2:1
WSRC-TR-93-526
Rev 0
July 1993

Results of the Fourth Quarter Tritium Survey of the F- and H-Area Seeplines: March 1993 (U)

K. L. Dixon and V. A. Rogers

Prepared for the U.S. Department of Energy under contract no. DE-AC09-89SR18035

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED JFD

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.

This report has been reproduced directly from the best available copy.

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, P. O. Box 62, Oak Ridge, TN 37831; prices available from (615) 576-8401.

Available to the public from the National Technical Information Service, U. S. Department of Commerce, 5285 Port Royal Rd., Springfield, VA 22161

Results of the Fourth Quarter Tritium Survey of the F- and H-Area Seepines: March/April 1993

K. L. Dixon and V. A. Rogers

Abstract

The Environmental Sciences Section (ESS) established a quarterly monitoring program of the Four Mile Creek seepine down gradient from the F- and H-Area seepage basins. The program surveys and tracks changes in tritium, specific conductivity, and pH for the seepine water. Measurements from the fourth quarter survey (March/April 1993) showed lower tritium and conductivity measurements and higher pH values (pH 5 - 6) than measurements from previous studies. The results of the first four quarterly surveys suggest that infiltration of rainfall may be diluting and flushing the contaminants from the groundwater system. More measurements are needed to confirm these trends.

Executive Summary

In March/April 1993 the Environmental Sciences Section (ESS) surveyed the Four Mile Creek seepine down gradient from the F- and H-Area seepage basins for tritium, specific conductivity, and pH. The survey was the fourth of eight quarterly surveys for monitoring the movement of contaminants from the basins since closure. Surface-water samples were collected from 60 locations along the seepine; Haselow et al. (1990) sampled 44 of the locations, 16 were on the seepine south of 643-E, which is a decommissioned area in the Solid Waste Disposal Facility. Samples were collected from 3 locations along Four Mile Creek.

Results indicate that rainfall may be diluting the contaminant plume that leached from the seepage basins and flushing the contaminant plume out of the shallow groundwater in the wetland systems below the basins. ESS found tritium activities in the F- and H-Area seepines significantly lower than the activities measured by Haselow et al. (1990). Conductivity measurements exhibited the same trends as tritium activities in both areas, indicating that salt ions are also being removed from the wetland system. Concentrations of hydrogen ions also decreased in both areas, which indicates that conditions are changing from very strongly acidic to slightly acidic (pH 5 - 6), which is normal for these wetlands.

The seepine south of 643-E, along a tributary of Four Mile Creek, is influenced by tritium from the burial grounds. The tributary is a natural drainage that was used

to discharge effluent from F-Area separations prior to the construction of the engineered effluent canal. Tritium activities ranged from 37 to 682 pCi/ml on the east side of the drainage and from 29 to 44,000 pCi/ml on the west side. The tritium concentration measured in the stream of the natural drainage was 12,000 pCi/ml. Results suggest that the tritium outcrop area has been encapsulated by the sampling locations established on the west side of the drainage. Conductivity and pH measurements taken on both sides of the drainage were similar and were within the range of normal values for the area. The low conductivity values measured along the drainage way suggest that the tritium plume outcropping in the area emanates from 643-E since wastes introduced into 643-E contained low levels of salt ions compared to the waste in the F- and H-Area basins.

The results suggest that contaminant concentrations are decreasing at the F- and H-Area seepines and are consistent with results from previous quarters (Dixon and Rogers, 1992; Dixon and Rogers 1993a and b). Areas of stressed vegetation are showing signs of recovery as contaminant concentrations decrease and pH increases. Aluminum concentrations measured along the seepine in 1989 (Haselow et al., 1990) were high enough to be potentially toxic to plants. Increases in pH (to about neutral) will reduce the solubility of aluminum and thereby reduce this as a possible source of plant toxicity. Concentrations of aluminum, as well as other metals, measured along the seepine in July 1992 were substantially lower than 1989 concentrations reflecting the increase in pH (Dixon and

Rogers, 1993c). Field observations of the stressed areas has revealed that vegetation in most is recovering.

