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Distribution of Radionuclides in L-Lake Surface Sediments Phase 3 (U)

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Abstract

Gamma-emitting radionuclides in L Lake were examined *in situ* with an underwater High Purity Germanium (HPGe) detector and further studied by retrieving various sediment samples for analysis by HPGe gamma spectrometry. The predominant man-made radionuclide detected was cesium-137. These measurements constituted Phase 3 of a four phase strategy for characterizing L-Lake contaminants. The data provided by these studies will be utilized in the preparation of an Environmental Impact Statement that evaluates the consequences of discontinuing river water pumping to the man-made cooling water reservoirs on the Savannah River Site. A site evaluation report will also be prepared for the L-Lake basin.

Introduction

L Lake is a 400-hectare (1000-acre), man-made reservoir located in the southeastern quadrant of the Savannah River Site (SRS). The lake, constructed in 1985, was created by impounding the middle reaches of Steel Creek. When completed, it served as a once-through cooling reservoir for L Reactor. L Reactor was refurbished in the early 1980s and was restarted in 1985 after 13 years of shutdown. The reservoir's purpose was to limit the thermal damage to the lower reaches of Steel Creek caused by secondary cooling water releases.

The operations of P and L Reactors began in 1954. Secondary cooling water pumped from the Savannah River, through the reactors, and discharged into Steel Creek increased the natural flow rate of 1 cubic meter per second to a maximum of 24 cubic meters per second. This secondary cooling water was released at temperatures as high as 70 degrees centigrade (158 degrees Fahrenheit) to SRS streams. P-Reactor cooling was diverted from Steel Creek to Par Pond in 1963, and L Reactor was placed on standby and shut down in 1968 (Tinney et al. 1986).

As a result of reactor operations from 1954-1968, aquatic and riparian vegetation in Steel Creek were killed, and extensive channel erosion took place. From 1955 to 1973, approximately 284 curies of cesium-137 was released to Steel Creek. Since cesium has a strong affinity for sediments, the majority of the released material was adsorbed to them and deposited with them in the Steel Creek floodplain prior to reaching the Savannah River. An inventory of the cesium-137 in Steel Creek, at 1991 decay-corrected concentrations, estimates 8 curies upstream from L Reactor, 30 curies between L Reactor and the Steel Creek delta, 20 curies in the Steel Creek delta, and 8 curies between the delta and the mouth of Steel Creek at the Savannah River Site boundary, a total of 66 curies in the Steel Creek system (Brisbin et al. 1974; Gladden et al. 1985; Carlton et al. 1992).

During the construction of L Lake, soil removed from the stream bed and floodplain of Steel Creek at the dam site was placed in a planned waste containment pit. The dredged soil was allowed to dry, then leveled and covered with 1.6 meters (m) (5 feet) of clean soil (Zeigler et al. 1985). Approximately 46,400 cubic meters (1.6 million cubic feet)

of contaminated soil was removed from the dam site. Although only the upper 1.2 m (4 feet) of stream bed material was considered to be contaminated, the stream bed was excavated to a depth of 3 m (10 feet) (Gladden et al. 1989). This contaminated soil was estimated to contain 0.2 curies of cesium-137 and 0.02 curies of cobalt-60 (Zeigler et al. 1985). The buried waste containment pit was covered by the reservoir when the lake was filled (DOE 1984).

In 1985, prior to the filling of L Lake, EG&G Energy Measurements, Inc. (EG&G/EM) used aerial gamma survey measurements to establish a baseline radiological survey of the Steel Creek drainage basin. Gamma maps of the area, created from the EG&G overflight data, confirmed the deposition of man-made radionuclides in the Steel Creek stream bed (Feimster 1992), which was subsequently covered by the reservoir.

In response to the need for a full-scale contaminants screening study, a four-phase sampling program was established. This program was designed to develop a complete and defensible list of contaminants for L Lake and to identify all contaminants of concern (COC) in the sediments of L Lake. During the summer of 1996, the Savannah River Technology Center (SRTC), Environmental Sciences Section (ESS) established and conducted a four-phase program to characterize the current spatial distribution of radioactive and metal contaminants in the sediments of L Lake. Phase 1 of the program sampled surface sediments to identify radioisotopes and metals and determine their concentrations. Phase 2 used vibracore technology to penetrate the surface sediment and provide deeper core sediment samples from the L Lake basin. Phase 3 used a high purity germanium (HPGe) underwater gamma detector *in-situ* to examine gamma-emitting radionuclides in the surface sediments in order to assess the possibility of sediments redistribution from the stream bed and floodplain at the bottom of the lake. Phase 4 used acoustic impedance technology to map the distribution of floodplain sediments in the basin and to detect buried materials such as vegetation and floodplain sediment covered by a sandy overburden.

