water Monitoring Program are made, in addition to the primary tracers, for other nuclides and nonradioactive elements where the material occurs in a specific waste or is of special interest from health hazard considerations. These materials are: gross alpha, Cr^{+6} , F^- , ^{60}Co , ^{106}Ru , ^{90}Sr , ^{238}U , ^{131}I , ^{137}Cs , ^{125}Sb . Gamma ray spectrometry analysis is also made infrequently on selected well samples for detection of other gamma-emitting radionuclides that may have escaped detection by the other analyses.

Radionuclide concentrations in the ground water beneath Hanford are evaluated in terms of their respective Concentration Guides (CGs) while nonradioactive materials are compared to the U.S. Public Health Service recommended drinking water standards (DWS). While these guides pertain to drinking water, at present no ground water from zones having concentrations greater than the standards is used for human or animal consumption. However, the comparison provides a conservative method of evaluating the potential significance of most water-borne materials. The Concentration Guides used in this report are those which apply to uncontrolled areas. Table 1 shows the detection limit and applicable CG or DWS for various materials analyzed for under the routine Ground-Water Monitoring Program.

TABLE 1 Lower Analytical Detection Limit and
Applicable CG or DWS

Analysis	Detection Limit	CG or DWS
β_t (as ^{106}Ru)	0.08 ^(a)	NA ^(b)
Gross Alpha (as ^{239}Pu)	0.017 ^(a)	NA ^(b)
^3H	1.0 ^(a)	3000 ^(a)
^{60}Co	0.02 ^(a)	50 ^(a)
^{90}Sr	0.03 ^(a)	0.3 ^(a)
^{106}Ru	0.06 ^(a)	10 ^(a)
^{125}Sb	0.06	100
^{131}I	0.01 ^(a)	0.3 ^(a)
^{137}Cs	0.02 ^(a)	20 ^(a)
NO_3^-	0.5 ^(c)	45 ^(c)
F^-	0.08 ^(c)	1.4 ^(c)
Cr^{+6}	3 ^(c)	50 ^(c)

(a) pCi/mL.

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

(c) mg/L.

Figures 2, 3 and 4 (in the pocket on back page) are maps that show the configuration and concentration of β_t , ^3H and NO_3^- , respectively, in the unconfined ground water beneath the Hanford site for CY-1974. The maps also show the locations of the site monitoring wells.⁴ The isopleths on the map show concentration zones rather than discrete concentration contours because the data do not justify the display of concentration isopleths in more detail. Data from waste disposal operations and ground-water contamination in the 200 Areas are not included in this report. However, data from the 200 Areas were used to provide continuity for the maps.

Appendix A contains tabular analytical data for CY-1974 on average, maximum and minimum concentrations of the primary tracers (gross beta, tritium and nitrate) in the ground water for CY-1974. Gross beta is calculated as ^{106}Ru and the concentrations indicated at or below the detection limit of 0.08 pCi/mL (8.00E-02 in the table) are considered "less than" values,

although not so marked on the table because of the inability of the computer card keypunch unit to accept the "less than" symbol (<). For the same reason, ^3H concentrations below the detection limit of 1.0 pCi/ml and NO_3^- concentrations below the detection limit of 0.5 mg/l are considered "less than" values.

Appendix B contains data on routine analyses for materials other than the primary tracers. Appendix C contains results of ground-water analyses made for quality assurance or other special purposes during 1974. Appendix D shows the results of chemical and spectrochemical analyses of water from selected wells.

Table 2 shows the number of wells, areal distribution, number of samples and number of analyses involved in the routine Ground-Water Monitoring Program to provide the data shown in Appendixes A and B.

TABLE 2. Numerical Data on the Routine Ground-Water Monitoring Program - CY-1974

<u>Area</u>	<u>Wells Sampled</u>	<u>Number of Samples</u>	<u>Number of Analyses</u>
100 Areas	24	51	155
200 Areas	30	81	102
300 Area	13	83	376
600 Area	178	670	1300
Other	<u>5</u>	<u>10</u>	<u>20</u>
TOTAL	250	895	1953

Gross Beta (β_t) Concentration in the Unconfined Ground Water

Figure 2 shows the configuration and concentration of β_t contamination in the unconfined ground water. Appendix A contains analytical data on the primary tracers for ground-water samples collected during CY-1974. The configuration of β_t contamination is static and shows essentially no change over the previous reporting period. The major β_t contamination plume extends southeasterly about 7.8 miles from the 200 East Area. Concentrations within this plume in all locations external to the 200 East Area are less

than 1.0 pCi/ml except for a questionable small zone near the southeast corner of the 200 East Area where the concentration may be slightly above 1.0 pCi/ml. Gross beta concentrations are decreasing in most locations within this plume. Figure 5 shows a graph of the β_t concentration history for Well 699-34-42 which monitors the upper part of the plume near the 200 East Area. The graph shows that β_t concentration in the ground water at this location has been decreasing over the past several years with an apparent half life of about 1.25 years (due to radioactive decay and hydrodynamic dispersion). Figures 6 and 7 show graphs of the β_t contamination history of Wells 699-31-31 and 699-32-22, respectively, which monitor the central part of the plume. Gross beta concentration has also been decreasing in both wells over the past several years (apparent half life of 1.4 years for 31-31 and 1.26 years for 32-22). Figure 8 shows a similar data plot for Well 699-20-20 which is located on the southeast border of the plume. Apparent half life is 2.3 years. Based on the last two sample results, β_t concentration probably has decreased below 0.1 pCi/ml.

Small zones of β_t contamination exist adjacent to the northwest part of the 200 East Area and the south end of the 200 West Area. Gross beta contamination in the ground water is also evident in the 100-N Reactor Area from liquid waste disposal to the 1301-N crib. Uranium from waste disposal facilities accounts for the β_t contamination in the ground water in the 300 Area.

Gross beta activity in the ground water beneath the Hanford site has been calculated and reported for many years as ^{106}Ru (as was done for this report) since radiochemical analyses in the past have shown that this nuclide accounts for a large fraction of the β_t activity. This evaluation may still be valid near the 200 Area disposal sites, but with a half life of one year, decay reduces the proportion of ^{106}Ru in the mixture of beta emitters with distance (time) from the source areas (200 Areas). Initial evaluations to more fully characterize the concentration of beta emitters that occur in ground water away from the 200 Areas (essentially southeast of the 200 East Area) indicate that ^{60}Co is the dominant nuclide. Table 3 shows ^{106}Ru to ^{60}Co ratios (with increasing distance from the 200 East Area).

CONCENTRATION HISTORY

FIGURE 5. Gross Beta Concentration - Well 699-34-42

CONCENTRATION HISTORY

FIGURE 6. Gross Beta Concentration - Well 699-31-31

CONCENTRATION HISTORY

FIGURE 7. Gross Beta Concentration - Well 699-32-32

CONCENTRATION HISTORY

FIGURE 8. Gross Beta Concentration - Well 699-20-20

TABLE 3 Ruthenium-106 to ^{60}Co Ratios
for Selected Wells Southeast of
200 East Area - CY-1974 Data

Well Number	$^{106}\text{Ru}/^{60}\text{Co}$
699-34-39A	1.12
31-31	0.29
20-20	0.20
26-15	0.17

If it is assumed that ^{60}Co and ^{106}Ru make up the total beta emitter contribution in the ground water away from the 200 Areas (other than ^3H which is not detected by the gross beta measurement), then ^{106}Ru makes up 20% or less than the total and ^{60}Co contributes 80% or more.

Conversion of β_t counting data to pCi/mL, calculated as ^{106}Ru , is not strictly correct for this mixture. The gas flow proportional counting equipment used for the β_t analyses has a higher efficiency for counting the relatively "hard" beta ray associated with ^{106}Ru (actually the accompanying ^{106}Rh daughter). Cobalt-60 has "softer" beta radiation and is detected less efficiently. For well water samples, total counting efficiency for ^{106}Ru may be higher by a factor of four over the counting efficiency for ^{60}Co . This is due to increased self-absorption of the ^{60}Co beta radiation by the residue that is deposited on the counting planchet when the water sample is evaporated as well as the actual lower detection efficiency.

The Energy Research and Development Administration Manual Chapter 0524 contains the Standards for Radiation Protection and lists the CGs for individual radionuclides. Manual Chapter 0524 also defines the method of calculating CGs for mixtures of radionuclides. The uncontrolled use CG for ^{106}Ru in water is 10 pCi/mL. The CG for ^{60}Co is 50 pCi/mL. The CG is 42 pCi/mL for a mixture of 80% ^{60}Co and 20% ^{106}Ru . As an example, water containing 1.0 pCi/mL β_t calculated as ^{106}Ru (10% of the ^{106}Ru CG) actually contains 3.4 pCi/mL β_t if the contributing radionuclides are 80% ^{60}Co and 20% ^{106}Ru . The latter value is 8% of the CG for the mixture. In this case, the difference in apparent concentration has little or no impact on content of radioactivity compared to the applicable CG. However,

it does point out that the β_t value, as presently calculated, cannot be considered a precise measurement of β_t concentration nor should it be compared to the ^{106}Ru CG without additional qualification. The β_t analysis does provide a screening process with adequate sensitivity to detect occurrence and changes in one parameter of radioactivity in the ground water beneath the Hanford site. It thus serves as a valuable tool in the Monitoring Program.

Tritium (^3H) Concentration in the Unconfined Ground Water

Figure 3 shows the configuration and concentration of ^3H in the unconfined ground water. Appendix A contains tabular maximum, minimum and average data for ground-water samples collected during CY-1974. Configuration of ^3H contamination in the ground water shows little changes from the previous reporting period, considering the change in map lower display units from 0.9-3 pCi/ml on the CY-1973 map to 30-300 pCi/ml on the CY-1974 map. The detectable front of the main plume from 200 East Area has expanded slightly. The 200 West contamination zone has remained essentially static as has the area north of Gable Butte - Gable Mountain. Changes in ^3H concentrations within the contaminated zones vary, depending upon location.

Figure 9 shows a graph of the ^3H concentration history for Well 699-38-70 which monitors the 200 West Area plume adjacent to the east side of the 200 West Area. The graph shows that ^3H in the ground water at this site has been decreasing over the past ten years or more. Figure 10 graphs the ^3H concentration history for Well 699-32-70 which monitors the south part of the 200-West plume. The increase in ^3H concentration over the past several years announces the approach of a concentration front as it spreads toward the south.

CONCENTRATION HISTORY

CONCENTRATION HISTORY

FIGURE 10. Tritium Concentration - Well 699-32-70

Figure 11 shows a graph of the ^3H concentration history for Well 699-37-43 which is located near the neck in the upper part of the ^3H plume from the 200 East Area. Tritium concentration at this location has remained essentially at the same level over the past several years. Figure 12 shows the ^3H graph for Well 699-31-31 located in the west central part of the 200 East Area plume. Tritium concentration at this location has remained at the same level for approximately ten years.

Figures 13, 14, and 15 show ^3H graphs for Wells 699-8-17, 1-18, and 2-3, respectively, that monitor the southeast extension of the 200 East plumes. These wells have exhibited general increases in ^3H concentration over the past several years, indicating continued southeastern movement of the contamination front. Well 699-8-25 (Figure 16), located west of the above wells, shows a decrease in ^3H over the past several years, indicating that the front probably is maintaining its relative position at this location.

Figure 17 shows the ^3H graph for Wells 699-15-15A and B. These wells are located on the eastern edge of the plume from 200 East Area toward the south end of the plume. The ^3H data from Well 699-15-15A has long appeared anomalous because the ^3H concentration in water samples from this well have been lower by an order of magnitude or more than the concentration in adjacent wells to the north, south and west. If the data are correct, this causes a "hook" in the contamination plume with an area of presently uncontaminated (by ^3H) ground water incised with the plume. Because of this unusual configuration, Well 699-15-15A was considered as not providing an adequate monitoring structure. Well 699-15-15B was drilled adjacent to the existing well in 1972 and completed in a manner known to provide a good ground-water monitoring well (i.e: short water column, well screen and sampling pump). As Figure 17 shows, the average ^3H concentration in the ground water at this site, as indicated by water samples from Well 699-15-15B (indicated by crosses on the graph), remained essentially unchanged over previous results from Well 699-15-15A, although data scatter appears less after use of the new well began. Wells 699-15-15 A and B are in an area of low permeability, and most of the contaminated water from the 200 East Area plume moves around the area rather than through it.

