D. B. Moore, Section Manager
Authorized Derivative Classifier

WSRC-RP-90-0591

Analysis of Soil and Water at the Four Mile Creek Seepline near the F&H Areas of SRS (U)

June 20, 1990

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Environmental Sciences

WESTINGHOUSE SAVANNAH RIVER COMPANY
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SAVANNAH RIVER SITE
AIKEN, SC 29808

Prepared for the U. S. Department of Energy under Contract No. DE-AC09-88SR18035

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Executive Summary

Several soil and water samples were collected along the Four Mile Creek (FMC) seepline at the F & H Areas of the Savannah River Site. The samples were analyzed for concentrations of metals, radionuclides, and inorganic constituents. The results of the analyses are summarized below for the soil and water samples.

Soil

Soil concentrations were compared to values obtained from a survey of unimpacted soils on the SRS (Looney et al., 1989).

Cadmium is the only metal that exceeds the maximum SRS background soil value (1.19 ppm), and that was only for one sample out twenty-six. Gross beta exceeds the background value (23 pCi/g) four out of twenty-six times; ^{90}Sr exceeded the maximum background value (<1 pCi/g) six out of twenty-six times, and $^{233/234}$U and ^{238}U each exceeded the maximum background value for total uranium (4.7 pCi/g) one out of twenty-six times.

^{241}Am, ^{244}Cm, ^{60}Co, ^{129}I, ^{238}Pu, and ^{226}Ra may also be above background activities at least in one sample. However, because there are no available background data to compare the results, this conclusion is based on: 1) an apparent correlation with other impacted soil samples (high values of other radionuclides such as ^{90}Sr), 2) comparison with soil samples that are out of the central portion of the plume, and 3) knowledge of constituents that have potentially been released into the basins in the past.

Water

Water concentrations were compared to proposed or established drinking water standards.

All of the metals concentrations are below the Primary Drinking Water Standard at the FMC **seepline** except for cadmium in F-Area. Measured cadmium concentrations were slightly above the proposed standard of 5 ppb (but not the established standard of 10 ppb) during both the 1988 and 1989 sampling period at one point in the central portion of the plume from the basins. Manganese and iron concentrations are above the Secondary Drinking Water Standard at both the F & H Area seepline. Aluminum and sodium concentrations are apparently elevated, but no standards exist for these constituents. The sodium is probably from the caustic discharged to the basins, and the aluminum is probably being leached from the soil matrix (Looney et al., 1988).

Gross alpha, gross beta, ^{241}Am, ^{129}I, ^{3}H, ^{226}Ra, ^{89}Sr, ^{90}Sr, $^{233/234}$U, and ^{238}U are above either the proposed or established drinking

water standard at one point or more along the F-Area FMC seepline. Gross alpha, gross beta, ^{3}H, ^{226}Ra, ^{89}Sr, and ^{90}Sr are above either the proposed or established drinking water standard at one point or more along the H-Area FMC seepline. ^{244}Cm, ^{60}Co, ^{134}Cs and ^{137}Cs have apparently impacted the seepline water as indicated by the elevated concentrations of these constituents in the central portion of the plume as compared to the outer edges. Gross beta and ^{3}H are above either the proposed or established drinking water standard at one point or more in FMC.

Nitrate is also above the PDWS (10 ppm) at both the F & H Area seepline, but not in the creek.

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INTRODUCTION

Until 1988, solutions containing sodium hydroxide, nitric acid, low levels of radionuclides (mostly tritiated water) and some metals were discharged to unlined seepage basins at the F and H Areas of the Savannah River Site (SRS) as part of normal operations (Killian et al, 1987a,b). The basins are now being closed according to the Resource Conservation and Recovery Act (RCRA). As part of the closure, a Part B Post-Closure Care Permit is being prepared. The information included in this report will fulfill some of the data requirements for that Part B permit.

The area that includes the basins is bounded to the north and west by Upper Three Runs Creek, and to the south by Four Mile Creek (Figure 1). These tributaries of the Savannah River are drains for the shallow groundwater system in the area. Constituents entering the basins seep to the underlying water table. Once in the water table, most of the constituents flow horizontally to the south in the water table towards Four Mile Creek (FMC). However, a relatively small fraction of the constituents enter a lower water-bearing formation that flows towards Upper Three Runs Creek. Numerical simulations of flow in the hydrologic system underlying the basins indicate that travel times for unretarded constituents from the basins to FMC is on the order of 10 years, and about 70 years from the basins to Upper Three Runs Creek (GeoTrans, 1988). Discharges to the basins started in the 1950's. Therefore, a steady-state profile for unretarded constituents (e.g. tritium) has developed between the basins and FMC. It is unlikely that constituents emanating from the basins have reached Upper Three Runs Creek.

FMC is bordered by well developed floodplains and wetland areas. Consequently, a portion of the groundwater moving downgradient from the basins to FMC reaches the surface prior to entering the stream. This downslope region of saturated or near-saturated surface soils is most easily distinguished by a transition from upland to wetland type vegetation (conifers to bottomland hardwoods), and this transition zone is designated in this report as the seepline.

The goal of the work reported herein is to document the impacts from the basins on FMC and the wetlands adjacent to FMC. The study of FMC has been completed in a phased approach. Looney et al. (1988) reported the results of a preliminary nonradionuclide study to determine impacts to the area. Then in the fall of 1988, soil cores and water samples were taken along the FMC seepline and analyzed for both nonradioactive and radioactive constituents listed in Table 1. This study was followed by an extensive survey along the FMC seepline where tritium was measured at over three hundred points. Because tritiated water essentially moves as untritiated water, this study provides a detailed delineation of the size and nature of the impacted groundwater. In the late summer of 1989, water and soil samples were again taken at points along FMC. The list of constituents analyzed during this sampling period are also listed in Table 1. The 1988 soil and water sampling period followed a below normal precipitation period, and the 1989 sampling period followed an above normal precipitation period. Several other constituent specific studies have been completed along FMC in the area in both the 1960's and 1970's. These studies are given as references in Looney et al., 1988, which is given as Appendix A.

Extensive Seepline Survey for pH, Conductivity and Tritium

During March, 1989, seepline water samples were taken at over three hundred points along the FMC. The samples were collected by excavating a cylindrical plug of soil about ten inches deep and with a diameter of about five inches at a nearly saturated zone along FMC. Water was allowed to seep into the excavated space, and a twenty milliliter sample was collected. The water sample was analyzed for conductivity in the field, and for tritium at a QA level 1 laboratory. Additional samples were collected using the same procedure during January, 1990 to complete the seepline study. All sampling locations are shown on Figures 2 and 3 (foldout maps at the end).

During the 1990 sampling for tritium, sixteen duplicate samples were collected (HSP-94 to HSP-109) to determine whether the concentration of tritium was changing substantially along the seepline (Table 2). A statistical analysis was completed using paired differences (Appendix B). The statistical analysis does not allow one to reject the hypothesis that the tritium concentrations are equivalent, even though nine out of sixteen recent samples have greater tritium concentrations. Ostensibly, the variance in the data is too great to statistically determine a difference. As a result, tritium and conductivity data obtained during the 1989 and 1990 sampling period are presented together.

The complete results of the tritium seepline survey are given in Table 2. Concentrations of tritium in the seepline water ranged from below the analytical detection limit to three orders of magnitude above the primary drinking water standard (PDWS), which is 20 pCi/ml. As expected, the tritium results provide excellent evidence of the extent of the plume from the basins. The results also delineate regions of preferential subsurface flow. This is depicted in Figures 4 and 5 where the concentration of tritium along the seepline is represented as proportional to the size of the shaded circles for F-Area and H-Area, respectively. A pattern of larger circles denotes the areas of preferential flow. Also shown in these figures is that the extent of the plume falls off exponentially from the center of the plume. Evidence of preferential flow exists even away from the center of the plume.

Figure 6 shows the tritium concentrations for the entire area. The tritium concentrations increase downgradient from the F&H Area seepage basins and from the Old Burial Ground. The information in this report is intended for the F&H Basins closure, but the Old Burial Grounds may also influence both the surface and subsurface water chemistry in the vicinity.

The results of the field-measured specific conductivity are given in Table 2 and are illustrated in Figure 7. The measured conductivities are influenced by the soil and water chemistry at the point of sampling. Nevertheless, the conductivity data correlate fairly well with the tritium concentrations (elevated tritium with elevated conductivity) except for a few samples in the vicinity of influence of the Old Burial Ground. This is because the Old Burial Ground received discharges containing tritium, but not nearly the volume of ions (salts) that the basins did. Thus, the conductivities directly downgradient from the Old Burial Ground are relatively low even though some tritium concentrations are above the PDWS.

The pH varies along the seepline from 3.7 to 6.5 with an average value of 4.90 (Appendix C). The pH has been reduced because of the nitric acid that was discharged to the basins. The acidity of the groundwater influences the observed metals concentrations for two reasons. The species of metals and thus the solubility is a function of the pH, and the acid is "dissolving" the soil matrix. The former observation is well documented in the geochemical literature, and the latter observation was reported in Looney et al., 1988 (Appendix A).

Extended Chemical Analyses

In addition to the extensive sampling for tritium, pH, and conductivity along FMC, additional seepline water, stream water, and soil core samples were collected and analyzed in 1988 and 1989 for the constituents listed in Table 1. The 1988 sampling was during a low precipitation period, and the 1989 sampling was during a high precipitation period. The locations of the sampling points for the 1988 soil, 1989 soil, 1988 water, and 1989 water are given in Figures 8, 9, 10, and 11, respectively. The coded locations on these figures correspond to those given in the tables of this document, but in the tables the year proceeds the code. Note that the there is not a direct correspondence between 1988 and 1989 sampling points. For instance, 88HW1 is not at the same point as 89HW1.

For the 1988 water samples, a stream or creek sample is denoted with a CW (creek water), and a seepline sample is denoted as a HW or FW. In 1989, FW and HW indicate whether the water sample is closest to F-Area or H-Area, but not a stream or seepline sample. The following codes are for in-stream samples: 89HW-2, 89HW-7, 89HW-8, 89FW-4. (This information is provided in the tables.)

Both the 1988 and 1989 soil samples are coded with a FS or HS (F-soil or H-Soil) and a prefix to denote the year the sample was collected. Again, there is not a direct correspondence between a 1988 sample and a 1989 sample location. Selection of 1988 soil samples for analyses was based on scans of radioactivity, and the 1989 soil samples were selected to fulfill data needs.

Sample Collection

Water

The seepline water samples were collected as described earlier. The stream water samples were collected by immersing collection containers into the stream. The water samples were preserved according to the conditions specified in DPSOP-254. For example, water samples that were analyzed for metals were kept at 4°C, then filtered with a 45 micron filter, and then preserved with nitric acid to reduce the pH to below 2.0.

Soil

Three meter-long continuous soil core samples were taken at the points listed in Figure 8 and 9. The soil cores were collected by first vibracoring a 10 centimeter diameter aluminum tube down 3 meters. This tube served as an outer casing to prevent borehole collapse after retrieval of the soil core. A 7.5 centimeter tube was then vibracored inside the outer tube.

After the inner 7.5 cm diameter core was in place, it was capped with a plumber's test plug, and a vacuum was applied with a hand pump to ensure recovery of the core. The inner core barrel was retrieved by utilizing a jack, tripod, and tackle arrangement. All soil samples were stored at approximately 4°C until analysis. Soil cores were halved, and one portion has been stored for future reference.

The soil cores were separated into approximately 25 centimeter sections (10 inches) for those samples collected during 1988. The cores collected during 1989 were separated according to lithologic sections and each distinct section was coded with a letter. The soil core descriptions are given in Appendix D along with the lettering scheme.

Analytical Results

Soil

The analytical results obtained from the analyses of soil core samples are reported in Tables 3, 4, and 5 for metals, radionuclides, and inorganics, respectively. For the 1988 data, the number proceeding the colon corresponds to the number of inches below the surface. For the 1989 data, letters are used to denote lithologic zones (Appendix D). To determine if the soil in the vicinity of the basins is impacted, the data were compared to results obtained from a background soil study of other unimpacted areas at the SRS (Looney et al., 1990). The soil in the vicinity of the basins is defined as impacted if it exceeds the maximum value determined from the background soil study.

Cadmium was the only metal that exceeded the maximum background value (1.19 ppm), and that was only for one sample out 26. None of the inorganics (nitrate and chloride) exceeded the background values. Probably because these chemicals are relatively mobile, and therefore are not bound to the soil matrix. Gross beta exceeded the background value (23 pCi/g) four out of twenty-six times; ^{90}Sr exceeded the maximum background value (<1 pCi/g) six out of twenty-six times, and $^{233/234}$U and ^{238}U each exceeded the maximum background value for total uranium (4.7 pCi/g) one out of twenty-six times.

^{241}Am, ^{244}Cm, ^{60}Co, ^{129}I, ^{238}Pu, and ^{226}Ra may also be above background values at least once for each of these constituents. However, there are no available background data to compare the results; therefore this observation is based on: 1) an apparent correlation with other impacted soil samples (high values of other radionuclides such as ^{90}Sr), 2) comparison with soil samples that are out of the central portion of the plume, and 3) knowledge of constituents that have potentially been released into the basins in the past.

Water

The analytical results obtained from the analyses of seepline and stream water samples are reported in Tables 6, 7, and 8 for metals, radionuclides, and miscellaneous parameters, respectively. Federal water standards (PWDS, Secondary Drinking Water Standards (PDWS), Maximum Concentration Levels) are used for comparison, for constituents in which they exist. For some of the chemicals, both established and proposed standards have been published. In this case, the lower of the two values is used for comparison (see Appendix E). Also, for some constituents, there are no standards, and as a result, one can only postulate whether the concentration is elevated (indirectly or directly) from past discharges to the basins.

All of the metals concentrations are below the PDWS at the FMC **seepline** except for cadmium in F-Area (Table 6). Measured cadmium concentrations were slightly above the proposed standard of 5 ppb (but not the established standard of 10 ppb) during both the 1988 and 1989 sampling period at one point in the central portion of the plume from the basins. Manganese and iron concentrations are above the SDWS at both the F & H Area seepline. However, this standard was established to avoid staining (rust spots). Aluminum and sodium concentrations are apparently elevated, but no standards exist for these constituents. The sodium is probably from the caustic discharged to the basins, and the aluminum is probably being leached from the soil matrix (Looney et al., 1988).

Gross alpha, gross beta, ^{241}Am, ^{129}I, ^{3}H, ^{226}Ra, ^{89}Sr, ^{90}Sr, $^{233/234}U$, and ^{238}U are above either the proposed or established drinking water standard at one point or more along the F-Area FMC seepline (Table 7). Gross alpha, gross beta, ^{3}H, ^{226}Ra, ^{89}Sr, and ^{90}Sr are above either the proposed or established drinking water standard at one point or more along the H-Area FMC seepline. ^{244}Cm, ^{60}Co, ^{134}Cs and ^{137}Cs have apparently impacted the seepline water as indicated by the elevated concentrations of these constituents in the central portion of the plume as compared to the outer edges. Only gross beta and ^{3}H are above either the proposed or established drinking water standard at one point or more in FMC.

Nitrate is also above the PDWS (10 ppm) at both the F & H Area seepline (Table 8), but not in the stream. However, it is at least half the PWDS in FMC in both F & H Area. The concentration of chloride is apparently unaffected by the basins, because the upstream sample at 89HW-8 is about the same as along the seepline and in FMC (Table 8).

References

GeoTrans, 1988. Characterization of Groundwater Flow and Transport in the General Separations Area Savannah River Plant, report prepared for E.I. du Pont and de Nemours, Savannah River Laboratory, Aiken, SC.

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Looney, B.B., C.A. Eddy, M. Ramdeen, J. Pickett, V. Rogers, P.A. Shirley, and M.T. Scott, 1990. Geochemical and Physical Properties of Soils and Shallow Sediments at the Savannah River Site, WSRC-RP-90-0464.

Table 1. Analyses completed for 1988 and 1989 soil and water samples.

METALS	1988 WATER	1988 SOIL	1989 WATER	1989 SOIL
Ag	X	X	X	X
Sb	X	X		
Al	X	X	X	X
As			X	X
Ba	X	X		
Cd	X	X	X	X
Cr	X	X	X	X
Cu	X	X	X	X
Fe	X	X		
Hg	X	X	X	X
K	X	X		
Mg	X	X		
Mn	X	X		
Na	X	X	X	X
Ni	X	X	X	X
Pb	X	X	X	X
Se			X	X
Si	X			
Sn	X	X		
Th		X		
Zn	X	X	X	X
Alkalinity, Acidity	X		X	
Chloride	X		X	X
Nitrogen (NH_3, NO_3)	X		X	X
Phosphate	X			
Total Hardness			X	
pH	X		X	
Conductivity	X		X	

Table 1. (continued)

Low Level Radionuclides	1988 WATER	1988 SOIL	1989 WATER	1989 SOIL
Am-241	X	X	X	X
Cs-125				
Cs-134	X	X	X	
Cs-137	X	X	X	X
Co-60	X	X	X	
Cm-244	X	X		
Eu-152	X	X		
Eu-154	X			
H-3	X	X	X	X
I-129		X	X	X
Np-237	X	X	X	X
Pu-238	X	X	X	X
Pu-239/240	X	X	X	X
Ra-(total)			X	X
Ra-226	X	X		
Ru-106			X	X
Sb-125	X	X		
Sr-89/90	X	X	X	X
Tc-99	X	X	X	X
U-233,234	X	X		
U-238	X	X	X	X
Gamma PHA			X	X
Gross Alpha & Beta	X	X	X	X

Table 2. Tritium concentrations and conductivities of Four Mile Creek Seepline Water (Sample Date: 3/89).

Sample	SRS Coordinate North	SRS Coordinate East	Tritium (pCi/ml)	Conductivity (μmhos/cm)
HSP-1	70574	57141	1600	156
HSP-2	70642	56992	7100	256
HSP-3	70711	56879	14000	468
HSP-4	70710	56819	11000	292
HSP-5	70769	56819	9900	281
HSP-6	70809	56868	12000	318
HSP-8	71005	56990	24000	556
HSP-9	70970	57141	12000	317
HSP-10	71044	57142	1700	171
HSP-11	71099	57046	960	80
HSP-12	71115	56960	4500	218
HSP-13	71056	56878	12000	592
HSP-14	71038	56810	6800	393
HSP-15	71085	56791	1000	82
HSP-16	71150	56786	2500	216
HSP-18	71276	56662	2700	149
HSP-19	71253	56539	3400	148
HSP-20	71142	56489	6500	183
HSP-21	71028	56520	5800	189
HSP-22	70989	56483	5100	161
HSP-23	70921	56500	6600	184
HSP-24	70910	56347	3100	140
HSP-25	70960	56297	3300	135
HSP-26	71016	56236	6600	205
HSP-27	71121	56208	4500	202
HSP-28	71194	56192	5700	244
HSP-29	71278	56257	9200	257
HSP-30	71397	56302	3400	121
HSP-31	71490	56342	4100	214
HSP-32	71580	56281	3100	215
HSP-33	71656	56262	3800	176
HSP-34	71698	56193	5600	331
HSP-35	71768	56185	2200	121
HSP-36	71813	56148	2800	210
HSP-37	71778	56037	7600	231
HSP-38	71788	55969	6500	227
HSP-39	71838	55903	6700	242
HSP-40	71844	55773	7200	256
HSP-41	71768	55736	5700	224
HSP-42	71691	55749	8500	310
HSP-43	71644	55722	10000	413
HSP-44	71659	55818	14000	333
HSP-45	71653	55917	5500	255
HSP-46	71621	56052	11000	318
HSP-47	71534	56077	19000	426
HSP-48	71455	56059	21000	569
HSP-49	71389	55987	11000	551
HSP-50	71338	55903	18000	537

Table 2. Continued (Sample Date: 3/89)

Sample	SRS Coordinate North	East	Tritium (pCi/ml)	Conductivity (μmhos/cm)
HSP-51	71344	55821	19000	654
HSP-52	71413	55743	20000	699
HSP-53	71491	55671	19000	669
HSP-54	71561	55705	18000	631
HSP-55	71618	55754	14000	561
HSP-56	71599	55619	15000	452
HSP-57	71567	55516	15000	581
HSP-58	71658	55391	18000	551
HSP-59	71608	55296	9500	280
HSP-60	71629	55190	21000	473
HSP-61	71696	55115	1300	85
HSP-62	71767	54970	1300	155
HSP-63	71772	54882	290	34
HSP-64	71846	54768	320	38
HSP-65	71909	54746	130	51
HSP-66	71924	54707	620	49
HSP-67	71797	54668	480	31
HSP-68	71772	54760	490	39
HSP-69	71740	54824	400	35
HSP-70	71720	54891	380	30
HSP-71	71588	54937	450	40
HSP-74	71426	54779	250	73
HSP-75	71472	54664	290	81
HSP-76	71494	54571	400	146
HSP-77	71530	54511	280	43
HSP-78	71605	54426	490	53
HSP-79	71652	54338	1000	80
HSP-80	71722	54222	2000	76
HSP-81	71776	54084	240	39
HSP-82	71849	54015	150	60
HSP-83	71946	53969	230	187
HSP-84	72120	53880	720	51
HSP-85	72181	54022	370	22
HSP-86	72228	54016	790	41
HSP-87	72309	54071	190	38
HSP-88	72414	54081	940	49
HSP-89	72492	54156	410	56
HSP-90	72585	54162	500	59
HSP-91	72726	54225	530	29
HSP-92	72672	54129	230	26
HSP-93	72643	54030	210	48
HSP-94	72553	53964	240	50
HSP-95	72492	53980	570	32
HSP-96	72433	54024	1100	54
HSP-97	72371	54029	1100	37
HSP-98	72266	53955	1800	34
HSP-99	72224	53910	1200	55
HSP-100	72244	53854	1300	44
HSP-101	72296	53743	690	37

Table 2. Continued (Sample Date: 3/89)