Introduction

Seepage basins in the F and H Area of SRS received low-level radioactive-waste effluent from the chemical separation processes in the general separation areas. The basins retained the effluent to delay its release to the environment. The waste effluent consisted principally of sodium hydroxide, nitric acid, low levels of various radionuclides, and some metals (Killian et al., 1985a and 1985b). Discharges of tritiated water to the seepage basins accounted for most of the radioactivity (Fenimore and Horton, 1972).

The Savannah River Laboratory (now the Savannah River Technology Center) conducted an extensive study aimed at characterizing the shallow groundwater outcropping into Four Mile Creek and its associated seepage line in 1988 and 1989 (Haselow et al., 1990). As a part of this study, Haselow et al. (1990) surveyed for tritium, pH, and conductivity. Researchers measured low pH values, elevated conductivity, and tritium values along the seep lines and determined that contaminants leaching from the F- and H-Area seepage basins were impacting the areas.

SRS stopped discharges to the seepage basins in 1988 and capped and sealed the basins in 1990 to reduce the release of the contaminants. Scientists hypothesized that after eliminating the contaminant source, annual rainfall amounts and natural groundwater flow would dilute and flush the remaining contaminant plume out of the shallow groundwater over time. After the contaminant plume in the shallow groundwater is diluted and flushed out, the wetland systems below the basins will recover.

To investigate this hypothesis, a quarterly sampling program was established. ESS sampled 44 of the seepage locations sampled by Haselow et al., (1990) for tritium, pH, and specific conductivity. The Haselow et al. (1990) results established the baseline to which the results from this study were compared. It was chosen as the baseline since it was the only data available that was collected during the time frame that basin discharges were discontinued. The Haselow et al. (1990) data should be representative of conditions during normal operation. This sampling program is intended to complement semiannual sampling of the seepage line for selected Resource Conservation Recovery Act Appendix IX characterization, which began in July 1992. A draft report summarizing results from the semiannual sampling program has been completed (Dixon and Rogers, 1993c).

The Environmental Protection Department expressed concern about possible seepage of tritium and other contaminants from 643-E. To investigate this possibility, several locations on the H-Area seepage line south of 643-E were established and have been incorporated into the quarterly sampling plan.

Methods

ESS conducted the fourth round of sampling in the quarterly tritium survey in late March and early April 1993. Sampling locations were selected that, according to 1989 data, exhibited high and low values for the three variables of concern. Attempts were made to establish even ground coverage along both seep lines. ESS collected 60 samples along the seep lines in F and H Area: 22 along the F-Area seepage line, 22 along the H-Area seepage line, 16 locations on the FHB seepage line south of 643-E, and 3 locations on Four Mile Creek. Figures 1 and 2 show the sampling locations.

Prior to sampling for the first quarter, the Health Protection Department (HPD) collected and monitored soil samples from several locations along both seep lines for gamma radioactivity. HPD did not detect measurable levels of gamma radiation, and protective clothing was chosen based on the findings. During sampling operations in the seepage areas, protective clothing consisted of rubber boots and disposable rubber gloves. These measures were intended to prevent dermal contact with seepage water.

Seepage sampling locations were marked and labeled previously with PVC stakes. Water samples were collected within a 3-ft radius of the PVC stake by boring a hole into the soil with a 3.5 in. soil auger until water was reached. Polyethylene sample containers (25 ml) were dipped into the water until full and then capped to collect water for tritium analysis. The outside of each container was then rinsed with deionized water and sealed in a small polyethylene bag to minimize the possibility of contamination. The small bags were then placed in a large polyethylene bag, which was sealed for analysis. The Environmental Monitoring Section (EMS) performed tritium analysis. EMS counted aliquots of 5 ml for 20 minutes, which yielded a lower detection limit of 1.3 pCi/ml (WSRC-3Q1-4, 1992).