CONCENTRATION HISTORY

FIGURE 11. Tritium Concentration - Well 699-37-43

CONCENTRATION HISTORY

FIGURE 12. Tritium Concentration - Well 699-31-31

CONCENTRATION HISTORY

FIGURE 13. Tritium Concentration - Well 699-8-17

CONCENTRATION HISTORY

FIGURE 14. Tritium Concentration - Well 699-1-18

CONCENTRATION HISTORY

FIGURE 15. Tritium Concentration - Well 699-2-3

CONCENTRATION HISTORY

FIGURE 16. Tritium Concentration - Well 699-8-25

CONCENTRATION HISTORY

FIGURE 17. Tritium Concentration - Well 699-15-15A and B

Well 699-42-12 (Figure 18) is located near the northeast end of the ^3H plume from 200 East Area. Tritium concentration in the ground water at this location, as shown by the graph, continues to increase as the contamination "front" moves through the well.

Residual ^3H is noted in the 100 Areas and contemporary ^3H occurs in and adjacent to the 100-N Area. The only area external to the 200 Areas where ^3H concentrations in the ground water occurs above the CG of 3000 pCi/ml is adjacent to the southeast corner of the 200 West Area. Elsewhere, ^3H is well below the CG. Tritium, of course, travels through the soil essentially unaffected by ion exchange or adsorption and thus provides the most representative radioactive tracer of ground-water movement.

Nitrate (NO_3^-) Concentration in the Unconfined Ground Water

Figure 4 shows the configuration and concentration of NO_3^- in the unconfined ground water. Appendix A contains tabular NO_3^- data. Some NO_3^- information is also included in Appendixes C and D. Few significant changes in NO_3^- configuration or concentration are noted over the past reporting period. Considerable data scatter are observed in the NO_3^- analyses. Based on the general consistency of the ^3H data, the scatter must be due to the analytical procedure and/or the nonconservative nature of the NO_3^- ion; as many chemical and biochemical reactions can take place that will greatly change the NO_3^- concentrations, particularly if proper sampling, preservation and storage procedures are not followed.

Nitrate concentrations in the ground water (external to the 200 Areas) above the Drinking Water Standard of 45 mg/l continue to be observed in the central part of the plume from 200 East Area, immediately north of the 200 East Area and in and adjacent to the 100-F Area. Small zones that show NO_3^- concentrations in excess of 45 mg/l occur in the 300 Area, southeast of the 200 East Area (centered on Wells 699-34-42 and 34-41) and adjacent to the southeast corner of the 200 West Area.

CONCENTRATION HISTORY

FIGURE 18. Tritium Concentration - Well 699-42-12

Figure 19 shows a graph of the NO_3^- concentration history for Well 699-34-41 which monitors the upper part of the plume from the 200 East Area. Nitrate concentration in the ground water at this site has remained at about the same level (~ 75 mg/l) for the past two years and had increased, perhaps, by 25 mg/l over the preceeding two years. Figure 20 shows the NO_3^- concentration graph for Well 699-26-15 which monitors the east side of the zone within the plume from 200 East Area that exceeds 45 mg/l. Nitrate concentration at this site has remained constant at about 53 mg/l over the past four years. Based on the last analysis made in 1974, NO_3^- may be starting to decrease at this location. Well 699-27-8 (Figure 21) is located about 2.25 miles east of Well 26-15. Nitrate data scatter is fairly high, but the concentration may be increasing to exceed 45 mg/l. If later samples verify this observation, a somewhat anomalous situation will exist between Wells 26-15 and 27-8.

Figure 22 shows the NO_3^- concentration for Wells 699-15-15A and B. Although the NO_3^- concentration in the ground water at this location is well above detection limit, as noted with the ^3H data, concentration of NO_3^- in adjacent wells to the north, south and west are higher by at least one order of magnitude. The 4.5-45 mg/l isopleth has been extended to include Well 699-10-E12 (Figure 23). It is probable that the average concentration of NO_3^- has exceeded 4.5 mg/l for at least the past two years, although data scatter is considerable.

Additional Radiocontaminants in the Ground Water

Appendix B contains routine analyses made under the Ground-Water Monitoring Program for materials other than the primary tracers (β_t , ^3H and NO_3^-). Appendix C contains special and quality assurance analyses for a number of discrete nuclides. Appendix E shows the CY-1974 analyses for ^{106}Ru , ^{60}Co and ^{129}I , which were made under a special study. The data shown in these appendixes, indicate that several nuclides occur at low levels in the ground water beneath the Hanford site and their relative concentration and distribution generally follow the pattern of the primary tracers. Outside

CONCENTRATION HISTORY

FIGURE 19. Nitrate Concentration - Well 699-34-41

CONCENTRATION HISTORY

FIGURE 20. Nitrate Concentration - Well 699-26-15

CONCENTRATION HISTORY

FIGURE 21. Nitrate Concentration - Well 699-27-8

CONCENTRATION HISTORY

FIGURE 22. Nitrate Concentration - Well 699-15-15A and B

CONCENTRATION HISTORY

FIGURE 23. Nitrate Concentration - Well 699-10-E12

of the 200 Areas, alpha contamination occurs only in the 300 Area ground water from discharge of uranium-bearing wastes.

Gamma scans were made on samples from Wells 699-36-46-P, 38-70, 34-51, and 399-8-3. No significant gamma radiation was detected above background.

Iodine-129 Concentration in the Unconfined Aquifer

As a result of ten years of cooperative research by the Atlantic Richfield Hanford Company and Battelle-Northwest, a large amount of data has been collected regarding the concentration of certain radionuclides in the ground water. The ground-water samples were collected as part of a special study to develop analytical methods and techniques for low-level detection of selected radionuclides but not to provide comprehensive monitoring of these elements.

The advancements in analytical methods and techniques resulting from this research have made it possible to detect ^{129}I in very low concentrations. Consequently ^{129}I can be used as another effective tracer in ground-water monitoring. Because of this, and because ^{129}I has a long half-life (1.6×10^7 yr) and a low concentration guide (60 pCi/l), it is of interest in the ground-water monitoring program.

The ground-water samples which were analyzed for ^{129}I in 1974 indicate a distribution pattern generally agreeing with that of other contaminants. The highest concentrations occurred beneath the 200 Areas, with concentration decreasing to background levels with distance from the disposal sites in these areas. No ^{129}I samples collected external to the 200 Areas had concentrations greater than 15% of the concentration guide, while approximately 75% of the samples were less than 0.5% of this guide. The data in Appendix E show that ^{129}I as well as ^{60}Co and ^{106}Ru concentrations in the Hanford ground water outside of the immediate area of the disposal sites are well within the concentration guides.

Additional Water Quality Data for the Unconfined Aquifer

Appendix D contains chemical and spectrochemical data from analyses by the U.S. Geological Survey for selected wells on the Hanford site. A large number of elements and components are dissolved in the ground water. Although differences do exist in concentrations of some materials in the ground water, no definite trends are apparent. Many of the higher concentrations of some elements noted in the spectrochemical analyses are attributable to steel well casing, particularly when dipped samples are used rather than pumped samples.

Status of Contamination in the Lower Aquifer (Confined) Zones

Water samples from certain horizons below the Hanford site regional water table are obtained from either vertically separated tubes (piezometers) contained within a single well or from piezometer tubes drilled as separate wells. Those few wells which have shown detectable gross beta or tritium activity have not done so consistently with time.

At present, it is believed that none of the deep aquifers being sampled contain contaminants that are attributable to operations on the Hanford site. Table 4 shows analytical data for the confined and unconfined zones where adjacent wells or piezometers exist for sampling both zones. These data, though limited in areal extent, support the above conclusion.

TABLE 4. Tritium and Nitrate Data for Confined and Unconfined Ground-Water Zones

<u>Location (Well Number)</u>	<u>Unconfined Zone (Surface)</u>		<u>Confined Zone</u>	
	<u>^3H (pCi/ml)</u>	<u>NO_3^- (Mg/l)</u>	<u>^3H (pCi/ml)</u>	<u>NO_3^- (mg/l)</u>
699-36-46	1900	1.7	<0.5	<0.5
699-S6-E4	~1.0	6.0	<0.5	<0.5
699-14-E6	~0.7	~0.9	<0.5	<0.5
699-24-1	~0.8	0.6	<0.5	<0.5
699-36-61	<0.9	9.8	<0.5	0.6
699-10-E12		~10.0	<0.5	<0.5
699-S11-E12	<0.5	<0.5	<0.5	<0.5

RADIOLOGICAL IMPACT

Ground-water transport of contaminants resulting from waste disposal on the Hanford site represents a potential pathway of exposure via water obtained from either 1) wells which penetrate the unconfined aquifer or the 2) Columbia River into which water from the unconfined aquifer flows. The following discussion examines these two potential pathways.

Ground Water

Presently, the contaminant plumes are restricted to the Hanford site as shown in Figures 2, 3, and 4. As the plumes expand, the contaminant concentration will gradually decrease through additional dilution, adsorption for most contaminants, and, in the case of radioactive contaminants, decay. Presently drinking water is obtained from the ground water at both the FFTF and WPPSS sites. Contaminant levels for these sites are monitored routinely. Concentrations determined at these two sites averaged 0.27% and 10% of CG respectively. Withdrawal of water for general public use is not presently planned.

ERDA Manual Chapter 0524 Appendix (Annex A) states that concentrations of radionuclide mixtures in water shall be limited so that the sum of the ratio between isotopic concentration and the applicable CG does not exceed unity (1.0) as:

$$\frac{C_A}{CG_A} + \frac{C_B}{CG_B} + \frac{C_C}{CG_C} \dots \leq 1.0$$

where C_A , C_B , C_C , etc. are the radionuclides present and CG_A , CG_B , CG_C , etc. are the concentration guides. The "worst case" highest concentration of radionuclides observed in ground water nearest the Columbia River in 1974 (outside of the 200 Areas and 100-N Area) was from Well 699-27-8.

Following the procedure for determining maximum permissible concentration of radionuclide mixtures in water:

$$\frac{^{60}\text{Co}}{50} + \frac{^{90}\text{Sr}}{0.3} + \frac{^{106}\text{Ru}}{10} + \frac{^{137}\text{Cs}}{20} + \frac{^{129}\text{I}}{.06} + \frac{^{99}\text{Tc}}{30} + \frac{^3\text{H}}{3000} = .405$$

Since Well 699-27-8 is about three miles from the Columbia River and the nearest area of ground-water discharge, this record is indicative of the worst case possible for the Hanford site.

A more typical example of ground-water discharge to the Columbia River would be Well 699-HAN-19, which is located 0.7 miles from the river. Using the same procedure:

$$\frac{^{60}\text{Co}}{50} + \frac{^{90}\text{Sr}}{.3} + \frac{^{106}\text{Ru}}{10} + \frac{^{137}\text{Cs}}{20} + \frac{^{129}\text{I}}{.06} + \frac{^{99}\text{Tc}}{30} + \frac{^3\text{H}}{3000} = .0051$$

or a value less than 1% of the maximum permissible concentration.

Columbia River

The unconfined aquifer empties into the Columbia along the Hanford reach of the river with a average flow of less than 100 cfs. Contaminants resulting from 200 Area Waste Disposal Operations are transported by this flow. Superimposed upon this flow is seepage from the 1301-N trench. The average flow of the Columbia River is approximately 130,000 cfs. The combination of the small flow of ground water entering the Columbia River, the low concentrations of any possible contaminant, the release of much larger quantities of similar contaminants to the river from the 1301-N trench, plus the large dilution of the Columbia River has precluded the detection of any impact of ground-water transport of contaminants from the 200 Areas on the Columbia River. Extensive sampling of Columbia River water above and below the Hanford reach of the Columbia River

has not shown any observable impact from known releases to the river due to seepage from the 1301-N trench during 1974⁵ let alone incremental additions due to ground-water transport.