Sample	SRS Coordinate North	East	Tritium (pCi/ml)	Conductivity (μmhos/cm)
HSP-102	72347	53673	700	40
HSP-103	72448	53665	510	43
HSP-104	72529	53539	660	38
HSP-105	72632	53427	740	44
HSP-106	72720	53376	640	60
HSP-107	72806	53410	480	47
HSP-108	72887	53419	600	58
HSP-109	72933	53294	680	73
HSP-201	70409	57235	470	74
HSP-202	70473	57346	560	56
HSP-203	70448	57445	940	110
HSP-205	70282	57522	12	139
HSP-206	70143	57525	19	62
HSP-207	70094	57506	17	135
HSP-208	70029	57451	19	84
HSP-209	69906	57444	20	72
HSP-210	69859	57537	15	55
HSP-211	69876	57624	18	43
HSP-212	69858	57690	19	27
HSP-213	69796	57740	15	57
HSP-214	69690	57759	18	37
HSP-215	69586	57790	16	58
HSP-216	69500	57865	10	56
HSP-217	69468	57939	11	50
HSP-101N	70622	56346	22	31
HSP-102N	70570	56437	22	36
HSP-103N	70528	56524	18	26
HSP-104N	70468	56620	150	56
HSP-105N	70431	56698	71	70
HSP-106N	70429	56761	18	29
HSP-107N	70419	56838	19	47
HSP-108N	70405	56915	18	57
HSP-109N	70340	56974	22	39
HSP-110N	70304	57138	19	44
HSP-111N	70269	57192	21	44
HSP-112N	70208	57295	12	60
HSP-113N	70122	57308	14	46
HSP-114N	70066	57280	18	47
HSP-115N	70000	57257	15	32
HSP-116N	69922	57274	21	32
HSP-101S	70403	55016	18	33
HSP-102S	70525	55003	24	31
HSP-103S	70621	54989	17	35
HSP-104S	70705	54946	21	28
HSP-105S	70768	54873	20	26
HSP-106S	70786	54788	23	30
HSP-107S	70854	54710	23	46
HSP-108S	70885	54631	21	32
HSP-109S	70950	54550	20	29

Table 2. Continued (Sample Date: 3/89)

Sample	SRS Coordinate North	East	Tritium (pCi/ml)	Conductivity (μmhos/cm)
HSP-110S	71038	54509	23	19
HSP-111S	71112	54464	16	26
HSP-112S	71201	54486	29	42
HSP-113S	71256	54443	22	36
T-1	71248	55795	21000	
T-2	71150	55769	1600	
T-3	71051	55742	8200	
T-4	70957	55717	10000	
T-5	70861	55691	140	
T-6	70764	55665	31	
T-7	70668	55639	26	
FSP-1	72776	49011	1100	72
FSP-2	72796	49133	520	94
FSP-3	72830	49222	70	42
FSP-4	72877	49355	1600	122
FSP-5	72965	49414	2400	425
FSP-6	73009	49460	1700	236
FSP-7	73008	49540	3400	681
FSP-8	73080	49562	3000	1175
FSP-9	73221	49626	2900	589
FSP-10	73375	49600	850	167
FSP-11	73475	49707	4100	417
FSP-12	73602	49644	260	30
FSP-13	73674	49656	69	32
FSP-14	73685	49802	14000	666
FSP-15	73576	49863	1200	52
FSP-16	73521	49871	8600	714
FSP-17	73439	49907	8600	794
FSP-18	73308	49791	5200	1043
FSP-19	73177	49778	4900	1424
FSP-20	73060	49741	6600	1193
FSP-21	73026	49608	7600	1029
FSP-22	72953	49585	3600	1015
FSP-23	72862	49554	3100	851
FSP-24	72803	49665	2700	1325
FSP-25	72821	49764	3000	790
FSP-26	72932	49801	4400	1095
FSP-27	73060	49856	3400	780
FSP-28	73082	49980	4000	1203
FSP-29	73143	50134	4600	534
FSP-30	73216	50164	5200	490
FSP-31	73330	50132	970	44
FSP-32	73367	50258	3600	174
FSP-33	73306	50302	10000	540
FSP-34	73156	50261	14000	810
FSP-35	73065	50297	11000	1100
FSP-36	72940	50292	8900	1200
FSP-37	72960	50368	8800	1660
FSP-38	73019	50514	7100	800

Table 2. Continued (Sample Date: 3/89)

Sample	SRS Coordinate North	East	Tritium (pCi/ml)	Conductivity (μmhos/cm)
FSP-39	73013	50596	6800	905
FSP-40	73101	50630	7800	900
FSP-41	73229	50566	8000	575
FSP-42	73401	50511	7500	590
FSP-43	73528	50395	8700	580
FSP-44	73616	50404	6000	469
FSP-45	73715	50470	1400	229
FSP-46	73709	50574	100	96
FSP-47	73609	50607	100	40
FSP-48	73504	50648	600	52
FSP-49	73537	50778	610	92
FSP-50	73593	50915	100	143
FSP-51	73555	51021	94	60
FSP-52	73582	51148	25	30
FSP-53	73610	51256	39	18
FSP-54	73619	51370	19	60
FSP-55	73707	51434	19	30
FSP-56	73824	51488	19	50
FSP-57	73958	51489	20	34
FSP-58	74079	51524	23	31
FSP-59	74183	51554	17	66
FSP-60	74157	51612	790	29
FSP-200	72898	48882	810	315
FSP-201	72966	48767	560	305
FSP-202	73084	48793	2100	446
FSP-203	73177	48828	1300	308
FSP-204	73281	48801	3000	895
FSP-205	73383	48816	5300	1233
FSP-206	73471	48844	3900	1036
FSP-207	73550	48801	2700	445
FSP-208	73644	48870	430	41
FSP-209	73727	48859	1400	199
FSP-210	73742	48761	220	53
FSP-211	73704	48708	110	40
FSP-212	73589	48701	570	193
FSP-213	73486	48725	2800	860
FSP-214	73437	48735	3300	1032
FSP-215	73332	48711	3800	739
FSP-216	73264	48737	4200	854
FSP-217	73192	48736	3800	938
FSP-218	73124	48678	2000	401
FSP-219	73039	48659	1600	426
FSP-220	72983	48644	560	147
FSP-221	73012	48572	790	140
FSP-222	73062	48505	710	123
FSP-223	73155	48484	760	115
FSP-224	73221	48533	250	112
FSP-225	73283	48579	680	254
FSP-226	73308	48601	1300	306

Table 2. Continued (Sample Date: 3/89)

Sample	SRS Coordinate North	East	Tritium (pCi/ml)	Conductivity (μmhos/cm)
FSP-227	73324	48501	1100	204
FSP-228	73305	48428	1500	259
FSP-229	73305	48331	350	54
FSP-230	73246	48298	430	95
FSP-231	73181	48373	250	70
FSP-232	73169	48456	520	96
FSP-233	73118	48468	650	103
FSP-234	73034	48482	670	66
FSP-235	72979	48587	580	84
FSP-236	72943	48599	530	112
FSP-237	72915	48536	310	67
FSP-238	72939	48453	680	79
FSP-239	72937	48367	250	37
FSP-240	72878	48287	57	42
FSP-241	72853	48190	560	36
FSP-242	72780	48085	180	53
FSP-243	72786	47980	390	48
FSP-244	72806	47918	280	50
FSP-245	72794	47833	980	116
FSP-246	72856	47842	780	90
FSP-247	72946	47901	590	102
FSP-248	73030	47918	960	120
FSP-249	73107	47905	580	84
FSP-250	73186	47867	200	42
FSP-251	73280	47881	460	59
FSP-252	73341	47913	570	66
FSP-253	73403	47938	210	31
FSP-254	73446	47896	90	41
FSP-255	73471	47821	370	52
FSP-256	73435	47770	400	56
FSP-257	73385	47735	270	46
FSP-258	73307	47777	510	49
FSP-259	73225	47779	150	78
FSP-260	73148	47794	360	61
FSP-261	73071	47800	730	91
FSP-262	72988	47811	630	64
FSP-263	72918	47797	220	59
FSP-264	72873	47758	100	57
FSP-265	72844	47697	110	62
FSP-266	72805	47594	92	44
FSP-267	72724	47578	94	85
FSP-268	72703	47545	270	35
FSP-269	72777	47509	32	28
FSP-270	72805	47411	40	50
FSP-271	72779	47393	62	29
FSP-272	72773	47362	45	39
FSP-273	72842	47349	32	54
FSP-274	72850	47278	49	39
FSP-275	72847	47193	39	69

Table 2. Continued (Sample Date: 3/89)

Sample	SRS Coordinate North	East	Tritium (pCi/ml)	Conductivity (μmhos/cm)
FSP-276	72823	47118	30	56
FSP-277	72788	47086	28	49
FSP-278	72853	47058	24	42
FSP-279	72833	46982	27	47
FSP-280	72837	46853	24	47
FSP-281	72824	46785	31	55
FSP-282	72869	46720	22	37
FSP-283	72887	46672	33	95
FSP-284	72870	46608	33	57
FSP-285	72884	46560	99	37
FSP-286	72961	46603	45	24
FSP-287	73043	46676	72	22
FSP-288	73094	46724	59	83
FSP-289	73045	46791	25	53
FSP-290	73160	46865	35	49
FSP-291	73235	46717	19	24
FSP-292	73209	46681	20	24
FSP-293	73136	46677	18	36
FSP-294	73083	46635	19	49
FSP-295	73026	46573	17	56
FSP-296	72924	46540	10	18
FSP-297	72904	46541	15	44
FSP-298	72886	46453	17	46
FSP-299	72864	46402	20	44
FSP-300	72848	46364	17	37
FSP-301	72842	46277	16	34
FSP-302	72804	46209	16	29
FSP-303	72798	46145	58	94
FSP-304	72795	46070	16	52
FSP-305	72773	45993	17	41
FSP-306	72769	45919	16	23
FSP-307	72831	45937	18	29
FSP-308	72899	45968	18	33
FSP-309	72971	45947	13	36

Table 2. Continued (Sample Date 1/90)

Sample	SRS Coordinate North	East	Tritium (pCi/ml)	Conductivity (μmhos/cm)
FSP-101E	72496	49222	50	82
FSP-102E	72483	49339	65	82
FSP-103E	72507	49379	60	36
FSP-104E	72545	49399	32	36
FSP-105E	72598	49470	58	27
FSP-106E	72648	49527	43	78
FSP-107E	72633	49628	18	22
FSP-108E	72605	49754	63	13
FSP-109E	72630	49836	68	25
FSP-110E	72647	49910	45	20
FSP-111E	72667	49989	73	25
FSP-112E	72683	50060	78	22
FSP-113E	72675	50142	38	17
FSP-114E	72706	50221	28	60
FSP-115E	72710	50301	82	14
FSP-116E	72686	50359	44	20
FSP-117E	72685	50421	39	19
FSP-101W	72505	48015	80	228
FSP-102W	72500	48107	110	123
FSP-103W	72535	48178	53	39
FSP-104W	72585	48261	48	55
FSP-105W	72606	48339	55	62
FSP-106W	72648	48412	83	61
FSP-107W	72626	48472	71	43
FSP-108W	72613	48544	32	60
FSP-109W	72635	48635	28	53
FSP-110W	72638	48722	34	79
FSP-61	74097	51686	18	32
FSP-62	74027	51678	10	21
FSP-63	73964	51677	10	19
FSP-64	73908	51648	<2.2	26
FSP-65	73828	51591	29	34
FSP-66	73752	51529	NA	NA
FSP-67	73681	51501	13	27
FSP-68	73627	51528	<2.2	25
FSP-69	73603	51640	33	42
FSP-70	73625	51721	31	42
FSP-71	73674	51818	NA	
FSP-72	73699	51919	28	20
FSP-73	73674	51992	22	31
FSP-74	73636	52086	14	43
FSP-75	73607	52153	22	24
FSP-76	73666	52198	30	26
FSP-77	73631	52256	30	26
FSP-78	73514	52189	32	17
FSP-79	73446	52127	25	17
FSP-80	73336	52124	85	55
FSP-81	73281	52197	19	41
FSP-82	73324	52278	19	30

Table 2. Continued (Sample Date: 1/90)

Sample	SRS Coordinate North	East	Tritium (pCi/ml)	Conductivity (μmhos/cm)
FSP-83	73383	52360	19	33
FSP-84	73379	52424	180	39
FSP-85	73354	52486	5.9	43
FSP-86	73299	52536	49	33
FSP-87	73239	52590	19	43
FSP-88	73204	52666	35	19
FSP-89	73220	52728	22	31
FSP-90	73214	52788	31	28
FSP-91	73152	52829	220	17
FSP-92	73109	52898	140	18
FSP-93	73026	52971	37	22
HSP-94	72553	53963	750	28
HSP-95	72492	53980	750	26
HSP-96	72433	54023	1600	45
HSP-97	72371	54029	1500	51
HSP-98	72265	53954	1500	43
HSP-99	72224	53909	1200	28
HSP-100	72243	53854	1800	64
HSP-101	72296	53742	950	28
HSP-102	72347	53673	610	78
HSP-103	72448	53664	400	58
HSP-104	72529	53539	810	52
HSP-105	72631	53427	810	103
HSP-106	72720	53375	740	58
HSP-107	72806	53409	460	124
HSP-108	72887	53418	910	61
HSP-109	72932	53293	230	75

Table 3. 1988 and 1989 Four Mile Creek Seepline Soil Results - Metals

SAMPLE	Ag	Al	As	Cd	Cr	Cu	Hg	Na	Ni	Pb	Se	Zn
	←					mg/kg						→
88HS3:40-50	<2	1400		<0.8	5.3	<4	0.12	<700	<7	2.4		<3
88HS4:50-60	<2	10000		2.1	15	<6	0.12	<800	<9	4.2		6.6
88HS4:110-120	<2	3200		<1	12	<6	0.22	<800	<9	2.4		<4
88HS5:40-50	<2	1700		<0.8	<2	<4	0.11	<600	<7	1.6		3.9
88HS5:50-60	<2	3400		<1	4.5	<5	0.19	<800	<8	1.7		<4
88HS7:60-70	<2	7900		<1	11	<5	0.07	<900	<8	4.3		6.2
88HS10:40-50	<2	8200		<1	9.0	<5	0.09	<700	<9	8.5		<4
88FS1:70-80	<2	4400		<1	3.6	<5	0.26	<700	<8	2.0		<4
88FS3:10-20	<2	6000		<2	10	<9	0.04	<600	<10	2.6		15
88FS3:100-110	<2	2700		<0.8	<2	<4	0.11	<600	<6	20		13
88FS6:30-40	<2	390		<0.8	<2	<4	0.19	<600	<7	<0.7		3.8
88FS6:60-70	<2	1300		<0.9	<1	<4	0.31	<700	<7	0.82		<3
88FS6:80-90	<2	1700		<1	<2	<5	0.19	<1000	<8	0.98		<4
88FS8:60-70	<4	8300		<2	11	<9	0.10	<400	<20	2.5		10
88FS8:60-70	<2	1800		<0.8	10	<4	0.25	<600	<6	0.85		4.5
88FS11:70-80	<2	2500		<0.8	3.4	<4	0.04	<600	<6	1.3		7.2
89HS-1C	<10.8	1480	<0.80	<0.20	34.4	<1.4	<0.1	17.4	9.90	3.08	<0.80	2.15
89HS-1H	<10.8	1300	<0.80	<0.20	18.9	<1.4	<0.1	22.5	<6.8	2.89	<0.80	5.95
89HS-2B	<10.8	298	<0.80	<0.20	<0.6	<1.4	<0.1	11.1	<6.8	3.87	<0.80	3.98
89HS-2I	<10.8	491	1.11	<0.20	3.75	<1.4	<0.1	15.1	<6.8	2.31	<0.80	5.00
89FS-1B	<10.8	3690	1.58	<0.20	5.81	<1.4	<0.1	20.0	<6.8	3.93	<0.80	3.38
89FS-1K	<10.8	338	<0.80	<0.20	18.8	<1.4	<0.1	18.7	<6.8	1.44	<0.80	2.19
89FS-2E	<10.8	61.4	<0.80	<0.20	<0.6	<1.4	<0.1	9.45	<6.8	<0.6	<0.80	<1.8
89FS-2G	<10.8	1480	<0.80	<0.20	26.2	1.73	<0.1	25.4	8.97	0.90	<0.80	<1.8
89FS-3E	<10.8	2300	<0.80	<0.20	5.56	1.44	<0.1	25.8	<6.8	3.91	<0.80	<1.8
89FS-3F	<10.8	2380	<0.80	<0.20	13.6	2.11	<0.1	19.3	<6.8	3.54	<0.80	<1.8

Table 3. Continued

SAMPLE	Sb	Ba	Fe	Mg	Mn	Sn	Tl
	←			mg/kg			→
88HS3:40-50	<10	<30	32	<800	<3	<10	<2
88HS4:50-60	<10	<50	17000	<1000	25	<20	<1
88HS4:110-120	<10	<40	1600	<1000	<3	<20	<2
88HS5:40-50	<10	<30	300	<800	3.9	<20	<1
88HS5:50-60	<10	<40	970	<1000	<3	<20	<1
88HS7:60-70	<10	<40	2300	<1000	5.0	<10	<1
88HS1:40-50	<10	61	1200	<1000	3.7	<20	<2
88FS1:70-80	<10	<40	2900	<1000	3.6	<20	<2
88FS3:10-20	<20	<70	2700	<2000	12	<20	<1
88FS3:100-110	<10	<30	520	<800	5.8	<10	<2
88FS6:30-40	<10	<30	<10	<800	3.0	<10	<1
88FS6:60-70	<10	<30	1800	<900	<3	<20	<2
88FS6:80-90	<10	<40	2600	<1000	3.2	<10	<2
88FS8:60-70	<20	<80	96	<2000	15	<30	<1
88FS8:100-110	<10	<30	10000	<800	<2	<10	<2
88FS11:70-80	<10	<30	2600	<8	5.8	<20	<2

Table 4. 1988 and 1989 Four Mile Creek Seepline Soil Results - Radionuclides

SAMPLE	Gross Alpha	Gross Beta	^{241}Am	^{244}Cm	^{60}Co	^{134}Cs	^{137}Cs	^{152}Eu
	←			pCi/g				→
88HS-3:40-50	9.0	8.6	0.0069	0.0018	<0.041	<0.034	<0.04	<0.086
88HS-4:50-60	8.2	10	0.0011	0.0009	<0.036	<0.05	<0.042	<0.11
88HS-4:110-120	1.6	8.6	0.0037	0.0014	<0.05	<0.06	<0.04	<0.12
88HS-5:40-50	6.4	32	0.4170	0.4270	3.75	<0.09	<0.05	<0.11
88HS-5:50-60	15	20	0.0014	0.0005	1.38	<0.024	<0.017	<0.045
88HS-7:60-70	13	45	0.0012	0.0004	1.84	<0.028	<0.021	<0.05
88HS-10:40-50	17	8.6	0.0017	0.0007	<0.042	<0.036	<0.037	<0.11
88FS-1:70-80	6.8	6.4	0.0171	0.023	<0.011	<0.015	<0.010	<0.028
88FS-3:10-20	5.9	40	0.631	0.300	0.071	<0.077	0.040	<0.13
88FS-3:100-110	2.2	6.4	0.0805	0.115	<0.032	<0.036	<0.031	<0.07
88FS-6:30-40	19	9.1	0.365	0.636	<0.031	<0.038	<0.029	<0.07
88FS-6:60-70	14	7.3	0.199	0.308	<0.012	<0.013	<0.010	<0.024
88FS-6:80-90	9.1	7.3	0.244	0.413	0.0061	<0.010	<0.008	<0.022
88FS-8:60-70	17	37	0.047	0.071	0.0069	<0.15	<0.11	<0.2
88FS-8:100-110	5.0	13	0.135	0.346	<0.037	<0.034	<0.030	<0.08
88FS-11:70-80	7.3	7.3	0.0002	0.0002	<0.041	<0.043	<0.035	<0.08
89HS-1C	5.4	13			<0.2	0.09	<0.2	
89HS-1H	<4	7.7			<0.3	<1.2	<0.2	
89HS-2B	8.1	15			<0.2	<1.1	<0.2	
89HS-2I	3.4	<5			<0.3	<1.4	<0.3	
89FS-1B	10	15			<0.2	<0.8	<0.1	
89FS-1K	<4	12			<0.2	<1.2	<0.2	
89FS-2E	6.8	<6			<0.2	<0.6	<0.2	
89FS-2G	<5	8.8			<0.2	<0.8	<0.2	
89FS-3E	4.8	<5			<0.1	<0.9	<0.2	
89FS-3F	<4	6.4			<0.1	0.1	<0.1	

Table 4. Continued

SAMPLE	^{129}I	^{237}Np	^{238}Pu	$^{239/240}Pu$	^{226}Ra	^{106}Ru	^{125}Sb	^{89}Sr
	←			pCi/g				→
88HS-3:40-50	0.91	0.0008	0.0012	0.0003	0.609	<0.38	<0.09	0.84
88HS-4:50-60	0.77	0.0025	0.0098	0.0017	0.655	<0.40	<0.10	1.00
88HS-4:110-120	4.50	0.0014	0.0089	0.0007	0.886	<0.41	<0.11	0.95
88HS-5:40-50	1.82	0.0431	0.108	0.0110	0.859	0.55	<0.12	24.4
88HS-5:50-60	0.81	0.0868	0.0024	0.0021	1.06	<0.19	<0.043	47.3
88HS-7:60-70	0.64	0.109	0.0044	0.0003	0.723	<0.23	<0.05	12.4
88HS-10:40-50	0.82	0.0019	0.0067	0.0015	1.52	<0.44	<0.11	0.63
88FS-1:70-80	5.32	0.0023	0.0024	0.0016	0.416	<0.11	<0.026	1.73
88FS-3:10-20	4.77	0.0082	0.0016	0.0074	1.25	<0.50	<0.11	2.67
88FS-3:100-110	1.36	0.0005	0.0017	0.0038	0.768	<0.29	<0.07	0.92
88FS-6:30-40	2.89	0.0008	0.0003	0.0029	0.432	<0.30	<0.07	1.11
88FS-6:60-70	3.17	0.0032	0.0008	0.0026	0.285	<0.10	<0.02	1.30
88FS-6:80-90	0.73	0.0020	0.0012	0.0006	0.335	<0.07	<0.02	1.00
88FS-8:60-70	1.62	0.0101	0.0018	0.0012	4.09	<0.86	<0.23	8.45
88FS-8:100-110	0.81	0.0012	0.0017	0.0023	0.214	<0.32	<0.08	1.04
88FS-11:70-80	0.68	0.0030	0.0027	0.0019	0.295	<0.33	<0.08	1.28
89HS-1C	<3.1	<1	<1	<1	3.2			<1
89HS-1H	<3.5	<1	<1	<1	5.7			<1
89HS-2B	<3.9	<1	<1	<1	2.1			<1
89HS-2I	<4.6	<1	<1	<1	2.3			<1
89FS-1B	<3.1	<1	<1	<1	3.1			<1
89FS-1K	<4.8	<1	<1	<1	1.6			<1
89FS-2E	<2.5	<1	<1	<1	1.0			<1
89FS-2G	<3.3	<1	<1	<1	1.9			<1
89FS-3E	<3.7	<1	<1	<1	1.8			<1
89FS-3F	<2.2	<1	<1	<1	2.1			<1

