WSRC-TR-95-0369

Results of the Quarterly Tritium Survey of Fourmile Branch and Its Seeplines in the F and H Areas of SRS: May 1995

by

J. W. Koch

Westinghouse Savannah River Company
Savannah River Site
Aiken, South Carolina 29808

K. L. Dixon

DOE Contract No. DE-AC09-89SR18035

DISCLAIMER

744077

WSRC-TR-95-0369
Rev 0

Results of the Quarterly Tritium Survey of Fourmile Branch and its Seeplines in the F- and H-Areas of SRS: May 1995 (U)

Westinghouse Savannah River Company
Savannah River Site
Aiken SC 29808

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

WSRC-TR-95-0369
Rev 0
May 1995

Results of the Quarterly Tritium Survey of Fourmile Branch and its Seeplines in the F-and H-Areas of SRS: May 1995 (U)

J. W. Koch II and K. L. Dixon

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

Results of the Quarterly Tritium Survey of Fourmile Branch and its Seeplines in the F and H Areas of SRS: May 1995

J. W. Koch II and K. L. Dixon

Abstract

The Environmental Sciences Section (ESS) of the Savannah River Technology Center (SRTC) established a quarterly monitoring program of the Fourmile Branch (FMB) stream and its associated seepline located down gradient from the F- and H-Area Seepage Basins. The primary focus of this program was to survey and track changes in tritium levels; however, specific conductivity, and pH were also surveyed and tracked. The measurements from the eleventh survey (May 1995) exhibited similar tritium levels, conductivity measurements, and pH values to data from previous sampling events. The overall results of the tritium survey and stream monitoring data (Looney et al., 1993) indicate that the tritium plume resulting from the past operation of the seepage basins continues to flush from the Fourmile Branch wetland system.

Executive Summary

In May 1995 the Environmental Sciences Section (ESS) surveyed the Fourmile Branch seepline down gradient from the F- and H-Area Seepage Basins for tritium, specific conductivity, and pH. The survey was the eleventh quarterly survey scheduled to monitor the movement of contaminants from the basins since closure in 1990. Surface-water samples were collected from 60 locations along the seepline and from three stream locations along Fourmile Branch. The seepline locations included 22 from F Area, 22 from H Area, and 16 from the seepline south of 643-E, which is a decommissioned area in the Solid Waste Disposal Facility. Forty-four of the locations were sampled in 1989 by the Savannah River Laboratory (now Savannah River Technology Center) as part of an extensive characterization study (Haselow et al. 1990). ESS found that tritium activities in both F- and H-Area seeplines in May 1995 were significantly lower than the activities measured by Haselow et al. (1990). Eight locations showed a significant increase in tritium activity above the March 1989 results.

Previous sampling events have consistently shown a declining trend in tritium activity at the F-and H-Area seepline. Total tritium fluxes to the wetlands and FMB have steadily declined since basin closure (Looney et al., 1993) and overall results from this tritium survey continue to support this finding. Differences in tritium activities measured at individual seepline sampling locations from one sampling event to the next represent seasonal variability in the depth to water table, amounts of rainfall, and changes due to the flushing of the plume from the wetland system. Conclusions about tritium fluxes to the wetlands and FMB should consider the long-term surface water, seepline, and groundwater monitoring data and not rely on quarterly changes in concentrations at seepline monitoring stations alone.

May 1995 conductivity measurements exhibited the same general trends as tritium activities in both F and H Areas. Concentrations of hydroxide ions increased in both areas. This indicates that conditions are changing from extremely acid (pH < 4.5) to slightly acid (pH 5.1 - 6.7), which is closer to normal for this type of wetland. Aluminum concentrations measured along the seepline in 1989 (Haselow et al., 1990) were elevated enough to be potentially toxic to plants. An increase in pH reduces the solubility of aluminum and thereby decreases the potential for aluminum toxicity to plants. Concentrations of aluminum, as well as other metals, measured along the seepline in July 1992 were substantially lower than 1989 concentrations reflecting the increase in pH (Dixon and Rogers, 1993c). Field observations have revealed that vegetation in all areas is showing noticeable recovery, (Nelson and Irwin, 1994).

The seepline south of 643-E, along a tributary of Fourmile Branch, is influenced by tritium migrating from the Burial Ground Complex. The tributary (old F-Area effluent ditch) is a natural drainage that received effluent discharge from F-Area Separations prior to the construction of the engineered effluent canal. The May 1995 tritium activities on the east side of the drainage ranged from 25 to 774 pCi/ mL and on the west side from 134 to 23,900 pCi/mL. The tritium activity measured in the stream of the natural drainage was 20,600 pCi/mL. These results suggest that the tritium outcrop area has been delineated by the sampling locations established on the west side of the drainage channel. As the tritium activity shifts slightly among sample locations there has been no indication that a reduction in overall tritium activity is occurring. Conductivity and pH measurements taken on both sides of the drainage were similar to those recorded in December 1994 and were within the range of normal values for this wetland. The low conductivity values measured along the drainage way suggest that the tritium plume outcropping in the area emanates from 643-E because wastes introduced into 643-E contained low levels of salt ions compared to the waste in the F-and H-Area Seepage Basins.

Introduction

Seepage basins in the F and H Areas of SRS received low-level radioactive waste effluent from the chemical separation processes in the General Separation Area, (GSA). The basins retained the effluent and allowed it to be slowly release into the soil. 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 a majority of the radioactivity (Fenimore and Horton, 1972).

The Savannah River Laboratory (now the Savannah River Technology Center) conducted an extensive study designed to characterize the shallow groundwater outcropping into Fourmile Branch (FMB) and its associated seepline 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 found low pH and elevated conductivity and tritium values along the seeplines and concluded that contaminants leaching from the F- and H-Area Seepage Basins were impacting the wetlands below the basins. SRS stopped discharges to the seepage basins in 1988 and capped and sealed the basins in 1990 to eliminate the source of contaminants. Scientists hypothesized that after the elimination of the contaminant source, annual rainfall and natural groundwater flow would flush the remaining contaminant plume out of the shallow groundwater over time. After the contaminant plume in the shallow groundwater is flushed out, the impacted wetland systems immediately down gradient from the basins should recover.

To investigate this hypothesis, a quarterly sampling program was established in May 1992. ESS sampled 44 of the seepline 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 the quarterly sampling program are compared. These collection points were chosen as the baseline because they are the only data available that were collected before the basin discharges were discontinued. The Haselow et al. (1990) data should be representative of conditions immediately prior to closing the basins. This sampling program is intended to complement semiannual sampling of the seepline for selected Appendix IX constituents, which began in July 1992. A report summarizing results from the semi-annual sampling program has been completed (Dixon and Rogers, 1993e).

There was expressed concern about the source of tritium and other contaminants that possibly emanate from an area in the southwest corner of 643-E rather than from the closed basins. To investigate this possibility, numerous sampling locations on the H-Area seepline south of 643-E were established and have been incorporated into the quarterly sampling plan.

Methods

ESS conducted the eleventh sampling for the quarterly tritium survey in May 1995. Sampling locations were the same as those selected in the tenth round of sampling. These locations, 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 seeplines. ESS collected 60 samples from the seeplines in F and H Area: 22 from the F-Area seepline, 22 from the H-Area seepline, and 16 from the FHB seepline south of 643-E Area. One sample was taken from the old effluent stream. ESS also collected three stream samples from locations on Fourmile Branch. Figures 1 and 2 approximate sampling locations.

Prior to sampling for the first quarter in May 1992, the Health Protection Department (HPD) collected soil samples from several locations along both seeplines and monitored them for gamma radioactivity. HPD did not detect gamma radiation; therefore, ESS selected rubber boots and disposable rubber gloves as protective clothing to prevent dermal contact with seepline water during sampling operations.

Seepline sampling locations had been previously marked and labeled with PVC stakes. Samples were collected within a three foot radius of the PVC stake by boring a hole into the soil with a small soil auger, generally six inches and not more than eighteen inches deep to obtain sample. To collect water for tritium analysis, polyethylene sample containers (25 mL) were dipped into the water until full and then capped. 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 sealed in a large polyethylene bag. The Environmental Monitoring Section (EMS) performed tritium analysis (total activity). EMS counted 5 mL aliquots 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. All sampling equipment was thoroughly rinsed with deionized water at the end of each day.