In summary, there is presently no observable affect of ground-water transport of contaminants from the 200 Areas on the Columbia River. All of the levels observed to date are less than 10% of the most restrictive ERDA manual chapter guidelines and, in fact, are less-than concentrations of naturally occurring or worldwide fallout radioactivity in the Columbia River.⁶

REFERENCES

1. K. L. Kipp, Jr., Radiological Status of the Groundwater Beneath the Hanford Project, January - December, 1973, BNWL-1860 Battelle-Northwest, Richland, WA, January 1975.
2. U.S. Energy Research and Development Administration, "Standards for Radiation Protection," ERDA Manual, Chapter 0524, (Appendix) Annex A, Table II, Column 2, November 1968.
3. Recommended Drinking Water Standards, U.S. Public Health Service, Washington, DC, 1962.
4. K. L. Kipp, V. L. McGhan and D. W. Damschen, Hanford Wells, BNWL-1739 Battelle-Northwest, Richland, WA, June 1973.
5. J. J. Fix, Environmental Surveillance at Hanford for CY-1974, BNWL-1910, Battelle, Pacific Northwest Laboratories, Richland, WA, 1975.
6. J. J. Fix, A "Filter-Resin" Sampling Method for Measurement of Radioactivity in Columbia River Water, BNWL-SA-5630, Battelle, Pacific Northwest Laboratories, Richland, WA, 1975.

APPENDIX A

GROSS BETA, TRITIUM AND NITRATE CONCENTRATIONS IN THE GROUND WATER

APPENDIX A. Gross Beta, Tritium and Nitrate Concentrations
in the Ground Water (Unconfined Aquifer)

(CY-1974)

<u>Well No.</u>	<u>Gross Beta (pCi/mL)</u>	<u>Tritium (pCi/mL)</u>	<u>Nitrate (mg/L)</u>
199 H3 2	MAX AVE 7.50E-02* MIN	MAX AVE MIN	MAX AVE 5.00E-01* MIN
199 H4 4	MAX AVE 1.03E-01* MIN	MAX AVE 6.15E 00* MIN	MAX AVE 1.75E 00* MIN
199 H9 1	MAX AVE MIN	MAX AVE 3.80E 00* MIN	MAX AVE 7.35E 00* MIN
199 02 5	MAX AVE MIN	MAX AVE 2.00E 01* MIN	MAX 4.90E 01 AVE 3.78E 01 MIN 3.00E 01
199 05 12	MAX AVE 7.50E-02* MIN	MAX 2.20E 01 AVE 1.36E 01 MIN 7.90E 00	MAX AVE 3.40E 01* MIN
199 F5 1	MAX AVE MIN	MAX 1.10E 02 AVE 2.80E 01 MIN 5.60E-01	MAX AVE 1.80E 00* MIN
199 F7 1	MAX AVE MIN	MAX AVE 2.95E 00* MIN	MAX AVE MIN
199 F8 1	MAX AVE MIN	MAX 3.40E 01 AVE 2.53E 01 MIN 2.10E 01	MAX 6.90E 01 AVE 5.93E 01 MIN 5.10E 01
199 H3 1	MAX AVE MIN	MAX AVE 1.50E 01* MIN	MAX 2.60E 01 AVE 1.95E 01 MIN 1.60E 01
199 K 11	MAX AVE MIN	MAX AVE 5.16E 01* MIN	MAX 1.30E 01 AVE 5.30E 00 MIN 5.00E-01
199 K 19	MAX AVE MIN	MAX AVE 7.80E 00* MIN	MAX AVE 1.60E 00* MIN

*3 values or less, no max or min calculated

APPENDIX A. Gross Beta, Tritium and Nitrate Concentrations
in the Ground Water (Unconfined Aquifer)

(CY-1974)

Well No.	Gross Beta (pCi/ml)	Tritium (pCi/ml)	Nitrate (mg/l)
199 K 24	MAX AVE 8.00E-02* MIN	MAX 8.50E 00 AVE 7.80E 00 MIN 7.10E 00	MAX 2.00E 00 AVE 1.35E 00 MIN 5.00E-01
199 K 22	MAX AVE MIN	MAX AVE 2.50E 00* MIN	MAX AVE 5.00E-01* MIN
199 N 3	MAX AVE 2.04E 01* MIN	MAX AVE 1.75E 02* MIN	MAX AVE MIN
199 N 4	MAX AVE 7.50E-02* MIN	MAX AVE 5.35E 02* MIN	MAX AVE 5.00E-01* MIN
199 N 6	MAX AVE 2.90E-01* MIN	MAX AVE 7.75E 01* MIN	MAX AVE MIN
199 N 10	MAX AVE 8.67E-02* MIN	MAX AVE 1.15E 02* MIN	MAX AVE 5.00E-01* MIN
199 N 14	MAX AVE 3.55E-01* MIN	MAX AVE 7.90E 01* MIN	MAX AVE 7.10E 00* MIN
199 N 15	MAX 4.20E-01 AVE 2.68E-01 MIN 1.90E-01	MAX 2.20E 02 AVE 1.35E 02 MIN 1.00E 02	MAX 1.10E 01 AVE 9.10E 00 MIN 6.40E 00
299 E13 12	MAX AVE 7.75E-02* MIN	MAX AVE 4.60E 00* MIN	MAX AVE 1.30E 01* MIN
299 E16 2	MAX 4.20E-01 AVE 2.05E-01 MIN 8.00E-02	MAX AVE MIN	MAX AVE 4.00E 00* MIN
299 E17 5	MAX 1.90E-01 AVE 1.21E-01 MIN 8.00E-02	MAX AVE MIN	MAX 2.20E 02 AVE 1.87E 02 MIN 1.50E 02

*3 values or less, no max or min calculated

APPENDIX A. Gross Beta, Tritium and Nitrate Concentrations
in the Ground Water (Unconfined Aquifer)

(CY-1974)

Well No.	Gross Beta (pCi/ml)	Tritium (pCi/ml)	Nitrate (mg/l)
299 E17 8	MAX 1.20E-01 AVE 8.58E-02 MIN 7.50E-02	MAX AVE MIN	MAX 2.10E 02 AVE 1.68E 02 MIN 1.10E 02
299 E24 2	MAX 2.71E-01 AVE 1.28E-01 MIN 7.50E-02	MAX AVE 8.07E 03* MIN	MAX AVE 2.70E 02* MIN
299 E24 4	MAX 8.00E-02 AVE 7.67E-02 MIN 7.50E-02	MAX AVE 8.80E 02* MIN	MAX 2.70E 01 AVE 2.08E 01 MIN 1.50E 01
299 E24 9	MAX 3.80E-01 AVE 1.89E-01 MIN 7.50E-02	MAX AVE MIN	MAX 9.70E 02 AVE 3.60E 02 MIN 1.50E 02
299 E24 10	MAX 1.00E-01 AVE 8.63E-02 MIN 7.50E-02	MAX AVE 1.40E 04* MIN	MAX 5.00E-01 AVE 5.00E-01 MIN 5.00E-01
299 E25 6	MAX 2.90E-01 AVE 9.54E-02 MIN 7.50E-02	MAX 6.50E 02 AVE 4.04E 02 MIN 2.40E 02	MAX AVE 1.22E 01* MIN
299 E25 11	MAX 1.30E 00 AVE 5.25E-01 MIN 1.20E-01	MAX AVE 9.50E 01* MIN	MAX AVE 8.50E 00* MIN
299 E26 2	MAX AVE 3.10E-01* MIN	MAX AVE 4.90E 01* MIN	MAX AVE 3.40E 00* MIN
299 E26 4	MAX 1.20E 01 AVE 1.10E 00 MIN 7.50E-02	MAX AVE 3.73E 02* MIN	MAX AVE 3.13E 00* MIN
299 E28 5	MAX AVE 7.50E-02* MIN	MAX AVE 4.30E 01* MIN	MAX AVE 9.80E 00* MIN
299 E28 13	MAX 8.00E-02 AVE 7.67E-02 MIN 7.50E-02	MAX AVE MIN	MAX AVE 4.63E 01* MIN

*3 values or less, no max or min calculated

APPENDIX A. Gross Beta, Tritium and Nitrate Concentrations
in the Ground Water (Unconfined Aquifer)

(CY-1974)

<u>Well No.</u>	<u>Gross Beta (pCi/ml)</u>	<u>Tritium (pCi/ml)</u>	<u>Nitrate (mg/l)</u>
299 E28 16	MAX 2.70E-01 AVE 1.18E-01 MIN 8.00E-02	MAX AVE MIN	MAX AVE 3.25E 02* MIN
299 F33 10	MAX AVE 6.00E-01* MIN	MAX AVE 1.00E 03* MIN	MAX AVE 4.70E 02* MIN
299 E33 25	MAX 1.20E 00 AVE 9.93E-01 MIN 7.90E-01	MAX 4.10E 02 AVE 3.65E 02 MIN 3.20E 02	MAX 3.00E 02 AVE 2.58E 02 MIN 2.30E 02
299 E34 1	MAX AVE MIN	MAX AVE MIN	MAX AVE 5.00E-01* MIN
299 W6 1	MAX AVE 8.00E-02* MIN	MAX AVE MIN	MAX AVE 4.80E 02* MIN
299 W11 3	MAX AVE 8.00E-02* MIN	MAX AVE MIN	MAX AVE 1.10E 02* MIN
299 W11 17	MAX 1.20E-01 AVE 8.41E-02 MIN 7.50E-02	MAX AVE MIN	MAX AVE 1.43E 02* MIN
299 W15 7	MAX 4.70E-01 AVE 3.58E-01 MIN 2.80E-01	MAX AVE MIN	MAX AVE 6.80E 01* MIN
299 W18 5	MAX 8.50E-02 AVE 7.75E-02 MIN 7.50E-02	MAX AVE 1.85E 01* MIN	MAX AVE 5.00E-01* MIN
299 W19 3	MAX AVE MIN	MAX AVE MIN	MAX AVE 1.80E 01* MIN
299 W21 1	MAX AVE MIN	MAX AVE MIN	MAX AVE 9.00E 01* MIN

*3 values or less, no max or min calculated

APPENDIX A. Gross Beta, Tritium and Nitrate Concentrations
in the Ground Water (Unconfined Aquifer)

(CY-1974)

Well No.	Gross Beta (pCi/ml)	Tritium (pCi/ml)	Nitrate (mg/l)
299 W22 1	MAX 2.70E 01 AVE 1.66E 01 MIN 8.10E 00	MAX AVE MIN	MAX AVE 3.60E 00* MIN
299 W22 22	MAX 5.90E-01 AVE 4.57E-01 MIN 3.00E-01	MAX AVE 5.30E 02* MIN	MAX AVE 7.33E-01* MIN
299 W22 26	MAX 2.00E 01 AVE 9.51E 00 MIN 7.50E-02	MAX 1.50E 04 AVE 8.60E 03 MIN 1.30E 01	MAX AVE 2.10E 02* MIN
299 W23 4	MAX 2.30E-01 AVE 9.00E-02 MIN 7.50E-02	MAX 7.30E 04 AVE 8.64E 03 MIN 1.30E 01	MAX 8.50E 01 AVE 2.37E 01 MIN 1.90E 00
399 1 1	MAX 2.30E-01 AVE 9.37E-02 MIN 7.50E-02	MAX AVE MIN	MAX 4.90E 01 AVE 2.97E 01 MIN 1.10E 01
399 1 2	MAX 1.60E-01 AVE 1.16E-01 MIN 7.50E-02	MAX AVE MIN	MAX 2.10E 02 AVE 5.91E 01 MIN 9.50E 00
399 1 3	MAX 8.00E-02 AVE 7.75E-02 MIN 7.50E-02	MAX AVE MIN	MAX 2.20E 02 AVE 9.28E 01 MIN 1.40E 01
399 1 4	MAX 7.50E-02 AVE 7.50E-02 MIN 7.50E-02	MAX AVE MIN	MAX 2.00E 01 AVE 1.42E 01 MIN 8.70E 00
399 3 1	MAX 8.00E-02 AVE 7.59E-02 MIN 7.50E-02	MAX AVE MIN	MAX 7.90E 01 AVE 3.91E 01 MIN 1.30E 01
399 3 8	MAX 1.70E 00 AVE 7.13E-01 MIN 1.00E-01	MAX AVE MIN	MAX AVE MIN
399 4 1	MAX 7.50E-02 AVE 7.50E-02 MIN 7.50E-02	MAX AVE MIN	MAX 3.90E 01 AVE 1.62E 01 MIN 5.00E-01