ESS measured specific conductivity and pH in situ with conductivity and pH electrodes (WSRC-L14.1, 1992a and 1992b). The electrodes were rinsed with deionized water after each sampling and all sampling equipment was thoroughly rinsed with water at the end of each day.

Results and Observations

Concentrations of variables measured at seepage sampling locations fluctuate throughout the year. Climate, especially rainfall, influences measured concentrations. Low rainfall for a few months prior to sampling could concentrate constituents, and high rainfall amounts could dilute the constituents in the shallow groundwater at the seepage intercept. Rainfall measured at SRS at the weather station in F Area from January through March 1993 was 57.07 cm. The average rainfall from January 1960 to December 1991 for F Area was 35.89 cm. This indicates that for the fourth quarter tritium survey, rainfall amounts in F and H Areas are above normal. This should be considered when interpreting the survey results.

Figures 3 through 8 show comparisons of 1989, December 1992, and March/April 1993 tritium, conductivity, and pH measurements; data for the first and second quarter surveys can be found in Dixon and Rogers (1992 and 1993a). Figures 9 through 11 show the data for the locations on the seepage south of 643-E in H Area. These sampling locations were assigned the identification prefix FHB. Figures 12 through 14 show the data for the FMC locations.

Tritium Measurements

F Area

Tritium values in the F-Area seepage line ranged from 23 to 8060 pCi/ml (see Table 1 and Figure 3). Of the 22 sampling locations in F Area, none had tritium activities elevated above background that exceeded the 1989 measurements by more than 10%. No values exceeded the maximum value recorded in 1989 of 14,000 pCi/ml. The graphs in Figure 3 show that the tritium activity in most sampling locations either decreased significantly or remained relatively unchanged. These results are generally consistent with results from previous quarters.

To investigate the hypothesis that the March 1993 tritium activities are significantly less than in 1989, ESS conducted a Wilcoxon signed-rank test. The Wilcoxon signed-rank test uses the sign and the magnitude of the rank of the differences between pairs of measurements to compare nonparametric data (Daniel, 1978). This test was chosen because it allows comparisons of paired data without assumptions of normality. The results showed that the March/April 1993 concentrations were significantly less ($P=0.005$) than the 1989 concentrations.

Generally, the locations with the greatest decrease in tritium activity are closest to the seepage basins. In contrast, those further away show little change or even an increase

in tritium activities. These changes indicate that the bulk of the tritium plume in the wetland system has passed the locations closest to the seepage basins and is exiting the wetland system at the points closest to Four Mile Creek. This supports the general hypothesis that annual rainfall amounts would dilute the remainder of the contaminant plume emanating from the seepage basins. Due to the complex hydrologic system present in the basin areas, it is inappropriate to draw final conclusions at this point in the study about why tritium activities are exhibiting these trends. Final conclusions should not be drawn until after further sampling has been completed and seepage data has been compared to groundwater data.

H Area

Tritium values in the H-Area seepage line ranged from 83 to 7920 pCi/ml (see Table 2 and Figure 4). Of the 22 sampling locations, none had tritium activities elevated above background that exceeded the 1989 measurements by more than 10%. The graphs in Figures 5 and 6 show that most locations have either decreased or have remained relatively unchanged. These results are generally consistent with the first and second quarter results.

To investigate the hypothesis that March 1993 tritium activities are significantly less than in 1989, ESS conducted a Wilcoxon signed-rank test. This test was chosen because it allows comparisons of paired data without assumptions of normality (Daniel, 1978). The results showed that the March 1993 concentrations were significantly less ($P=0.001$) than the 1989 concentrations.

ESS found the tritium activities in H-Area sampling locations nearest to the seepage basin exhibited the greatest decrease. The activity at locations further away had a less significant decrease or increased. These changes indicate that the bulk of the tritium plume in the wetland system has passed the locations closest to the seepage basins and is exiting the wetland system at the points closest to the creek. Again, due to the complex hydrologic system present in the basin areas, it is inappropriate to draw final conclusions at this point in the study about why tritium activities are exhibiting these trends. Final conclusions should not be drawn until after further sampling has been completed and seepage data has been compared to groundwater data.