Results and Observations

Parameters measured at seepline sampling locations fluctuate throughout the year. Seepline measurements are made on water collected from fixed locations at the distal end, or toe outcrop, of the contaminant plume. Because the plume is dynamic (i.e., influenced by weather and other activities in the area) seepline monitoring is sensitive to both long term changes and seasonal/transient influences. Climatic and seasonal conditions, especially rainfall amounts influence measured concentrations Groundwater flow paths in F and H Area are complex, as illustrated in Figures 3 and 4. Recharge to the groundwater is primarily due to infiltration of rainwater (rainfall minus runoff and evapotranspiration). Groundwater then moves laterally to Fourmile Branch and its tributaries.

As the water travels toward the stream, additional infiltration forces up-gradient water deeper. Near the stream, the flow lines rise to the surface, emerging between the seepline and the stream (which acts as the groundwater "drain"). This typical vertical trajectory, a path curving downward near the groundwater divide and then upward into draining surface water, is shown as flow lines on Figures 3 and 4.

Figure 3 shows the flow lines without contaminated water from the seepage basins and Figure 4 shows the addition of contaminated flow lines resulting from F and H Area operation of the basins. The theoretical plume geometry is clearly confirmed by the real vertical profile of the F-Area Seepage Basin plume based on the detailed grid wells available in the 1970s (Looney et al., 1993). Changes in the water balance in the area influence the flow velocity and tend to move the plume either deeper or shallower and cause the location of the contaminated water to move. This is especially important to data interpretation if the "toe" of the plume is shifting relative to the fixed sample locations. Figure 5 summarizes the projected changes in the plume based on a range of transient activities. Increased rainfall (or other activities that increase infiltration such as harvesting trees) result in increased plume velocity and movement downward and away from the seepline. This decreases contaminant concentrations at the seepline sampling locations. Less infiltration decreases plume velocity and causes the plume to move upward and outcrop closer to the basins. This results in increased contaminant concentrations as measured at the seepline sampling locations.

Low rainfall for a few months prior to sampling increases constituent concentrations, and high rainfall decreases constituent concentrations in the shallow groundwater at the seepline intercept. Rainfall measured at SRS at the weather station in F Area for January through May 1995 was 48 cm. From 1960 to 1991, the average rainfall measured in F Area for this same period was 55.2 cm. This indicates that average rainfall in the area was slightly below normal for this sample period. Figure 6 shows a comparison of May 1995 rainfall to the long term average (1960-1991). It is hypothesized that below average rainfall observed in the area for this period would cause contaminant concentrations to decrease at sample locations closer to the basins and to increase at the more distant locations. This decrease in infiltration causes the toe of the plume to migrate upward through the soil profile and the arrival point to move away from the FMB and towards the basins. Tritium concentrations at eleven sample locations were above the March 1989 readings, with these sample locations showing average tritium activity increases of only 553 pCi/mL. Generally, these are the most distant sample location points from the closed basins along Fourmile Branch.

Figures 7 through 12 show comparisons of March 1989 with June and May 1995 tritium, conductivity, and pH measurements for locations in F- and H-Area seepline. Data for the first nine surveys can be found in Dixon and Rogers (1992, 1993a, 1993b, 1993c, 1993d and 1993e, and 1994), and Rogers et al. (1994a, 1994b, and 1994c). Figures 13 through 15 show the data for the Fourmile Branch stream locations. Figures 16 through 18 show the data for the sampling locations along the old effluent seepline and include one stream sample from the branch channel south of 643-E. These sampling locations were identified with the prefix FHB.

F- and H-Area Seepline Tritium Measurements

F Area

May 1995 tritium values in the F-Area seepline ranged from 17 to 5,930 pCi/mL (Figure 6 and Table 2). In F Area, water was obtained from 6 to approximately 18 inches below the soil surface. In 1989, maximum tritium activity (14,000 pCi/mL) was measured at FSP014 and FSP034 sample locations which are closer to the closed basins.

As with data from previous sampling events, a Wilcoxon signed-rank test was conducted to compare May 1995 tritium activities to March 1989 activities. 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 May 1995 concentrations were significantly lower ($P=0.092$) than the 1989 concentrations.

H Area

Tritium values in the H-Area seepline ranged from 120 to 11,800 pCi/mL (Figure 8 and Table 3). Two of the 22 sampling locations were dry and three sampling locations had tritium activities that exceeded the 1989 measurements by more than ten percent. All of these are the furthest sample locations from the closed basins. No sample's activity exceeded the maximum value of 24,000 pCi/mL measured in March 1989. As with data from F Area, a Wilcoxon signed-rank test was conducted to compare May 1995 tritium activities to March 1989 activities. The results showed that the May 1995 concentrations were significantly less ($P=0.0033$) than the 1989 concentrations for H Area.

Figures 7 and 8 show tritium activity at F and H Area for the May 1995 sampling event. Tritium concentrations increased at 8 sample locations, while 33 locations either decreased or were relatively unchanged compared to the December 1994 sampling event. There were three dry sites. Overall, sampling has shown a declining trend in tritium concentrations at the F-and H-Area seeplines.

It is important to note that total tritium fluxes to the wetlands and FMB have steadily declined since basin closure (Looney et al., 1993) and that overall results of the tritium survey support this finding. Differences in tritium concentrations measured at seepline sampling locations from one sampling event to the next represent seasonal variability and variable rainfall as well as changes due to the flushing of the plume from the wetland system.

F- and H-Area Seepline Conductivity Measurements

F Area

Conductivity measurements in the F-Area seepline ranged from 30 to 1,865 µS/cm (Figure 9 and Table 2). Due to the variability of conductivity measurements, only differences of 100 µS/cm or more are considered significant. Of the 21 locations sampled at the F-Area seepline, two locations measured more than 100 µS/cm above the 1989 measurements. A comparison of the graphs in Figures 7 and 9 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 Spearman rank correlation coefficient was found to be $r_s = 0.89$, suggesting that the two parameters are exhibiting the same trends. This similarity is to be expected because tritium serves to track the movement of the contaminant plume from the basins (Haselow et al., 1990).

H Area

Conductivity measurements in the H-Area seepline ranged from 22 to 438 µS/cm (Figure 10 and Table 3). None of the sampling locations, had a measurement of more than 100 µS/cm above the 1989 measurements. Data in Figures 8 and 10 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. The probability that the two parameters exhibited independent trends was $P<0.001$ The rank correlation coefficient ($r_s = 0.71$) for H Area was less than that for F Area, but still suggested a good correlation.

F- and H-Area Seepline pH Measurements

F- Area pH values ranged from 3.2 to 6.6 with an average value of 5.1 (Figure 11 and Table 2). H- Area pH values ranged from 4.7 to 6.2 with an average of 5.6 (Figure 12 and Table 3). The pH for the entire seepline (F and H Areas combined) averaged 5.3. The average increased 0.4 units over the 4.9 average in 1989 (Haselow et al., 1990). An increase in pH will affect the solubility of metals in the soil which should improve the soil water chemistry and enhance the recovery of wetland vegetation stressed indirectly by low pH. Aluminum concentrations measured along the seepline in 1989 (Haselow et al., 1990) were high enough to be toxic to plants. Increases in pH from an average of 4.9 in 1989 to 5.3 have reduced the amount of aluminum in solution and thereby reducing it as a possible source of plant toxicity. Concentrations of aluminum and other metals measured along the seepline in July 1992 were substantially lower than 1989 concentrations, reflecting the effects of the increase in pH (Dixon and Rogers, 1993e). Field observations have revealed that vegetation in all of the stressed areas is making noticeable recovery (Nelson and Irwin, 1994).

Fourmile Branch Measurements

Figures 13 through 15 show the tritium, conductivity, and pH values for the Fourmile Branch stream sampling locations. Table 4 provides the data used in the figures. Tritium activities at these locations ranged from 63 to 643 pCi/mL. These values were consistent with previous data and show increases in tritium down stream as the seepline water enters the channel of Fourmile Branch. Conductivity measurements ranged from 71 to 75 µS/cm and pH ranged from 6.4 to 7.0. Both conductivity and pH values were at near normal levels.

Solid Waste Disposal Facility (643-E) Seepline Measurements

The graphs in Figures 16 through 18 show tritium, conductivity, and pH values for the seepline and stream sampling locations south of 643-E, which is part of the Solid Waste Disposal Facility. Table 5 provides the data used in the figures. This seepline is along the natural drainage (old F-Area effluent ditch) that was used to discharge effluent from F-Area separations prior to the construction of the engineered effluent canal.

Tritium activities for the locations on the east side of the drainage ranged from 25 to 774 pCi/mL. Activities on the west side of the drainage ranged from 134 to 23,900 pCi/mL. The tritium activity at the stream location in the drainage (FHB012) was 20,600 pCi/mL.