*3 values or less, no max or min calculated

APPENDIX A. Gross Beta, Tritium and Nitrate Concentrations
in the Ground Water (Unconfined Aquifer)

(CY-1974)

Well No.			Gross Beta (pCi/ml)	Tritium (pCi/ml)	Nitrate (mg/l)
399	4	1	MAX 1.00E-01 AVE 8.12E-02 MIN 7.50E-02	MAX AVE MIN	MAX 4.80E 01 AVE 3.87E 01 MIN 6.70E 00
399	4	8	MAX AVE 7.50E-22* MIN	MAX AVE MIN	MAX AVE 1.90E 01* MIN
399	5	1	MAX AVE MIN	MAX AVE MIN	MAX 2.20E 01 AVE 1.50E 01 MIN 8.70E 00
399	6	1	MAX AVE MIN	MAX AVE MIN	MAX 1.40E 01 AVE 1.10E 01 MIN 9.30E 00
399	8	2	MAX AVE MIN	MAX AVE MIN	MAX AVE 7.93E 00* MIN
399	8	3	MAX AVE MIN	MAX AVE MIN	MAX 1.00E 01 AVE 6.45E 00 MIN 4.90E 00
699	S12	3	MAX AVE MIN	MAX 1.20E 00 AVE 7.23E-01 MIN 5.20E-01	MAX AVE MIN
699	S11E12A		MAX AVE MIN	MAX AVE 5.00E-01* MIN	MAX AVE MIN
699	S8	19	MAX AVE MIN	MAX 1.00E 00 AVE 6.22E-01 MIN 5.00E-01	MAX 2.10E 00 AVE 1.46E 00 MIN 5.00E-01
699	S6 E4C		MAX AVE MIN	MAX AVE 5.00E-01* MIN	MAX 5.00E-01 AVE 5.00E-01 MIN 5.00E-01
699	S6 E4D		MAX AVE MIN	MAX 1.50E 00 AVE 1.02E 00 MIN 5.00E-01	MAX AVE MIN

*3 values or less, no max or min calculated

APPENDIX A. Gross Beta, Tritium and Nitrate Concentrations
in the Ground Water (Unconfined Aquifer)

(CY-1974)

Well No.	Gross Beta (pCi/ml)	Tritium (pCi/ml)	Nitrate (mg/l)
699 S3 E12	MAX AVE MIN	MAX AVE 5.00E-01* MIN	MAX 2.00E 01 AVE 5.14E 00 MIN 5.00E-01
699 S0 8	MAX AVE MIN	MAX 1.40E 01 AVE 8.08E 00 MIN 5.80E 00	MAX AVE MIN
699 1 18	MAX AVE MIN	MAX AVE 2.10E 02* MIN	MAX 1.70E 01 AVE 1.32E 01 MIN 8.10E 00
699 2 3	MAX AVE MIN	MAX 6.20E 01 AVE 5.10E 01 MIN 4.60E 01	MAX 1.90E 01 AVE 1.25E 01 MIN 5.00E-01
699 2 33	MAX AVE MIN	MAX 1.20E 00 AVE 8.50E-01 MIN 5.30E-01	MAX AVE 1.13E 00* MIN
699 3 45	MAX AVE MIN	MAX AVE 5.40E-01* MIN	MAX AVE 6.00E-01* MIN
699 8 17	MAX 8.00E-02 AVE 7.75E-02 MIN 7.50E-02	MAX AVE 1.45E 02* MIN	MAX AVE 2.70E 01* MIN
699 8 25	MAX 8.00E-02 AVE 7.60E-02 MIN 7.50E-02	MAX 2.30E 02 AVE 2.06E 02 MIN 1.90E 02	MAX AVE 2.37E 01* MIN
699 8 32	MAX AVE MIN	MAX 1.00E 00 AVE 6.83E-01 MIN 4.80E-01	MAX 6.00E-01 AVE 5.17E-01 MIN 5.00E-01
699 9 22	MAX AVE MIN	MAX AVE MIN	MAX AVE 5.00E-01* MIN
699 10 E12	MAX AVE MIN	MAX AVE 5.00E-01* MIN	MAX 2.00E 01 AVE 7.16E 00 MIN 5.00E-01

*3 values or less, no max or min calculated

APPENDIX A. Gross Beta, Tritium and Nitrate Concentrations
in the Ground Water (Unconfined Aquifer)

(CY-1974)

Well No.	Gross Beta (pCi/ml)	Tritium (pCi/ml)	Nitrate (mg/l)
699 13 1	MAX AVE MIN	MAX 3.00E 02 AVE 1.46E 02 MIN 1.40E 01	MAX 1.60E 01 AVE 9.82E 00 MIN 3.50E 00
699 13 1A	MAX AVE MIN	MAX 3.90E 02 AVE 2.47E 02 MIN 5.70E 01	MAX 1.60E 01 AVE 1.45E 01 MIN 1.20E 01
699 13 1B	MAX AVE MIN	MAX 2.10E 01 AVE 1.80E 01 MIN 1.50E 01	MAX 4.80E 00 AVE 4.08E 00 MIN 3.50E 00
699 14 E6P	MAX AVE MIN	MAX AVE 5.00E-01* MIN	MAX AVE 5.00E-01* MIN
699 14 E6Q	MAX AVE MIN	MAX AVE 1.16E 00* MIN	MAX 5.00E-01 AVE 5.00E-01 MIN 5.00E-01
699 14 E6R	MAX AVE MIN	MAX AVE 1.00E 00* MIN	MAX AVE 5.00E-01* MIN
699 14 E6S	MAX AVE MIN	MAX AVE 5.00E-01* MIN	MAX AVE 5.00E-01* MIN
699 14 E6T	MAX AVE MIN	MAX AVE 6.90E-01* MIN	MAX 1.60E 00 AVE 8.60E-01 MIN 5.00E-01
699 14 3A	MAX AVE MIN	MAX AVE 6.30E-01* MIN	MAX AVE 2.93E 00* MIN
699 15 15B	MAX 8.00E-02 AVE 7.60E-02 MIN 7.50E-02	MAX 7.00E-01 AVE 5.46E-01 MIN 5.00E-01	MAX 1.30E 01 AVE 1.20E 01 MIN 1.00E 01
699 15 15C	MAX AVE MIN	MAX AVE MIN	MAX AVE 1.10E 01* MIN

*3 values or less, no max or min calculated

APPENDIX A. Gross Beta, Tritium and Nitrate Concentrations
in the Ground Water (Unconfined Aquifer)

(CY-1974)

Well No.	Gross Beta (pCi/mL)	Tritium (pCi/mL)	Nitrate (mg/L)
699 15 26	MAX AVE MIN	MAX AVE 3.55E 02* MIN	MAX AVE 2.80E 01* MIN
699 17 5	MAX AVE MIN	MAX 8.50E-01 AVE 6.19E-01 MIN 4.30E-01	MAX 3.70E 01 AVE 2.19E 01 MIN 5.00E-01
699 19 43	MAX AVE MIN	MAX AVE MIN	MAX 6.10E 00 AVE 5.32E 00 MIN 4.50E 00
699 20 ESP	MAX AVE MIN	MAX AVE MIN	MAX 5.00E-01 AVE 5.00E-01 MIN 5.00E-01
699 20 ESO	MAX AVE MIN	MAX AVE MIN	MAX AVE 5.00E-01* MIN
699 20 EST	MAX AVE MIN	MAX AVE MIN	MAX 4.20E 00 AVE 1.98E 00 MIN 5.00E-01
699 20 E12	MAX AVE MIN	MAX AVE 5.30E-01* MIN	MAX 5.00E-01 AVE 5.00E-01 MIN 5.00E-01
699 20 20	MAX 1.40E-01 AVE 1.03E-01 MIN 8.80E-02	MAX AVE 3.91E 02* MIN	MAX AVE 4.85E 01* MIN
699 20 39	MAX AVE MIN	MAX 8.50E-01 AVE 6.35E-01 MIN 4.90E-01	MAX 7.80E 00 AVE 6.23E 00 MIN 3.40E 00
699 24 1P	MAX AVE MIN	MAX AVE 5.30E-01* MIN	MAX AVE 5.00E-01* MIN
699 24 1D	MAX AVE MIN	MAX AVE 1.00E 00* MIN	MAX AVE 5.00E-01* MIN

*3 values or less, no max or min calculated

APPENDIX A. Gross Beta, Tritium and Nitrate Concentrations
in the Ground Water (Unconfined Aquifer)

(CY-1974)

Well No.			Gross Beta (pCi/ml)	Tritium (pCi/ml)	Nitrate (mg/l)
699	24	1T	MAX AVE MIN	MAX AVE 7.95E-01* MIN	MAX AVE 6.50E-01* MIN
699	24	33	MAX 1.00E-01 AVE 8.25E-02 MIN 7.50E-02	MAX AVE 3.93E 02* MIN	MAX AVE 1.02E 01* MIN
699	24	46	MAX AVE MIN	MAX AVE 6.00E-01* MIN	MAX 5.20E 00 AVE 2.67E 00 MIN 8.00E-01
699	25	70	MAX AVE MIN	MAX AVE MIN	MAX AVE 2.77E 00* MIN
699	26	15	MAX 2.30E-01 AVE 1.61E-01 MIN 7.50E-02	MAX AVE 1.30E 03* MIN	MAX AVE 3.90E 01* MIN
699	26	69	MAX AVE MIN	MAX AVE MIN	MAX AVE 1.13E 01* MIN
699	27	8	MAX 2.60E-01 AVE 1.72E-01 MIN 1.00E-01	MAX AVE 9.90E 02* MIN	MAX 5.40E 01 AVE 4.35E 01 MIN 3.30E 01
699	28	40	MAX 8.30E-02 AVE 7.63E-02 MIN 7.50E-02	MAX AVE 5.40E 01* MIN	MAX 7.70E 00 AVE 5.65E 00 MIN 3.20E 00
699	29	7A	MAX AVE MIN	MAX 1.60E 00 AVE 9.08E-01 MIN 6.00E-01	MAX 1.90E 00 AVE 1.46E 00 MIN 1.20E 00
699	31	31	MAX AVE 1.30E-01* MIN	MAX AVE 1.70E 03* MIN	MAX AVE 3.05E 01* MIN
699	31	53B	MAX AVE 7.50E-02* MIN	MAX 1.40E 00 AVE 1.05E 00 MIN 6.90E-01	MAX 9.00E 00 AVE 6.75E 00 MIN 4.80E 00

*3 values or less, no max or min calculated

APPENDIX A. Gross Beta, Tritium and Nitrate Concentrations
in the Ground Water (Unconfined Aquifer)

(CY-1974)