The purpose of this study is to begin an evaluation of the potential environmental impacts of reducing or eliminating the flow requirements to the SRS river water distribution system (DOE 1995). There are no plans to restart L Reactor. Without input from the Savannah River, it is predicted that L Lake would eventually drain because the watershed above the lake is not sufficiently large enough to maintain it. Allowing L Lake to drain is a cost-saving option being considered by DOE. The sediment analysis provides definitive information on the contaminants in L Lake. This information will be considered in the decision on the future of L Lake. Phase 3 was completed in August 1996 and is discussed in this report. Phase 1, Phase 2, and Phase 4 tasks will be presented in separate reports.

Methods

Sample Locations

A Global Positioning System (GPS) roving receiver was used to record the sampling locations. GPS is a satellite-based navigation system developed to provide a consistent, accurate method of simplifying navigation and global positioning. The GPS receiver can determine its present position anywhere on earth with an accuracy to 15 m (50 feet). L-Lake sampling coordinates are designated as waypoints and are identified throughout this report by Universal Transverse Mercator (UTM) coordinates.

In-Situ Measurements of Radionuclide Distribution in the L-Lake Basin

Phase 3 used an underwater gamma detector for the collection of *in-situ* data from the lake basin. The measurements of gamma-emitting radioisotopes (primarily cesium-137 and cobalt-60) in surface sediments of L Lake were conducted from

May-June 11, 1996. With the HPGe, the count rate is proportional to the radiation levels that were observed during the 1985 overflight when the sediments were not covered by water (Feimster 1992) Therefore, the count-rate profiles generated by the detector are appropriate for comparison with the 1985 gamma mappings.

Grab samples of the bottom sediments were also collected and analyzed with low-level HPGe gamma spectrometry in the Underground Counting Facility. The grab samples were taken to determine the incidence of man-made radionuclides present in the sediments at levels below the detection limit of the underwater HPGe detector. The goal of the HPGe sampling was to determine the edge of the gamma-emitting radionuclide (cesium-137 and cobalt-60) contamination in the lake bed and compare it with the contour established in 1985.

The overall equipment has been described in detail in Winn (1992, 1993, 1995a,b). The detector was lowered by a winch until its housing rested on the surface sediment. Two- minute counting intervals were made at 192 locations. At each location, the count rate of the 662 keV cesium-137 gamma spectrum was determined and recorded in the field. Geographic position measurements and depths were recorded.

Results

Underwater HPGe detector measurements of the lake-bottom radioactivity were conducted at locations shown in Figure 1. The data from these measurements are presented in Table 1, where each measurement is characterized by its location coordinates, water depth, and cesium-137 count rate.

Various quality checks were used to appraise the measurements. Locations with suspiciously low count rates were recounted after repositioning the detector to ensure that obstructions such as stumps did not prevent it from resting directly on the bottom sediments. After each measurement, any sediment sticking to the bottom screen was flushed away to prevent cross-contaminating measurements between sites. Before, during, and after each series of measurements, a cesium-137/cobalt-60 calibration source was used to assure proper detector operation; a total of 52 calibration checks were made during the measurements. All field results were reviewed and refined as appropriate at the laboratory.

The 1996 grid sampling within the old Steel Creek channel and floodplain was used to develop continuous computer-modeled isodose contours. These data were decay-corrected to 1995 and used with the 1995 underwater HPGe data from L Lake. A surface modeling package (TIN or Triangulated Irregular Network) was used to create Figure 2 from these data.

Contour lines, or isolines, are used in Figure 3 to spatially represent the gamma dose from cesium-137 contamination as measured by the underwater HPGe detector. These 1995 isodose contours are distributed similarly to the isodose contours measured by the 1985 EG&G overflights (Figure 4; Feimster 1992).

All count rate data were decay-corrected to 1995. A dose conversion was performed (see Dunn 1995). All dose/point data were corrected to simulate an annual exposure of 15 millirem for a resident living on the lake bed. The resident was assumed to be in residence in a home that provided 20% shielding 350 days per year, 24 hours per day. The dose interval contours in Figure 3 were generated from known point data. The contour lines were interpolated between known dose/point data.