Table 4. Continued

SAMPLE	^{90}Sr	^{99}Tc	$^{233/234}U$	^{238}U
	←	pCi/g		→
88HS-3:40-50	0.06	0.06	0.818	0.823
88HS-4:50-60	0.07	5.64	0.668	0.732
88HS-4:110-120	0.05	0.02	0.814	0.836
88HS-5:40-50	13.0	1.14	0.473	0.426
88HS-5:50-60	5.5	2.04	0.673	0.659
88HS-7:60-70	14.5	0.39	0.832	0.736
88HS-10:40-50	0.057	0.03	1.30	1.21
88FS-1:70-80	0.26	0.04	0.264	0.254
88FS-3:10-20	2.94	19.3	9.68	9.59
88FS-3:100-110	0.084	0.03	0.927	0.945
88FS-6:30-40	0.131	0.06	2.57	3.56
88FS-6:60-70	0.086	0.12	0.768	1.34
88FS-6:80-90	0.18	0.04	0.709	0.886
88FS-8:60-70	8.95	0.11	0.95	0.777
88FS-8:100-110	1.05	0.16	2.65	3.38
88FS-11:70-80	0.16	0.04	0.244	0.246
89HS-1C	<1	<1		<1
89HS-1H	<1	<1		<1
89HS-2B	<1	<1		<1
89HS-2I	<1	<1		<1
89FS-1B	<1	<1		<1
89FS-1K	<1	<1		<1
89FS-2E	<1	<1		<1
89FS-2G	<1	<1		<1
89FS-3E	<1	<1		<1
89FS-3F	<1	<1		<1

Table 5. 1989 Seepline Soil Chloride and Nitrate Concentrations

SAMPLE	Chloride	Nitrate
89HS-1C	<1.3	<0.5
89HS-1H	2.1	1.0
89HS-2B	1.9	3.6
89HS-2I	4.5	1.0
89FS-1B	2.0	0.8
89FS-1K	1.3	1.1
89FS-2E	1.8	3.4
89FS-2G	2.0	4.2
89FS-3E	1.8	1.1
89FS-3F	2.2	3.5

Table 6. 1988 and 1989 Four Mile Creek Seepline and Stream Water Samples - Metals

SAMPLE	Ag	Al	As	Cd	Cr	Cu	Hg	Na	Ni	Pb	Se	Zn
	←					mg/l						→
88HW-1	<0.01	0.21		<0.005	<0.01	<0.025	<0.0002	77	<0.04	<0.005		<0.02
88HW-1	<0.01	0.25		<0.005	<0.01	<0.025	<0.0002	79	<0.04	<0.005		<0.02
88FW-1	<0.01	54		<0.005	0.011	<0.025	<0.0002	160	0.074	0.006		0.25
88FW-2	<0.01	81		<0.005	0.027	0.033	<0.0002	190	0.098	0.008		0.34
88FW-3	<0.01	<0.2		0.007	<0.01	<0.025	<0.0002	39	<0.04	<0.005		0.03
88FW-4	<0.01	82		<0.005	0.014	<0.025	0.0003	170	0.067	0.005		0.56
88CW-1	<0.01	<0.2		<0.005	<0.01	<0.025	<0.0002	14	<0.04	<0.005		<0.02
88CW-2	<0.01	<0.2		<0.005	<0.01	<0.025	0.0003	14	<0.04	<0.005		<0.02
88CW-3	<0.01	<0.2		<0.005	<0.01	<0.025	<0.0002	12	<0.04	<0.005		0.059
88CW-4	<0.01	<0.2		<0.005	0.018	<0.025	<0.0002	2.9	<0.04	<0.005		0.029
89HW-1	<0.004	0.07	<0.003	<0.006	0.003	<0.007	<0.0002	5.5	<0.034	<0.003	<0.002	0.010
*89HW-2	<0.004	0.05	<0.003	<0.006	<0.003	<0.007	<0.0002	11.7	<0.034	<0.003	<0.002	<0.009
89HW-3	<0.004	0.28	<0.003	0.0043	0.0043	<0.007	<0.0002	13.4	<0.034	<0.003	<0.002	<0.009
89HW-4	<0.004	0.08	<0.003	<0.006	<0.003	<0.007	<0.0002	63.3	<0.034	<0.003	<0.002	<0.009
89HW-5	<0.004	0.59	<0.003	<0.006	0.0034	0.018	<0.0002	126.	<0.034	<0.003	<0.002	0.027
89HW-6	<0.004	0.10	0.003	<0.006	<0.003	<0.007	<0.0002	7.38	<0.034	<0.003	<0.002	0.014
*89HW-7	<0.004	0.47	<0.003	<0.006	0.0021	<0.007	<0.0002	10.2	<0.034	0.0049	<0.002	0.028
*89HW-8	<0.004	0.07	<0.003	<0.006	<0.003	<0.007	<0.0002	25.9	<0.034	<0.003	<0.002	0.009
89FW-1	<0.004	0.05	0.0045	<0.006	<0.003	<0.007	<0.0002	1.53	<0.034	<0.003	<0.002	<0.009
89FW-2	<0.004	0.12	<0.003	<0.006	<0.003	<0.007	<0.0002	14.0	<0.034	<0.003	<0.002	<0.009
89FW-3	<0.004	35.9	0.0032	0.0073	0.0048	<0.007	<0.0002	94.9	0.05	<0.003	<0.002	0.107
*89FW-4	<0.004	0.03	<0.003	<0.006	<0.003	<0.007	<0.0002	12.1	<0.034	<0.003	<0.002	<0.009
89FW-5	<0.004	76.8	<0.003	<0.006	<0.003	0.060	<0.0002	105.	<0.034	0.0033	<0.002	0.120
89FW-6	0.012	86.9	<0.003	<0.006	<0.003	0.060	<0.0002	118.0	0.06	0.0043	<0.002	0.160
89FW-7	<0.004	0.13	<0.003	0.0017	<0.003	<0.007	<0.0002	29.7	<0.034	<0.003	<0.002	0.160

* In-stream water sample

Note: 88 and 89 data are not at the same points, e.g. 88HW1 and 89HW1 are at different points.

Table 6. Continued

SAMPLE	Sb	Ba	Fe	Mg	Mn	Sn	Tl
	mg/l						
88HW-1	<0.6	<0.2	0.31	<5	0.033	<0.08	<0.01
88HW-1	<0.6	<0.2	0.35	<5	0.036	<0.08	<0.01
88FW-1	<0.6	0.61	0.57	<5	6.3	<0.08	<0.01
88FW-2	<0.6	0.77	0.31	<5	8.1	<0.08	<0.01
88FW-3	<0.6	<0.2	<0.1	<5	0.98	<0.08	<0.01
88FW-4	<0.6	0.97	0.37	<5	5.6	<0.08	<0.01
88CW-1	<0.6	<0.2	0.12	<5	0.079	<0.08	<0.01
88CW-2	<0.6	<0.2	0.23	<5	0.058	<0.08	<0.01
88CW-3	<0.6	<0.2	0.27	<5	0.10	<0.08	<0.01
88CW-4	<0.6	<0.2	1.80	<5	1.10	<0.08	<0.01

Table 7. 1988 and 1989 Four Mile Creek Seepline and Stream Water Samples - Radionuclides

SAMPLE	Gross Alpha	Gross Beta	^{241}Am	^{244}Cm	^{60}Co	^{134}Cs	^{137}Cs	^{152}Eu	^{154}Eu
	←			pCi/l					→
88HW-1	4.09	1230	0.018	0.045	<11.4	<7.3	<8.2	<11	<25
88HW-1	3.09	1350	0.022	0.049	<13.6	<10	<12	<14	<30
88FW-1	255	2250	13.2	23.55	<25.4	<11	<16	<17	<0.01
88FW-2	545	2282	20.1	38.9	<17.7	<11	<13	<13	<0.09
88FW-3	63.6	655	1.54	3.35	<14.6	<12	<36	<17	<0.08
88FW-4	155	2950	4.73	6.77	<21.8	<8.2	<9.1	<11	<0.06
88CW-1	6.36	95.5	0.057	0.181	<12.3	<9.6	<24	<12	<0.06
88CW-2	2.27	79.5	0.016	0.039	<14.6	<10	<25	<15	<0.05
88CW-3	5.00	65	0.087	0.126	<14.6	<11	<25	<16	<0.010
88CW-4	0.64	0.91	0.011	0.019	<13.2	<9.5	<9.1	<11	<0.06
89HW-1	5.9	71			<1.1	<5.8	13		
*89HW-2	4.0	39			<4.7	<9.1	4.4		
89HW-3	3.8	25			<4.9	<23	3.4		
89HW-4	33	4800			64	<6.5	4.4		
89HW-5	<6	71			12	2.3	120		
89HW-6	5.6	370			<1.2	4.1	180		
*89HW-7	<3	190			<1.1	1.4	62		
*89HW-8	<4	4.4			<1.2	<5.3	0.6		
89FW-1	<4	9.9			<1.2	<5.6	0.6		
89FW-2	12	82			0.8	<7.1	46		
89FW-3	89	2100			2.2	0.4	<0.7		
*89FW-4	4.9	94			<0.7	<3	4.9		
89FW-5	4.9	94			5.1	0.6	1.7		
89FW-6	1800	2800			6.2	<6.5	5.6		
89FW-7	350	4600			130	<71	<13		

* In-stream water sample

Note: 88 and 89 data are not at the same points, e.g. 88HW1 and 89HW1 are at different points.

TABLE 7. Continued

SAMPLE	^{129}I**	^{237}Np	^{3}H	^{238}Pu	$^{239/240}Pu$	^{226}Ra	^{106}Ru	^{125}Sb	^{89}Sr
	← pCi/l →								
88HW-1	48.2	0.24	2.57E+7	0.023	0.036	0.88	<73	<19	64
88HW-1	5.36	0.51	2.74E+7	0.016	0.025	2.44	<86	<27	59
88FW-1	25.7	0.96	1.07E+7	0.047	0.017	154	<123	<33	73
88FW-2	337	0.67	1.45E+7	0.009	0.003	142	<143	<31	82
88FW-3	24.2	0.16	2.44E+6	0.075	0.042	8.59	<8.6	<30	36
88FW-4	258	0.60	1.88E+7	0.028	0.023	106	<106	<23	91
88CW-1	1.0	0.044	1.00E+6	0.037	0.013	1.96	<96	<26	2.3
88CW-2	0.9	0.139	1.28E+6	0.026	0.006	1.07	<96	<22	1.8
88CW-3	1.0	0 ± 0.03	1.50E+5	0.155	0.009	1.79	<113	<33	0.82
88CW-4	2.0	0.112	3.93E+3	0.003	0.0103	0.43	<7.7	<20	0.18
89HW-1	<42	<1	2.20E+5	<1	1.0	3.9			4.9
*89HW-2	<61	<1	1.10E+6	<1	<1	1.8			<1
89HW-3	<39	<1	1.50E+6	<1	<1	1.4			<1
89HW-4	<39	<1	1.60E+7	<1	<1	30.			320
89HW-5	<26	<1	6.50E+6	<1	<1	2.0			<2
89HW-6	<55	<1	1.80E+5	<1	<1	1.8			<2
*89HW-7	<47	<1	8.60E+4	<1	<1	1.2			<1
*89HW-8	<39	<1	4.30E+3	<1	<1	1.0			<1
89FW-1	<41	<1	4.30E+4	<1	<1	1.0			<1
89FW-2	<47	<1	9.70E+5	<1	<1	7.6			65
89FW-3	<24	<1	5.90E+6	<1	<1	140			20
*89FW-4	<23	<1	8.10E+5	<1	<1	1.8			<1
89FW-5	130	<1	1.20E+7	<1	<1	48			10
89FW-6	370	<1	1.50E+7	<1	<1	72			20
89FW-7	410	<1	2.90E+6	<1	<1	430			<3

* In-stream water sample

** Values may be low because of the low pH.

Note: 88 and 89 data are not at the same points, e.g. 88HW1 and 89HW1 are at different points.

Table 7. Continued

SAMPLE	^{90}Sr	^{99}Tc	$^{233/234}U$	^{238}U
	←	pCi/l		→
88HW-1	320	74.5	0.13	0.055
88HW-1	403	64.1	0.50	0.50
88FW-1	686	110	91.8	110
88FW-2	750	155	146	175
88FW-3	176	21.6	15.1	190
88FW-4	864	68.2	451	51.4
88CW-1	20.7	2.97	0.536	0.61
88CW-2	11.2	3.41	0.074	0.10
88CW-3	5.41	2.69	0.205	0.23
88CW-4	0.936	5.23	0.968	0.99
89HW-1	31	<7		1.5
89HW-2	6.8	50		<1
89HW-3	1.0	64		<1
89HW-4	1800	280		<1
89HW-5	3.7	170		<1
89HW-6	5.2	<7		<1
89HW-7	5.5	<7		<1
89HW-8	1.3	<7		<1
89FW-1	<1	<7		9.8
89FW-2	21	48		33.
89FW-3	790	130		2.5
89FW-4	16	26		<1
89FW-5	370	330		95.
89FW-6	350	1200		96.
89FW-7	3200	22		<1

Table 8. 1989 Four Mile Creek Seepline and Stream Water Samples - Miscellaneous Parameters

SAMPLE	Alkalinity	Acidity	Chloride	Nitrate	Total Hardness	pH	Conductivity (µV/cm)
	←	mg/l		→			
89HW-1	16	16.2	1.5	0.22	155	5.57	73.7
*89HW-2	ND	20.6	4.6	1.4	139	6.30	93.5
89HW-3	9.0	15	4.1	26.6	152	5.59	88.6
89HW-4	148	**	1.2	8.9	73.3	7.21	320
89HW-5	200	26	10.9	29.9	186	6.98	62.1
89HW-6	8.0	4.0	4.3	4.1	127	6.35	78.0
*89HW-7	8.0	2.0	5.5	5.7	196	6.37	91.6
*89HW-8	ND	7.6	5.7	0.15	196	5.34	35.9
89FW-1	ND	20.4	2.0	1.3	76.7	4.32	22.9
89FW-2	19.6	8.40	4.5	7.5	63.3	6.12	96.2
89FW-3	**	244	2.4	687	187	3.86	1410
*89FW-4	17.8	0.8	3.8	6.0	166	6.81	93.7
89FW-5	**	480	1.9	1090	3400	3.90	1900
89FW-6	**	554	2.0	1130	1500	3.77	2120
89FW-7	ND	31.6	3.8	177	117	5.43	333

ND = NO DETECTION
* In-stream water sample
** Procedure could not be performed because of the pH.

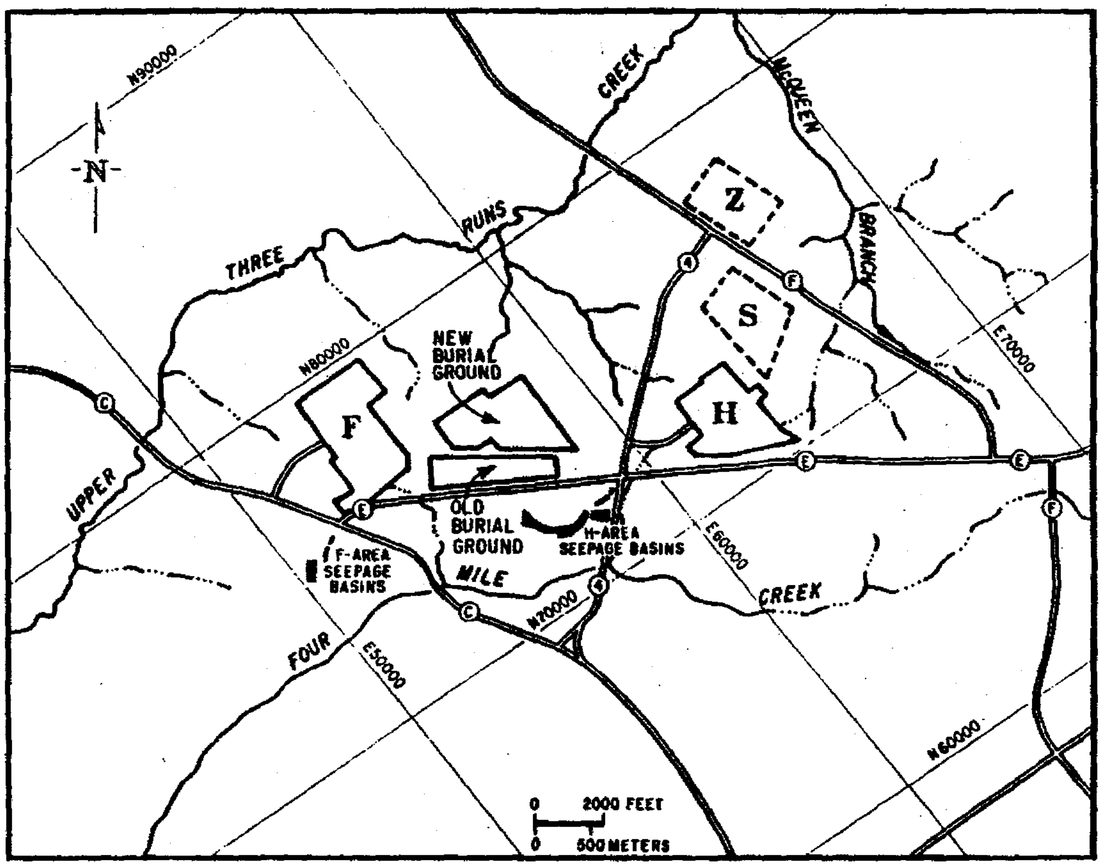

Figure 1. Location of the Separations (F&H) Area.

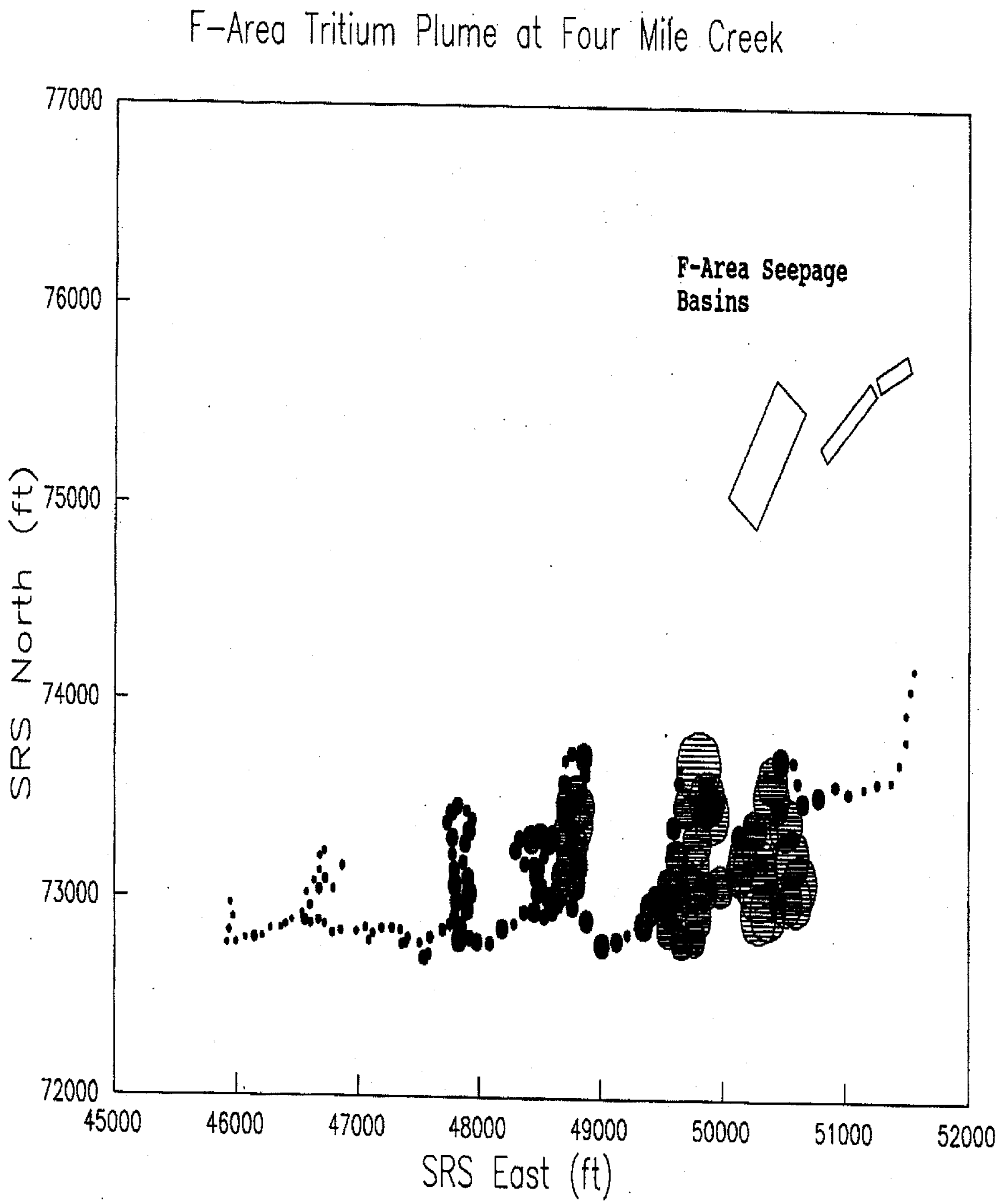

Figure 4. F-Area tritium plume at the Four Mile Creek seepline (circles are proporti al to the concentration).