Well No.	Gross Beta (pCi/ml)	Tritium (pCi/ml)	Nitrate (mg/l)
699 31 65	MAX AVE MIN	MAX AVE MIN	MAX 2.00E 01 AVE 1.60E 01 MIN 1.20E 01
699 32 22	MAX 2.60E-01 AVE 2.46E-01 MIN 2.20E-01	MAX AVE 1.50E 03* MIN	MAX 6.70E 01 AVE 6.18E 01 MIN 5.20E 01
699 32 43	MAX AVE 1.40E-01* MIN	MAX AVE 6.05E 02* MIN	MAX AVE 3.10E 01* MIN
699 32 62	MAX AVE MIN	MAX AVE 6.33E-01* MIN	MAX AVE 5.00E-01* MIN
699 32 70	MAX 8.00E-02 AVE 7.80E-02 MIN 7.50E-02	MAX 5.50E 02 AVE 1.59E 02 MIN 5.40E 01	MAX AVE 1.93E 01* MIN
699 32 72	MAX 8.00E-02 AVE 7.70E-02 MIN 7.50E-02	MAX AVE 8.47E 01* MIN	MAX 3.20E 00 AVE 8.86E-01 MIN 5.00E-01
699 32 77	MAX AVE 7.50E-02* MIN	MAX AVE 1.20E 00* MIN	MAX AVE 6.70E 01* MIN
699 34 39A	MAX 1.60E-01 AVE 1.00E-01 MIN 7.50E-02	MAX AVE 1.75E 03* MIN	MAX AVE 8.57E 00* MIN
699 34 41	MAX 3.30E-01 AVE 2.93E-01 MIN 1.90E-01	MAX 2.00E 03 AVE 1.70E 03 MIN 1.00E 03	MAX 7.90E 01 AVE 7.35E 01 MIN 6.90E 01
699 34 42	MAX 4.30E-01 AVE 3.25E-01 MIN 2.00E-01	MAX 2.00E 03 AVE 1.87E 03 MIN 1.80E 03	MAX 8.30E 01 AVE 7.48E 01 MIN 6.40E 01
699 34 51	MAX 7.50E-02 AVE 7.50E-02 MIN 7.50E-02	MAX 8.00E-01 AVE 5.95E-01 MIN 4.80E-01	MAX 1.00E 01 AVE 6.98E 00 MIN 1.10E 00

*3 values or less, no max or min calculated

APPENDIX A. Gross Beta, Tritium and Nitrate Concentrations
in the Ground Water (Unconfined Aquifer)

(CY-1974)

<u>Well No.</u>	<u>Gross Beta (pCi/ml)</u>	<u>Tritium (pCi/ml)</u>	<u>Nitrate (mg/l)</u>
699 35 9	MAX 8.00E-02 AVE 7.75E-02 MIN 7.50E-02	MAX 5.80E 01 AVE 3.78E 01 MIN 2.30E 01	MAX 1.50E 01 AVE 1.11E 01 MIN 5.00E-01
699 35 56	MAX AVE 7.50E-02*	MAX 3.40E 02 AVE 7.67E 01 MIN 4.00E 00	MAX 9.00E-01 AVE 5.80E-01 MIN 5.00E-01
699 35 70	MAX 4.40E-01 AVE 2.03E-01 MIN 8.00E-02	MAX 9.10E 03 AVE 7.73E 03 MIN 7.00E 03	MAX 2.00E 01 AVE 1.38E 01 MIN 3.20E 00
699 35 78	MAX 8.00E-02 AVE 7.63E-02 MIN 7.50E-02	MAX 3.00E 00 AVE 1.51E 00 MIN 8.00E-01	MAX 3.50E 00 AVE 2.00E 00 MIN 5.00E-01
699 36 460	MAX AVE 8.00E-02*	MAX AVE 5.30E-01*	MAX AVE 5.00E-01*
699 36 462	MAX 8.00E-02 AVE 7.63E-02 MIN 7.50E-02	MAX AVE 1.90E 03*	MAX 1.70E 00 AVE 8.43E-01 MIN 5.00E-01
699 36 61A	MAX AVE 7.50E-02*	MAX 1.10E 00 AVE 7.24E-01 MIN 5.00E-01	MAX 1.20E 01 AVE 1.10E 01 MIN 9.80E 00
699 36 61B	MAX AVE MIN	MAX AVE 7.45E-01* MIN	MAX AVE 5.50E-01* MIN
699 36 93	MAX AVE MIN	MAX AVE MIN	MAX AVE 5.00E-01* MIN
699 37 43	MAX 7.50E-02 AVE 7.50E-02 MIN 7.50E-02	MAX 1.00E 02 AVE 9.05E 01 MIN 8.30E 01	MAX 5.00E-01 AVE 5.00E-01 MIN 5.00E-01
699 37 82A	MAX AVE MIN	MAX AVE 5.50E-01* MIN	MAX AVE MIN

*3 values or less, no max or min calculated

APPENDIX A. Gross Beta, Tritium and Nitrate Concentrations
in the Ground Water (Unconfined Aquifer)

(CY-1974)

Well No.			Gross Beta (pCi/mL)	Tritium (pCi/mL)	Nitrate (mg/L)
699	38	55	MAX	MAX	MAX
			AVE	AVE 1.00E 01*	AVE
			MIN	MIN	MIN
699	38	70	MAX	MAX	MAX
			AVE	AVE 6.60E 01*	AVE
			MIN	MIN	MIN
699	39	39	MAX	MAX	MAX
			AVE	AVE 3.56E 00*	AVE
			MIN	MIN	MIN
699	39	79	MAX	MAX 1.50E 00	MAX
			AVE	AVE 1.01E 00	AVE
			MIN	MIN 7.00E-01	MIN
699	40	1	MAX	MAX 1.20E 01	MAX
			AVE	AVE 3.62E 00	AVE
			MIN	MIN 4.30E-01	MIN
699	40	33	MAX	MAX	MAX
			AVE	AVE 1.28E 00*	AVE
			MIN	MIN	MIN
699	40	62	MAX	MAX 1.00E 01	MAX
			AVE	AVE 5.35E 00	AVE
			MIN	MIN 1.90E 00	MIN
699	41	23	MAX	MAX	MAX
			AVE	AVE 8.27E 02*	AVE
			MIN	MIN	MIN
699	42	12	MAX	MAX	MAX
			AVE	AVE 2.70E 02*	AVE
			MIN	MIN	MIN
699	42	42	MAX	MAX	MAX
			AVE	AVE 5.80E 02*	AVE
			MIN	MIN	MIN
699	43	42	MAX	MAX	MAX
			AVE	AVE 4.45E 02*	AVE
			MIN	MIN	MIN

*3 values or less, no max or min calculated

APPENDIX A. Gross Beta, Tritium and Nitrate Concentrations
in the Ground Water (Unconfined Aquifer)

(CY-1974)

<u>Well No.</u>	<u>Gross Beta (pCi/ml)</u>	<u>Tritium (pCi/ml)</u>	<u>Nitrate (mg/l)</u>
699 43 39	MAX AVE MIN	MAX AVE 6.73E-01* MIN	MAX AVE MIN
699 44 04	MAX AVE MIN	MAX AVE 7.37E-01* MIN	MAX AVE MIN
699 45 42	MAX AVE MIN	MAX AVE 7.35E 02* MIN	MAX AVE MIN
699 45 69	MAX AVE MIN	MAX 7.70E 00 AVE 2.83E 00 MIN 5.30E-01	MAX AVE MIN
699 46 21	MAX AVE MIN	MAX 3.70E 00 AVE 2.12E 00 MIN 1.00E 00	MAX AVE MIN
699 47 35A	MAX AVE MIN	MAX 1.30E 00 AVE 8.22E-01 MIN 4.80E-01	MAX AVE MIN
699 47 46	MAX AVE MIN	MAX 1.00E 00 AVE 6.93E-01 MIN 4.90E-01	MAX AVE MIN
699 47 62	MAX AVE MIN	MAX AVE 5.97E-01* MIN	MAX AVE MIN
699 48 71	MAX AVE MIN	MAX 1.20E 00 AVE 8.25E-01 MIN 5.00E-01	MAX AVE MIN
699 49 28	MAX AVE MIN	MAX AVE 8.40E-01* MIN	MAX AVE MIN
699 49 55	MAX AVE MIN	MAX AVE 7.50E-01* MIN	MAX AVE MIN

*3 values or less, no max or min calculated

APPENDIX A. Gross Beta, Tritium and Nitrate Concentrations
in the Ground Water (Unconfined Aquifer)

(CY-1974)

<u>Well No.</u>	<u>Gross Beta (pCi/ml)</u>	<u>Tritium (pCi/ml)</u>	<u>Nitrate (mg/l)</u>
699 49 57	MAX AVE MIN	MAX 3.90E 02 AVE 2.50E 02 MIN 1.60E 02	MAX AVE MIN
699 49 79	MAX AVE MIN	MAX AVE 7.30E-01* MIN	MAX AVE MIN
699 50 28A	MAX AVE MIN	MAX 1.20E 00 AVE 6.86E-01 MIN 5.00E-01	MAX AVE MIN
699 50 42	MAX AVE MIN	MAX AVE 5.40E 00* MIN	MAX AVE MIN
699 50 53	MAX AVE MIN	MAX 2.70E 00 AVE 1.60E 00 MIN 9.90E-01	MAX AVE MIN
699 50 85	MAX AVE MIN	MAX AVE 6.90E-01* MIN	MAX AVE MIN
699 51 63	MAX AVE MIN	MAX 8.50E-01 AVE 7.18E-01 MIN 5.00E-01	MAX AVE MIN
699 51 75	MAX AVE MIN	MAX AVE 8.23E-01* MIN	MAX AVE MIN
699 53 47	MAX AVE MIN	MAX 1.30E 00 AVE 1.12E 00 MIN 7.00E-01	MAX AVE MIN
699 53 55A	MAX AVE MIN	MAX 1.50E 00 AVE 9.58E-01 MIN 4.30E-01	MAX AVE MIN
699 54 42	MAX AVE MIN	MAX AVE 5.40E-01* MIN	MAX AVE MIN

*3 values or less, no max or min calculated

APPENDIX A. Gross Beta, Tritium and Nitrate Concentrations
in the Ground Water (Unconfined Aquifer)

(CY-1974)

<u>Well No.</u>	<u>Gross Beta (pCi/mL)</u>	<u>Tritium (pCi/mL)</u>	<u>Nitrate (mg/L)</u>
699 54 45	MAX AVE MIN	MAX 1.00E 02 AVE 2.05E 01 MIN 4.80E-01	MAX AVE MIN
699 54 57	MAX AVE MIN	MAX 1.00E 00 AVE 6.27E-01 MIN 5.00E-01	MAX AVE MIN
699 55 50A	MAX AVE MIN	MAX AVE 1.83E 00* MIN	MAX AVE MIN
699 55 50C	MAX AVE MIN	MAX AVE 8.10E-01* MIN	MAX AVE MIN
699 55 95	MAX AVE MIN	MAX AVE 1.40E 00* MIN	MAX AVE MIN
699 59 58	MAX AVE MIN	MAX 4.70E 00 AVE 4.35E 00 MIN 3.80E 00	MAX AVE MIN
699 60 57	MAX AVE MIN	MAX 2.00E 00 AVE 1.66E 00 MIN 8.40E-01	MAX AVE MIN
699 60 60	MAX AVE MIN	MAX 2.50E 00 AVE 2.28E 00 MIN 1.80E 00	MAX AVE MIN
699 61 62	MAX AVE MIN	MAX 2.90E 00 AVE 2.45E 00 MIN 2.20E 00	MAX AVE MIN
699 61 66	MAX AVE MIN	MAX 1.00E 00 AVE 6.68E-01 MIN 5.00E-01	MAX AVE MIN
699 63 58	MAX AVE MIN	MAX 3.20E 00 AVE 2.33E 00 MIN 8.20E-01	MAX AVE MIN

*3 values or less, no max or min calculated

APPENDIX A. Gross Beta, Tritium and Nitrate Concentrations
in the Ground Water (Unconfined Aquifer)

(CY-1974)