Conductivity Measurements

F Area

Conductivity measurements in the F-Area seepage line ranged from 30 to 1548 $\mu\text{S}/\text{cm}$ (see Table 1 and Figure 5). Due to

the extreme variability of conductivity measurements, ESS only considered differences of 100 $\mu\text{S}/\text{cm}$ or more to be significant. Of the 22 sampling locations in the F-Area seepage line, only 2 had measurements of more than 100 $\mu\text{S}/\text{cm}$ above the 1989 measurements; both locations exhibited elevated tritium concentrations. A comparison of the graphs in Figures 3 and 5 suggests that conductivity follows the same general trends as the tritium activities. Using a Spearman rank correlation test for nonparametric data, it was found that the probability that tritium and conductivity exhibited independent trends was $P < 0.001$. The rank correlation coefficient was found to be $r_s = 0.89$, suggesting that the two parameters are exhibiting the same trends. This similarity was expected because tritium traces the movement of the contaminant plume from the basins (Haselow et al., 1990). These results suggest that the salt ions are also exiting the wetland system in F Area.

H Area

Conductivity measurements in the H-Area seepage line ranged from 33 to 340 $\mu\text{S}/\text{cm}$ (see Table 2 and Figure 6). None of the 22 sampling locations had measurements of more than 100 $\mu\text{S}/\text{cm}$ above the 1989 measurements. Observation of Figures 4 and 6 suggest that conductivity and tritium are following the same general trends. The Spearman rank correlation test for nonparametric data was used to investigate the correlation of H-Area tritium activities and conductivity values. Again, it was found that the probability that the two parameters exhibited independent trends was $P < 0.001$. The rank correlation coefficient ($r_s = 0.87$) for H Area was slightly lower than in F Area, but still suggested a strong correlation.

pH Measurements

F-Area pH values ranged from 3.4 to 6.1 with an average value of 5.0 (Table 1 and Figure 7). H-Area pH values ranged from 4.7 to 6.6 with an average of 5.9 (Table 2 and Figure 8). The pH for the entire seepage line (F and H Areas combined) averaged 5.5. The average increased 0.6 units over the 4.9 average in 1989 (Haselow et al., 1990). While the average pH remains in the acidic range, the fourfold decrease in hydrogen ion concentration further indicates that the contaminant plume is exiting the system. The decrease in hydrogen ion concentration has ranged from four to fivefold compared to 1989 measurements in each of the past four surveys. The increase in pH will affect the solubility of metals in the soil which will enhance the recovery of wetlands potentially stressed indirectly by low pH. Aluminum concentrations measured along the seepage line in 1989 (Haselow et al., 1990) were high enough to be potentially toxic to plants. Increases in pH (to about neutral) will reduce the solubility of aluminum and

thereby reduce this as a possible source of plant toxicity. Concentrations of aluminum, as well as other metals, measured along the seepage line in July 1992 were substantially lower than 1989 concentrations reflecting the increase in pH (Dixon and Rogers, 1993c). Field observations of the stressed areas has revealed that vegetation in most is recovering.

Four Mile Creek

Figures 9 through 11 show the tritium, conductivity, and pH values for the Four Mile Creek sampling locations, and Table 3 provides the data used in the figures. Tritium activities at these locations ranged from 47 to 425 pCi/ml suggesting that seepage from the basins is impacting the stream. Conductivity measurements ranged from 40 to 56 $\mu\text{S}/\text{cm}$ and pH ranged from 6.29 to 6.33. Both conductivity and pH values are at near normal levels.

Solid Waste Disposal Facility (643-E Old Burial Ground) Seepage Line Results

The graphs in Figures 12 through 14 show tritium, conductivity, and pH values for the seepage line and stream sampling locations south of 643-E, which is part of the Solid Waste Disposal Facility. Table 4 provides the data used in the figures. This seepage line is along the natural drainage that was used to discharge effluent from F-Area separations prior to the construction of the engineered effluent canal. In addition to the locations on the east side of the drainage sampled in previous surveys, several new seepage line sampling locations were established on the west side to enhance the resolution of sampling in this area. Also, sampling of some locations that exhibited background tritium activities in previous surveys was discontinued.