Conductivity measurements on both sides of the drainage were near background at most locations and ranged from 27 to 191 µS/cm. Conductivity values are typical of the conductivity values being reported in the water table wells in the vicinity of the old F-Area effluent ditch (EMS, 1993). Using the Spearman rank correlation test, no correlation ($r_s = .38$) was found between conductivity and tritium for these locations. The pH values ranged from 3.9 to 6.1 with an average of 5.6.

These results are consistent with the Haselow et al. (1990) results for the western portion of the H-Area seepline, particularly near location HSP103. Haselow et al. (1990) found that down gradient from 643-E, conductivity values were near background while tritium concentrations were elevated. This was attributed to tritiated wastes deposited in 643-E. Tritium activities measured along the seepline down gradient of 643-E (particularly sample points 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 forced the tritium plume to outcrop down gradient. It appears that the groundwater containing tritium is moving below the fill material and outcropping on the west side of the drainage channel. The results suggest that the sampling locations on the west side of the drainage have delineated the tritium plume with the center located at or near FHB018.

Conclusions

Tritium concentrations measured at most locations during May 1995 remained relatively unchanged compared to previous sampling events. These results vary only slightly from previous sampling events and are attributed to seasonal water table change along with the dynamic nature of the groundwater tritium plume movement. The trend indicates that sample locations near the Fourmile channel and the most distant from the capped basins show elevated tritium concentration. Total tritium fluxes to the wetlands and FMB have steadily declined since basin closure (Looney et al., 1993) and overall results from the tritium survey support this finding. These findings support the hypothesis that the tritium plume in F and H Area is being flushed from the shallow groundwater. Differences in tritium concentrations measured at seepline sampling locations from one sampling event to the next represent seasonal and rainfall variability as well as changes due to flushing of the contaminant plume from the wetland system. No correction has been made for tritium decay because of the short time between sample events. Conclusions about tritium fluxes to the wetlands and FMB should consider the complexity of the groundwater system and should be based on long-term surface water, seepline, and groundwater monitoring data and not on quarterly changes in concentrations at seepline monitoring locations

Evaluation of data from 16 seepline locations south of the 643-E Area indicates that tritium migrating from 643-E is outcropping at the F- Area effluent drain, particularly on the west side of the stream channel. It appears that sampling locations on the west side of the channel have delineated the tritium outcrop area with the present climatic and hydrologic conditions. Data does not indicate that the tritium plume has decreased over the past seven sampling events. The lack of decrease in tritium concentration supports the assumption that the source of tritium is coming from 643-E rather than the capped basins.

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 Seeplines: 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 Seeplines: 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 Seeplines: December 1992. WSRC-TR-93-284, Westinghouse Savannah River Company, Savannah River Technology Center, Aiken, SC.

Dixon, K.L. and V.A. Rogers. 1993c. Results of the Fourth Quarter Tritium Survey of the F- and H-Area Seeplines: March/April 1993. WSRC-TR-93-526, Westinghouse Savannah River Company, Savannah River Technology Center, Aiken, SC.

Dixon, K.L. and V.A. Rogers. 1993d. Results of the Quarterly Tritium Survey of Fourmile Branch and Its Seeplines in the F- and H-Areas of SRS: June 1993. WSRC-TR-93-656, Westinghouse Savannah River Company, Savannah River Technology Center, Aiken, SC.

Dixon, K.L. and V.A. Rogers. 1993e. Semi-Annual Sampling of Fourmile Branch and Its Seeplines in the F and H Areas of SRS: July 1992. WSRC-TR-93-289, Westinghouse Savannah River Company, Savannah River Technology Center, Aiken, SC.

Dixon, K.L., and V.A. Rogers, and B.B. Looney. 1994. Results of the Quarterly Tritium Survey of Fourmile Branch and its Seeplines in the F and H Areas of SRS: September 1993 (U) WSRC-TR-94-0286-ESS, Westinghouse Savannah River Company, Savannah River Technology Center, Aiken, SC.

Rogers, V.A., K.L. Dixon, and B.B. Looney. 1994. Results of the Quarterly Tritium Survey of Fourmile Branch and its Seeplines in the F and H Areas of SRS: December 1993. (U) WSRC-TR-94-0342, Westinghouse Savannah River Company, Savannah River Technology Center, Aiken, SC.

Rogers, V.A., K.L. Dixon, and B.B. Looney. 1994. Results of the Quarterly Tritium Survey of Fourmile Branch and its Seeplines in the F and H Aeas of SRS: March 1994. (U) WSRC-TR-94-0408, Westinghouse Savannah River Company, Savannah River Technology Center, Aiken, SC.

Rogers, V.A., K.L. Dixon, and B.B. Looney. 1994. Results of the Quarterly Tritium Survey of Fourmile Branch and its Seeplines in the F and H Aeas of SRS: June 1994. (U) WSRC-TR-94-0441, Westinghouse Savannah River Company, Savannah River Technology Center, Aiken, SC.

Rogers, V.A., K.L. Dixon, and B.B. Looney. 1994. Results of the Quarterly Tritium Survey of Fourmile Branch and its Seeplines in the F and H Aeas of SRS: September 1994. (U) WSRC-TR-94-0536, Westinghouse Savannah River Company, Savannah River Technology Center, Aiken, SC.

Koch, J.W. and K.L. Dixon, 1994. Results of the Quarterly Tritium Survey of Fourmile Branch and its Seeplines in the F and H Aeas of SRS: December 1994. (U) WSRC-TR-95-0300, Westinghouse Savannah River Company, Savannah River Technology Center, Aiken, SC.

Nelson, E.A. and Irwin, J.E. 1994. Current Vegetation Characteristics within Tree-Kill Zones of F and H Areas (U) WSRC-TR-94-0203 Westinghouse Savannah River Company, Savannah River Technology Center, Aiken, SC.

Environmental Monitoring Section. 1993. The Savannah River Site's Ground Water Monitoring Program, Second Quarter Report. ESH-EMS-930097, Westinghouse Savannah River Company, 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 Fourmile Branch Seepline 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.

Looney, B.B., J.S. Haselow, C.M. Lewis, M.K. Harris, D.E. Wyatt, C.S. Hetrick. 1993. Projected Tritium Releases from F & H Area Seepage Basins and the Solid Waste Disposal Facilities to Fourmile Branch (U). WSRC-RP-93-459, Westinghouse Savannah River Company, Savannah River Technology Center, Aiken, SC. 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.

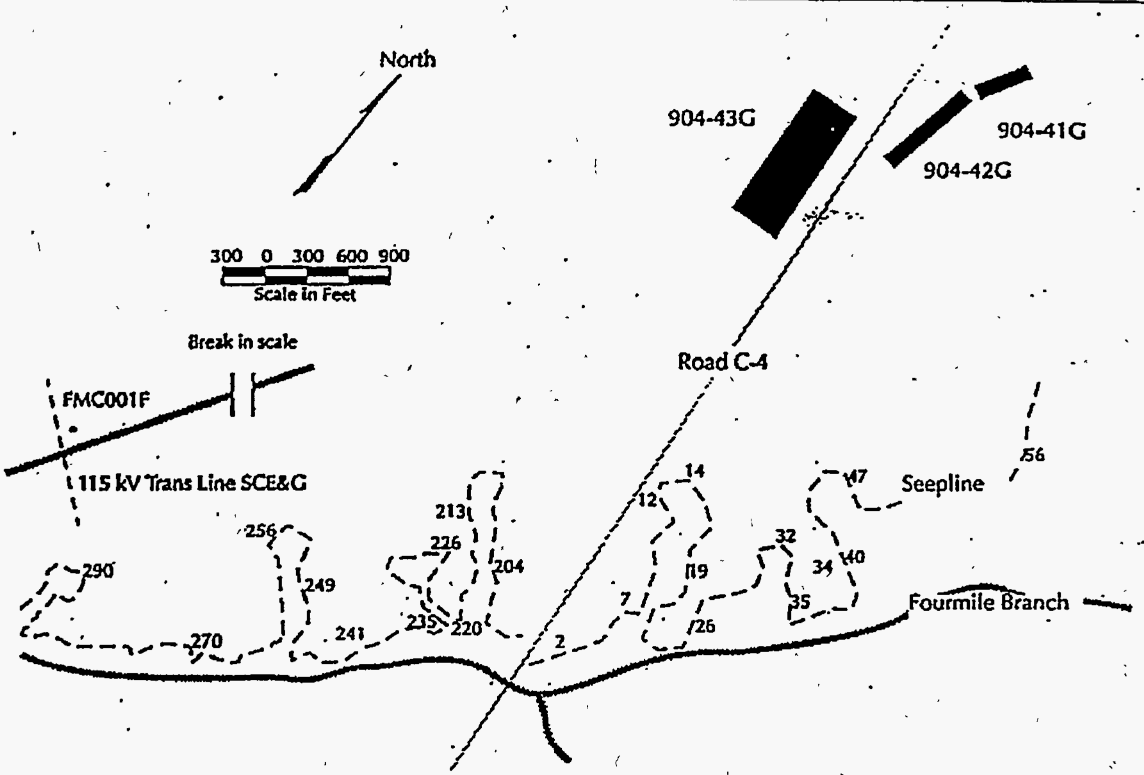

Figure 1. Location of F-Area Seepage Basins and Seepline Sampling Points.