At the 76 locations in Figure 5, sediment samples were retrieved from the lake bottom. These samples were dried and counted overnight or longer on either the 90%- or 166%-efficient HPGe detectors in the Underground Counting Facility (Winn et al. 1987). These samples had cesium-137 concentra-

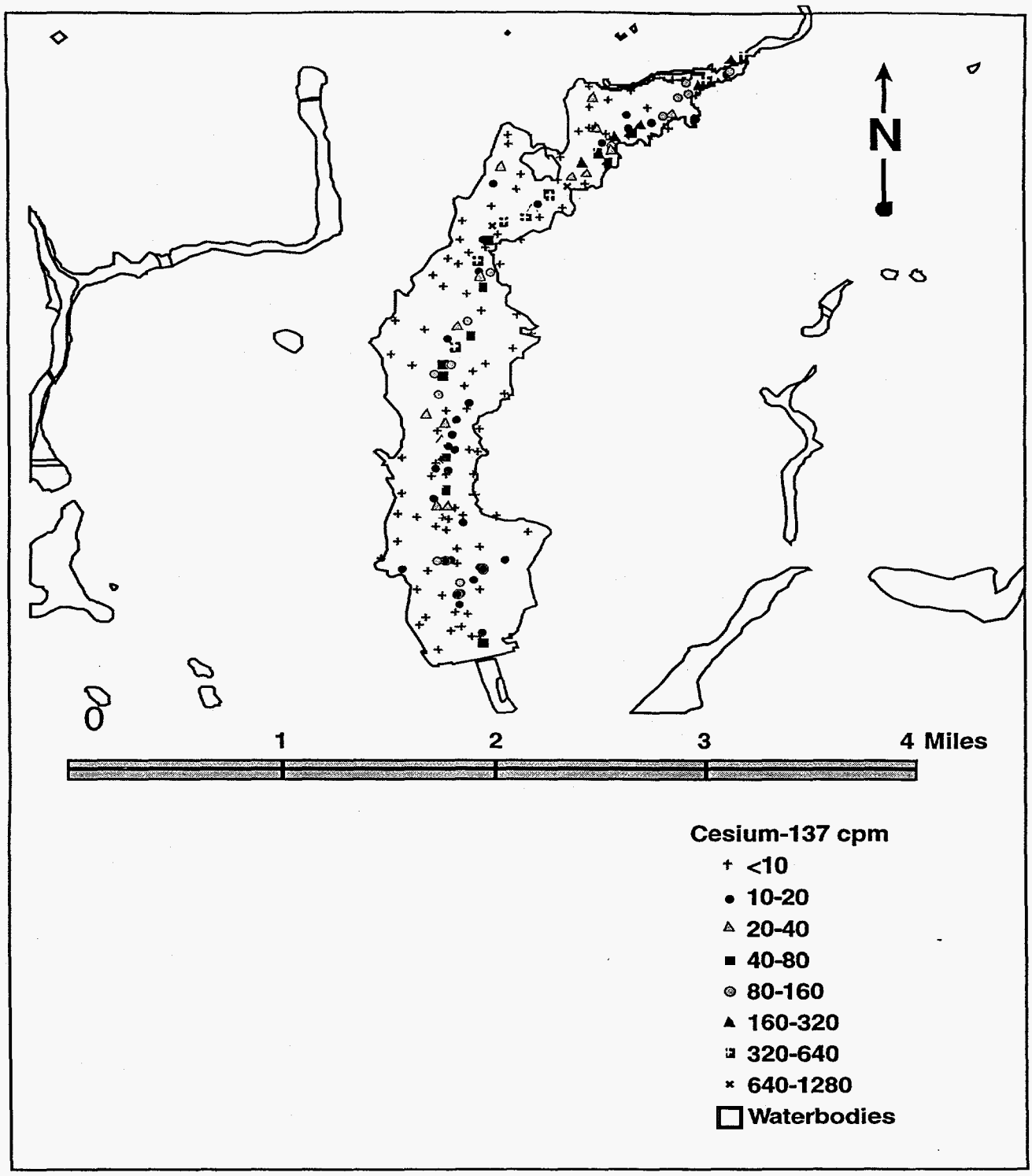

Figure 1. Distribution of cesium-137 in L-Lake sediments as determined by an underwater detector.

tions ranging from 138 to more than 47,000 picoCuries per kilogram (pCi/kg). Cobalt-60 was the only man-made isotope observed other than cesium-137; it occurred at concentrations two orders of magnitude lower than those for cesium-137. The cobalt-60 concentrations ranged from 0 to more than 800 pCi/kg (Table 2). Sample results are from the top few centimeters of sediments.