Tritium activities for the locations on the east side of the drainage ranged from 37 to 682 pCi/ml. Activities on the west side of the drainage ranged from 29 to 44,000 pCi/ml. The tritium activity at the stream location in the drainage (FHB012) was 12,000 pCi/ml.

Conductivity measurements for locations on both sides of the drainage were near background and ranged from 29 - 185 $\mu\text{S}/\text{cm}$. No correlation ($r_s = 0.30$) was found to exist between conductivity and tritium for these locations using the Spearman rank correlation test. Values of pH ranged from 4.4 to 6.2 with an average of 5.5.

These results are consistent with the Haselow et al. (1990) results for the western portion of the H-Area seepage line, particularly near location HSP103. Haselow et al. (1990) found that conductivity values down gradient of 643-E were near background while tritium concentrations were

elevated. This was attributed to tritiated wastes deposited in 643-E. Tritium activities measured along the seepage down gradient of 643-E (particularly those on the west side) suggest that tritium migrating from 643-E and outcropping in this area is substantial. The appearance of tritium on the west side as opposed to the east side of the drainage suggests that soil material placed in the northern reaches of the natural drainage is impacting the local hydrology. It appears that the groundwater and tritium are moving below the fill material and outcropping on the west side of the drainage. The results suggest that the sampling locations on the west side of the drainage have encapsulated the tritium outcrop area with the center located at or near FHB018.

Conclusions

Results from the fourth quarter tritium survey indicate that the contaminant plume migrating from the F- and H-Area seepage basins is beginning to exit the wetland system down gradient from the basins. These results are consistent with results from previous quarters. ESS attributes this to the closure and capping of the basins, which eliminated the hydraulic head driving the contaminants out of the basin, thereby eliminating the source of the contaminants. WSRC scientists hypothesized that after the basins were capped, annual rainfall amounts would dilute and flush out the remaining contaminant plume. Results from each of the past four tritium surveys appear to support this hypothesis; however, due to the complex hydrologic system present in the basin areas, it is inappropriate to draw final conclusions at this point in the study. Additional collections of seepage data combined with groundwater data will be used to fully assess the trends.

Evaluation of data from several seepage locations south of the 643-E facility indicates that tritium migrating from 643-E is outcropping at the natural drainage in the area, particularly on the west side. It appears that sampling locations on the west side of the drainage have delineated the tritium outcrop area.

References

- Daniel, W.W. 1978. Applied Nonparametric Statistics. Houghton Mifflin Company, Boston, MA.
- Dixon, K.L. and V.A. Rogers. 1992. Results of the First Quarter Tritium Survey of the F- and H-Area Seepages: May 1992. WSRC-TR-92-304, Westinghouse Savannah River Company, Savannah River Technology Center, Aiken, SC.
- Dixon, K.L. and V.A. Rogers. 1993a. Results of the Second Quarter Tritium Survey of the F- and H-Area Seepages: September 1992. WSRC-TR-93-129, Westinghouse Savannah River Company, Savannah River Technology Center, Aiken, SC.
- Dixon, K.L. and V.A. Rogers. 1993b. Results of the Third Quarter Tritium Survey of the F- and H-Area Seepages: December 1992. WSRC-TR-93-284, Westinghouse Savannah River Company, Savannah River Technology Center, Aiken, SC.
- Dixon, K.L. and V.A. Rogers. 1993c. Semi-Annual Sampling of Fourmile Branch and its Seepages in the F and H Areas of SRS: July 1992. WSRC-TR-93-289, Westinghouse Savannah River Company, Savannah River Technology Center, Aiken, SC.
- Fenimore, J.W. and J.H. Horton. 1972. Rating History and Environmental Effects of Seepage Basins in Chemical Separations Areas of the Savannah River Plant. DPST-72-548, E.I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, SC.
- Haselow, J.S., M. Harris, B.B. Looney, N.V. Halverson, and J.B. Gladden. 1990. Analysis of Soil and Water at the Four Mile Creek Seepage Near the F and H Area of SRS (U). WSRC-RP-90-0591, WSRC-TR-92-304, Westinghouse Savannah River Company, Savannah River Technology Center, Aiken, SC. Savannah River Laboratory, Aiken, SC.
- Killian, T.H., N.L. Kolb, P. Corbo, and I.W. Marine. 1985a. F-Area Seepage Basins. DPST-85-704, E.I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, SC.
- Killian, T.H., N.L. Kolb, P. Corbo, and I.W. Marine. 1985b. H-Area Seepage Basins. DPST-85-706, E.I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, SC.
- WSRC-3Q1-4. 1992. Determination of Tritium in Water. Procedure 2760, Rev 0. Westinghouse Savannah River Company, Aiken, SC.
- WSRC-L14.1. 1992a. Procedure for Cole-Parmer Portable Conductivity Meter Model 1481-40. Procedure 2-79, Rev 1. Westinghouse Savannah River Company, Aiken, SC.
- WSRC-L14.1. 1992b. Procedure for Cole-Parmer Model 5985-80 pH Meter. Procedure 2-81, Rev 1. Westinghouse Savannah River Company, Aiken, SC.