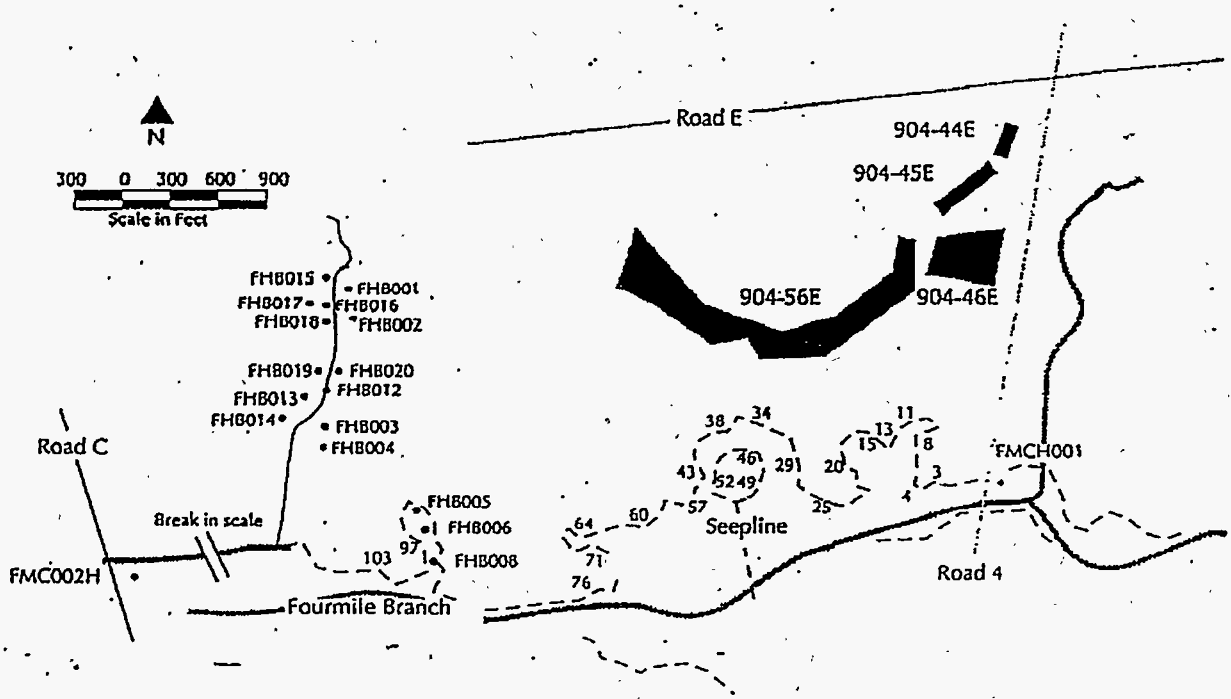

Figure 2. Location of H-Area Seepage Basins and Seepline Sampling Points and FHB Sampling Points.

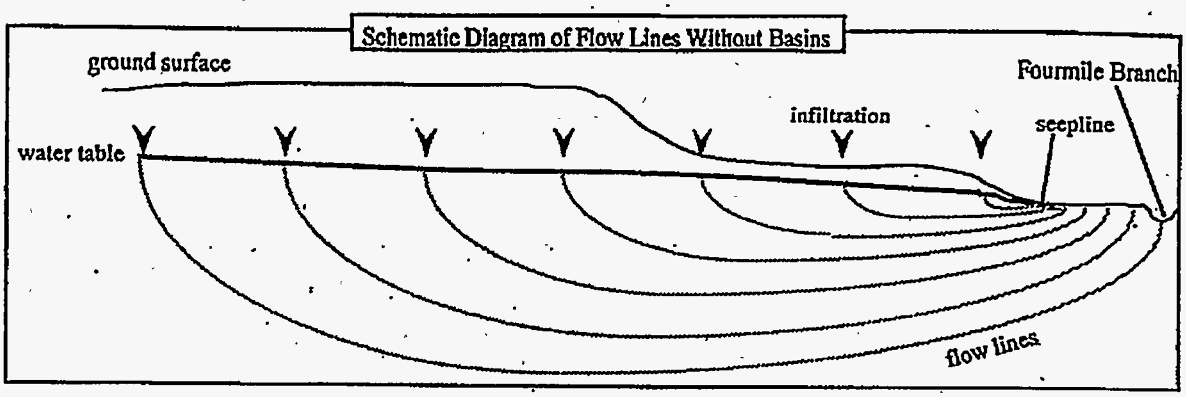

Figure 3. Schematic Diagram of Flow Lines in the Shallow Groundwater at the F- and H-Area without Seepage Basins

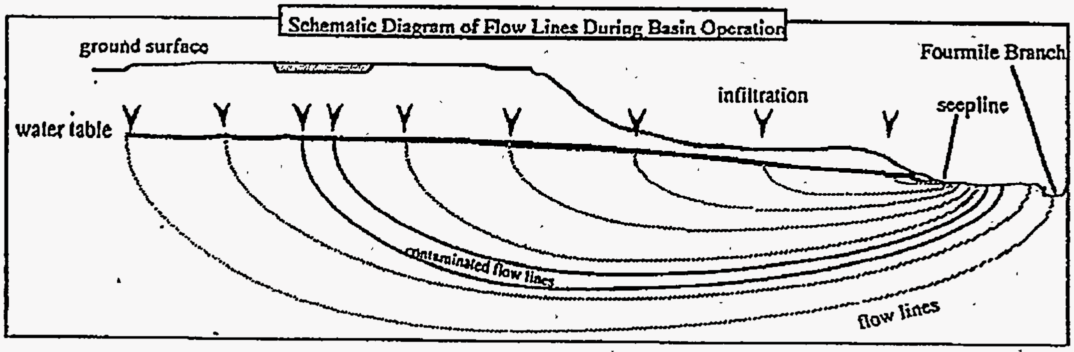

Figure 4. Schematic Diagram of Flow Lines in the Shallow Groundwater at the F- and H-Area Seepline during Basin Operation

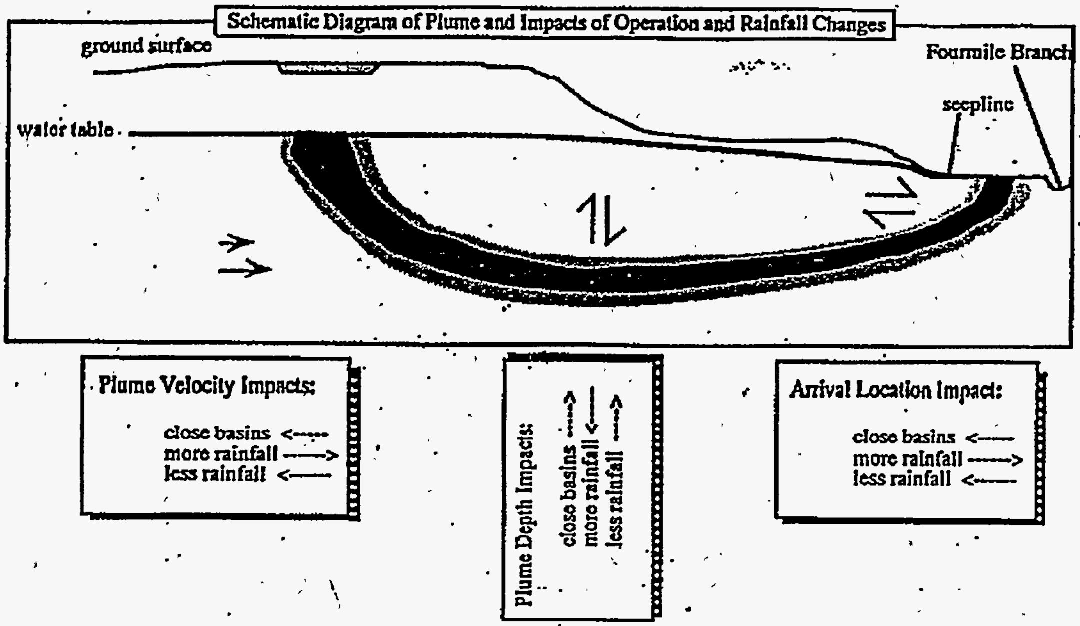

Figure 5. Schematic of the Tritium Plume Migrating from F- and H-Area Seepage Basins