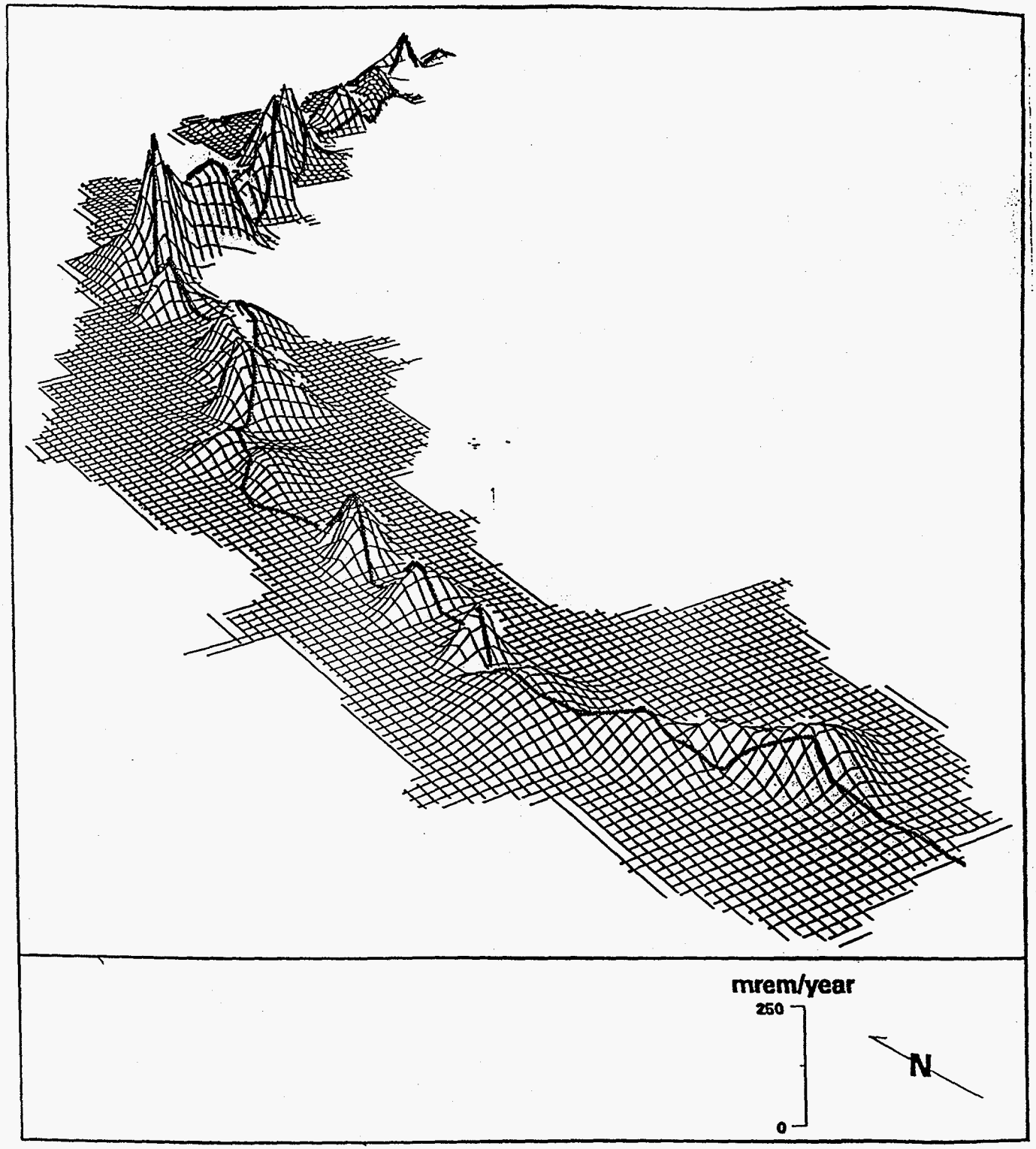

Figure 2. Current cesium-137 surface model (based on 1995 and 1996 sampling programs).