<u>Well No.</u>			<u>Gross Beta (pCi/ml)</u>	<u>Tritium (pCi/ml)</u>	<u>Nitrate (mg/l)</u>
699	64	62	MAX	MAX 1.80E 00	MAX
			AVE	AVE 1.38E 00	AVE
			MIN	MIN 1.10E 00	MIN
699	65	50	MAX	MAX	MAX
			AVE	AVE 1.50E 00*	AVE
			MIN	MIN	MIN
699	65	59	MAX	MAX	MAX
			AVE	AVE 1.33E 00*	AVE
			MIN	MIN	MIN
699	65	72	MAX	MAX 2.10E 00	MAX
			AVE	AVE 1.65E 00	AVE
			MIN	MIN 1.20E 00	MIN
699	65	83	MAX	MAX 1.30E 02	MAX
			AVE	AVE 3.43E 01	AVE
			MIN	MIN 2.00E 00	MIN
699	66	58	MAX	MAX 2.40E 00	MAX
			AVE	AVE 1.73E 00	AVE
			MIN	MIN 9.00E-01	MIN
699	66	64	MAX	MAX 1.10E 00	MAX
			AVE	AVE 8.75E-01	AVE
			MIN	MIN 7.00E-01	MIN
699	67	51	MAX	MAX	MAX
			AVE	AVE 1.00E 00*	AVE
			MIN	MIN	MIN
699	67	86	MAX	MAX	MAX
			AVE	AVE 3.90E 00*	AVE
			MIN	MIN	MIN
699	67	98	MAX	MAX	MAX
			AVE	AVE 7.00E-01*	AVE
			MIN	MIN	MIN
699	68	105	MAX	MAX	MAX
			AVE	AVE 1.00E 00*	AVE
			MIN	MIN	MIN

*3 values or less, no max or min calculated

APPENDIX A. Gross Beta, Tritium and Nitrate Concentrations
in the Ground Water (Unconfined Aquifer)

(CY-1974)

<u>Well No.</u>	<u>Gross Beta (pCi/ml)</u>	<u>Tritium (pCi/ml)</u>	<u>Nitrate (mg/l)</u>
699 69 38	MAX AVE MIN	MAX AVE 5.90E-01* MIN	MAX AVE MIN
699 69 45	MAX AVE MIN	MAX AVE 5.50E 00* MIN	MAX AVE MIN
699 70 68	MAX AVE MIN	MAX AVE 9.65E-01* MIN	MAX AVE MIN
699 71 30	MAX AVE MIN	MAX AVE 5.30E-01* MIN	MAX AVE MIN
699 71 52	MAX AVE MIN	MAX AVE 4.30E 00* MIN	MAX AVE MIN
699 71 77	MAX AVE MIN	MAX AVE 1.17E 00* MIN	MAX AVE MIN
699 72 73	MAX AVE MIN	MAX AVE 1.00E 00* MIN	MAX AVE MIN
699 72 88	MAX AVE MIN	MAX AVE 1.50E 01* MIN	MAX AVE MIN
699 72 92	MAX AVE MIN	MAX AVE 1.07E 01* MIN	MAX AVE MIN
699 74 44	MAX AVE MIN	MAX 9.40E-01 AVE 6.35E-01 MIN 5.00E-01	MAX AVE MIN
699 74 43	MAX AVE MIN	MAX 2.40E 00 AVE 1.44E 00 MIN 8.00E-01	MAX AVE MIN

*3 values or less, no max or min calculated

APPENDIX A. Gross Beta, Tritium and Nitrate Concentrations
in the Ground Water (Unconfined Aquifer)

(CY-1974)

<u>Well No.</u>	<u>Gross Beta (pCi/mL)</u>	<u>Tritium (pCi/mL)</u>	<u>Nitrate (mg/L)</u>
699 74 67	MAX AVE MIN	MAX AVE 1.00E 00* MIN	MAX AVE MIN
699 77 36	MAX AVE MIN	MAX 1.00E 00 AVE 7.24E-01 MIN 4.80E-01	MAX AVE MIN
699 77 54	MAX AVE MIN	MAX AVE 9.40E-01* MIN	MAX AVE MIN
699 78 62	MAX AVE MIN	MAX AVE 8.40E-01* MIN	MAX AVE MIN
699 80 43P	MAX AVE MIN	MAX AVE 5.60E-01* MIN	MAX AVE MIN
699 81 58	MAX AVE MIN	MAX AVE 1.13E 00* MIN	MAX AVE MIN
699 83 47	MAX AVE MIN	MAX AVE 8.67E-01* MIN	MAX AVE MIN
699 84 35A	MAX AVE MIN	MAX AVE 7.10E-01* MIN	MAX AVE MIN
699 86 60	MAX AVE MIN	MAX AVE 1.55E 02* MIN	MAX AVE MIN
699 87 42A	MAX AVE MIN	MAX AVE 8.93E-01* MIN	MAX AVE MIN
699 87 55	MAX AVE MIN	MAX 1.60E 02 AVE 1.44E 02 MIN 1.10E 02	MAX AVE MIN

*3 values or less, no max or min calculated

APPENDIX A. Gross Beta, Tritium and Nitrate Concentrations
in the Ground Water (Unconfined Aquifer)

(CY-1974)

<u>Well No.</u>	<u>Gross Beta (pCi/ml)</u>	<u>Tritium (pCi/ml)</u>	<u>Nitrate (mg/l)</u>
699 89 35	MAX AVE MIN	MAX 1.40E 00 AVE 8.70E-01 MIN 4.80E-01	MAX AVE MIN
699 90 45	MAX AVE MIN	MAX AVE 2.73E 01* MIN	MAX AVE MIN
699 96 49	MAX AVE MIN	MAX AVE 1.60E 01* MIN	MAX AVE MIN
699 97 43	MAX AVE MIN	MAX AVE 8.30E 00* MIN	MAX AVE MIN
699 HAN 6	MAX AVE MIN	MAX 1.00E 00 AVE 7.96E-01 MIN 5.00E-01	MAX AVE MIN
699 HAN 19	MAX AVE MIN	MAX 7.10E 00 AVE 1.94E 00 MIN 4.30E-01	MAX AVE MIN

*3 values or less, no max or min calculated

APPENDIX B

ROUTINE ANALYSES FOR MATERIALS OTHER
THAN PRIMARY TRACERS

APPENDIX B

ROUTINE ANALYSES FOR MATERIALS OTHER THAN PRIMARY TRACERS

<u>WELL NUMBER</u>	<u>^{60}Co</u>	<u>^{90}Sr</u>	<u>^{103}Ru</u>	<u>^{106}Ru</u>	<u>^{131}I</u>	<u>^{125}Sb</u>
<u>199-B3-1</u>						
11-27-74	.028±.024	—	—	—	—	—
<u>199-H4-3</u>						
11-25-74	.025±.024	[TOT Alpha:<.017; F ⁻ ; 0.8 ppm; Cr ⁺⁶ : 250 ppb]			—	—
<u>199-N-3</u>						
06-03-74	.07±.03	.18	.25±.052	<.13	1.10±.22	
<u>199-N-4-0</u>						
06-03-74	—	<.025	—	—	—	—
<u>199-N-6</u>						
06-04-74	.044±.032	<.028	—	.33±.076	—	—
<u>199-N-10-P</u>						
06-04-74	—	<.025	—	<.05	—	—
<u>199-N-14</u>						
06-04-74	.125±.33	<.025		.22±.078	.18±.19	.13±.04
<u>199-N-15</u>						
06-04-74	.078±.03	<.025	—	.26±.07	—	—
11-27-74	.110±.128	.009±.009	—	.46±.13	—	—

<u>WELL NUMBER</u>	<u>pCi/mℓ Alpha</u>	<u>ppb Cr⁺⁶</u>	<u>ppm F⁻</u>	<u>pCi/mℓ U</u>
<u>399-1-1</u>				
03-11-74	.043	-	-	-
04-18-74	.030	-	-	-
05-14-74	.017	-	-	-
06-10-74	.058	-	-	-
07-17-74	.017	-	-	-
08-16-74	.017	<3	0.9	-
09-17-74	.017	-	-	-
10-18-74	.018	<3	0.4	-
11-13-74	.017	-	1.2	-
12-12-74	.047	-	1.2	.044
<u>399-1-2</u>				
01-29-74	.020	23	3.5	-
04-01-74	.048	28	1.1	-
06-03-74	.057	21	1.2	-
07-27-74	.073	22	1.2	-
09-17-74	.077	6.8	0.6	-
11-25-74	.041	< 3	0.4	-
<u>399-1-3</u>				
08-16-74	.061	5.7	2.6	-
10-18-74	.090	<3	0.8	-
11-13-74	-	-	1.4	-
12-12-74	-	-	1.3	.082
<u>399-1-4</u>				
04-01-74	.032	3.4	0.8	-
07-27-74	.035	8	0.8	-
09-17-74	.034	<3	0.5	-
<u>399-3-1</u>				
01-29-74	.017	6.6	6.6	-
04-01-74	.042	4.8	0.8	-
07-27-74	.042	9.3	1.1	-
09-17-74	.061	7.4	0.4	-
11-13-74	.090	<3	1.9	-
12-12-74	.034	<3	1.2	.022

<u>WELL NUMBER</u>	<u>pCi/m² Alpha</u>	<u>ppb Cr⁺⁶</u>	<u>ppm F⁻</u>
<u>399-3-8</u>			
01-23-74	.042	-	-
02-15-74	.062	-	-
03-11-74	.040	-	-
04-17-74	.030	-	-
05-14-74	.075	-	-
06-10-74	.017	-	-
07-17-74	.034	-	-
09-17-74	.052	-	-
11-13-74	.017	-	-
12-12-74	.041	-	-
<u>399-4-1</u>			
01-29-74	.017	5.1	0.6
06-03-74	-	10.7	-
07-27-74	.034	18.7	0.4
09-14-74	.029	<3	0.5
11-25-74	-	<3	-
<u>399-4-7</u>			
01-29-74	.037	4.2	0.7
04-01-74	.150	3.4	0.8
06-03-74	-	13	0.6
07-27-74	.044	< 3	0.7
08-16-74	-	17	-
09-30-74	.087	14	0.7
11-25-74	-	< 3	-
<u>399-4-8</u>			
02-15-74	.038	< 2	0.5

<u>WELL NUMBER</u>	<u>pCi/m² Alpha</u>	<u>ppb Cr⁺⁶</u>	<u>ppm F⁻</u>
<u>399-5-1</u>			
01-29-74	<.017	4	0.3
04-01-74	<.017	4.8	0.2
07-27-74	.019	18.7	0.4
09-30-74	<.017	< 3	0.3
<u>399-6-1</u>			
01-29-74	<.017	4.6	0.4
04-01-74	.021	5.8	0.2
06-03-74	-	7.7	-
07-27-74	<.017	5.3	0.2
09-30-74	<.017	<3	0.2
<u>399-8-2</u>			
04-04-74	<.017	<3	0.2
08-01-74	<.017	<3	0.3
10-02-74	<.017	<3	0.2
<u>399-8-3</u>			
01-29-74	<.017	<2	0.4
04-01-74	<.017	<3	0.4
08-16-74	<.017	<3	0.2
09-30-74	<.017	<3	0.2
<u>699-S19-E13</u>			
01-29-74	<.017	<2	0.3
04-01-74	<.017	<3	0.2
07-29-74	<.017	<3	0.2
09-30-74	<.017	<3	0.3
<u>699-S27-E14</u>			
02-04-74	<.017		
04-04-74	<.017	<3	0.1
08-01-74	<.017	<3	0.2
10-02-74	<.017	<3	0.3

<u>WELL NUMBER</u>	<u>pCi/mL</u> <u>Alpha</u>	<u>ppb</u> <u>Cr⁺⁶</u>	<u>ppm</u> <u>F⁻</u>
<u>699-S29-E12</u>			
02-04-74	<.017	<2	0.3
04-04-74	<.017	<3	0.2
08-01-74	<.017	<3	0.2
10-02-74	<.017	<3	0.2
<u>699-S30-E15A</u>			
02-04-74	<.017	<2	<0.2
04-04-74	<.017	<3	<0.1
08-01-74	<.017	<3	<0.1
10-02-74	<.017	<3	<0.1