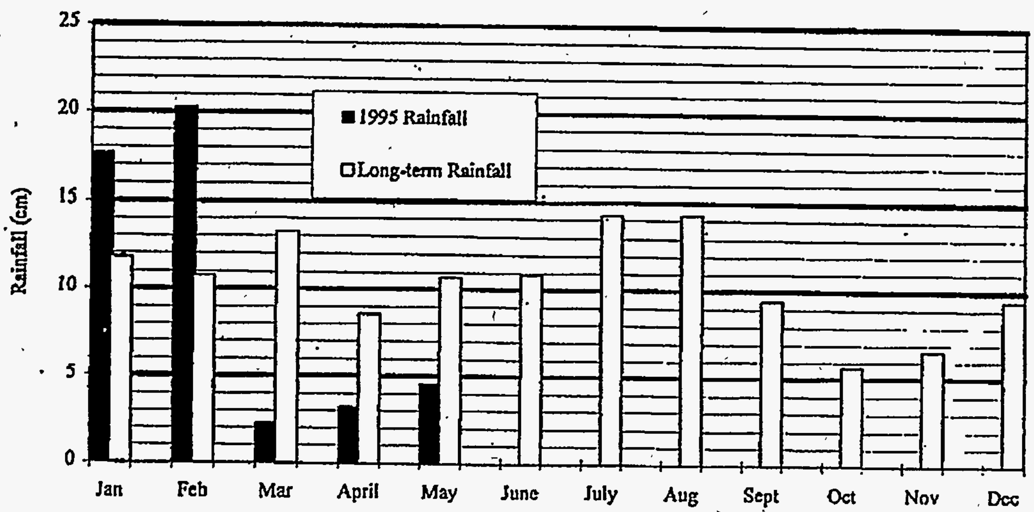

Figure 6. Comparison of 1994 Monthly Rainfall Totals to the Long-Term Average (1960-1991) for the F-Area Weather Station

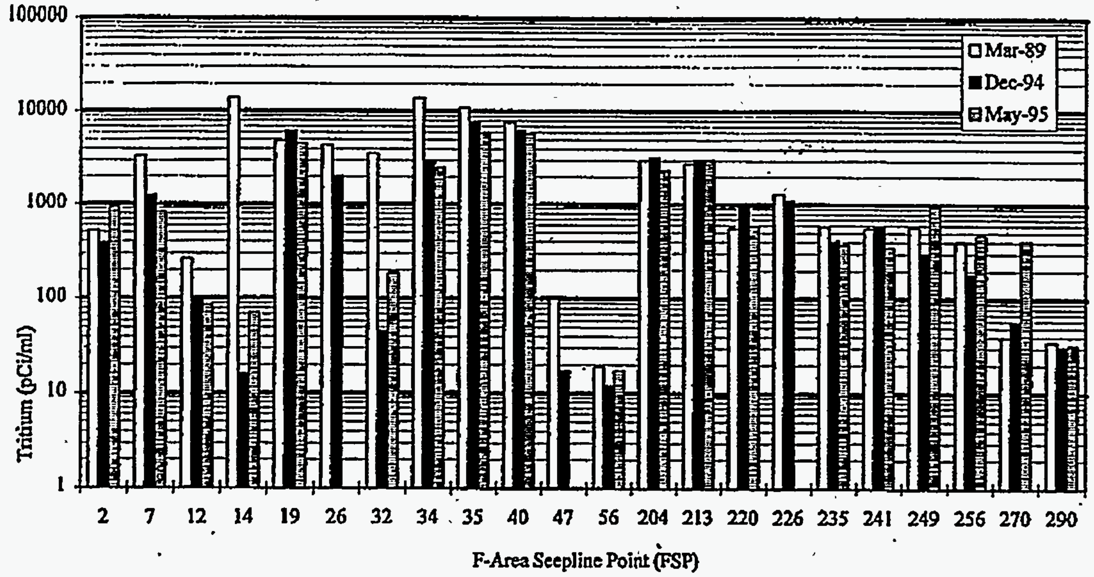

Figure 7. Comparison of Tritium Concentrations for Selected F-Area Seepline Locations

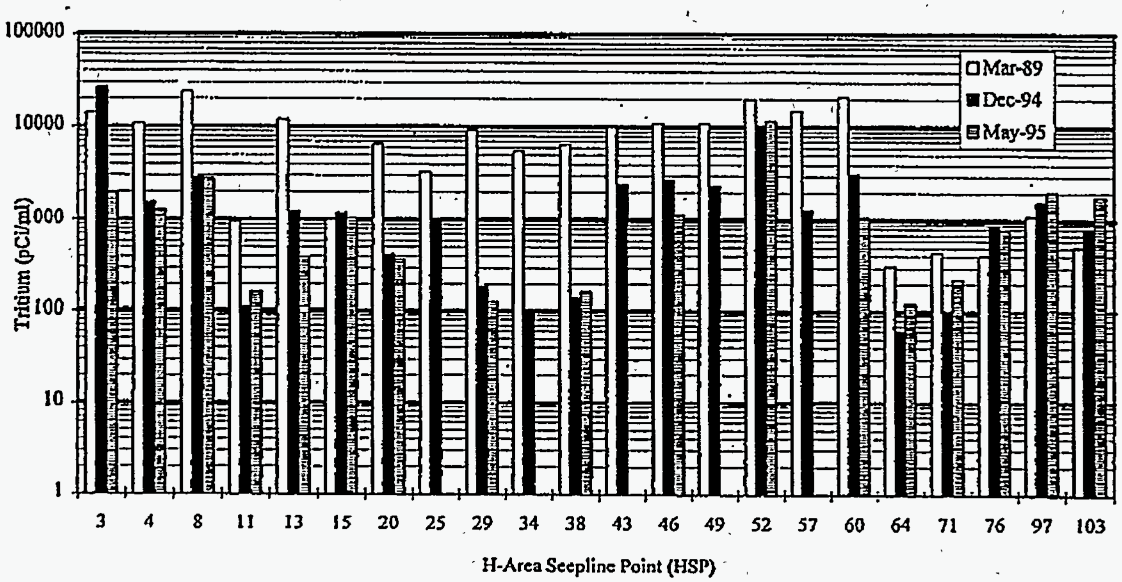

Figure 8. Comparison of Tritium Measurements for Selected H-Area Seepline Locations

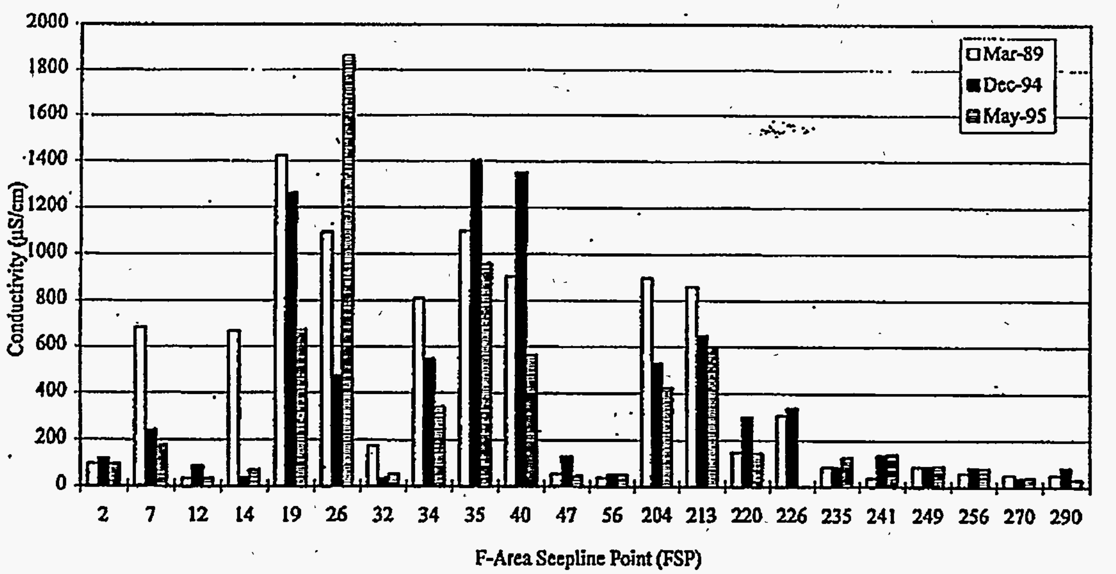

Figure 9. Comparison of Conductivity Measurements for Selected F-Area Seepline Locations