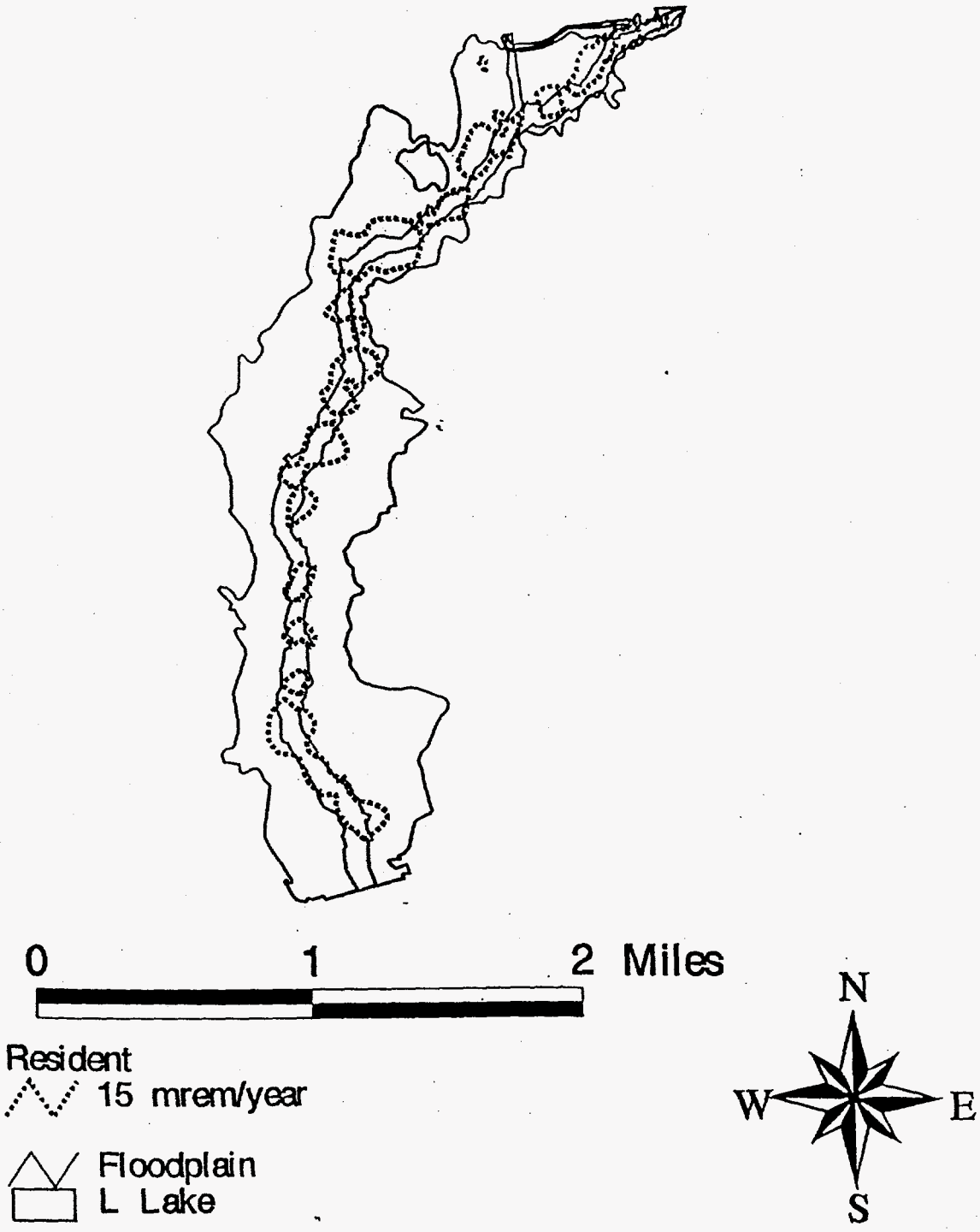

Figure 3. The 1995 resident scenario cesium-137 15-mrem isodose contours.