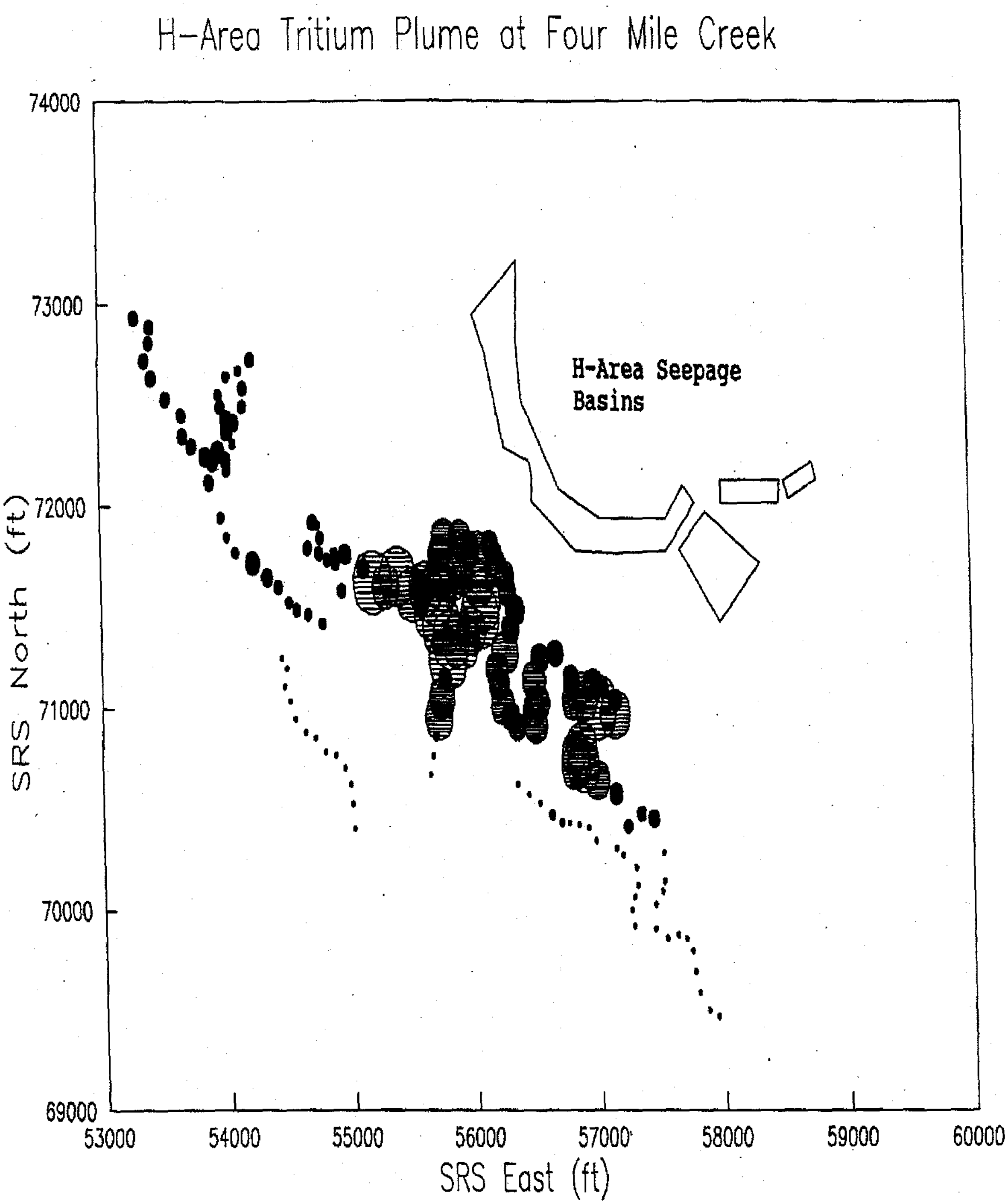

Figure 5. H-Area tritium plume at the Four Mile Creek seepline (circles are proportional to the concentration).

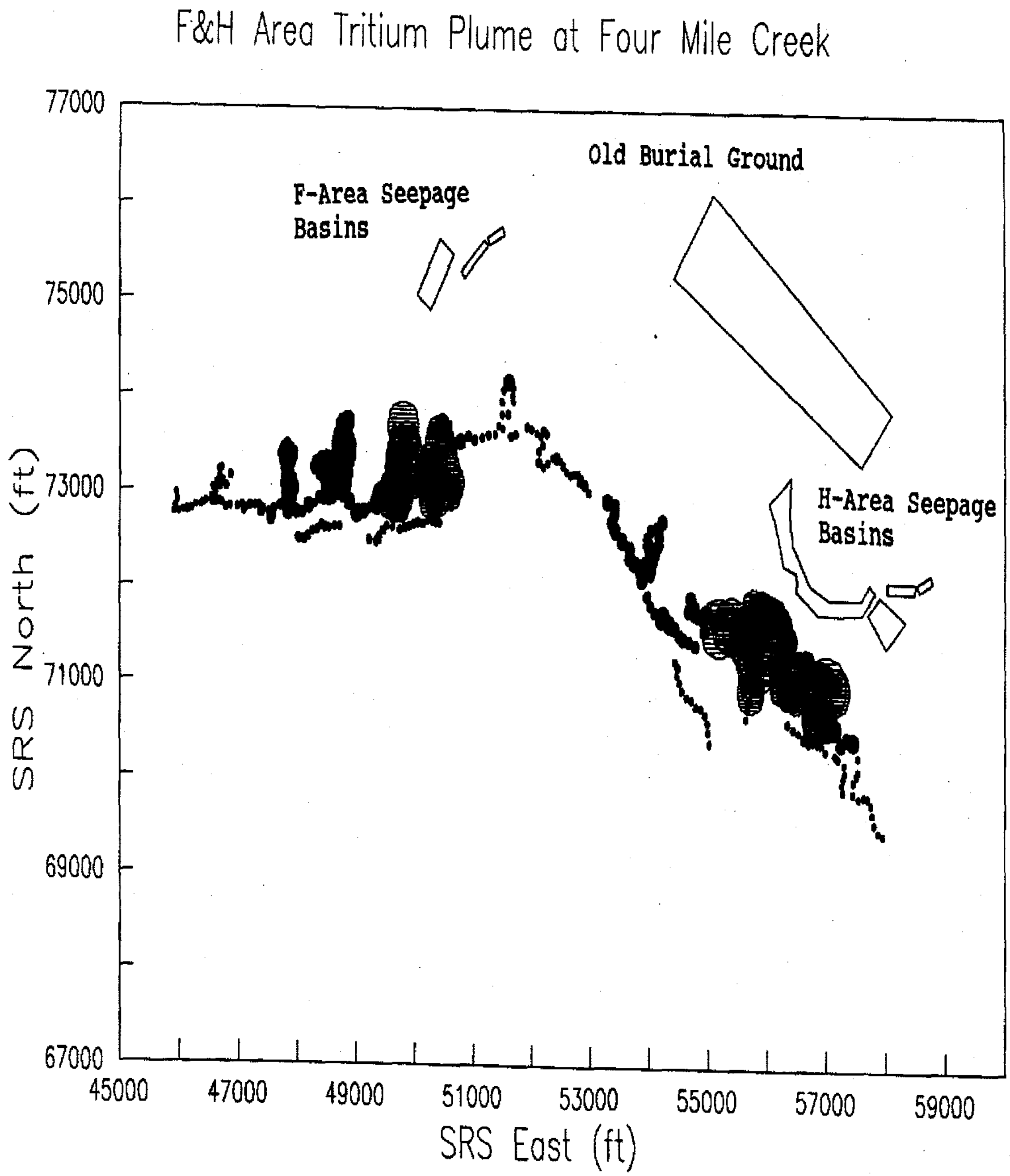

Figure 6. F&H Area tritium plume at the Four Mile Creek seepline (circles are proportional to concentration).

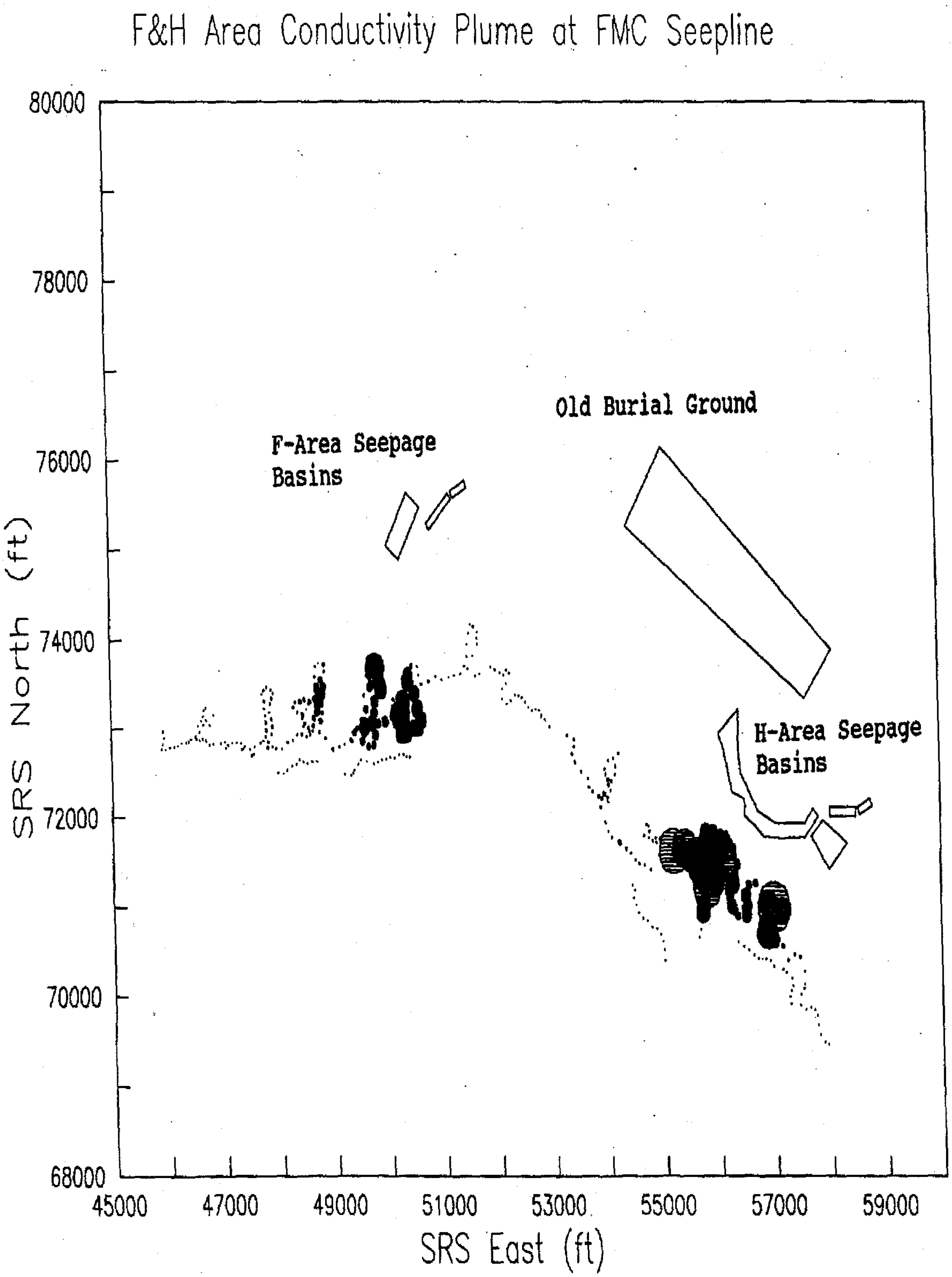

Figure 7. F&H Area conductivity plume at the Four Mile Creek seepline (circles are proportional to conductivity).

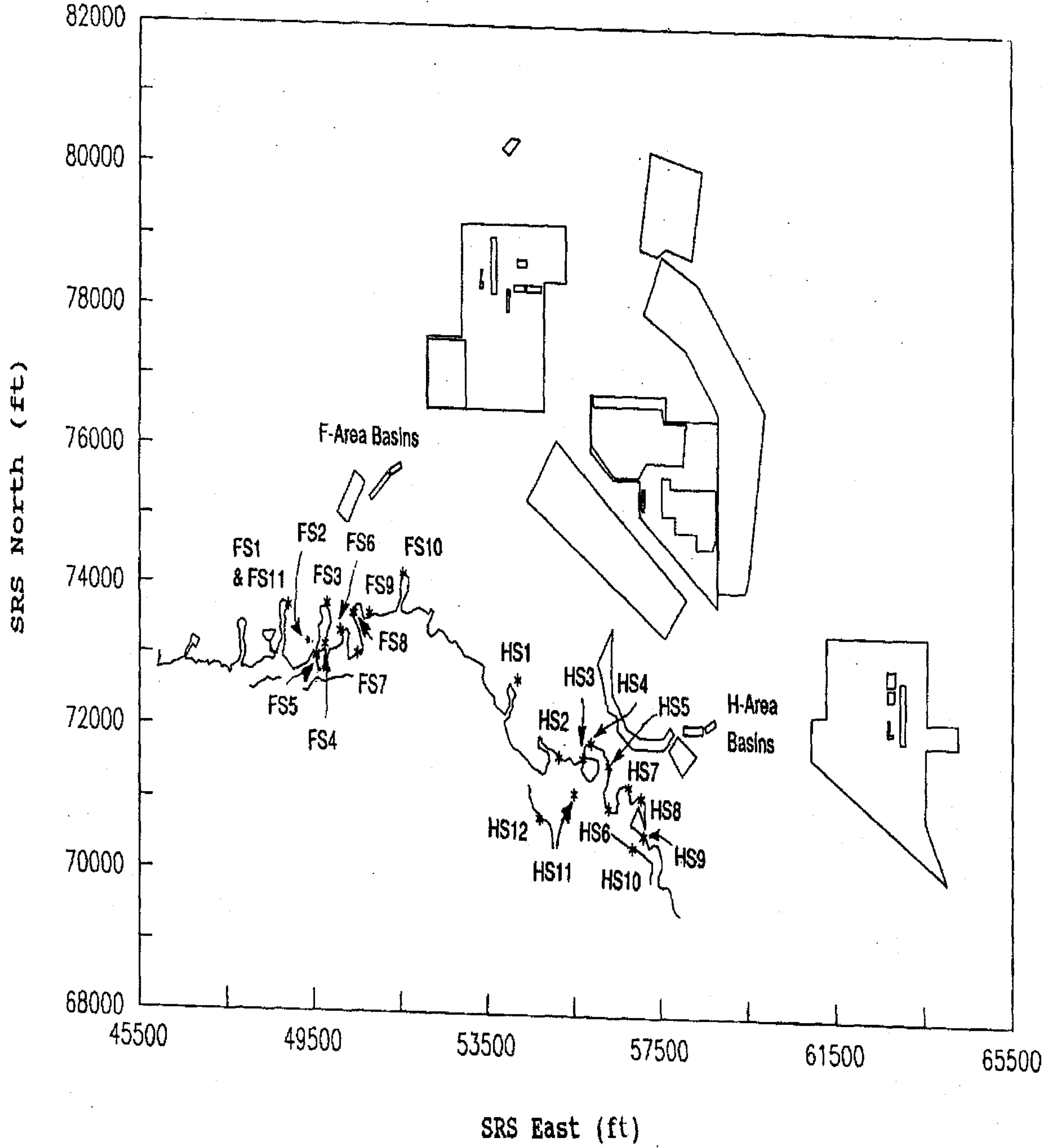

Figure 8. Location of vibracore samples collected in 1988.

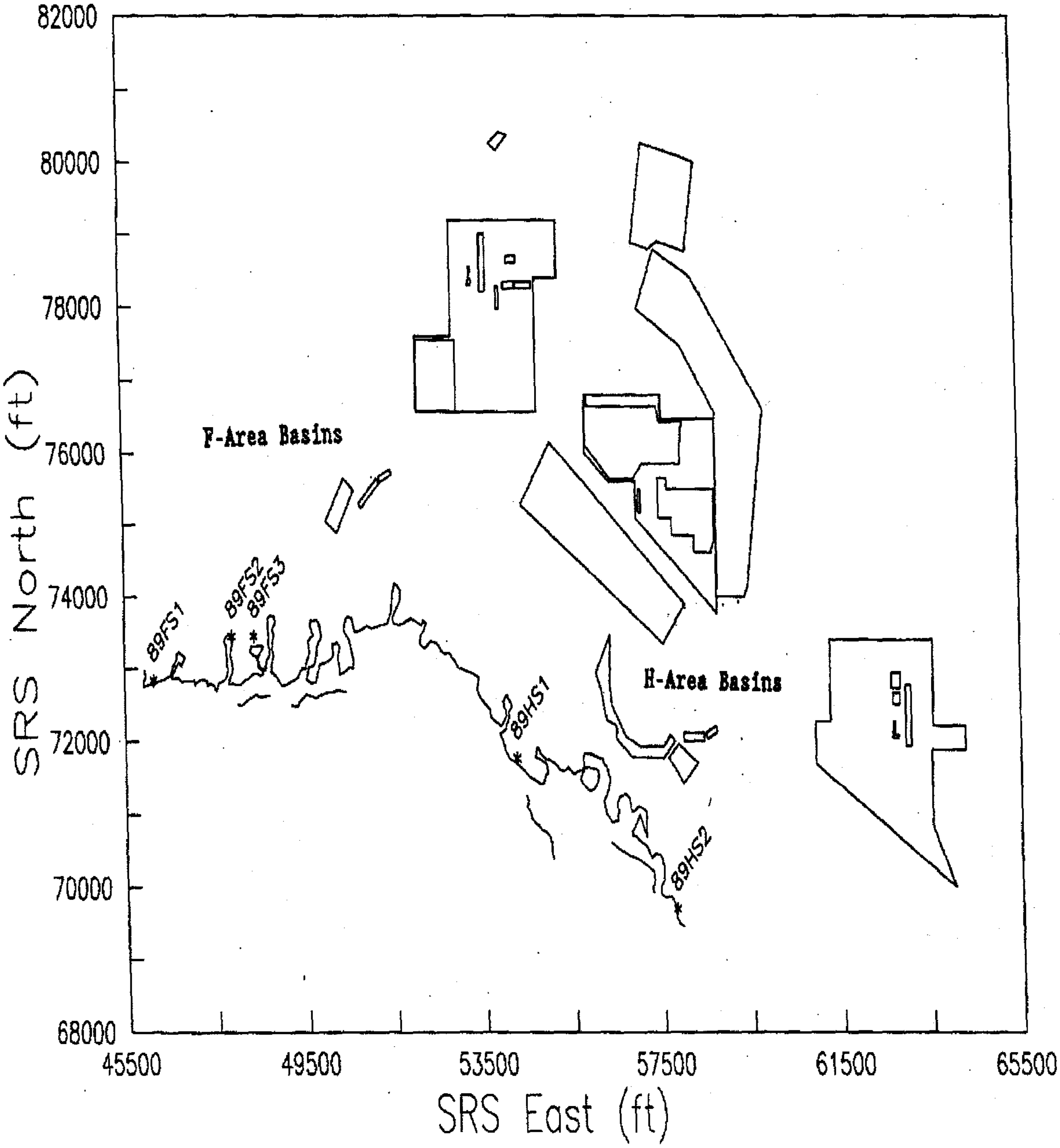

Figure 9. Location of vibracore samples collected in 1989.

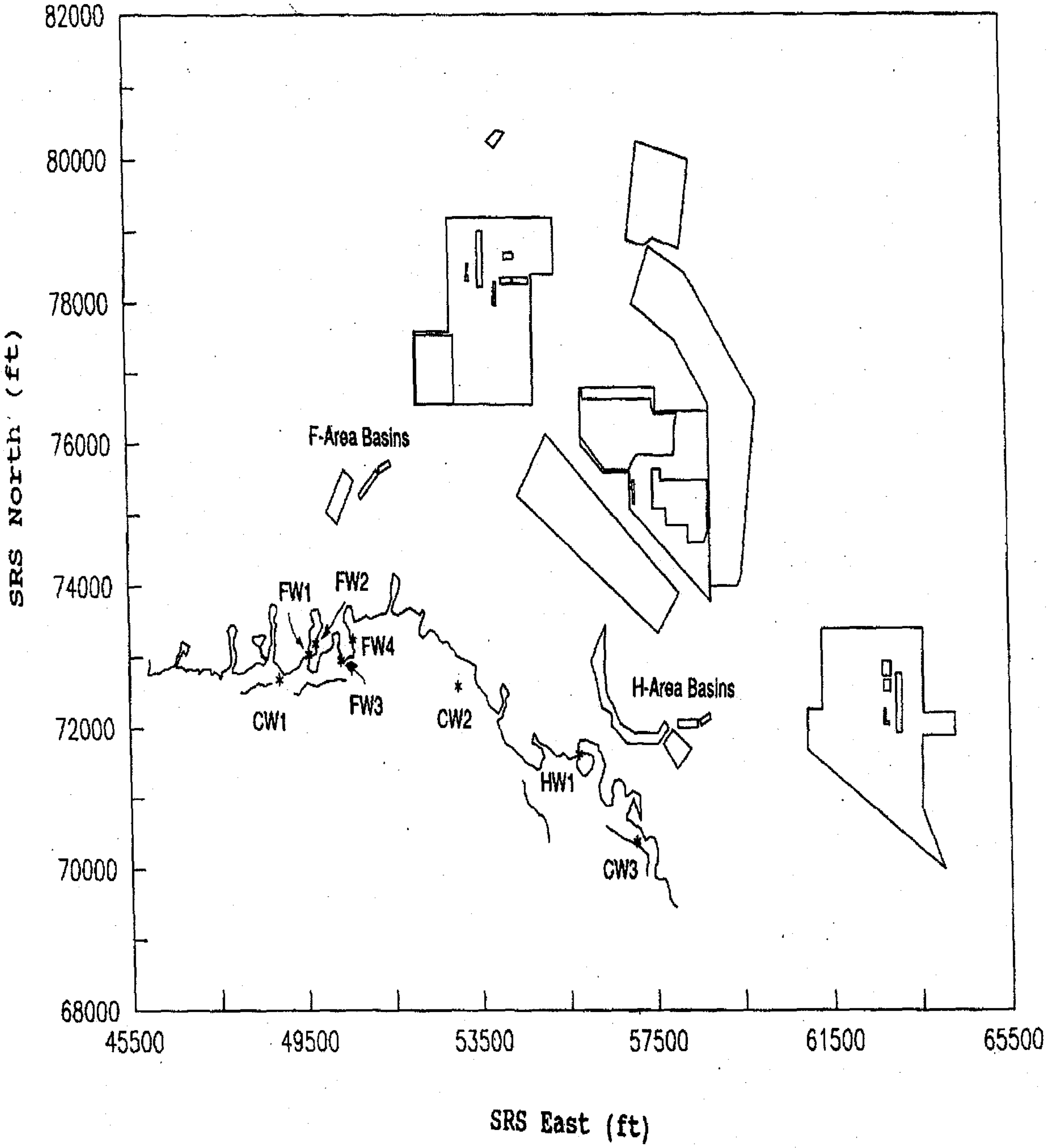

Figure 10. Location of seepline water samples collected in 1988.