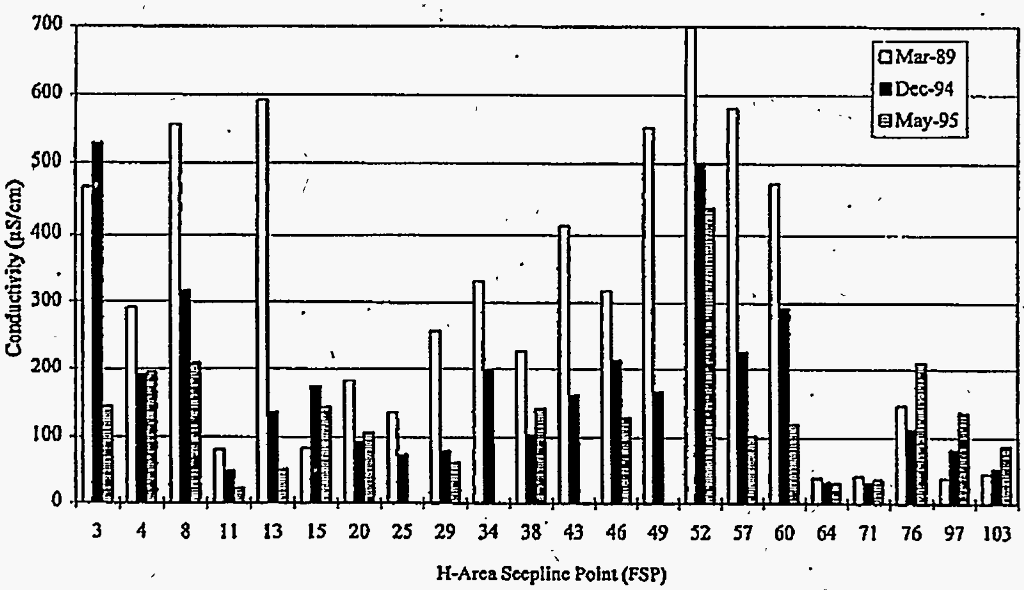

Figure 10. Comparison of Conductivity Measurements for Selected H-Area Seepline Locations.

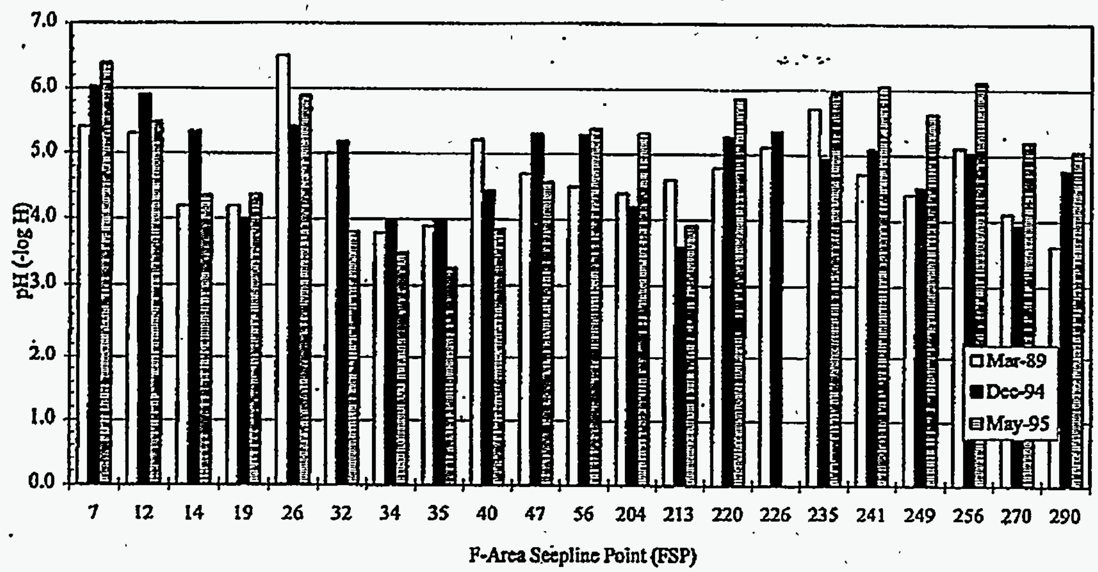

Figure 11. Comparison of pH Measurements for Selected F-Area Seepline Locations

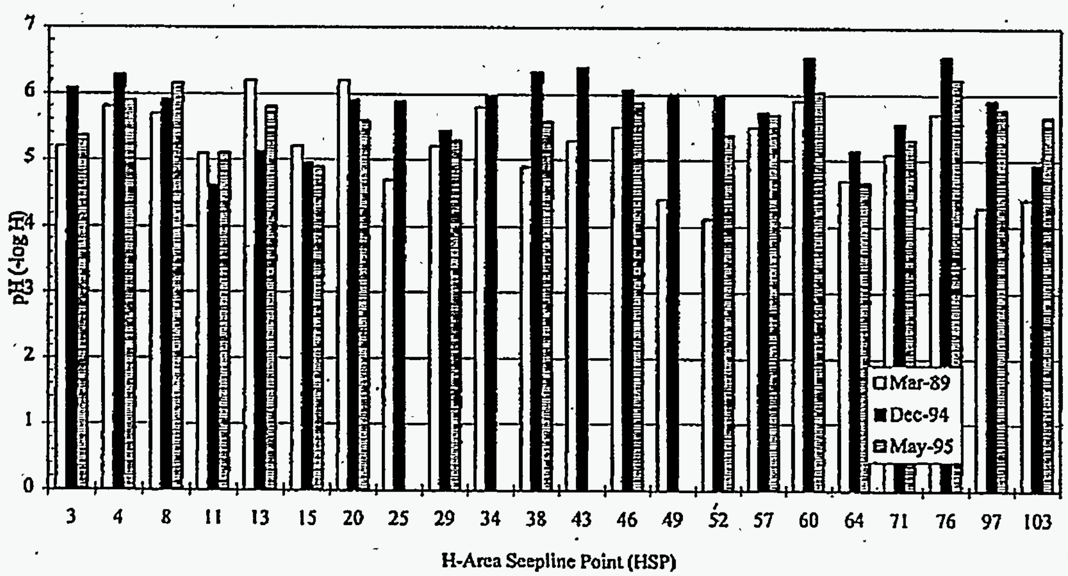

Figure 12. Comparison of pH Measurements for Selected H-Area Locations

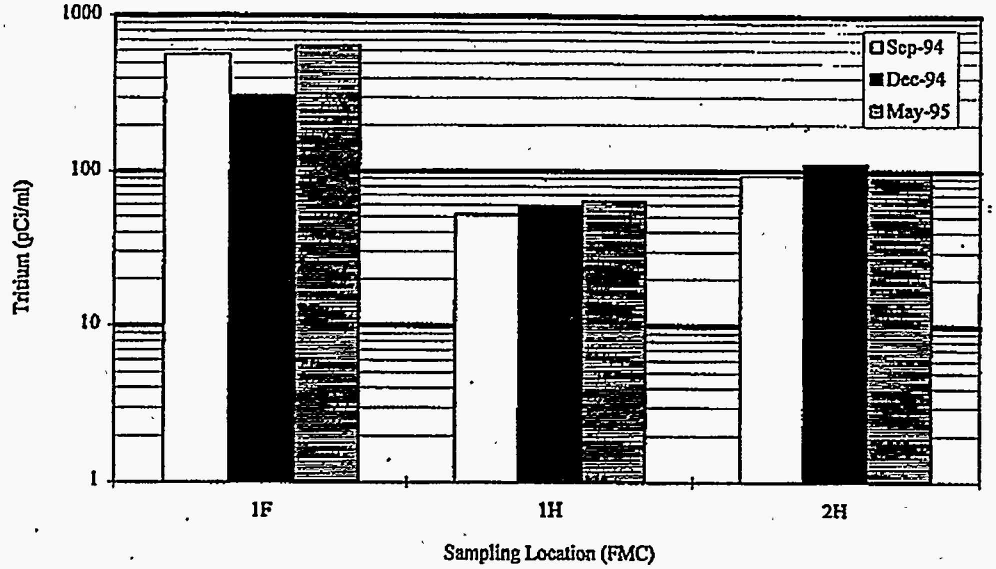

Figure 13. Comparison of Tritium Concentrations for Selected Fourmile Branch Locations