Figure 3. Comparison of March 1989, December 1992, and March 1993 Tritium Concentrations for selected F-Area Seepage Locations

Figure 4. Comparison of March 1989, December 1992, and March 1993 Tritium Concentrations for selected H-Area Seepage Locations

Figure 5. Comparison of March 1989, December 1992, and March 1993 Conductivity Measurements for selected F-Area Seepage Locations

Figure 6. Comparison of March 1989, December 1992, and March 1993 Conductivity Measurements for selected H-Area Seepage Locations

Figure 7. Comparison of March 1989, December 1992, and March 1993 pH Measurements for selected F-Area Seepage Locations

Figure 8. Comparison of March 1989, December 1992, and March 1993 pH Measurements for selected H-Area Seepage Locations

Figure 9. Comparison of December 1992 and March 1993 Tritium Concentrations for Selected Locations on the Seep Line South of 643-E

Figure 10. Comparison of December 1992 and March 1993 Conductivity Measurements for Selected Locations on the Seep Line South of 643-E

Figure 11. Comparison of December 1992 and March 1993 pH Measurements for Selected Locations on the Seep Line South of 643-E

Figure 12. December 1992 and March 1993 Tritium Measurements for selected Four Mile Creek Locations

Figure 14. December 1992 and March 1993 pH Measurements for selected Four Mile Creek Locations

Figure 13. December 1992 and March 1993 Conductivity Measurements for selected Four Mile Creek Locations

Tables

Table 1. Comparison of F-Area Seepage Measurements of Tritium, Conductivity, and pH in March 1989, September 1992, and December 1992

Location	Tritium (pCi/mL)			Conductivity (μ S/cm)			pH (- log H)		
	Mar 89	Dec 92	Mar 93	Mar 89	Dec 92	Mar 93	Mar 89	Dec 92	Mar 93
2	520	161	98	94	61	67	5.6	6.0	5.4
7	3400	1039	680	681	200	145	5.4	5.6	5.3
12	260	15	27	30	65	37	5.3	6.1	5.1
14	14000	334	165	666	104	136	4.2	4.4	4.2
19	4900	5908	1620	1424	1060	344	4.2	4.1	3.9
26	4400	5332	4830	1095	1080	1210	6.5	6.6	6.0
32	3600	263	65	174	92	74	5.0	4.7	4.3
34	14000	4212	965	810	542	219	3.8	4.0	3.8
35	11000	10906	8050	1100	1298	1084	3.9	4.1	3.4
40	7800	6519	8060	900	949	1548	5.2	4.2	3.5
47	100	24	26	52	n/a	81	4.7	5.8	5.5
56	19	13	23	34	66	66	4.5	5.7	5.4
204	3000	861	867	895	129	263	4.4	5.6	5.9
213	2800	1470	3060	860	223	539	4.6	5.5	4
220	560	625	423	147	110	79	4.8	5.5	6.4
226	1300	1200	825	306	270	220	5.1	5.3	5.6
235	580	472	329	84	63	63	5.7	6.0	5.9
241	560	270	106	36	62	68	4.7	5.6	5.9
249	580	114	43	84	39	47	4.4	5.2	5.1
256	400	293	402	56	46	102	5.1	6.3	5.8
270	40	33	27	50	24	32	4.1	5.2	5.2
290	35	35	54	49	33	30	3.6	5.1	5.6