<u>WELL NUMBER</u>	<u>pCi/mL</u>		
	<u>¹⁰⁶Ru</u>	<u>⁶⁰Co</u>	<u>¹³⁷Cs</u>
<u>699-20-20</u>			
02-04-74	<.500	-	-
<u>699-26-15</u>			
02-04-74	<.500	-	-
08-01-74	<.200	-	-
<u>699-31-310</u>			
02-28-74	<.500	-	-
09-09-74	<.110	-	-
<u>699-32-43</u>			
09-09-74	-	.047±.025	<.020
<u>699-34-51</u>			
06-03-74	<.050	-	-
<u>699-36-460</u>			
11-20-74	-	.030±.024	-
<u>699-38-700</u>			
01-15-74	1.000±.600	-	-

<u>WELL NUMBER</u>	<u>⁹⁰Sr</u>
<u>699-39-39</u>	
01-23-74	<.034
02-12-74	<.027
03-11-74	<.026
04-17-74	<.027
05-14-74	<.027
06-18-74	<.025
07-18-74	<.025
08-13-74	.112
09-17-74	<.0074

<u>699-40-33</u>	
01-23-74	<.029
02-12-74	<.027
03-11-74	<.026
04-17-74	<.028
05-14-74	<.024
06-18-74	<.024
07-18-74	<.027
08-13-74	<.023
09-17-74	<.011
11-12-74	<.025

<u>699-42-42-0</u>	
10-15-74	.0086
12-11-74	<.007

<u>WELL NUMBER</u>	<u>pCi/ml</u>		
	<u>⁹⁰Sr</u>	<u>⁶⁰Co</u>	<u>¹⁰⁶Ru</u>
<u>699-43-42</u>			
01-23-74	.034	-	-
02-12-74	<.026	-	-
03-11-74	<.027	-	-
04-17-74	<.028	-	-
05-14-74	.031	-	-
06-18-74	.032	-	-
07-18-74	.038	-	-
08-13-74	.122	-	-
09-17-74	.018	-	-
 <u>699-47-35</u>			
02-01-74	-	.028±.024	-
 <u>699-50-53</u>			
01-16-74	-	-	<.9
05-01-74	-	.440	<.54
07-09-74	-	.830	<.055
11-26-74	-	.063±.027	-

APPENDIX C

SPECIAL AND QUALITY ASSURANCE
ANALYSES FOR VARIOUS WELLS

APPENDIX C

SPECIAL AND QUALITY ASSURANCE ANALYSES FOR VARIOUS WELLS ANALYSIS BY BNW TECHNICAL ANALYSIS SECTION

Well/Sample Date	Nuclides					pCi/mℓ total B as ¹⁰⁶ Ru
	mg/ℓ NO ₃	pCi/mℓ ¹⁰⁶ Ru	pCi/mℓ ³ H	pCi/mℓ ¹³⁷ Cs	pCi/mℓ ⁶⁰ Co	
199-D8-3 6-13-74	7.	-	10.	<.02	<.02	<.08
6-13-74	7.	<.05	6.3	<.02		<.08
199-F5-4 6-18-74	.9	<.05	28.	<.02	<.03	<.075
199-F5-6 6-14-74	3.5	-	1.2±.66	<.02	<.02	<.08
199-F7-1 6-10-74	90.	-	4.6	<.03	<.03	<.08
199-N-4 6-11-74	6.	<.08	24.	<.02	.07±.03	<.075
699-S12-3 5-24-74	5.2	<.075	<.85	<.02	<.05	<.024
699-S11-E12A 12-3-74	-	<.18	2.3±.62	<.019	<.021	<.08
699-S3-25 12-3-74	-	.13±.13	<.53	<.023	<.022	<.075
699-2-3 12-3-74	-	<.12	59.	<.023	<.03	<.075

Well/Sample Date.	mg/l NO ₃	pCi/ml ¹⁰⁶ Ru	pCi/ml ³ H	pCi/ml ¹³⁷ Cs	pCi/ml ⁶⁰ Co	pCi/ml total B as ¹⁰⁶ Ru
659-8-32 5-9-74	7.	<.056	<.85	<.02	<.02	<.075
699-9-E2 5-29-74	3.	<.053	.83±.66	<.02	<.02	<.075
699-24-33 5-21-74	22.	<.05	410.	<.02	.C25±.025	.11
5-21-74	22.	<.05	410.	<.02	<.033	<.08
699-27-8 12-3-74	-	<.18	1200	<.03	.C74±.03	.17
699-32-70 5-22-74	17	<.05	60.	<.026	<.02	<.08
6-19-74	18	-	55.	<.026	<.032	<.075
6-20-74	14	-	28.	<.02	<.05	<.075
699-35-9 6-20-74	7	-	59.	<.023	<.025	<.075
699-42-12 12-3-74	-	<.11	310	<.019	<.039	<.08
699-43-42 5-16-74	2	<.05	420.	<.033	<.043	<.08
699-45-69 5-31-74	43	<.052	.56±.66	<.02	<.029	<.075
699-48-71 6-4-74	12	<.052	<.58	<.02	<.02	<.08
699-49-28 5-11-74	.5	<.05	<.68	<.03	<.02	<.075
6-6-74	.5	<.052	1.3±.66	<.02	<.02	<.075

Well/Sample Date	mg/l NO ₃	pCi/ml ¹⁰⁶ Ru	pCi/ml ³ H	pCi/ml ¹³⁷ Cs	pCi/ml ⁶⁰ Co	pCi/ml total B as ¹⁰⁶ Ru
699-53-47 5-16-74	.5	<.05	.85±.6	<.02	<.032	<.075
699-57-83 6-3-74	4.3	<.053	1x10 ³	<.02	.087±.029	.13
699-65-72 6-12-74	6.3	—	1.6±.66	<.02	<.02	<.08
699-56-103 6-11-74	1.	<.052	1.3±.66	<.02	<.02	<.08
699-68-105 6-6-74	.5	<.052	.66±.66	<.02	<.038	<.075
699-69-38 12-3-74	—	<.11	<.53	<.038	<.022	<.075
699-71-30 B 6-12-74	1.2	<.05	.66±.66	<.02	<.028	<.08
699-72-88 6-5-74	11.	<.051	15.	<.02	<.02	<.08
699-78-62 6-18-74	4.	<.05	<1.1	<.02	<.02	<.08
Han 19 5-30-74	3.	<.073	1.1±.66	<.022	<.02	<.08
5-30-74	11.	<.052	.66±.66	<.02	<.02	<.075
12-3-74		<.19	<.53	<.02	<.021	<.075
Han 24 5.7		<.05	<.75	<.022	<.024	<.075

QUALITY ASSURANCE ANALYSES FOR VARIOUS WELLS
ANALYSIS BY STATE OF WASHINGTON DEPARTMENT OF SOCIAL AND HEALTH SERVICES

Well/Sample Date	Nuclide (pCi/ml)			
	Gross Beta	^3H	^{106}Ru	^{60}Co
199-D8-3 6-13-74	.012	6.48	<.05	<.01
199-F5-6 6-27-74	.013	.39	<.05	<.01
199-F7-1 5-10-74	.008	4.09	<.05	<.01
199-K-19 6-27-74	.015	7.33	<.05	<.01
199-K-22 6-24-74	.04	2.82	<.05	<.01
699-S29-E12 5-74	.005	<.2	<.05	<.01
699-S12-3 5-10-74	.005	<.02	<.05	<.01
699-2-3 5-10-74	.01	43.9	<.05	<.01
699-17-5 5-16-74	.005	<.2	<.05	<.01
699-24-33 5-21-74	.035	392.	<.05	.025
699-32-70 6-20-74	.005	24.5	<.05	<.01
699-78-62 6-13-74	.005	<.2	<.05	<.01

APPENDIX C

RADIOCHEMICAL ANALYSES FOR VARIOUS WELLS SAMPLED NOVEMBER, 1974 ANALYSIS BY CENTRAL LABORATORY, U.S.G.S, SALT LAKE CITY, UTAH

(pCi/ml)	WELL 699- 2-3	WELL 699- 42-12	WELL 699- S11-E12 A	WELL 699- 27-8	WELL 699- 69-38	WELL 699- 53-25	WELL 699- 33-56	WELL 699- 49-55	WELL 699- HAN-19
³ H	46.	230.	<.48	880.	<.48	<.48	<.48	<.48	<.48
GROSS BETA (As ¹³⁷ Cs)	0.02	0.06	0.01	0.25	0.017	0.011	0.022	0.015	.007
¹³⁷ Cs	<3.x10 ⁻⁴	5.x10 ⁻⁴	<3.x10 ⁻⁴	<2.1x10 ⁻³	<3.x10 ⁻⁴	<3.x10 ⁻⁴	3.x10 ⁻⁴	3.x10 ⁻⁴	<3.x10 ⁻⁴
⁹⁰ Sr	<4.x10 ⁻⁴	<4.x10 ⁻⁴	<4.x10 ⁻⁴	<4.x10 ⁻⁴	6.x10 ⁻⁴	<4.x10 ⁻⁴	3.7x10 ⁻³	<4.x10 ⁻⁴	<4.x10 ⁻⁴
¹²⁹ I	<0.02	<0.01	<0.012	<0.012	<0.012	<0.012	<0.012	<0.012	<0.012
⁶⁵ Zn	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
¹²⁵ Sb	<0.015	<0.015	<0.015	≈0.015	<0.015	<0.015	<0.015	<0.015	<0.015
⁹⁹ Tc	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02

APPENDIX D

SPECTROCHEMICAL ANALYSES FOR VARIOUS
WELLS SAMPLED NOVEMBER 1974

APPENDIX D

Water Quality Results From Various Wells Sampled November 1974 Analysis by Central Laboratory, USGS, Salt Lake City, Utah

Quality Component		Well 699- 2-3	Well 699- 42-12	Well 699- Han-19	Well 699- S11-E12A	Well 699- 27-8	Well 699- 69-38	Well 699- S3-25	Well 699- 33-56	Well 699- 49-55
Alk, Tot (as CaCO ₃)	mg/l	126	118	138	126	119	258	125	167	94
Arsenic Diss	ug/l	14	8	10	12	9	3	8	5	11
Bicarbonate	mg/l	153	144	168	153	145	314	152	204	115
Bromide	mg/l	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
Calcium Diss	mg/l	44	41	31	39	56	72	51	42	55
Carbon Dioxide	mg/l	3.1	2.3	3.4	2.4	2.3	16	3.1	6.5	1.5
Carbonate	mg/l	0	0	0	0	0	0	0	0	0
Chloride Diss	mg/l	8.9	13	3.1	5.8	13	14	23	7.6	24
Chromium Diss	ug/l	0	0	0	0	0	0	10	0	0
Chromium Hexavalent	ug/l	3	6	0	0	3	0	0	0	0
Color		3	0	0	0	0	8	0	3	0
Conductivity	umhos/cm	418	440	321	352	486	704	513	429	601
Copper Dissolved	ug/l	8	2	2	8	1	3	12	9	1
Cyanide	mg/l	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00
Fluoride Diss	mg/l	0.3	0.4	0.4	0.3	0.2	0.1	0.5	0.3	0.3
Hardness Noncarb	mg/l	30	42	0	17	70	0	60	0	100
Hardness Total	mg/l	160	160	110	140	190	220	190	160	200
Hydroxide	mg/l	0	0	0	0	0	0	0	0	0
Iodide	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00
Iron Diss	ug/l	60	30	50	330	20	330	1600	2400	180
Iron Ferrous	ug/l	40	30	50	60	20	260	90	200	120
Magnesium Diss	mg/l	11	14	7.1	11	12	8.8	14	13	15
Nitr. NO ₂ As NO ₂ Dis	mg/l	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.03	0.00
Nitr. NO ₃ As NO ₃ Dis	mg/l	22	28	4.2	22	58	15	0.27	11	12
Nitrogen NH ₄ Asn Tot	mg/l	0.06	0.01	0.02	0.04	0.04	2.3	0.03	0.06	0.03
Nitrogen NO ₂ Asn Dis	mg/l	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00
Nitrogen NO ₃ Asn Dis	mg/l	5.0	6.4	0.95	4.9	13	3.4	0.06	2.4	2.8
NO ₂ + NO ₃ As N Diss	mg/l	5.0	6.4	0.95	4.9	13	3.4	0.06	2.4	2.8
PH		7.9	8.0	7.9	8.0	8.0	7.5	7.9	7.7	8.1
Phosphorus Tot As P	mg/l	0.02	0.01	0.03	0.05	0.02	1.5	0.06	0.02	0.08
Potassium Diss	mg/l	6.3	5.4	5.4	4.6	6.4	13	7.3	5.8	7.7
Residue Dis Calc Sum	mg/l	270	285	216	238	318	429	308	284	398
Residue Dis Ton/Aft		0.37	0.39	0.29	0.32	0.43	0.58	0.42	0.39	0.54
SAR		0.7	0.8	1.1	0.6	0.6	1.9	0.8	0.9	1.3
Selenium Diss	ug/l	3	3	1	1	2	0	1	2	1
Silica Diss	mg/l	35	39	37	39	36	23	28	39	36
Sodium Diss	mg/l	19	24	25	16	19	64	26	27	41
Sodium Percent		20	24	32	19	17	37	23	26	30
Sulfate Diss	mg/l	48	49	20	25	46	64	81	36	150
Turbidity (JTU)		1	1	1	1	1	1	3	9	10
Water Temp (DEG C)			17.5	17.5	17.5	16.5	14.5	18.5	—	—

APPENDIX D

SPECTROCHEMICAL ANALYSES FOR VARIOUS WELLS SAMPLED NOVEMBER, 1974
ANALYSIS BY CENTRAL LABORATORY, U.S.G.S, SALT LAKE CITY, UTAH

D-2.