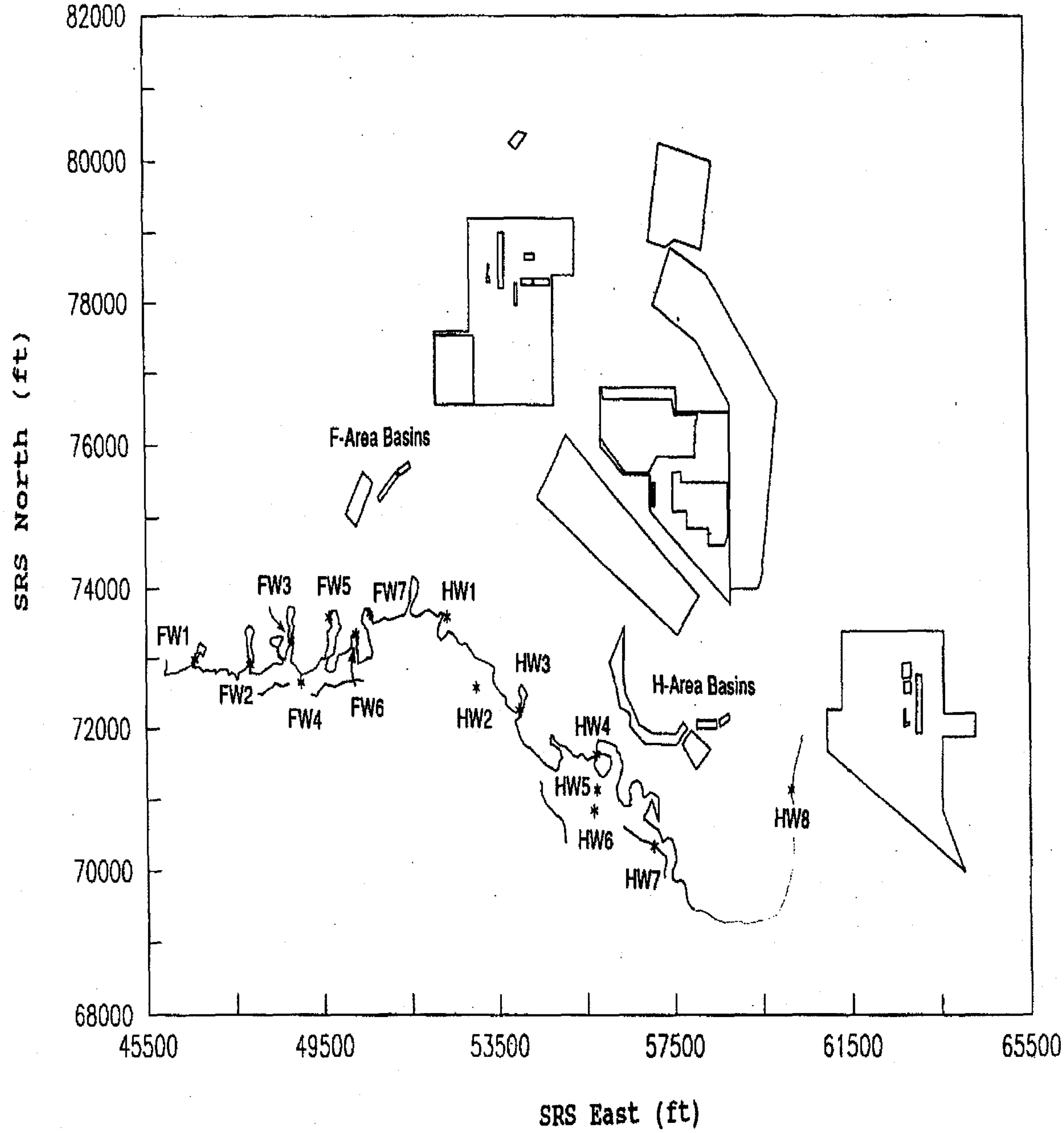

Figure 11. Location of seepline water samples collected in 1989.

Technical Division APPENDIX A DPST-88-229
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January 19, 1988

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SAMPLING AND ANALYSIS OF SURFACE WATER IN THE VICINITY OF THE F- AND H- AREA SEEPAGE BASINS

Introduction and Summary

Observations from the wetlands downgradient of the F-Area and H-Area Seepage Basins suggest that the water cropping out along the seep line is impacting a small area of the terrestrial/wetlands environment along Four Mile Creek. The primary source of the water in these areas, as well as dissolved constituents in this water, are the seepage basins. The seepage basins have received large volumes of dilute liquid wastewater since the late 1950's. The primary dissolved constituents in the wastewater are hydrogen ion (low pH), nitrate and sodium. The wastewater also contains relatively low concentrations of other chemical constituents (e.g., lead and mercury). The radioactive constituent with the highest activity in the wastewater is tritium; other relatively mobile radionuclides in the wastewater include ^{90}Sr, ^{99}Tc, ^{129}I, and ^{237}Np.

The authors would like to acknowledge the assistance of two subcontracting organizations: Environmental and Chemical Sciences, New Ellenton SC, and C. B. Shedrow Environmental Consultants, Inc., Columbia, SC.

A key element in the technical assessment of the wetlands downgradient of the F- and H- Area Seepage Basins is an analysis of the chemistry of the water cropping out at the seep lines. The bulk chemistry of this water, including major cations, major anions and ionic strength will determine the chemical speciation of all of the various solutes in the water. Detailed chemical analysis of the surface water in the area will:

- assist in determining the cause of the observed vegetation stress in the area and aid in estimating the recovery period (if the stress is related to water chemistry); and

- assist in determining the nature and extent of migration for various solutes (i.e., which waste constituents have been sequestered in the subsurface and which have migrated in the water).

The overall objective of the sampling and analysis program was to collect and analyze water samples from the subject wetlands along with upstream and downstream samples from Four Mile Creek.

In general, the results confirm the hypothesis that several trace metals are not migrating in the groundwater. Some constituents (primarily, sodium, nitrate and hydrogen ions) have reached the seep line and are affecting the bulk chemistry of the groundwater and surface water in the seep area. Several constituents (including aluminum, calcium, copper, ~~barium~~ and others) appear to be leaching out of the subsurface matrix along the flow path in the low pH water. All of the nonradioactive constituents measured along the seep line are below primary drinking water standards except cadmium in F-Area (0.041 mg/L maximum) and nitrate in both F-Area (546 mg/L maximum) and H-Area (36 mg/L maximum).

Samples from Four Mile Creek suggest that the input of the major constituents (primarily nitrate and sodium) from the seep areas (or area outfalls) is measurable in the stream. The remaining nonradioactive constituents do not measurably impact the stream. The sampling and analysis described below represents a high quality screening of the area that will aid researchers who are planning a more robust characterization (including more sites and analysis of a range of radionuclides) in the future.

Sampling

Representative surface water samples were collected from the seep areas downgradient of the F-Area and H-Area Seepage Basins and from Four Mile Creek upstream and downstream of these seep areas. At each seep area, the precise sampling location was chosen based on a screening of the specific conductivity of the water along the seep line; the location with the highest measured specific conductivity in each seep area was selected for detailed field and laboratory measurements (see attachment 1). The samples were collected in clean polyethylene beakers and bottles. The samples collected for metals were filtered in the field with a Nalgene Type A disposable polystyrene filter unit containing a 0.45 um equivalent pore size nitrocellulose membrane filter. The metals samples were then placed in acid washed bottles and preserved with 2 ml of nitric acid. Mercury analyses were performed on both the filtered and unfiltered (bulk) samples. Also, both filtered and nonfiltered samples for all metals were collected in Four mile Creek downstream of the F-Area Seepage Basins. Field notes and a description of each sample location are summarized in Table 1 (a complete listing is in Attachment 1). Figure 1 is a map showing the locations of the sampling sites.

Results

The various analyses are summarized in Tables 2 and 3. The complete data set is presented in Attachment 2. The median and maximum values for each location, along with the number of samples collected ~~is~~ are presented in Table 2. Table 3 shows the relationship between the filtered and unfiltered samples collected downstream of the F-Area Seepage Basins.

Discussion

The primary goals associated with the interpretation of these chemical data, along with the ecological and hydrogeological data, are to: (1) evaluate the potential effects of seepage basin operation on the downgradient receptors, (2) quantify the expected recovery of these areas following closure, and (3) determine the nature and extent of migration of the various solutes in the subsurface system. A preliminary discussion of these topics based on the chemical screening of surface waters in the vicinity of the seepage basins is presented below.

The concentrations of the various constituents in the seep areas downgradient of the seepage basins suggest that basin operations have significantly affected these areas. The concentrations of several waste constituents (primarily sodium, nitrate, and hydrogen ion) are elevated in the surface water along the seep line. This finding is consistent with the findings of Horton and Carothers (1974) in which elevated concentrations of nitrate were reported. Horton and Carothers (1974) reported a maximum seep line concentration of 217 mg/L (as N) in F Area and 242 mg/L (as N) in H Area. The data in Attachment 2 show that current levels at the same approximate locations are 174 to 546 mg/L (as N) in F Area and 22.9 to 36.3 mg/L (as N) in H Area. The appearance of tritium (Reichert, 1962, 1968), ^{99}Tc, ^{129}I (Anderson, 1980; Kantelo, 1987), and nitrate in the water along the seep line in the mid sixties and early seventies and relatively constant concentrations thereafter suggests that the front of these constituents (along with sodium) is relatively mobile and that the system has approximately reached a steady state. Horton and Carothers (1974) concluded the following in regard to nitrate in the groundwater and Four Mile Creek:

- The territory between the seepage basins and Four Mile Creek can not be released for unrestricted use until the nitrate has been reduced substantially. [Based on flow rate considerations,] this is estimated to require a decade or more after discharge of nitrate to the basins ceases. Such variables as groundwater flow rate when it is not influenced by water from the basins and the biological rate of nitrate removal will influence this time period.

- [Based on an analysis of stream concentrations and outfall concentrations,] the seepage basins are the major contributor of nitrate to the creek. The H seepage basins contributed nitrate at a rate of 88 tons/yr and the F seepage basins 65 tons/year during the sampling period (August through September 1973).

Interpretation of the current chemical data set from the groundwater, seep line and Four Mile Creek is generally consistent with that developed primarily for nitrate by Horton and Carothers (1974). Thus, relatively mobile constituents will flush through the subsurface system. During this period, elevated concentrations will exist in the surface seeps; following this period, the concentrations in the groundwater and surface waters in the vicinity should decline. The low concentrations of the various hazardous constituents (e.g., lead and mercury) suggests that these are not factors in the observed vegetation stress. The high conductivity, the high sodium, nitrate, and aluminum concentrations, and the flooding of previously dry areas caused by the basins are likely the factors influencing the vegetation in the affected areas.

As a preliminary means to determine the significance of the current concentrations, the levels of the various constituents along the seep line and in Four Mile Creek were compared to primary drinking water standards. All of the nonradioactive constituents measured along the seep line are below primary drinking water standards except cadmium in F-Area (0.041 mg/L maximum) and nitrate in both F-Area (546 mg/L maximum) and H-Area (36 mg/L maximum). All chemical constituents are below their respective primary drinking water standards in Four Mile Creek. A comparison of the filtered and unfiltered samples from Four Mile Creek downstream of F Area (note that this site is downstream of both facilities) indicates that particles play a minor role in transporting metals at this location.

The analyses of the upstream and downstream samples from each area suggest that the following parameters are statistically impacted (i.e., using a t-test and the t values for 95% confidence, the concentration was significantly higher downstream):

H Area - conductivity, total dissolved solids, nitrate, phosphate, sodium, and potassium

F Area - conductivity, total dissolved solids, sodium, manganese and possibly cadmium.

The remaining constituents were either not statistically elevated, or the concentration in the stream was higher than the seep line, or the concentration was lower downstream than upstream. These data suggest that the basins may contribute measurable quantities of the identified constituents to the stream. Note, however, that several outfalls enter Four Mile Creek in the subject area. The outfalls between the H-Area upstream and downstream samples include H8, H9 (abandoned), H11, and H12. The outfalls between the F-Area upstream and downstream samples include F8, and F10.

The relative subsurface mobility of the various constituents originally present in the wastewater sent to the seepage basins can be assessed in a preliminary fashion by calculating a ratio between the measured concentration in water at the seep line and the measured concentration of the wastewater sent to the basin. This "transport factor" will vary as a function of the mechanisms operating in the flow path. For example, if a constituent is sorbed to the subsurface matrix, chemically neutralized, biologically transformed, or utilized as a nutrient, it will be removed from the flowing water and the concentration will be significantly lower at the seep line than in the waste (transport factor << 1). If the chemistry of the infiltrating wastewater results in significant leaching of a constituent from the subsurface materials, the concentration at the seep will be higher than the original wastewater (transport factor >> 1). If the transport factor is near 1 for a constituent, it may be traveling with the water (or may be governed by a combination of sorption and leaching).

Table 4 summarizes the transport factors calculated using the median seep line concentrations and the wastewater concentrations reported in Killian et al. (1987a, 1987b). In general,

- mercury and chromium appear to be sequestered by the soil.

- sulfate and sodium appear to move with the groundwater.

- some constituents appear to have reached the seep area in F Area (pH = 3.8) but not in H Area (pH = 6.4). These include zinc and possibly lead.

- several constituents appear to be leached from the matrix in F Area but not in H Area. These include silica, calcium, barium, copper, aluminum, manganese, and magnesium.

Note that this approach is not definitive, and further study of the mobility of solutes as a function of solution and soil properties is recommended.

The sampling and analysis of surface water samples in the vicinity of the F- and H- Area Seepage Basins was carried out in a careful manner and the results provide a high quality screening of the conditions in the area. These data, the on-going analysis of radionuclides in the samples, and future studies will assist SRP and SRL in developing a technically sound closure plan that protects human health and the environment.

Table 1
Summary of Field Measurements and Observations

H-Area Seepage Basins Samples

Seep Area--Sample numbers FH 002, FH 008, and FH 014

Samples collected along the seep line downgradient of the H Area Seepage Basins--south of Basin H4. The water was turbid containing leaf litter.

H-Area Upstream--Sample numbers FH 003, FH 009, and FH 015

Samples collected approximately 50 m downstream of Road F on Four Mile Creek. The stream in this area is small but well defined. Upstream (across the road) is a marshy wetland area. The samples were brown colored and contained some solids.

H-Area Downstream--Sample numbers FH 004, FH 010, and FH 016

Samples collected approximately 100 m upstream of Road C on Four Mile Creek. The area has a deep clean channel, a high flow and low solids.

Table 1 (continued)
Summary of Field Measurements and Observations

F-Area Seepage Basins Samples

Seep Area--Sample numbers FH 001, FH 007, and FH 013

Samples collected along the seep line downgradient of the F Area Seepage Basins--east of well cluster FSB 79. Water was turbid containing leaf litter and a large crop of filamentous algae.

F-Area Upstream--Sample numbers FH 005, FH 011, and FH 017

Samples collected approximately 100 m downstream of Road C on Four Mile Creek. The area is very mucky and marshy and breaks into many small channels in this area. One of the northern channels was selected for sampling. The water was turbid containing flocculant brown mud.

F-Area Downstream--Sample numbers FH 006, FH 018

Samples collected approximately 10 m downstream of F-Area steam line road on Four Mile Creek. The area has a deep clean channel, a high flow and the least solids of any site. Three additional samples were collected at this site (FH 012, FH 019, and FH 020); the additional samples were collected without filtering the metals subsample.

Table 2
Summary of the Chemical Analyses of the Surface Water in the Vicinity of the F- and H- Area Seepage Basins

Surface Water Data in the Vicinity of the H-Area Seepage Basins

Parameter	Units	Seep Line			Four Mile Creek Upstream			Four Mile Creek Downstream		
		N	Median	Maximum	N	Median	Maximum	N	Median	Maximum
pH	- log[H]	6	6.4	NA	4	5.0	NA	4	6.6	NA
conductivity	uS/cm	6	293	348	4	30	31	4	90	92
total dissolved solids	mg/L	3	278	310	3	39	42	3	72	75
alkalinity (as CaCO3)	mg/L	3	27.9	90.3	3	< 1.0	< 1.0	3	16.1	16.2
nitrate (as N)	mg/L	3	28.5	36.3	3	0.04	0.11	3	1.15	1.2
nitrite (as N)	mg/L	3	0.031	0.033	3	0.019	0.024	3	0.005	0.005
phosphate (as P)	mg/L	3	1.86	6.22	3	0.011	0.014	3	0.023	0.023
sulfate (as SO4)	mg/L	3	5.4	5.7	3	1.8	2.2	3	10.5	10.8
total carbon (as C)	mg/L	3	25.9	35.8	3	8.3	8.9	3	8.2	8.3
total inorganic carbon (as C)	mg/L	3	11.7	16.0	3	4.0	4.4	3	4.6	6.8
total organic carbon (as C)	mg/L	3	14.2	19.8	3	4.3	5.6	3	3.6	3.7
silica (as SiO2)	mg/L	3	5.5	5.6	3	10	10	3	9.9	10.2
chloride	mg/L	3	5.3	6.2	3	6.5	6.6	3	5.1	5.3
flouride	mg/L	3	< 0.1	< 0.1	3	< 0.1	< 0.1	3	< 0.1	< 0.1
total mercury (unfiltered)	mg/L	3	< 0.0001	< 0.0001	3	< 0.0001	< 0.0001	3	< 0.0001	0.00024
dissolved mercury (filtered)	mg/L	3	< 0.0001	0.00015	3	< 0.0001	0.00013	3	< 0.0001	0.00012
dissolved chromium	mg/L	3	< 0.001	< 0.001	3	< 0.001	< 0.001	3	< 0.001	< 0.001
dissolved lead	mg/L	3	< 0.003	< 0.003	3	< 0.003	< 0.003	3	< 0.003	< 0.003
dissolved cadmium	mg/L	3	< 0.0001	< 0.0001	3	< 0.0001	0.00011	3	< 0.0001	< 0.0001
dissolved nickel	mg/L	3	< 0.05	< 0.05	3	< 0.05	< 0.05	3	< 0.05	< 0.05
dissolved sodium	mg/L	3	68.4	69.3	3	2.8	2.8	3	13.1	13.2
dissolved potassium	mg/L	3	1.85	1.86	3	< 0.20	< 0.20	3	1.57	1.61
dissolved calcium	mg/L	3	1.67	1.8	3	1.45	1.47	3	4.03	4.12
dissolved magnesium	mg/L	3	1.43	1.48	3	0.55	0.55	3	0.66	0.69
dissolved barium	mg/L	3	< 0.05	< 0.05	3	< 0.05	< 0.05	3	< 0.05	< 0.05
dissolved copper	mg/L	3	< 0.05	< 0.05	3	< 0.05	< 0.05	3	< 0.05	< 0.05
dissolved manganese	mg/L	3	0.145	0.164	3	0.118	0.119	3	0.083	0.085
dissolved aluminium	mg/L	3	0.163	0.183	3	0.06	0.065	3	< 0.05	< 0.05
dissolved zinc	mg/L	3	< 0.02	< 0.02	3	< 0.02	< 0.02	3	< 0.02	< 0.02
dissolved antimony	mg/L	3	< 0.01	< 0.01	3	< 0.01	< 0.01	3	< 0.01	< 0.01
dissolved thallium	mg/L	3	< 0.004	< 0.004	3	< 0.004	< 0.004	3	< 0.004	< 0.004

Table 2 (continued)
Summary of the Chemical Analyses of the Surface Water in the Vicinity of the F- and H- Area Seepage Basins

Surface Water Data in the Vicinity of the F-Area Seepage Basins

Parameter	Units	Seep Line			Four Mile Creek Upstream			Four Mile Creek Downstream		
		N	Median	Maximum	N	Median	Maximum	N	Median	Maximum
pH	- log[H]	6	3.8	NA	4	6.7	NA	6	6.6	NA
conductivity	uS/cm	6	1295	1760	4	82	82	6	108	160
total dissolved solids	mg/L	3	1020	1100	3	73	74	5	82	83
alkalinity (as CaCO3)	mg/L	3	< 1.0	< 1.0	3	14.2	14.3	5	11.4	11.5
nitrate (as N)	mg/L	3	226	546	3	0.92	3.53	5	3.59	3.7
nitrite (as N)	mg/L	3	0.011	0.013	3	0.003	0.004	5	0.003	0.004
phosphate (as P)	mg/L	3	1.38	4.62	3	0.041	0.043	5	0.011	0.033
sulfate (as SO4)	mg/L	3	< 1.0	1	3	10.9	13.7	5	13.6	13.9
total carbon (as C)	mg/L	3	11.3	13.8	3	6.5	6.6	5	4.9	5.9
total inorganic carbon (as C)	mg/L	3	11.2	12.1	3	4.0	5.2	5	3.6	4.2
total organic carbon (as C)	mg/L	3	2.5	2.6	3	2.5	3.2	5	1.1	2.6
silica (as SiO2)	mg/L	3	57.5	59.9	3	10	10.1	5	10.1	10.3
chloride	mg/L	3	3.8	3.8	3	5.1	5.6	5	5	5.3
flouride	mg/L	3	0.29	0.43	3	< 0.1	< 0.1	5	< 0.1	< 0.1
total mercury (unfiltered)	mg/L	3	< 0.0001	0.00014	3	< 0.0001	< 0.0001	8	< 0.0001	0.00018
dissolved mercury (filtered)	mg/L	3	< 0.0001	< 0.0001	3	< 0.0001	< 0.0001	2	< 0.0001	0.00016
dissolved chromium	mg/L	3	< 0.001	< 0.001	3	< 0.001	< 0.001	2	< 0.001	< 0.001
dissolved lead	mg/L	3	0.0033	0.014	3	< 0.003	< 0.003	2	< 0.003	< 0.003
dissolved cadmium	mg/L	3	0.037	0.041	3	< 0.0001	< 0.0001	2	0.00028	0.00035
dissolved nickel	mg/L	3	< 0.05	0.056	3	< 0.05	< 0.05	2	< 0.05	< 0.05
dissolved sodium	mg/L	3	142	144	3	12.8	13.1	2	16.8	16.9
dissolved potassium	mg/L	3	1.91	2.16	3	1.33	1.38	2	1.33	1.34
dissolved calcium	mg/L	3	19.1	19.5	3	2.95	2.95	2	3.41	3.43
dissolved magnesium	mg/L	3	13.4	14.1	3	0.56	0.56	2	0.72	0.74
dissolved barium	mg/L	3	0.585	0.586	3	< 0.05	< 0.05	2	< 0.05	< 0.05
dissolved copper	mg/L	3	0.064	0.436	3	< 0.05	< 0.05	2	< 0.05	< 0.05
dissolved manganese	mg/L	3	2.72	2.72	3	0.079	0.08	2	0.137	0.146
dissolved aluminium	mg/L	3	64.3	68.9	3	< 0.05	< 0.05	2	-	0.648
dissolved zinc	mg/L	3	0.152	0.197	3	< 0.02	< 0.02	2	< 0.02	< 0.02
dissolved antimony	mg/L	3	< 0.01	< 0.01	3	< 0.01	< 0.01	2	< 0.01	< 0.01
dissolved thallium	mg/L	3	< 0.004	< 0.004	3	< 0.004	< 0.004	2	< 0.004	< 0.004