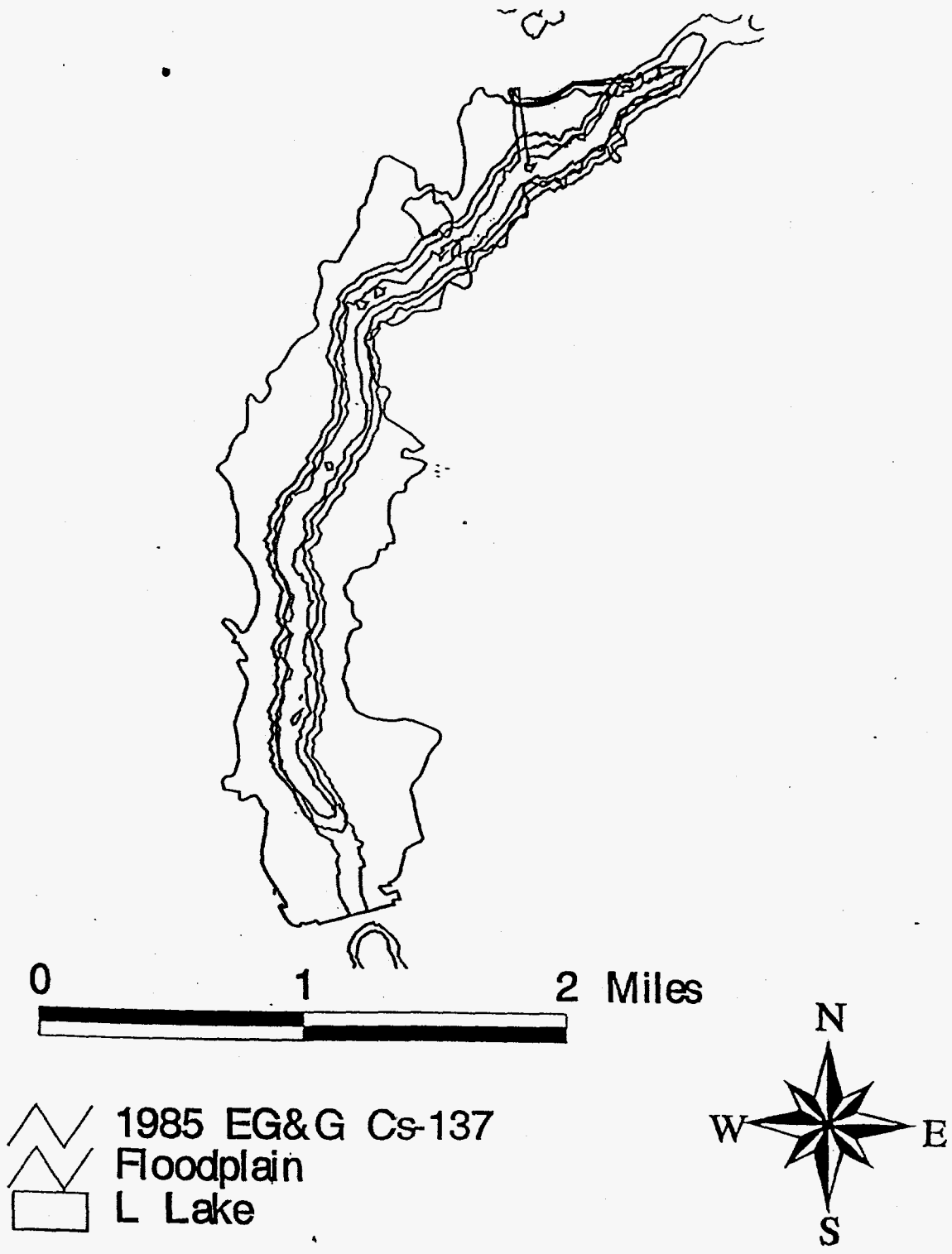

Figure 4. Cesium-137 isodose contours from 1985 overflight sodium iodide mapping (from Feimster 1992).