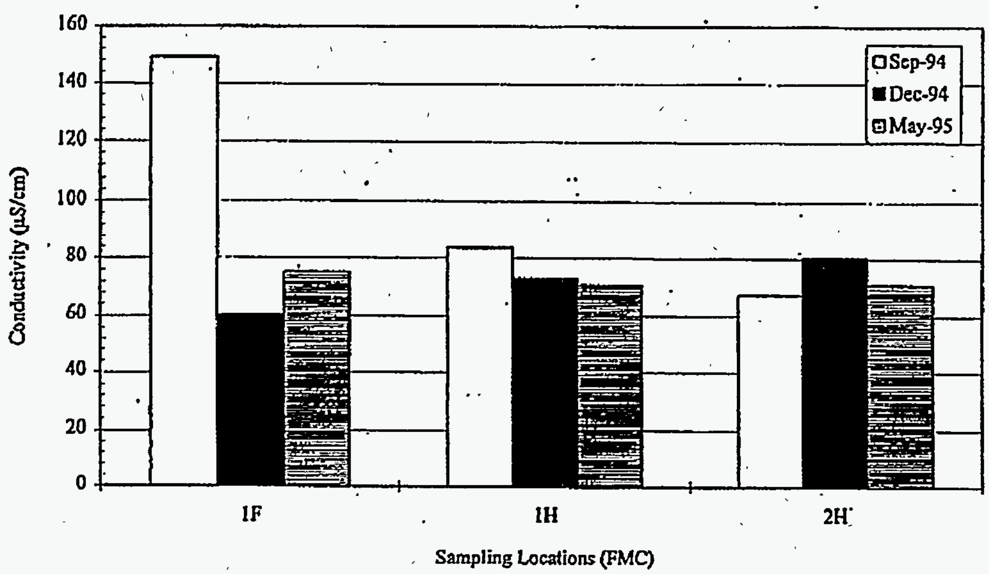

Figure 14. Comparison of Conductivity Measurements for Selected Fourmile Branch Locations

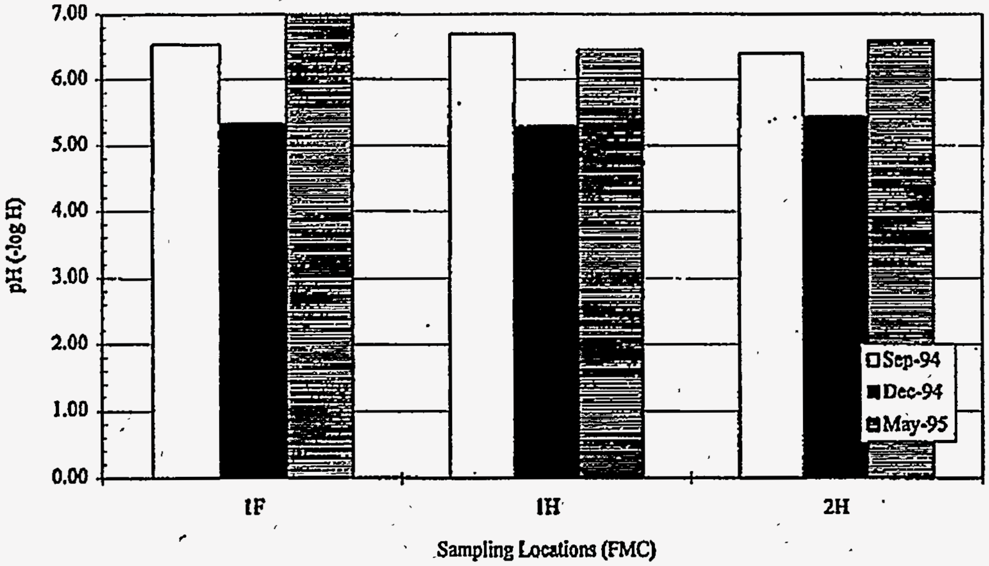

Figure 15. Comparison of pH Measurements for Selected Fourmile Branch Locations

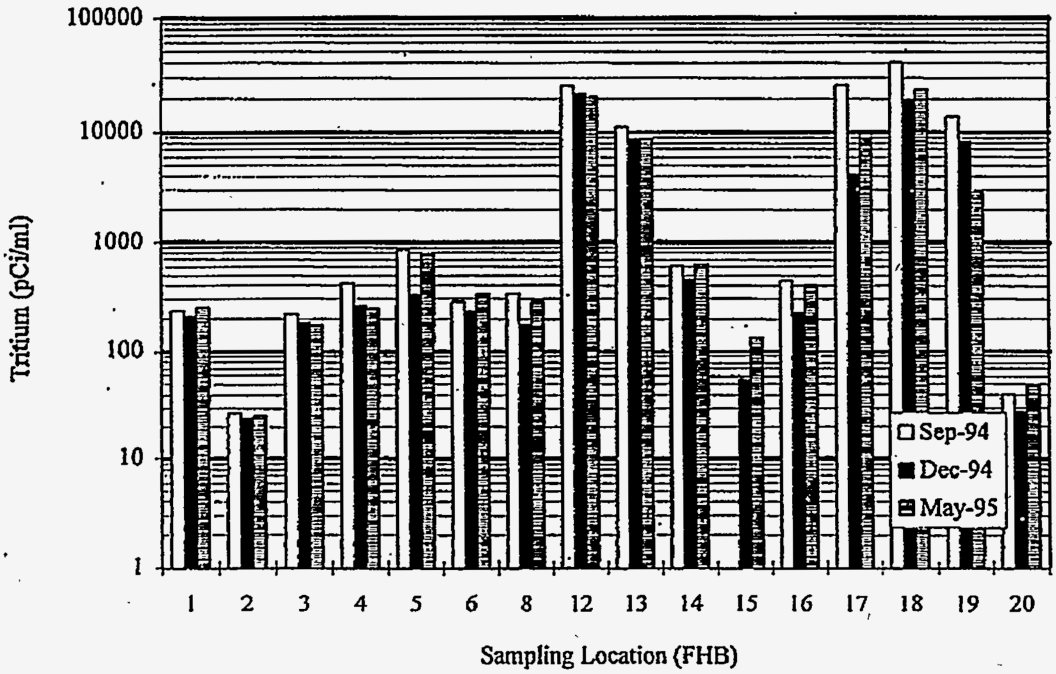

Figure 16. Comparison of Tritium Concentrations for Selected Locations on the Seepline South of 643-E

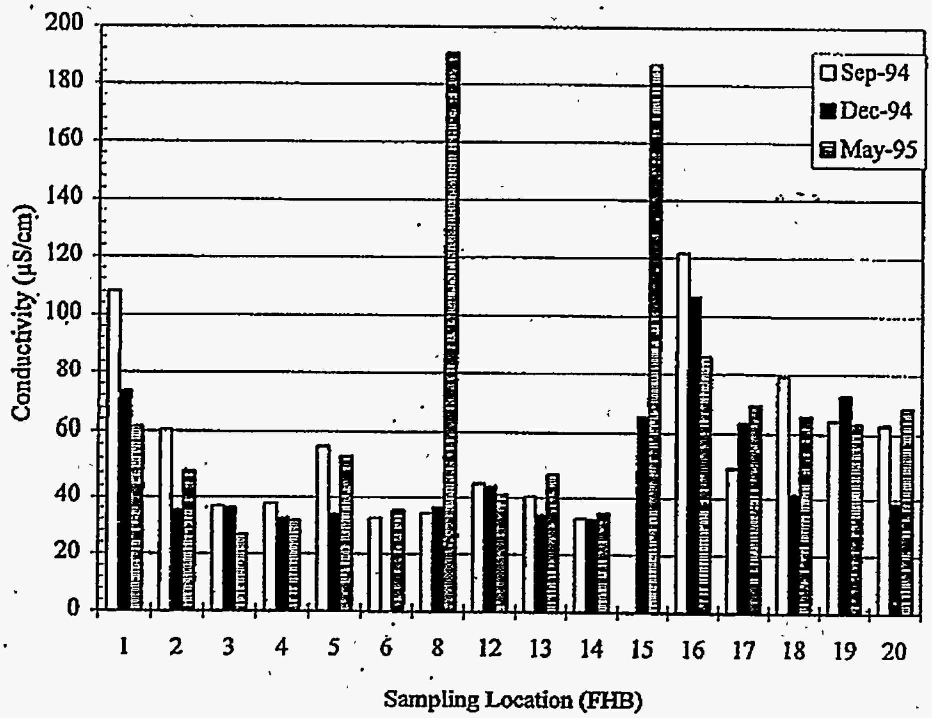

Figure 17. Comparison of Conductivity Concentrations for Selected Locations on the Seepline South of 643-E