Table 3
Comparison of Filtered and Unfiltered Metals Concentrations for Four Mile Creek Downstream of F-Area

Concentration Data From Four Mile Creek Downstream of F Area

Parameter	Units	Filtered Samples			Unfiltered Samples		
		N	Median	Maximum	N	Median	Maximum
mercury	mg/L	2	< 0.0001	0.00016	8	< 0.0001	0.00018
chromium	mg/L	2	< 0.001	< 0.001	3	< 0.001	< 0.001
lead	mg/L	2	< 0.003	< 0.003	3	< 0.003	< 0.003
cadmium	mg/L	2	0.00028	0.00035	3	0.00031	0.00036
nickel	mg/L	2	< 0.05	< 0.05	3	< 0.05	< 0.05
sodium	mg/L	2	16.8	16.9	3	17.0	17.0
potassium	mg/L	2	1.33	1.34	3	1.35	1.40
calcium	mg/L	2	3.41	3.43	3	3.45	3.47
magnesium	mg/L	2	0.72	0.74	3	0.71	0.75
barium	mg/L	2	< 0.05	< 0.05	3	< 0.05	< 0.05
copper	mg/L	2	< 0.05	< 0.05	3	< 0.05	< 0.05
manganese	mg/L	2	0.137	0.146	3	0.147	0.149
aluminium	mg/L	2	–	0.648	3	0.689	0.701
zinc	mg/L	2	< 0.02	< 0.02	3	< 0.02	< 0.02
antimony	mg/L	2	< 0.01	< 0.01	3	< 0.01	< 0.01
thallium	mg/L	2	< 0.004	< 0.004	3	< 0.004	< 0.004

Table 4

Calculated Transport Factors and Suggested Dominant Transport Mechanisms

Transport Factors based on F-Area Data

CONSTITUENT	TRANSPORT FACTOR
Mercury	< 0.03
Chromium	<0.08
Lead	0.1
Hydrogen Ion	0.1
Sulfate	0.2
Fluoride	0.2
Sodium	0.2
Nitrate	0.2
Zinc	0.5
Phosphate	0.6
Potassium	3.
Chloride	3.
Silica	6.
Calcium	40.
Barium	60.
Copper	60.
Aluminum	80.
Manganese	200.
Magnesium	200.

DOMINANT MECHANISMS

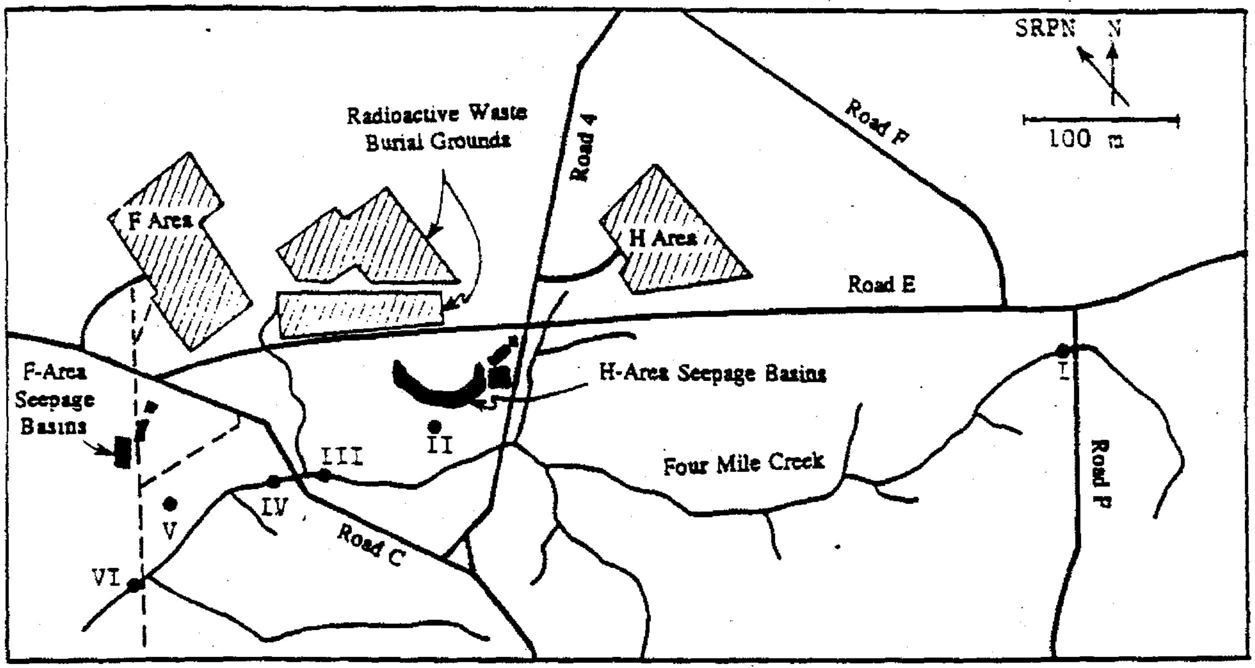
- sorbed on subsurface materials or neutralized
- transported in groundwater or a combination of sorption and leaching
- leaching of soils and sediments along flow path

Transport Factors based on H-Area Data

CONSTITUENT	TRANSPORT FACTOR
Hydrogen Ion	< 0.00001
Mercury	<0.00002
Zinc	0.006
Chromium	0.01
Lead	0.02
Nitrate	0.05
Calcium	0.05
Aluminum	0.05
Copper	0.1
Manganese	0.3
Barium	0.6
Fluoride	1.
Silica	1.
Sulfate	1
Magnesium	1.
Potassium	2.
Phosphate	3.
Sodium	4.
Chloride	5.

DOMINANT MECHANISMS

- sorbed on subsurface materials or neutralized
- transported in groundwater or a combination of sorption and leaching
- leaching of soils and sediments along flow path



Sample Location Key:

		Approximate Coordinates SRP N	SRP E
I	Four Mile Creek Upstream of H Area -	64750	68125
II	Seep Area Downgradient of H-Area Basins -	71800	55800
III	Four Mile Creek Downstream of H Area -	72250	53500
IV	Four Mile Creek Upstream of F Area -	73000	52250
V	Seep Area Downgradient of F-Area Basins -	73600	50400
VI	Four Mile Creek Downstream of F Area -	72875	48625

Figure 1. Locations and Names of the Sampling Sites

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Attachment 1

List of Parameters Analyzed and Field Notes

(Samples collected 12-08-87)

Table 1-1
List of Parameters Analyzed

pH (lab and field)
Conductivity (lab and field)
total dissolved solids
alkalinity
nitrate
nitrite
phosphate
sulfate
total carbon
total inorganic carbon
total organic carbon
silica
chloride
fluoride
mercury
chromium
lead
cadmium
nickel
sodium
potassium
calcium
magnesium
barium
copper
manganese
aluminum
zinc
antimony
thallium

Note: Samples for analysis of a limited number of radionuclides were collected. The results will be reported in a separate report. The samples were collected using clean bottles or beakers. In some cases the amount of solids in the three samples from a site varied significantly. A scheme employing a peristaltic pump is recommended for future sampling in these shallow seep areas that are underlain by flocculant muds.

Table 1-2
Field Measurements and Observations

H-Area Seepage Basins Samples

Seep Area--Sample numbers FH 002, FH 008, and FH 014

The conductivity of the standing water along the seep line ranged from 170 uS/cm to 245 uS/cm. The location of the highest conductivity was sampled. The pH and conductivity of the actual samples is listed below.

pH = 5.6 to 6.4
conductivity = 182 to 200 uS/cm
water temperature = 16.0° C.

Samples collected along the seep line downgradient of the H Area Seepage Basins--south of Basin H4. The water was turbid containing leaf litter.

H-Area Upstream--Sample numbers FH 003, FH 009, and FH 015

pH = 6.1
conductivity = 20 uS/cm
water temperature = 15.0° C.

Samples collected approximately 50 m downstream of Road F on Four Mile Creek. The stream in this area is small but well defined. Upstream (across the road) is a marshy wetland area. The samples were brown colored and contained some solids.

H-Area Downstream--Sample numbers FH 004, FH 010, and FH 016

pH = 6.0
conductivity = 70 uS/cm
water temperature = 18.0° C.

Samples collected approximately 100 m upstream of Road C on Four Mile Creek. The area has a deep clean channel, a high flow and low solids.

Table 1-2 (continued)
Field Measurements and Observations

F-Area Seepage Basins Samples

Seep Area--Sample numbers FH 001, FH 007, and FH 013

The conductivity of the standing water along the seep line ranged from 465 uS/cm to 1030 uS/cm. The location of the highest conductivity was sampled. The pH and conductivity of the actual samples is listed below.

pH = 3.4 to 3.8
conductivity = 920 to 950 uS/cm
water temperature = 11.8^{o} C.

Samples collected along the seep line downgradient of the F Area Seepage Basins--east of well cluster FSB 79. Water was turbid containing leaf litter and a large crop of filamentous algae.

F-Area Upstream--Sample numbers FH 005, FH 011, and FH 017

pH = 6.9
conductivity = 42 uS/cm
water temperature = 20.5^{o} C.

Samples collected approximately 100 m downstream of Road C on Four Mile Creek. The area is very mucky and marshy and breaks into many small channels in this area. One of the northern channels was selected for sampling. The water was turbid containing flocculant brown mud.

F-Area Downstream--Sample numbers FH 006, FH 018

pH = 6.3
conductivity = 70 uS/cm
water temperature = 17.0^{o} C.

Samples collected approximately 10 m downstream of F-Area steam line road on Four Mile Creek. The area has a deep clean channel, a high flow and the least solids of any site. Three additional samples were collected at this site (FH 012, FH 019, and FH 020); the additional samples were collected without filtering the metals subsample.

Attachment 2

Complete Data Set

Attachment 2

Table 2-1

Sample Location	Sample ID	pH (field)	pH (lab)	conductivity uS/cm (field)	conductivity uS/cm (lab)	total dissolved solids mg/L	Alkalinity (as CaCO3) mg/L
Seep Area Downgradient of H Area Basins	FH 002	6.4	6.31	182	348	278	19.6
Seep Area Downgradient of H Area Basins	FH 008	6.3	6.44	200	338	310	90.3
Seep Area Downgradient of H Area Basins	FH 014	5.6	6.43	200	341	260	27.9
Four Mile Creek Upstream of H Area	FH 003	6.1	4.97	20	30	39	< 1.0
Four Mile Creek Upstream of H Area	FH 009	--	5.04	--	31	42	< 1.0
Four Mile Creek Upstream of H Area	FH 015	--	5.07	--	30	35	< 1.0
Four Mile Creek Downstream of H Area	FH 004	6.0	6.59	70	90	75	16.2
Four Mile Creek Downstream of H Area	FH 010	--	6.64	--	92	72	16.1
Four Mile Creek Downstream of H Area	FH 016	--	6.67	--	90	72	15.9
Seep Area Downgradient of F Area Basins	FH 001	3.8	3.81	950	1760	1100	< 1.0
Seep Area Downgradient of F Area Basins	FH 007	3.4	3.82	920	1650	1020	< 1.0
Seep Area Downgradient of F Area Basins	FH 013	3.8	3.84	920	1640	785	< 1.0
Four Mile Creek Upstream of F Area	FH 005	6.9	6.66	42	82	74	13.5
Four Mile Creek Upstream of F Area	FH 011	--	6.73	--	82	73	14.2
Four Mile Creek Upstream of F Area	FH 017	--	6.73	--	82	70	14.3
Four Mile Creek Downstream of F Area	FH 006	6.3	6.58	70	109	82	11.5
Four Mile Creek Downstream of F Area	FH 012	--	6.64	--	109	79	11.5
Four Mile Creek Downstream of F Area	FH 018	--	6.64	--	107	82	11.4
Four Mile Creek Downstream of F Area	FH 019	--	6.72	--	160	83	10.3
Four Mile Creek Downstream of F Area	FH 020	--	6.62	--	108	79	11.3

Table 2-1 (continued)

Sample Location	Sample ID	Nitrate (as N) mg/L	Nitrite (as N) mg/L	Phosphate (as P) mg/L	Sulfate (as SO4) mg/L	Total carbon (as C) mg/L	Total inorganic carbon (as C) mg/L
Seep Area Downgradient of H Area Basins	FH 002	36.3	0.033	1.86	5.2	24.8	11.5
Seep Area Downgradient of H Area Basins	FH 008	22.9	0.031	6.22	5.7	35.8	16.0
Seep Area Downgradient of H Area Basins	FH 014	28.5	0.017	0.041	5.4	25.9	11.7
Four Mile Creek Upstream of H Area	FH 003	0.04	0.019	0.011	1.8	8.9	3.3
Four Mile Creek Upstream of H Area	FH 009	0.11	0.024	0.014	2.2	8.3	4.0
Four Mile Creek Upstream of H Area	FH 015	0.03	< 0.001	0.011	1.8	8.3	4.4
Four Mile Creek Downstream of H Area	FH 004	1.20	0.005	0.022	10.8	8.2	4.6
Four Mile Creek Downstream of H Area	FH 010	1.15	0.005	0.023	10.5	7.9	4.2
Four Mile Creek Downstream of H Area	FH 016	1.04	0.004	0.023	10.5	8.3	6.8
Seep Area Downgradient of F Area Basins	FH 001	546	< 0.001	1.38	< 1	10.6	8.1
Seep Area Downgradient of F Area Basins	FH 007	226	0.013	0.72	< 1	11.3	12.1
Seep Area Downgradient of F Area Basins	FH 013	174	0.011	4.62	1.0	13.8	11.2
Four Mile Creek Upstream of F Area	FH 005	0.90	0.004	0.041	10.9	6.5	4.0
Four Mile Creek Upstream of F Area	FH 011	0.92	< 0.001	0.041	10.9	6.6	3.4
Four Mile Creek Upstream of F Area	FH 017	3.53	0.003	0.043	13.7	6.4	5.2
Four Mile Creek Downstream of F Area	FH 006	3.59	0.004	0.017	13.7	5.1	3.0
Four Mile Creek Downstream of F Area	FH 012	3.43	< 0.001	0.011	13.9	5.9	3.3
Four Mile Creek Downstream of F Area	FH 018	0.10	0.003	0.011	10.6	4.9	4.2
Four Mile Creek Downstream of F Area	FH 019	3.70	0.003	0.033	13.6	4.7	3.6
Four Mile Creek Downstream of F Area	FH 020	3.70	0.003	0.011	13.6	4.8	3.9

Table 2-1 (continued)

Sample Location	Sample ID	Total organic carbon (as C) mg/L	Silica (as SiO2) mg/L	Chloride mg/L	Fluoride mg/L
Seep Area Downgradient of H Area Basins	FH 002	13.3	5.6	5.31	< 0.1
Seep Area Downgradient of H Area Basins	FH 008	19.8	5.2	6.20	< 0.1
Seep Area Downgradient of H Area Basins	FH 014	14.2	5.5	4.84	< 0.1
Four Mile Creek Upstream of H Area	FH 003	5.6	9.9	6.62	< 0.1
Four Mile Creek Upstream of H Area	FH 009	4.3	10.0	6.51	< 0.1
Four Mile Creek Upstream of H Area	FH 015	3.9	10.0	6.24	< 0.1
Four Mile Creek Downstream of H Area	FH 004	3.6	10.2	5.33	< 0.1
Four Mile Creek Downstream of H Area	FH 010	3.7	9.9	5.10	< 0.1
Four Mile Creek Downstream of H Area	FH 016	1.5	9.8	4.73	< 0.1
Seep Area Downgradient of F Area Basins	FH 001	2.5	59.9	3.16	0.28
Seep Area Downgradient of F Area Basins	FH 007	< 1.0	57.5	3.81	0.43
Seep Area Downgradient of F Area Basins	FH 013	2.6	57.2	3.81	0.29
Four Mile Creek Upstream of F Area	FH 005	2.5	10.1	5.62	< 0.1
Four Mile Creek Upstream of F Area	FH 011	3.2	10.0	5.08	< 0.1
Four Mile Creek Upstream of F Area	FH 017	1.2	10.0	4.82	< 0.1
Four Mile Creek Downstream of F Area	FH 006	2.1	10.3	5.33	< 0.1
Four Mile Creek Downstream of F Area	FH 012	2.6	10.1	4.98	< 0.1
Four Mile Creek Downstream of F Area	FH 018	< 1.0	10.3	4.99	< 0.1
Four Mile Creek Downstream of F Area	FH 019	1.1	10.1	4.94	< 0.1
Four Mile Creek Downstream of F Area	FH 020	< 1.0	10.3	4.92	< 0.1

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Table 2-1 (continued)

Sample Location	Sample ID	unfiltered Mercury (total) mg/L	filtered Mercury (dissolved) mg/L	Chromium mg/L	Lead mg/L	Cadmium mg/L	Nickel mg/L	Sodium mg/L
Filtered Samples (except as noted)								
Seep Area Downgradient of H Area Basins	FH 002	< 0.00010	0.00015	< 0.001	< 0.003	< 0.0001	< 0.05	68.4
Seep Area Downgradient of H Area Basins	FH 008	< 0.00010	< 0.00010	< 0.001	< 0.003	< 0.0001	< 0.05	68.0
Seep Area Downgradient of H Area Basins	FH 014	< 0.00010	< 0.00010	< 0.001	< 0.003	< 0.0001	< 0.05	69.3
Four Mile Creek Upstream of H Area	FH 003	< 0.00010	0.00013	< 0.001	< 0.003	< 0.0001	< 0.05	2.7
Four Mile Creek Upstream of H Area	FH 009	< 0.00010	< 0.00010	< 0.001	< 0.003	< 0.0001	< 0.05	2.8
Four Mile Creek Upstream of H Area	FH 015	< 0.00010	< 0.00010	< 0.001	< 0.003	0.00011	< 0.05	2.8
Four Mile Creek Downstream of H Area	FH 004	< 0.00010	0.00012	< 0.001	< 0.003	< 0.0001	< 0.05	13.1
Four Mile Creek Downstream of H Area	FH 010	0.00024	< 0.00010	< 0.001	< 0.003	< 0.0001	< 0.05	12.9
Four Mile Creek Downstream of H Area	FH 016	< 0.00010	< 0.00010	< 0.001	< 0.003	< 0.0001	< 0.05	13.2
Seep Area Downgradient of F Area Basins	FH 001	< 0.00010	< 0.00010	< 0.001	0.0033	0.037	< 0.05	144
Seep Area Downgradient of F Area Basins	FH 007	< 0.00010	< 0.00010	< 0.001	< 0.003	0.036	< 0.05	136
Seep Area Downgradient of F Area Basins	FH 013	0.00014	< 0.00010	< 0.001	0.014	0.041	0.056	142
Four Mile Creek Upstream of F Area	FH 005	< 0.00010	< 0.00010	< 0.001	< 0.003	< 0.0001	< 0.05	12.8
Four Mile Creek Upstream of F Area	FH 011	< 0.00010	< 0.00010	< 0.001	< 0.003	< 0.0001	< 0.05	12.5
Four Mile Creek Upstream of F Area	FH 017	< 0.00010	< 0.00010	< 0.001	< 0.003	< 0.0001	< 0.05	13.1
Four Mile Creek Downstream of F Area	FH 006	< 0.00010	< 0.00010	< 0.001	< 0.003	0.0002	< 0.05	16.9
Four Mile Creek Downstream of F Area	FH 012	< 0.00010	0.00016	< 0.001	< 0.003	0.00035	< 0.05	16.6
Unfiltered Samples (total concentrations)								
Four Mile Creek Downstream of F Area	FH 018	< 0.00010	< 0.00010	< 0.001	< 0.003	0.00031	< 0.05	17.0
Four Mile Creek Downstream of F Area	FH 019	< 0.00010	0.00018	< 0.001	< 0.003	0.00036	< 0.05	17.0
Four Mile Creek Downstream of F Area	FH 020	< 0.00010	< 0.00010	< 0.001	< 0.003	0.00034	< 0.05	16.9

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Table 2-1 (continued)