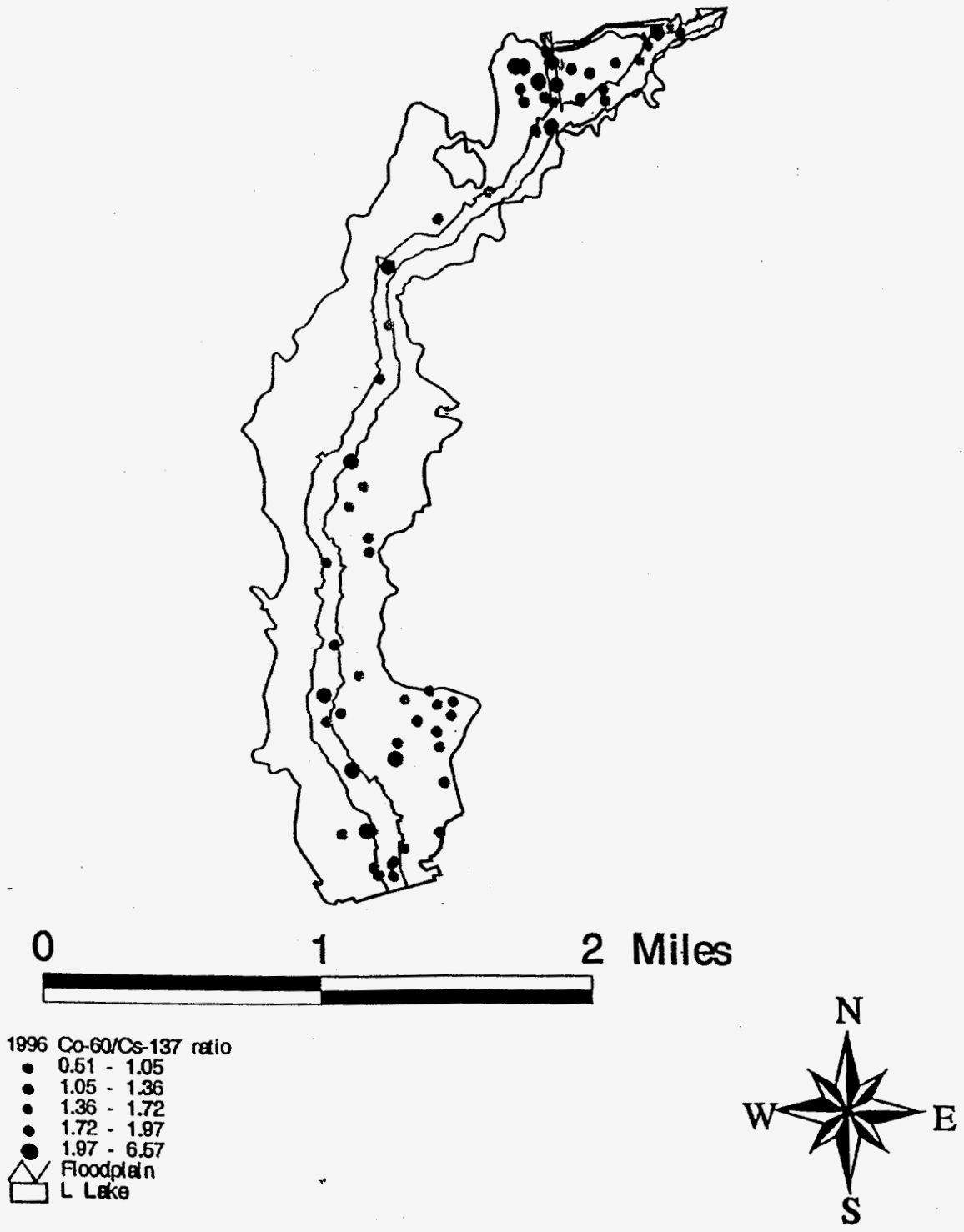

Figure 5. Cobalt-60:cesium-137 ratios at 76 locations in L Lake. 1996.

Table 1. Cesium-137 count rate (counts per minute), depth, and UTM coordinates at each location sampled in L Lake. 1996.[a]

Waypoint	Date	UTM[b] north	UTM east	Depth (feet)	Cesium-137 (cpm)[c]	Error (cpm)
2	5/14/96	3673505	441991	22	254	+/-10
3	5/14/96	3673555	441960	22	7	+/-2
4	5/14/96	3673618	441868	14	8	+/-2
5	5/14/96	3673609	441896	14	24	+/-4
6	5/14/96	3673781	441820	9	0	+/-1
7	5/14/96	3673866	441858	8	21	+/-3
8	5/14/96	3673845	441972	4	4	+/-2
9	5/14/96	3674208	443014	8	61	+/-5
10	5/14/96	3674245	443015	10	364	+/-15
11	5/14/96	3674200	442913	12	197	+/-12
12	5/14/96	3674105	442914	4	84	+/-7
13	5/14/96	3674065	442882	12	20	+/-4
14	5/14/96	3674114	442765	3	0	+/-1
15	5/14/96	3674023	442720	14	332	+/-16
16	5/14/96	3673970	442662	14	234	+/-12
17	5/14/96	3673998	442561	6	103	+/-8
18	5/14/96	3673902	442573	12	136	+/-9
19	5/14/96	3673727	442468	11	37	+/-4
20	5/14/96	3673780	442269	6	4	+/-3
21	5/14/96	3673656	442306	16	13	+/-3
22	5/14/96	3673539	442124	17	2	+/-3
23	5/14/96	3673598	442132	16	13	+/-3
24	5/14/96	3673529	442012	21	268	+/-10
25	5/14/96	3673398	441891	24	550	+/-20
26	5/14/96	3673380	441891	22	163	+/-13
27	5/14/96	3673320	441978	19	45	+/-5
28	5/14/96	3673302	441961	14	7	+/-3
29	5/14/96	3673412	442005	17	31	+/-4
30	5/14/96	3673466	441980	21	134	+/-7
31	5/14/96	3673483	441929	18	15	+/-4
32	5/14/96	3673600	441836	13	6	+/-3
33	5/14/96	3673718	442111	8	15	+/-4
34	5/14/96	3673638	442222	18	298	+/-15
35	5/14/96	3673717	442390	16	110	+/-9

[a] See Appendix A for 1995 underwater HPGe data.
[b] Universal Transverse Mercator.
[c] Counts per minute.