Table 2. Comparison of H-Area Seepage Measurements of Tritium, Conductivity, and pH in March 1989, September 1992, and December 1992

Location	Tritium (pCi/mL)			Conductivity (μS/cm)			pH (- log H)		
	Mar 89	Dec 92	Mar 93	Mar 89	Dec 92	Mar 93	Mar 89	Dec 92	Mar 93
3	14000	4067	2450	468	209	214	5.2	6.5	6.5
4	11000	2485	1300	292	243	153	5.8	6.5	6.6
8	24000	8611	6320	556	355	290	5.7	6.2	6.2
11	960	339	238	80	57	49	5.1	5.7	5.7
13	12000	5294	1690	592	335	138	6.2	6.6	6.3
15	1000	659	466	82	55	50	5.2	5.6	5.5
20	6500	1037	550	183	99	78	6.2	6.2	5.9
25	3300	2272	2440	135	89	72	4.7	5.5	5.8
29	9200	1335	529	257	120	85	5.2	5.5	5.7
34	5600	649	1070	331	194	132	5.8	6.1	6.0
38	6500	264	136	227	165	73	4.9	6.4	5.9
43	10000	2678	3850	413	156	156	5.3	6.3	6.1
46	11000	7140	7110	318	217	250	5.5	6.1	5.9
49	11000	7589	6150	551	204	171	4.4	6.3	6.4
52	20000	12396	7920	699	391	340	4.1	5.9	6.5
57	15000	2026	791	581	144	98	5.5	5.9	6.1
60	21000	229	631	473	186	150	5.9	6.1	6.1
64	320	107	83	38	46	39	4.7	5.5	5.3
71	450	283	194	40	41	33	5.1	5.7	5.7
76	400	414	91	146	123	60	5.7	6.3	5.4
97	1100	3692	1060	37	163	59	4.3	5.8	5.7
103	510	445	311	43	36	39	4.4	5.0	4.7

Table 3. Comparison of Seepage Below 643-E Measurements of Tritium, Conductivity, and pH in September 1992 and December 1992

Location	Tritium (pCi/mL)		Conductivity (μS/cm)		pH (- log H)	
	Dec 92	Mar 93	Dec 92	Mar 93	Dec 92	Mar 93
1	178	387	53	60	5.4	5.8
2	20	37	36	40	5.6	5.2
3	871	682	46	52	5.5	5.7
4	658	175	44	51	5.0	4.8
5	464	263	35	29	5.5	5.4
6	151	217	37	45	5.6	5.5
8	161	134	29	29	5.2	5.2
9	37	—	—	—	—	—
10	19	—	—	—	—	—
11	428	—	—	—	—	—
12	16617	12000	—	37	—	5.4
13	13587	2860	—	47	—	5.1
14	1700	1150	—	77	—	5.3

Table 4. Four Mile Creek Measurements of Tritium, Conductivity, and pH in December 1992

Location	Tritium (pCi/mL)		Conductivity (μ S/cm)		pH (-log H)	
	Dec 92	Mar 93	Dec 92	Mar 93	Dec 92	Mar 93
1F	455	425	68	56	6.2	6.3
1H	55	47	55	46	6.6	6.4
2H	2050	104	61	40	6.7	6.3

END

DATE

FILMED

3/24/94