Sample Location	Sample ID	Potassium mg/L	Calcium mg/L	Magnesium mg/L	Barium mg/L	Copper mg/L	Manganese mg/L	Aluminium mg/L
Filtered Samples (except as noted)								
Seep Area Downgradient of H Area Basins	FH 002	1.86	1.55	1.28	< 0.05	< 0.05	0.101	0.163
Seep Area Downgradient of H Area Basins	FH 008	1.76	1.67	1.48	< 0.05	< 0.05	0.164	0.137
Seep Area Downgradient of H Area Basins	FH 014	1.85	1.80	1.43	< 0.05	< 0.05	0.145	0.183
Four Mile Creek Upstream of H Area	FH 003	< 0.20	1.47	0.52	< 0.05	< 0.05	0.119	< 0.05
Four Mile Creek Upstream of H Area	FH 009	< 0.20	1.44	0.55	< 0.05	< 0.05	0.118	0.065
Four Mile Creek Upstream of H Area	FH 015	< 0.20	1.45	0.55	< 0.05	< 0.05	0.117	0.06
Four Mile Creek Downstream of H Area	FH 004	1.61	4.12	0.69	< 0.05	< 0.05	0.085	< 0.05
Four Mile Creek Downstream of H Area	FH 010	1.57	4.03	0.66	< 0.05	< 0.05	0.083	< 0.05
Four Mile Creek Downstream of H Area	FH 016	1.51	4.03	0.66	< 0.05	< 0.05	0.079	< 0.05
Seep Area Downgradient of F Area Basins	FH 001	2.16	19.1	12.7	0.586	0.064	2.72	68.9
Seep Area Downgradient of F Area Basins	FH 007	1.87	18.5	13.4	0.572	0.057	2.69	64.0
Seep Area Downgradient of F Area Basins	FH 013	1.91	19.5	14.1	0.585	0.436	2.72	64.3
Four Mile Creek Upstream of F Area	FH 005	1.27	2.95	0.56	< 0.05	< 0.05	0.054	< 0.05
Four Mile Creek Upstream of F Area	FH 011	1.33	2.84	0.54	< 0.05	< 0.05	0.079	< 0.05
Four Mile Creek Upstream of F Area	FH 017	1.38	2.95	0.56	< 0.05	< 0.05	0.08	< 0.05
Four Mile Creek Downstream of F Area	FH 006	1.31	3.38	0.74	< 0.05	< 0.05	0.127	< 0.05
Four Mile Creek Downstream of F Area	FH 012	1.34	3.43	0.70	< 0.05	< 0.05	0.146	0.648
Unfiltered Samples (total concentrations)								
Four Mile Creek Downstream of F Area	FH 018	1.35	3.47	0.75	< 0.05	< 0.05	0.127	< 0.05
Four Mile Creek Downstream of F Area	FH 019	1.27	3.40	0.69	< 0.05	< 0.05	0.149	0.689
Four Mile Creek Downstream of F Area	FH 020	1.40	3.45	0.71	< 0.05	< 0.05	0.147	0.701

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Table 2-1 (continued)

Sample Location	Sample ID	Zinc mg/L	Antimony mg/L	Thallium mg/L
Filtered Samples (except as noted)				
Seep Area Downgradient of H Area Basins	FH 002	< 0.02	< 0.01	< 0.004
Seep Area Downgradient of H Area Basins	FH 008	< 0.02	< 0.01	< 0.004
Seep Area Downgradient of H Area Basins	FH 014	< 0.02	< 0.01	< 0.004
Four Mile Creek Upstream of H Area	FH 003	< 0.02	< 0.01	< 0.004
Four Mile Creek Upstream of H Area	FH 009	< 0.02	< 0.01	< 0.004
Four Mile Creek Upstream of H Area	FH 015	< 0.02	< 0.01	< 0.004
Four Mile Creek Downstream of H Area	FH 004	< 0.02	< 0.01	< 0.004
Four Mile Creek Downstream of H Area	FH 010	< 0.02	< 0.01	< 0.004
Four Mile Creek Downstream of H Area	FH 016	< 0.02	< 0.01	< 0.004
Seep Area Downgradient of F Area Basins	FH 001	0.152	< 0.01	< 0.004
Seep Area Downgradient of F Area Basins	FH 007	0.146	< 0.01	< 0.004
Seep Area Downgradient of F Area Basins	FH 013	0.197	< 0.01	< 0.004
Four Mile Creek Upstream of F Area	FH 005	< 0.02	< 0.01	< 0.004
Four Mile Creek Upstream of F Area	FH 011	< 0.02	< 0.01	< 0.004
Four Mile Creek Upstream of F Area	FH 017	< 0.02	< 0.01	< 0.004
Four Mile Creek Downstream of F Area	FH 006	< 0.02	< 0.01	< 0.004
Four Mile Creek Downstream of F Area	FH 012	< 0.02	< 0.01	< 0.004
Unfiltered Samples (total concentrations)				
Four Mile Creek Downstream of F Area	FH 018	< 0.02	< 0.01	< 0.004
Four Mile Creek Downstream of F Area	FH 019	< 0.02	< 0.01	< 0.004
Four Mile Creek Downstream of F Area	FH 020	< 0.02	< 0.01	< 0.004

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Appendix B

Sample	Tritium Conc. (pCi/ml) (3/89)	(1/90)	d (1/90 - 3/89)
HSP-94	240	750	+510
HSP-95	570	750	+180
HSP-96	1100	1600	+500
HSP-97	1100	1500	+400
HSP-98	1800	1500	-300
HSP-99	1200	1200	0
HSP-100	1300	1800	+500
HSP-101	690	950	+260
HSP-102	700	610	-90
HSP-103	510	400	-110
HSP-104	660	810	+150
HSP-105	740	810	+70
HSP-106	640	740	+100
HSP-107	480	460	-20
HSP-108	680	910	+230
HSP-109	680	230	-450
Average	818	939	+121

$$s_d^2 = \frac{510^2+180^2+500^2+\ldots+450^2}{16} = 8900.$$

$$s_d = \sqrt{s_d^2} = 298$$

$$H_o:\ d=0.$$

$$t_o = \frac{\bar{d}-0}{s_d} = \frac{121}{298} = 0.40$$

$$\Pr\ (\ t > 0.40\ ) \approx 0.35$$

Station Designati	Cond. (µmhos/cm)	pH	Temp. (° C.)		Sampling Date
HSP-01	156	5	10		03/02/89
HSP-02	256	5.2	11	2	03/02/89
HSP-03	468	5.2	12	3	03/02/89
HSP-04	292	5.8	10	5	03/02/89
HSP-05	281	6.2	10	4	03/02/89
HSP-06	318	6.1	10	5	03/02/89
HSP-07	dry hole	dry hole	dry hole	dry hole	03/02/89
HSP-08	556	5.7	11	4	03/02/89
HSP-09	317	5.5	11	4	03/02/89
HSP-10	171	5.6	10	6	03/02/89
HSP-11	80	5.1	11	4	03/02/89
HSP-12	218	5.2	11	2	03/02/89
HSP-13	592	6.2	11	3	03/03/89
HSP-14	393	6.2	11	surface	03/03/89
HSP-15	82	5.2	11	surface	03/03/89
HSP-16	216	5	11	4	03/03/89
HSP-17	dry hole	dry hole	dry hole	dry hole	03/03/89
HSP-18	149	5.5	11	1	03/03/89
HSP-19	148	4.7	12	4	03/03/89
HSP-20	183	6.2	15	surface	03/03/89
HSP-21	189	6.1	14	1	03/06/89
HSP-22	161	5.4	15	1	03/06/89
HSP-23	184	4.7	15	4	03/06/89
HSP-24	140	5.2	14	3	03/06/89
HSP-25	135	4.7	15	7	03/06/89
HSP-26	205	5.2	14	2	03/06/89
HSP-27	202	5.4	14	6	03/06/89
HSP-28	244	5.7	14	2	03/06/89
HSP-29	257	5.2	15	3	03/06/89
HSP-30	121	5.3	15	3	03/06/89
HSP-31	214	5.6	14	1	03/06/89
HSP-32	215	5.5	14	6	03/06/89
HSP-33	176	5.8	14	6	03/06/89
HSP-34	331	5.8	14	8	03/06/89
HSP-35	121	5.8	13	1	03/07/89
HSP-36	210	5.4	13	7	03/07/89
HSP-37	231	5.3	13	10	03/07/89
HSP-38	227	4.9	12	5	03/07/89
HSP-39	242	5.1	12.5	4	03/07/89
HSP-40	256	4.7	12	3	03/07/89
HSP-41	224	4.8	12	8	03/07/89
HSP-42	310	5.2	12	8	03/07/89
HSP-43	413	5.3	12	9	03/07/89
HSP-44	333	5.2	12	8	03/07/89
HSP-45	255	4.5	12	6	03/07/89
HSP-46	318	5.5	12	8	03/07/89
HSP-47	426	5.4	12	6	03/07/89
HSP-48	569	4.5	12	10	03/07/89
HSP-49	551	4.4	13	8	03/07/89

HSP-50	537	4.4	12	7	03/07/89
HSP-51	654	4.8	12	6	03/07/89
HSP-52	699	4.1	12	7	03/07/89
HSP-53	669	4.4	12	10	03/07/89
HSP-54	631	4.4	12	8	03/07/89
HSP-55	561	6.9	10	6	03/09/89
HSP-56	452	5.9	11	5	03/09/89
HSP-57	581	5.5	12	5	03/09/89
HSP-58	551	6	11	4	03/09/89
HSP-59	280	6.1	11	8	03/09/89
HSP-60	473	5.9	11	8	03/09/89
HSP-61	85	5.9	11	8	03/09/89
HSP-62	155	5.8	11	7	03/09/89
HSP-63	34	5.1	10	3	03/09/89
HSP-64	38	4.7	10	4	03/09/89
HSP-65	51	5.1	11	4	03/09/89
HSP-66	49	4.6	12	3	03/09/89
HSP-67	31	5	10	8	03/09/89
HSP-68	39	4.9	10	3	03/09/89
HSP-69	35	4.4	10	1	03/09/89
HSP-70	30	4.6	10	8	03/09/89
HSP-71	40	5.1	9	3	03/09/89
HSP-72	dry hole	dry hole	dry hole	dry hole	03/09/89
HSP-73	dry hole	dry hole	dry hole	dry hole	03/09/89
HSP-74	73	6	9	4	03/10/89
HSP-75	81	3.8	11	5	03/10/89
HSP-76	146	5.7	11	7	03/10/89
HSP-77	43	5	11	4	03/10/89
HSP-78	53	4.6	12	surface	03/10/89
HSP-79	80	5.3	13	7	03/10/89
HSP-80	76	5	13	5	03/10/89
HSP-81	39	5.2	13	6	03/10/89
HSBP-82	60	4.9	13	5	03/10/89
HSBP-83	187	5.5	11	1	03/10/89
HSP-84	51	4.9	12	surface	03/10/89
HSP-85	22	4.5	11	4	03/10/89
HSP-86	41	4.7	12	9	03/10/89
HSP-87	38	4	12	5	03/10/89
HSP-88	49	4.3	11	surface	03/10/89
HSP-89	56	4.7	12	8	03/13/89
HSP-90	59	4.4	12	7	03/13/89
HSP-91	29	5.2	12	1	03/13/89
HSP-92	26	4.4	12	surface	03/13/89
HSP-93	48	4.1	12	4	03/13/89
HSP-94	50	4.2	12	8	03/13/89
HSP-95	32	4.5	12	3	03/13/89
HSP-96	54	4.1	12	8	03/13/89
HSP-97	37	4.3	12	8	03/13/89
HSP-98	34	4.7	12	10	03/13/89
HSP-99	55	4.7	12	2	03/13/89
HSP-100	44	4.7	13	3	03/13/89
HSP-101	37	4.8	13.5	8	03/13/89

HSP-102	40	4.4	14	3	03/13/89
HSP-103	43	4.4	14	5	03/13/89
HSP-104	38	4.7	14	surface	03/13/89
HSP-105	44	4.7	14	surface	03/13/89
HSP-106	60	5	14	3	03/13/89
HSP-107	47	4.5	13	surface	03/13/89
HSP-108	58	4.5	13	surface	03/13/89
HSP-109	73	4.8	16	4	03/13/89
HSP-201	74	4.6	12	5	03/01/89
HSP-202	56	4.9	12	6	03/01/89
HSP-203	110	5.4	11	6	03/01/89
HSP-204	dry hole	dry hole	dry hole	dry hole	03/01/89
HSP-205	139	5	12	surface	03/01/89
HSP-206	62	3.7	12.5	2	03/01/89
HSP-207	135	5	12	surface	03/01/89
HSP-208	84	4.5	12	1	03/01/89
HSP-209	72	3.5	12	2	03/01/89
HSP-210	55	4	11.5	2	03/01/89
HSP-211	43	3.8	11.5	2	03/01/89
HSP-212	27	3.8	11	1	03/01/89
HSP-213	57	3.9	11	surface	03/01/89
HSP-214	37	3.7	11	surface	03/01/89
HSP-215	58	4.5	11	2	03/01/89
HSP-216	56	4.7	11	2	03/01/89
HSP-217	50	3.6	11	surface	03/01/89
HSP-101S	33	4.2	12	8	03/14/89
HSP-102S	31	4.2	12	6	03/14/89
HSP-103S	35	4.3	12	3	03/14/89
HSP-104S	28	4.4	12	surface	03/14/89
HSP-105S	26	4.2	12	3	03/14/89
HSP-106S	30	4.4	12	3	03/14/89
HSP-107S	46	4.6	13	6	03/14/89
HSP-108S	32	4.4	13	2	03/14/89
HSP-109S	29	4.3	13	8	03/14/89
HSP-110S	19	4.7	13	3	03/14/89
HSP-111S	26	4.5	14	4	03/14/89
HSP-112S	42	4.4	14	5	03/14/89
HSP-113S	36	4.1	14	4	03/14/89
HSP-101N	31	4.9	13	3	03/15/89
HSP-102N	36	4.2	14	4	03/15/89
HSP-103N	26	4.4	14	2	03/15/89
HSP-104N	56	5.3	14	8	03/15/89
HSP-105N	70	5.3	14	5	03/15/89
HSP-106N	29	4.7	13	7	03/15/89
HSP-107N	47	4.5	13	7	03/15/89
HSP-108N	57	4.9	14	8	03/15/89
HSP-109N	39	4.4	15	6	03/15/89
HSP-110N	44	4.6	14	9	03/15/89
HSP-111N	44	4.7	14	3	03/15/89
HSP-112N	60	5.2	14	3	03/15/89
HSP-113N	46	4.3	18	surface	03/15/89
HSP-114N	47	4.2	15	surface	03/15/89

HSP-115N	32	4.9	14	8	03/15/89
HSP-116N	32	3.9	15	7	03/15/89
T-7	47	4.1	15	5	03/15/89
T-6	47	5.2	13	4	03/15/89
T-5	157	5.3	14	3	03/15/89
T-4	189	6.3	21	surface	03/15/89
T-3	320	6.5	21	3	03/15/89
T-2	226	6.7	22	surface	03/15/89
T-1	505	6.6	22	surface	03/15/89
FSP-01	72	5.6	19	1	03/28/89
FSP-02	94	5.6	15	8	03/27/89
FSP-03	42	5.8	15	10	03/27/89
FSP-04	122	5.7	16	8	03/27/89
FSP-05	425	5.8	16	surface	03/27/89
FSP-06	236	5	16	3	03/27/89
FSP-07	681	5.4	16	4	03/27/89
FSP-08	1175	4.5	15	surface	03/27/89
FSP-09	589	4.3	15	surface	03/27/89
FSP-10	167	4.7	15	surface	03/27/89
FSP-11	417	4.6	16	7	03/27/89
FSP-12	30	5.3	16	2	03/27/89
FSP-13	32	4.9	16	8	03/27/89
FSP-14	666	4.2	15	8	03/27/89
FSP-15	52	4.9	16	4	03/27/89
FSP-16	714	4.2	16	8	03/27/89
FSP-17	794	4.3	15	4	03/27/89
FSP-18	1043	4.1	14	4	03/24/89
FSP-19	1424	4.2	13	5	03/24/89
FSP-20	1193	4	12	2	03/24/89
FSP-21	1029	3.9	12	1	03/24/89
FSP-22	1015	4.2	13	6	03/24/89
FSP-23	851	4.3	13	5	03/24/89
FSP-24	1325	5.6	13	6	03/24/89
FSP-25	790	5.7	13	8	03/24/89
FSP-26	1095	6.5	12	1	03/24/89
FSP-27	780	4.6	12	surface	03/24/89
FSP-28	1203	3.9	13	surface	03/24/89
FSP-29	534	4.2	12	3	03/24/89
FSP-30	490	4	13	2	03/24/89
FSP-31	44	5.1	12	surface	03/24/89
FSP-32	174	5	12	2	03/24/89
FSP-33	540	3.9	15	4	03/20/89
FSP-34	810	3.8	15	4	03/20/89
FSP-35	1100	3.9	15	4	03/20/89
FSP-36	1200	4.2	15	surface	03/20/89
FSP-37	1660	4	15	4	03/20/89
FSP-38	800	4	15	surface	03/20/89
FSP-39	905	4.1	15	surface	03/20/89
FSP-40	900	5.2	14	2	03/20/89
FSP-41	575	3.9	15	2	03/20/89
FSP-42	590	3.7	15	4	03/20/89
FSP-43	580	3.6	15	2	03/20/89

FSP-44	R	469	4.7	15	2	03/20/89
FSP-43		*		15	5	03/17/89
FSP-44		229	5.2	14	10	03/17/89
FSP-45		96	5.3	15	8	03/17/89
FSP-46		40	4.7	15	4	03/17/89
FSP-47		52	4.7	15	6	03/17/89
FSP-48		92	5.2	15	4	03/17/89
FSP-49		143	5	15	8	03/17/89
FSP-50		60	4.7	14	7	03/17/89
FSP-51		30	4.9	15	5	03/17/89
FSP-52		18	4.5	15	2	03/17/89
FSP-53		60	4.4	15	surface	03/17/89
FSP-54		30	4.3	15	1	03/17/89
FSP-55		50	4.6	14	8	03/17/89
FSP-56		34	4.5	14	8	03/17/89
FSP-57		31	4.6	15	8	03/17/89
FSP-58		66	4.3	15	4	03/17/89
FSP-59		29	4.9	15	5	03/17/89
FSP-200		315	5.6	16	surface	03/28/89
FSP-201		305	5.4	15	6	03/28/89
FSP-202		446	4.8	17	surface	03/28/89
FSP-203		308	5.6	15	surface	03/28/89
FSP-204		895	4.4	15	surface	03/28/89
FSP-205		1233	4	15	surface	03/28/89
FSP-206		1036	4	15	6	03/28/89
FSP-207		445	4.1	16	2	03/28/89
FSP-208		41	5.5	16	7	03/28/89
FSP-209		199	5	18	2	03/28/89
FSP-210		53	5.5	15	12	03/28/89
FSP-211		40	5	16	8	03/28/89
FSP-212		193	5.6	15	6	03/28/89
FSP-213		860	4.6	15	8	03/28/89
FSP-214		1032	4.2	15	4	03/28/89
FSP-215		739	4.1	15	6	03/28/89
FSP-216		854	4	15	12	03/28/89
FSP-217		938	4.1	16	surface	03/28/89
FSP-218		401	4.6	16	8	03/29/89
FSP-219		426	5.4	16	6	03/29/89
FSP-220		147	4.8	16	9	03/29/89
FSP-221		140	5.8	16	surface	03/29/89
FSP-222		123	6.3	16	surface	03/29/89
FSP-223		115	6	16	14	03/29/89
FSP-224		112	5.3	16	10	03/29/89
FSP-225		254	5	16	1	03/29/89
FSP-226		306	5.1	17	3	03/29/89
FSP-227		204	5.1	17	3	03/29/89
FSP-228		259	5.2	17	3	03/29/89
FSP-229		54	4.8	16	5	03/29/89
FSP-230		95	4.5	16	5	03/29/89
FSP-231		70	4.3	16	surface	03/29/89
FSP-232		96	5.7	16	surface	03/29/89
FSP-233		103	5.5	16	4	03/29/89

FSP-234	66	5.4	16	8	03/29/89
FSP-235	84	5.7	16	10	03/29/89
FSP-236	112	5.5	16	8	03/29/89
FSP-237	67	5.2	16	11	03/30/89
FSP-238	79	5.7	16	12	03/30/89
FSP-239	37	5	17	6	03/30/89
FSP-240	42	4.8	17	4	03/30/89
FSP-241	36	4.7	16	8	03/30/89
FSP-242	53	5.2	17	2	03/30/89
FSP-243	48	4.8	16	8	03/30/89
FSP-244	50	4.6	16	6	03/30/89
FSP-245	116	5.7	17	7	03/30/89
FSP-246	90	5.4	17	4	03/30/89
FSP-247	102	4.7	17	5	03/30/89
FSP-248	120	4.9	17	10	03/30/89
FSP-249	84	4.4	16	8	03/30/89
FSP-250	42	4.6	16	9	03/30/89
FSP-251	59	5.2	17	4	03/30/89
FSP-252	66	5.3	16	5	03/30/89
FSP-253	31	4.6	16	5	03/30/89
FSP-254	41	4.4	16	12	03/30/89
FSP-255	52	5.2	16	4	03/30/89
FSP-256	56	5.1	16	6	03/30/89
FSP-257	46	4.8	16	4	03/30/89
FSP-258	49	5.2	17	8	03/30/89
FSP-259	78	4.5	17	8	03/30/89
FSP-260	61	5.1	17	9	03/30/89
FSP-261	91	5.4	16	2	03/31/89
FSP-262	64	5.4	17	8	03/31/89
FSP-263	59	4.9	17	6	03/31/89
FSP-264	57	4.9	17	4	03/31/89
FSP-265	62	4.4	17	8	03/31/89
FSP-266	44	4.8	17	2	03/31/89
FSP-267	85	4	14	2	04/11/89
FSP-268	35	3.8	13	3	04/11/89
FSP-269	28	3.7	13	6	04/11/89
FSP-270	50	4.1	13	4	04/11/89
FSP-271	29	4	13	surface	04/11/89
FSP-272	39	3.5	13	5	04/11/89
FSP-273	54	3.2	13	surface	04/11/89
FSP-274	39	3.1	13	8	04/11/89
FSP-275	69	3	13	10	04/11/89
FSP-276	56	3.1	13	8	04/11/89
FSP-277	49	4.6	13	7	04/12/89
FSP-278	42	3.9	13	surface	04/12/89
FSP-279	47	4.1	13	9	04/12/89
FSP-280	47	4	13	surface	04/12/89
FSP-281	55	4.5	14	3	04/12/89
FSP-282	37	4.3	14	6	04/12/89
FSP-283	95	4.9	14	7	04/12/89
FSP-284	57	4.2	14	8	04/12/89
FSP-285	37	4.9	14	surface	04/12/89