Elements (ppb)	Well 699- 2-3	Well 699- 42-12	Well 699- S11-E12A	Well 699- 27-8	Well 699- 69-38	Well 699- 53-25	Well 699- 33-56	Well 699- 49-55
Aluminum	7	10	52	6	110	270	90	100
Barium	50	50	53	65	62	62	63	34
Beryllium	<.4	<.4	<.4	<.5	<.7	<.5	<.5	<.5
Bismuth	<2	<2	<2	<2	<3	<2	<2	<3
Boron	12	20	13	15	10	57	16	20
Cadmium	12	<6	10	<6	<10	<9	140	<10
Chromium	4	5	8	4	<3	10	9	<3
Copper	10	2	7	2	3	11	9	1
Cobalt	<2	<2	<2	<2	<3	<2	<2	<2
Gallium	<.6	<.6	<.5	<.7	<1	<.7	<.7	<.8
Germanium	<2	<2	<2	<2	<3	<2	<2	<3
Iron	70	20	500	14	340	3400	2200	260
Lead	10	2	17	4	10	30	30	<3
Lithium	5	7	5	5	16	8	7	6

Elements (ppb)	Well 699- 2-3	Well 699- 42-12	Well 699- S11-E12A	Well 699- 27-8	Well 699- 69-38	Well 699- 53-25	Well 699- 33-56	Well 699- 49-55
Manganese	<1	4	12	12	250	250	86	14
Molybdenum	5	5	2	2	5	8	8	13
Nickel	<2	<2	<2	<2	<3	4	3	<3
Silver	<.2	<.2	<.2	<.2	<.3	<.2	<.2	<.3
Strontium	200	260	180	250	400	160	180	250
Tin	<2	<2	<2	<2	<3	<2	<2	<3
Titanium	<2	<2	3	<2	10	20	5	7
Vanadium	10	10	10	8	<3	2	10	10
Zinc	10	10	30	120	50	30	400	<8
Zirconium	<3	<3	<3	<3	<5	<4	<3	<4

APPENDIX E

SUMMARY OF ^{129}I ANALYSES OF
HANFORD SITE WELL WATER

APPENDIX E

SUMMARY OF ^{129}I ANALYSES OF HANFORD SITE WELL WATER FROM BATTELLE REPORT DRAFT ON ^{129}I , ^{60}Co AND ^{106}Ru MEASUREMENTS ON WATER SAMPLES FROM THE HANFORD PROJECT ENVIRONS

(Data Extracted From Reference 6)

Well Designation	Date Sampled	^{129}I (pCi/l)	^{60}Co (pCi/l)	^{106}Ru (pCi/l)
299-E16-1P	3-29-74	9.5E-02	3.0E-02	5.5E-01
299-E16-1Q	3-29-74	2.7E-01	1.0E-01	5.7E-01
299-E16-1R	3-29-74	1.5E+00	7.8E-01	2.7E+00
299-E17-1	4-9-74	2.4E+01	2.0E+01	4.3E+01
299-E17-5	4-9-74	3.5E+01	9.3E+00	6.1E+01
299-E19-1	4-9-74	3.2E-03	5.4E-02	1.6E-01
299-E23-20	4-9-74	1.3E-01	9.1E-02	5.6E-01
299-E23-2P	4-9-74	6.0E-02	8.3E-02	3.1E-01
299-E23-2Q	4-9-74	1.1E-01	1.2E-01	6.1E-01
299-E24-7	4-9-74	8.0E-02	1.4E+00	4.2E-01
299-E25-4	3-29-74	2.7E+01	1.2E-01	8.9E+01
299-E25-5	3-29-74	2.2E+01	1.2E-10	5.4E+01
299-E25-11	3-29-74	1.1E+01	4.0E-01	6.7E+02
299-E25-12	3-29-74	1.7E+01	2.3E-01	6.4E+02
299-E26-1	4-9-74	5.5E-02	2.0E-02	1.9E-02
299-E28-18	4-9-74	7.0E+00	3.3E+00	2.0E+03
299-E28-21	4-9-74	9.9E+00	2.5E+00	1.9E+03
299-E23-1	4-9-74	5.3E-01	2.8E+02	1.5E+01
299-E33-3	4-9-74	4.7E-01	2.8E+03	2.3E+01
299-E33-24	4-9-74	2.3E-01	5.2E+02	1.1E+02
299-E33-25	4-9-74	2.3E-01	8.3E+02	4.0E+01

<u>Well Designation</u>	<u>Date Sampled</u>	<u>^{129}I (pCi/l)</u>	<u>^{60}Co (pCi/l)</u>	<u>^{106}Ru (pCi/l)</u>
299-E34-1	4-9-74	5.9E-02	2.4E-02	8.1E-02
299-W6-1	3-27-74	3.8E-01	6.6E+00	7.2E+00
299-W10-8	3-27-74	3.1E-02	1.2E+00	4.1E-02
299-W11-10	3-27-74	2.0E-01	9.2E-02	1.0E-01
299-W11-23	3-27-74	1.2E-01	2.3E+00	3.6E-03
299-W11-24	3-27-74	2.4E-01	2.0E+01	1.8+00
299-W15-2	3-27-74	8.0E-04	2.3E-02	6.6E-02
299-W15-4	3-27-74	2.7E-01	3.0E-01	1.3E+02
299-W18-3	3-27-74	2.1E-03	8.0E-02	1.9E-01
299-W19-1	3-27-74	1.1E-02	-4.4E-03	2.7E-01
299-W19-4	3-27-74	3.9E-02	9.4E-02	2.8E-01
299-W21-1	3-27-74	1.3E+02	2.8E+02	1.3E+04
299-W22-14 O	3-27-74	4.0E+01	1.3E+00	3.7E+02
299-W22-14 P	3-27-74	2.1E+01	1.1E-01	2.6E+01
299-W22-25	3-27-74	3.2E+00	7.2E-01	1.5E+02
299-W22-38	3-27-74	4.3E-03	1.8E-01	9.0E+01
699-S29-E12	5-21-74	1.3E-04	-2.7E-03	1.6E-03
699-9-E2	5-29-74	5.4E-05	1.5E-03	3.5E-03
699-17-5	5-17-74	3.4E-04	8.8E-04	-1.3E-03
699-19-43	3-26-74	1.5E-03	2.6E-02	8.7E-02
699-24-33	3-26-74	9.9E-01	1.3E+01	3.3E+00
	5-22-74	1.1E+00	2.7E+01	8.5E+00 (Unfiltered)
600-25-70	3-26-74	6.5E-03	1.1E-02	1.6E-01
699-26-15	3-27-74	2.0E+00	1.2E+02	2.0E+01
699-27-8	6-3-74	1.9E+00	8.7E+01	1.3E+01

<u>Well Designation</u>	<u>Date Sampled</u>	<u>^{129}I (pCi/ℓ)</u>	<u>^{60}Co (pCi/ℓ)</u>	<u>^{106}Ru (pCi/ℓ)</u>
699-28-40 0	3-26-74	9.3E-02	3.5E+00	5.8E-01
699-31-31 0	3-26-74	5.4E+00	5.5E+01	1.6E+01
699-31-65	3-26-74	3.9E-03	3.7E-02	7.9E-02
699-32-70	3-26-74	9.8E-03	-8.4E-04	2.4E-01
	6-20-74	1.6E-03	8.8E-04	7.0E-02
699-34-39 A	3-26-74	8.7E+00	4.2E+01	4.7E+01
699-35-78	3-26-74	5.9E-03	3.4E-02	-5.0E-03
699-37-43	3-26-74	2.9E-01	2.7E-02	-1.6E-01
699-38-70	3-26-74	2.9E+00	1.1E+00	3.6E+01
600-39-79	3-26-74	3.6E-03	4.7E-02	9.2E-02
699-40-62	3-26-74	4.3E-03	-1.8E-02	-4.1E-02
699-45-69	3-27-74	8.3E-03	-1.4E-02	2.5E-01
699-48-71	3-27-74	3.4E-03	7.8E-03	-1.1E-02
699-49-55	3-29-74	1.1E-02	2.8E-03	-3.7E-02
699-49-57	3-29-74	1.8E-01	2.0E+03	3.4E+01
699-49-79	3-26-74	1.8E-03	-2.2E-02	8.6E-02
699-50-53	3-29-74	4.1E-02	5.9E+02	1.7E+00
699-53-103	5-10-74	5.4E-06	-2.0E-04	4.8E-05

DISTRIBUTIONNo. of
CopiesNo. of
CopiesOFFSITE

A. A. Churm
ERDA Chicago Patent Group
9800 S. Cass Avenue
Argonne, IL 60439

D. H. Slade
ERDA Div. of Biomedical
and Environmental Research
Washington, DC 20545

A. A. Schoen
ERDA Division of Operational
Safety
Washington, DC 20545

W. R. Wright, Jr.
ERDA Division of Nuclear
Fuel Cycle and Production
Washington, DC 20545

27 ERDA Technical Information Center

5 C. V. Smith
EPA Region X
1200 Sixth Avenue
Seattle, WA 98101

M. W. Lammering
EPA Office of Water Programs
5555 Ridge Avenue
Cincinnati, OH 45213

R. C. Scott
EPA Office of Water Programs
760 Market Street
San Francisco, CA 94102

C. Hall
Washington State Dept. of Social
and Health Services
Smith Tower
Seattle, WA 98104

T. Strong
Washington State Dept. of Social
and Health Services
Smith Tower
Seattle, WA 98104

Battelle Memorial Institute
Columbus, OH

ONSITE

7 ERDA Richland Operations Office

O. J. Elgert
R. L. Ferguson
J. A. Fernandez
P. G. Holsted
P. G. Rhoades
J. L. Rhoades
M. W. Tiernan

9 Atlantic Richfield Hanford

G. E. Backman
D. J. Brown
R. A. Deju
R. E. Gephart
G. L. Hanson
R. E. Isaacson
K. R. Price
B. J. Saueressig
ARHCO File

1 Hanford Environmental Health
Foundation

R. G. Anderson

No. of
Copies

5 United Nuclear Industries, Inc.

T. E. Dabrowski
A. E. Engler
N. R. Miller
W. G. Westover
UNI File

2 Washington Public Power Supply
System

F. E. Owen
D. D. Tilson

3 Westinghouse-Hanford Company - HEDL

R. O. Budd
F. D. Collins
R. B. Hall

32 Battelle-Northwest

D. B. Cearlock
J. P. Corley
J. R. Eliason (10)
J. J. Fix
L. J. Kirby
H. V. Larson (10)
D. A. Myers
J. R. Raymond
J. H. Soehnlein
C. M. Unruh
Technical Information (3)
Technical Publications