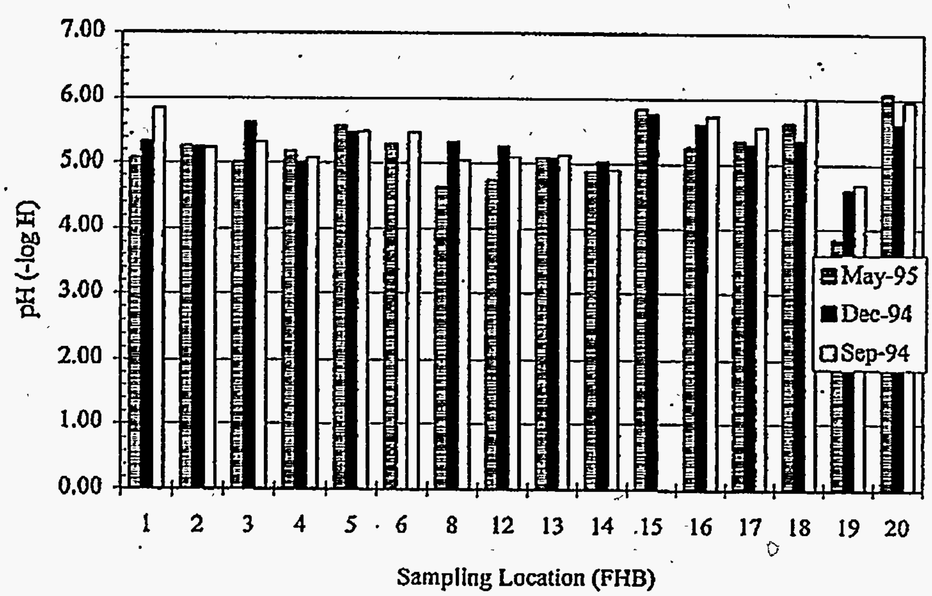

Figure 18. Comparison of pH Concentrations for Selected Locations on the Seepline South of 643-E

Table 1 Comparison of 1995 Monthly Rainfall to the Long Term Average Rainfall (1960-1991) from the F-Area Weather Station

Month	1995 Rainfall (cm)	Long-Term Rainfall (cm)
Jan	17.65	11.8
Feb	20.24	10.8
Mar	2.31**	13.3
April	3.25	8.6
May	4.5	10.7
June	-	10.9
July	-	14.3
Aug	-	14.3
Sept	-	9.5
Oct	-	5.7
Nov	-	6.6
Dec	-	9.5

**Lowest ever recorded rainfall for this month at this location

Table 2. Comparison of F-Area Seepline Measurements for Tritium, Conductivity, and pH for the March 1989, December 1994, and May 1995 Sampling Events.

	Tritium (pCi/ml)			Conductivity (µS/cm)				pH(-log H)	
Location	Mar-89	Dec-94	May-95	Mar-89	Dec-94	May-95	Mar-89	Dec-94	May-95
2	520	381	917	94	119	93	5.6	5.8	6.6
7	3400	1270	819	681	242	179	5.4	6.0	6.4
12	260	103	86	30	84	32	5.3	5.9	5.5
14	14000	16	72	666	37	69	4.2	5.3	4.4
19	4900	6300	4580	1424	1265	669	4.2	4.0	4.4
26	4400	2020	5000	1095	476	1865	6.5	5.4	5.9
32	3600	46	188	174	35	52	5.0	5.2	3.8
34	14000	3040	2530	810	545	343	3.8	4.0	3.5
35	11000	7810	5930	1100	1404	959	3.9	4.0	3.3
40	7800	6410	5720	900	1352	562	5.2	4.4	3.9
47	100	17	37	52	126	44	4.7	5.3	4.6
56	19	12	17	34	50	50	4.5	5.3	5.4
204	3000	3210	2340	895	528	425	4.4	4.2	5.3
213	2800	3050	3020	860	647	599	4.6	3.6	3.9
220	560	984	597	147	300	140	4.8	5.3	5.9
226	1300	1110	dry	306	339	dry	5.1	5.4	dry
235	580	410	378	84	82	122	5.7	5.0	6.0
241	560	585	349	36	133	138	4.7	5.1	6.1
249	580	301	940	84	84	88	4.4	4.5	5.6
256	400	187	471	56	82	78	5.1	5.0	6.1
270	40	58	408	50	33	35	4.1	3.9	5.2
290	35	31	32	49	81	30	3.6	4.8	5.1

Table 3. Comparison of H-Area Seepline Measurements for Tritium, Conductivity, and pH for the March 1989, December 1994, and May 1995 Sampling Events.

	Tritium (pCi/ml)			Conductivity (µS/cm)			pH (-log H)		
Location	Mar-89	Dec-94	May-95	Mar-89	Dec-94	May-95	Mar-89	Dec-94	May-95
3	14000	26400	1950	468	528	144	5.2	6.1	5.4
4	11000	1550	1300	292	191	194	5.8	6.3	5.9
8	24000	2850	2770	556	318	210	5.7	5.9	6.2
11	960	109	160	80	49	22	5.1	4.6	5.1
13	12000	1260	388	592	136	50	6.2	5.1	5.8
15	1000	1200	1040	82	173	144	5.2	5.0	4.9
20	6500	421	362	183	94	106	6.2	5.9	5.6
25	3300	1010	dry	135	73	dry	4.7	5.9	dry
29	9200	187	126	257	78	60	5.2	5.4	5.3
34	5600	94	dry	331	197	dry	5.8	6.0	dry
38	6500	141	161	227	103	142	4.9	6.3	5.6
43	10000	2430	dry	413	161	dry	5.3	6.4	dry
46	11000	2740	1150	318	214	127	5.5	6.1	5.9
49	11000	2360	dry	551	167	dry	4.4	6.0	dry
52	20000	9710	11800	699	501	438	4.1	6.0	5.4
57	15000	1300	595	581	226	102	5.5	5.7	5.7
60	21000	3150	1070	473	290	119	5.9	6.6	6.0
64	320	61	120	38	32	30	4.7	5.2	4.7
71	450	97	229	40	31	36	5.1	5.6	5.3
76	400	907	770	146	111	211	5.7	6.6	6.2
97	1100	1570	2040	37	82	134	4.3	5.9	5.8
103	510	807	1810	43	52	86	4.4	5.0	5.7

Table 4. Comparison of Fourmile Branch Stream Measurements for Tritium, Conductivity, and pH for the September 1994, December 1994, and May 1995 Sampling Events.

	Tritium (pCi/ml			Conductivity (µS/cm)			pH (-log H)		
Location	Sep-94	Dec-94	May-95	Sep-94	Dec-94	May-95	Sep-94	Dec-94	May-95
1F	567	312	643	149	61	75	6.53	5.34	6.99
1H	52	59	63	84	73	71	6.68	5.29	6.44
2H	93	113	97	68	80	71	6.39	5.44	6.59

Table 5. Comparison of 643-E Seepline Measurements for Tritium, Conductivity, and pH for the September 1994, December 1994, and May 1995 Sampling Events.

	Tritium (pCi/ml)			Conductivity (µS/cm)			pH (-log H)		
Location	Sep-94	Dec-94	May-95	Sep-94	Dec-94	May-95	Sep-94	Dec-94	May-95
1	236	553	258	108	91	61	5.9	5.4	5.1
2	27	25	25	60	51	49	5.2	5.0	5.3
3	217	370	176	37	40	27	5.3	5.3	5.0
4	421	785	249	38	40	32	5.1	5.1	5.2
5	858	907	774	56	40	53	5.5	5.0	5.6
6	285	378	344	32	33	35	5.5	5.1	5.3
8	342	419	287	34	32	191	5.0	4.5	4.6
12	25739	18738	20600	45	40	41	5.1	5.0	4.7
13	11381	13762	8800	40	46	48	5.1	5.3	5.1
14	614	939	639	32	34	34	4.9	4.9	4.9
15	dry	315	134	dry	187	187	dry	5.7	5.9
16	445	785	407	122	117	86	5.7	5.3	5.3
17	26193	36383	9660	50	57	70	5.6	5.2	5.4
18	40396	25966	23900	79	102	66	6.0	5.3	5.6
19	13784	30537	2870	64	55	63	4.7	4.1	3.9
20	40	42	49	63	125	69	6.0	5.8	6.1

Note: Location #12 is a stream sample location.