FSP-286	24	4.1	14	6	04/12/89
FSP-287	22	4.4	14	3	04/12/89
FSP-288	83	3.6	13	5	04/13/89
FSP-289	53	3.7	13	4	04/13/89
FSP-290	49	3.6	13	4	04/13/89
FSP-291	24	4.2	13	5	04/13/89
FSP-292	24	4.5	13	8	04/13/89
FSP-293	36	4.2	13	9	04/13/89
FSP-294	49	4.1	13	4	04/13/89
FSP-295	56	4	13	6	04/13/89
FSP-296	18	4.5	14	surface	04/13/89
FSP-297	44	5.2	14	7	04/13/89
FSP-298	46	4.4	14	surface	04/13/89
FSP-299	44	4.2	14	3	04/13/89
FSP-300	37	4.3	14	4	04/13/89
FSP-301	34	4.6	14	8	04/13/89
FSP-302	29	4.5	14	surface	04/13/89
FSP-303	94	5.4	14	surface	04/13/89
FSP-304	52	4.4	14	4	04/13/89
FSP-305	41	4.5	14	1	04/13/89
FSP-306	23	4.2	14	1	04/13/89
FSP-307	29	4.1	14	5	04/13/89
FSP-308	33	4.6	14	3	04/13/89
FSP-309	36	4	14	4	04/13/89

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FIELD GEOLOGIC LOG

APPENDIX D

PROJECT	Four Mile Creek Seepline
DATE	25 Sept. 89
SHEET	I of II
DRILLING SUBCONTRACTOR	Athena Tech. Inc.
WELL NO.	FS#1
LOCATION	F-Area
DRILLER	W.J. Sexton
LOGS PREPARED BY	W.J. Sexton
COMPANY	Athena
DRILLING METHOD	Vibracore

RUN NUMBER	DEPTH BELOW GROUND SURFACE, cm ~~FEET~~	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS/REMARKS
A	0–7			Poorly sorted sands mostly fine and medium, some clay. Occasional granule sized material - mixed with mud rooted soft ↓	medium gray
B	7–10			Poorly sorted sands with one fine gravel lens at 93cm mixed with mud. Iron stained and hard	iron stained/ yellow-orange
C	100–12			no more iron staining same as B but slightly harder	Gray
D	12–14			Fairly well sorted medium to fine sand, very little mud	yellow orange blonde
E	14–15			same as above except blonde	
F	15–16			Gravel bed with med. sand	- tan -
G	16–18			Well sorted fine sand	yellow & orange in spots.
"	18–200			mixed poorly sorted coarse sand with some mud	red & orange

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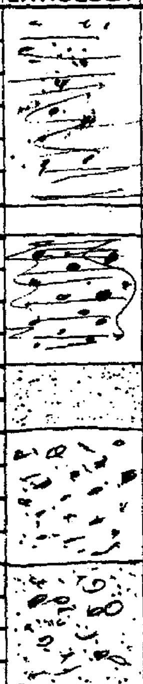
FIELD GEOLOGIC LOG

PROJECT	Four Mile Creek Seepline
DATE	25 Sept. 89
SHEET	II of II
DRILLING SUBCONTRACTOR	Athena Tech. Inc.
WELL NO.	FS #1
LOCATION	F-Area
DRILLER	W.J. Sexton
LOGS PREPARED BY	W.J. Sexton
COMPANY	Athena
DRILLING METHOD	Vibracore

RUN NUMBER	DEPTH BELOW GROUND SURFACE FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS/REMARKS
H cont'd	200			H continued	
	1				
	2				
	3			Iron stained layer	
I	4			same as H except harder	yellow & hard
J	5			Well sorted fine sand	yellow/orange
K	6			gravel rich zone with coarse sand	yellow
	7				
L	8			mixed f, m, c sand w/ gravel hard & clean no mud	orange
	9				
	300				
	1				
	2				
	3				
	4				
	5				
	6				
	7				
	8				
	9				
	0				

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FIELD GEOLOGIC LOG

PROJECT: Four Mile Creek Seepline	DATE: 25 Sept. 89	SHEET: I OF II
	DRILLING SUBCONTRACTOR: Athena Tech. Inc.	
WELL NO.: FS #2	LOCATION: F-Area	DRILLER: W. J. Sexton
LOGS PREPARED BY: W.J. Sexton	COMPANY: Athena	DRILLING METHOD: Vibracore

RUN NUMBER	DEPTH BELOW GROUND SURFACE ~~FEET~~ cm	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS/REMARKS
A	0, 1, 2, 3, 4			Dark Brown organic rich sediment, roots.	
B	5, 6, 7			Black reduced sediment, some rooting and 5% organic. Mostly medium and fine grained sand.	
C	8, 9, 100, 1, 2			~15% mud, fine and medium sand, black.	
D	3			Transition zone, dark gray, nearly pure sand.	
E	4, 5, 6, 7			Light gray, clean sand, mostly fine to medium, some pea grav.	
F	8			Brown mud bands between gravel rich sand.	
G	9, 200			Orange color with some mud but mostly sand.	

FIELD GEOLOGIC LOG

PROJECT	F-Area Seepage Basin
DATE	2 Oct. '89
SHEET	II of II
REFERENCE DATUM	
DRILLING CONTRACTOR	Athena Technologies, Inc
WELL NO.	FS #2
SRP COORDINATES	
DRILLER	W. J. Sexton
LOGGED BY	W. J. Sexton
COMPANY	Athena
DRILLING METHOD	Vibracore

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
G	200 – 2			Cont. (H) - Same Still Orange (Light)	
H	2 – 5			Light orange grading to light Grey - Mixed Sand mixed some small Gravel / Sand still mostly Fine & Med. - Matrix held together. L. mud, still only small %. Small iron stained (concretions)	
I	5 – 6			Well sorted very Fine Sand - Light gray to white - Some Mud ~ 5 to 10%	
J	6 – 8			Orange Very Coarse Sand Mixed with Small Gravel - Fairly clean < 5% mud - Good H_2O bearing zone	
K	8 – 300			Tan grading into light orange Very Coarse Sand Mixed with gravel to Cobble < 5% Silt & clay	

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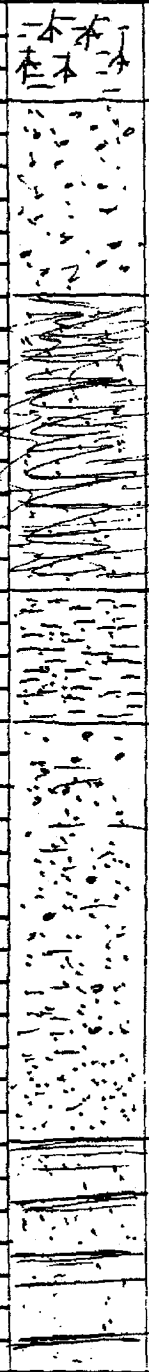
FIELD GEOLOGIC LOG

PROJECT: Four Mile Creek Seepline	DATE: 25 Sept. 89	SHEET: I OF II
		DRILLING SUBCONTRACTOR: Athena Tech. Inc.
WELL NO.: FS #3	LOCATION: F-Area	DRILLER: W.J. Sexton
LOGS PREPARED BY: W.J. Sexton	COMPANY: Athena	DRILLING METHOD: Vibracore



RUN NUMBER	DEPTH BELOW GROUND SURFACE, cm ~~FEET~~	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS/REMARKS
A	0–1			fine to medium sand with roots and mud	
B	1–4			medium to coarse sand - some oxidation, orange	
C	4–8			mixed fine and medium sand, black with mud and organics	
D	8–100			fine sand with high mud content, light gray	
E	100–7			Poorly sorted sand, medium and coarse, some iron staining and mud, mostly tan	
F	7–0			Fine sand with occasional medium and coarse sand, medium gray	

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FIELD GEOLOGIC LOG

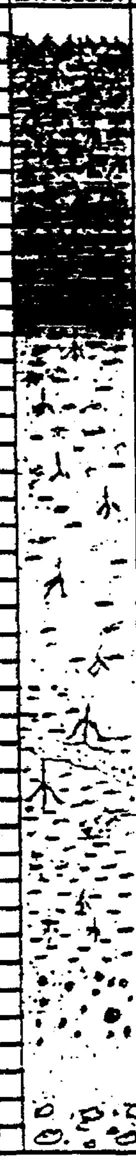
PROJECT: Four Mile Creek Seepline	DATE: 25 Sept. 89	SHEET: II of II
	DRILLING SUBCONTRACTOR: Athena Tech. Inc.	
WELL NO.: FS#3	LOCATION: F-Area	DRILLER: W. J. Sexton
LOGS PREPARED BY: W.J. Sexton	COMPANY: Athena	DRILLING METHOD: Vibracore

RUN NUMBER	DEPTH BELOW GROUND SURFACE, cm ~~FEET~~	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS/REMARKS
G	200–1			mixed fine and medium sand with pure mud lenses. Gray.	
H	2–3			mixed fairly well sorted fine sand	
I	3–300			Poorly sorted fine, medium and coarse sand, mud rich. Light gray	
	1				
	2				
	3				
	4				
	5				
	6				
	7				
	8				
	9				
	0				

FIELD GEOLOGIC LOG

PROJECT: H-Area Seepage Basin		DATE: 2 Oct. '89	SHEET: 1 OF II
	REFERENCE DATUM:	DRILLING CONTRACTOR: Athena Technologies, Inc.	
WELL NO.: HS #1	SRP COORDINATES:	DRILLER: W. J. SEXTON	
LOGGED BY: W. J Sexton	COMPANY:	DRILLING METHOD: Vibracore	

Core Taken on 28 Sept. '89

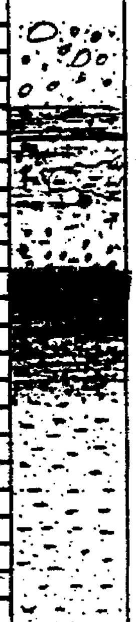


RUN NUMBER	DEPTH, FEET	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
(A)	0–3		Very Top green - Leaves [illegible] Then dark Brown - [illegible] Fine sand and mud nearly 50/50 - [illegible] zone [illegible] rather organic	
(B)	3–6		Sand content increasing [illegible] Fairly muddy - 20 to 30% organics less also - Color a little [illegible] To Black [illegible] - Fine Sand	
(C)	6–12		Massive Med. Gray and dark brown Random med. To large roots. Mud content down To < 5%	
(D)	12–15		A Couple of large roots - [illegible] Mud rich very fine Sand zone - Fine sand - (Brown) has migrated down into light gray zone	
(E)	15–17		Light Gray - Mud rich zone - [illegible] - very Fine sand ~ 60% mud / 40% VF [illegible] Roots	
(F)	17–19		Very light [illegible] To [illegible] gravel rich zone - [illegible] [illegible] mud in VFine sand - [illegible] ~ 5%	
(G)	19–20		Very Fine sand & white - < 5% mud Clean - well sorted	
(F)	20		Gravel rich zone - Clean [illegible] sand Fine / Med. / Coarse	

FIELD GEOLOGIC LOG

PROJECT: H-Area Seepage Basin	REFERENCE DATUM:	DATE: 2 Oct. '89 — SHEET: II of II
		DRILLING CONTRACTOR: Athena Technologies, Inc.
WELL NO.: HS #1	SRP COORDINATES:	DRILLER: W. J. Sexton
LOGGED BY: W. J. Sexton	COMPANY:	DRILLING METHOD: Vibracore

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
(H)	20 – 21			Very little if any mud present. Gravel is well rounded –	
(I)	22 – 24			Mostly coarse sand – Now orange – One white spot (230 cm) has mud mixed with fine sand. [illegible] all the mud < 5% – Horizontal laminations. Color light tan at [illegible] gravel. [illegible] gravel [illegible] – 240 to 245 cm	
(J)	25 – 26			Red – Med. Sand Fairly well sorted. occasional gravel stain – looks like some possible cross bedding < 5% mud	
(K)	27 – 31			Yellow tan – 20% mud 80% F. to V.F. sand well sorted –	



Depth scale: 20, 1, 2, 3, 4, 5, 6, 7, 8, 9, 30, 1, 2, 3, 4, 5, 6, 7, 8, 9, 0

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FIELD GEOLOGIC LOG

PROJECT		DATE	SHEET
Four Mile Creek Seepline		25 Sept. 89	II of II
		DRILLING SUBCONTRACTOR: Athena Tech. Inc.	
WELL NO.: HS#2	LOCATION: H-Area	DRILLER: W. J. Sexton	
LOGS PREPARED BY: W. J. Sexton	COMPANY: Athena	DRILLING METHOD: Vibracore	

RUN NUMBER	DEPTH BELOW GROUND SURFACE FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS/REMARKS
H	200			mud rich, ~50%, 50% mixed sand, pea gravel, green color	
I	1			sharp contact, red now. Otherwise the same as H	
	2				
	3				
	4				
J	5			modeled red sand/mud with tan mud spots	
	6				
	7				
	8				
	9				
K	300			same as J, but more mud spots.	
	1				
	2				
	3				
	4				
	5				
	6				
	7				
	8				
	9				
	0				

OSR 30-3 (Rev 12-89)

FIELD GEOLOGIC LOG

PROJECT: Four Mile Creek Seepline	DATE: 26 Sept. 89	SHEET: I OF II
	DRILLING SUBCONTRACTOR: Athena Tech. Inc.	
WELL NO.: HS#2	LOCATION: H-Area	DRILLER: W. J. Sexton
LOGS PREPARED BY: W. J. Sexton	COMPANY: Athena	DRILLING METHOD: Vibracore

RUN NUMBER	DEPTH BELOW GROUND SURFACE, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS/REMARKS
A	0–1			organic rich mixed mud and sand	
B	1–9			sand rich zone with only 5-10% mud. Sand is predominantly poorly sorted & medium, random gravel pebbles	
C	9–101 (10 0)			moderately well sorted medium to fine sand, clean, med. gray	
D	1–3			well sorted medium and fine sand, mud content is increasing - ~20%, light gray	
E	3–6			mud rich zone with roots. ~60% mud, ~40% fine sand, light gray	
F	6–8			medium sand with ~15% mud, medium brown	
	8–0			mixed sand fine and very fine sands, occasional medium coarse sand, tan.	

APPENDIX E

Exploration Resources

425 North Lumpkin Street, Athens, Georgia 30601

To: Carol Cummins, SRS
Dan Rogers, SRS
From: Lisa Vogel
Re: Drinking Water Standards
Date: January 23, 1990

I have compiled the drinking water standards for the Annual Report. The EPA proposed standards for radionuclides in 1986 and for some miscellaneous analytes in May of 1989. Neither the 1986 nor the 1989 proposals have been accepted. We have decided to use all the established standards we have and to use proposed standards for any analytes that do not have established standards. Please let me know whether or not you agree with this decision. Once I have received approval, I will be able to complete the Drinking Water Standards table in just a day or so.

CFR, 1986 gives a maximum contaminant level for turbidity. This level is applicable only to drinking water systems that use surface water; therefore, we have decided to omit turbidity from our list of drinking water standards.

The maximum contaminant level for cesium-134 in EPA, 1977, appears to be a mistake. Therefore, we have decided to use the proposed level from EPA, 1986, for cesium-134.

The following table compares the proposals with the established standards.

Analyte	Established Standard	Source	Proposed Standard	Source
Arsenic	0.05 mg/L	CFR, 1987	-	-
Barium	1 mg/L	CFR, 1987	5 mg/L	EPA, 1989
Cadmium	0.01 mg/L	CFR, 1987	0.005 mg/L	EPA, 1989
Chromium	0.05 mg/L	CFR, 1987	0.1 mg/L	EPA, 1989
Lead	0.05 mg/L	CFR, 1987	-	-
Mercury	0.002 mg/L	CFR, 1987	-	-
Nitrate (as N)	10 mg/L	CFR, 1987	-	-
Selenium	0.01 mg/L	CFR, 1987	0.05 mg/L	EPA, 1989
Silver	0.05 mg/L	CFR, 1987	-	-
Gross alpha	15 pCi/L	CFR, 1987	15 pCi/L	EPA, 1986
Tritium	20 pCi/mL	CFR, 1987	90 pCi/mL	EPA, 1986
Endrin	0.0002 mg/L	CFR, 1987	-	-
Lindane	0.004 mg/L	CFR, 1987	0.0002 mg/L	EPA, 1989
Methoxychlor	0.1 mg/L	CFR, 1987	0.4 mg/L	EPA, 1989
Toxaphene	0.005 mg/L	CFR, 1987	-	-
2,4-D	0.1 mg/L	CFR, 1987	0.07 mg/L	EPA, 1989
Silvex	0.01 mg/L	CFR, 1987	0.05 mg/L	EPA, 1989
Chloroform*	0.1 mg/L	CFR, 1987	-	-
Fluoride	4 mg/L	CFR, 1986	-	-

(404) 353-7983 · (404) 353-8085 · (404) 353-0716

Analyte	Established Standard	Source	Proposed Standard	Source
1,4-Dichlorobenzene (p-Dichlorobenzene)	0.075 mg/L	EPA, 1987	-	-
Benzene	0.005 mg/L	EPA, 1987	-	-
Carbon tetrachloride	0.005 mg/L	EPA, 1987	-	-
1,2-Dichloroethane	0.005 mg/L	EPA, 1987	-	-
Trichloroethene	0.005 mg/L	EPA, 1987	-	-
Vinyl chloride (Chloroethene)	0.002 mg/L	EPA, 1987	-	-
1,1-Dichloroethene	0.007 mg/L	EPA, 1987	-	-
1,1,1-Trichloroethane	0.2 mg/L	EPA, 1987	-	-
Beryllium-7	6,000 pCi/L	EPA, 1977	100,000 pCi/L	EPA, 1986
Carbon-14	2,000 pCi/L	EPA, 1977	3,000 pCi/L	EPA, 1986
Chromium-51	6,000 pCi/L	EPA, 1977	80,000 pCi/L	EPA, 1986
Manganese-54	300 pCi/L	EPA, 1977	3,000 pCi/L	EPA, 1986
Iron-55	2,000 pCi/L	EPA, 1977	10,000 pCi/L	EPA, 1986
Iron-59	200 pCi/L	EPA, 1977	1,000 pCi/L	EPA, 1986
Cobalt-58	9,000 pCi/L	EPA, 1977	2,000 pCi/L	EPA, 1986
Cobalt-60	100 pCi/L	EPA, 1977	200 pCi/L	EPA, 1986
Nickel-59	300 pCi/L	EPA, 1977	30,000 pCi/L	EPA, 1986
Nickel-63	50 pCi/L	EPA, 1977	10,000 pCi/L	EPA, 1986
Zinc-65	300 pCi/L	EPA, 1977	400 pCi/L	EPA, 1986
Strontium-89	20 pCi/L**	EPA, 1977	900 pCi/L	EPA, 1986
Strontium-90	8 pCi/L	EPA, 1977	50 pCi/L	EPA, 1986
Zirconium-95	200 pCi/L	EPA, 1977	3,000 pCi/L	EPA, 1986
Technetium-99	900 pCi/L	EPA, 1977	5,000 pCi/L	EPA, 1986
Ruthenium-103	200 pCi/L	EPA, 1977	4,000 pCi/L	EPA, 1986
Ruthenium-106	30 pCi/L	EPA, 1977	300 pCi/L	EPA, 1986
Antimony-125	300 pCi/L	EPA, 1977	4,000 pCi/L	EPA, 1986
Iodine-129	1 pCi/L	EPA, 1977	100 pCi/L	EPA, 1986
Iodine-131	3 pCi/L	EPA, 1977	700 pCi/L	EPA, 1986
Cesium-134	20,000 pCi/L	EPA, 1977	80 pCi/L	EPA, 1986
Cesium-137	200 pCi/L	EPA, 1977	100 pCi/L	EPA, 1986
Barium-140	90 pCi/L	EPA, 1977	1,000 pCi/L	EPA, 1986
Radium-226	-	-	4 pCi/L	EPA, 1986
Radium-228	-	-	8 pCi/L	EPA, 1986
Radium-226+228	5 pCi/L	CFR, 1987	-	-
Nitrite (as N)	-	-	0.001 mg/L	EPA, 1989
Chlordane	-	-	0.002 mg/L	EPA, 1989
Dibromochloropropane	-	-	0.0002 mg/L	EPA, 1989
cis-1,2-Dichloroethene	-	-	0.07 mg/L	EPA, 1989
trans-1,2-Dichloroethene	-	-	0.1 mg/L	EPA, 1989
1,2-Dichloropropane	-	-	0.005 mg/L	EPA, 1989
Ethylbenzene	-	-	0.7 mg/L	EPA, 1989
Heptachlor	-	-	0.0004 mg/L	EPA, 1989
Heptachlor epoxide	-	-	0.0002 mg/L	EPA, 1989
PCB's	-	-	0.0005 mg/L	EPA, 1989
Pentachlorophenol	-	-	0.2 mg/L	EPA, 1989
Styrene	-	-	0.005 mg/L	EPA, 1989
Tetrachloroethene	-	-	0.005 mg/L	EPA, 1989

Analyte	Established Standard	Source	Proposed Standard	Source
Toluene	-	-	2 mg/L	EPA, 1989
Xylenes	-	-	10 mg/L	EPA, 1989
Nonvolatile beta	-	-	50 pCi/L	EPA, 1986
Potassium-40	-	-	300 pCi/L	EPA, 1986
Tin-113	-	-	4,000 pCi/L	EPA, 1986
Uranium-234	-	-	28 pCi/L	EPA, 1986
Uranium-235	-	-	28 pCi/L	EPA, 1986
Uranium-238	-	-	28 pCi/L	EPA, 1986
Americium-241	-	-	4 pCi/L	EPA, 1986

* The level for total trihalomethanes is set at 0.1 mg/L. Because bromated methanes are rarely detected in SRS groundwater, EHP presumes that most of the trihalomethanes present in plant water are chloroform.

** This is the lower of two levels given for strontium-89.

Sources:

CFR (Code of Federal Regulations), 1986. "National Primary Drinking Water Regulations," *40 CFR, Part 141*, pp. 521-568, Washington, DC.

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EPA (U.S. Environmental Protection Agency), 1977. *National Interim Primary Drinking Water Regulations*, EPA-570/9-76-003, Washington, DC.

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EPA (U.S. Environmental Protection Agency), 1987. "National Primary Drinking Water Regulations; Synthetic Organic Chemicals; Monitoring for Unregulated Contaminants," *Federal Register*, July 8, 1987, pp. 25690-25717, Washington, DC.

EPA (U.S. Environmental Protection Agency), 1989. "National Primary and Secondary Drinking Water Regulations (Proposed Rule)," *Federal Register*, May 22, 1989, pp. 22062-22160, Washington, DC.