Table 1 (continued). Cesium-137 count rate (counts per minute), depth, and UTM coordinates at each location sampled in L Lake. 1996.[a]

Waypoint	Date	UTM[b] north	UTM east	Depth (feet)	Cesium-137 (cpm)[c]	Error (cpm)
36	5/14/96	3673880	442505	16	146	+/-10
37	5/20/96	3673567	442149	17	47	+/-4
39	5/20/96	3670021	440802	21	0	+/-2
40	5/20/96	3670200	440646	41	10	+/-3
41	5/20/96	3670322	440665	59	286	+/-14
42	5/20/96	3670361	440790	53	7	+/-3
43	5/20/96	3670296	440850	25	8	+/-2
44	5/20/96	3670386	440737	53	21	+/-4
45	5/20/96	3670283	440693	55	8	+/-3
46	5/20/96	3670268	440741	55	10	+/-3
47	5/20/96	3670388	440656	57	38	+/-5
48	5/21/96	3671277	440900	38	12	+/-2
49	5/21/96	3671189	440884	31	6	+/-3
50	5/21/96	3671113	440812	38	15	+/-3
51	5/21/96	3670992	440783	47	14	+/-4
52	5/21/96	3670903	440750	49	11	+/-7
53	5/21/96	3670820	440706	55	65	+/-5
54	5/21/96	3670756	440666	48	3	+/-2
55	5/21/96	3669265	440981	71	1	+/-2
56	5/21/96	3669314	440993	66	18	+/-5
57	5/21/96	3670442	440629	57	19	+/-5
58	5/21/96	3670582	440665	57	238	+/-11
59	5/21/96	3670681	440747	51	12	+/-3
60	5/21/96	3670787	440690	50	10	+/-3
62	5/21/96	3669543	440830	64	11	+/-3
63	5/21/96	3669488	440980	68	256	+/-14
64	5/21/96	3669669	440983	62	0	+/-2
65	5/21/96	3669850	440989	57	12	+/-5
66	5/21/96	3669933	440763	61	13	+/-4
67	5/21/96	3670175	440728	39	5	+/-3
68	5/21/96	3670235	440853	44	16	+/-4
69	5/21/96	3670519	440726	55	47	+/-6

[a] See Appendix A for 1995 underwater HPGe data.
[b] Universal Transverse Mercator.
[c] Counts per minute.

Table 1 (continued). Cesium-137 count rate (counts per minute), depth, and UTM coordinates at each location sampled in L Lake. 1996.[a]

Waypoint	Date	UTM[b] north	UTM east	Depth (feet)	Cesium-137 (cpm)[c]	Error (cpm)
70	5/21/96	3670658	440722	50	7	+/-2
71	5/21/96	3669849	440969	58	20	+/-4
72	5/21/96	3669738	440935	62	13	+/-3
73	5/23/96	3669600	440889	65	180	+/-9
74	5/23/96	3673295	441779	24	194	+/-16
75	5/23/96	3673229	441806	23	28	+/-4
76	5/23/96	3673170	441721	26	37	+/-6
77	5/23/96	3673093	441670	25	706	+/-24
78	5/23/96	3673029	441524	30	329	+/-11
79	5/23/96	3673049	441513	25	59	+/-6
80	5/23/96	3672952	441424	23	15	+/-4
82	5/23/96	3672911	441404	32	288	+/-18
83	5/23/96	3672847	441330	33	510	+/-20
84	5/23/96	3672815	441179	34	431	+/-14
85	5/23/96	3672691	441127	28	9	+/-3
86	5/23/96	3672764	441076	36	825	+/-27
87	5/23/96	3673546	441201	10	9	+/-3
88	5/23/96	3673463	441211	8	4	+/-2
89	5/23/96	3673273	441163	15	33	+/-9
90	5/23/96	3673129	441091	23	17	+/-4
91	5/23/96	3672937	441088	25	9	+/-3
92	5/23/96	3672794	441008	33	275	+/-15
93	5/23/96	3672647	441052	39	56	+/-6
94	5/23/96	3672653	441011	30	11	+/-2
95	5/23/96	3672478	440969	40	366	+/-16
96	5/23/96	3672245	441010	42	66	+/-6
97	5/23/96	3672101	440967	44	292	+/-15
98	5/23/96	3671959	440879	45	154	+/-10
99	5/23/96	3671833	440917	45	43	+/-6
100	5/23/96	3671738	440784	47	440	+/-18
101	5/23/96	3671592	440754	48	84	+/-7
102	5/23/96	3671500	440696	49	73	+/-14
103	5/23/96	3671343	440656	51	150	+/-9
104	5/23/96	3671159	440588	54	25	+/-3

[a] See Appendix A for 1995 underwater HPGe data.
[b] Universal Transverse Mercator.
[c] Counts per minute.

Table 1 (continued). Cesium-137 count rate (counts per minute), depth, and UTM coordinates at each location sampled in L Lake. 1996.[a]

Waypoint	Date	UTM[b] north	UTM east	Depth (feet)	Cesium-137 (cpm)[c]	Error (cpm)
105	6/5/96	3669263	440915	53	3	+/-2
106	6/5/96	3669350	440840	34	0	+/-2
107	6/5/96	3669452	440879	45	4	+/-2
108	6/5/96	3669639	440832	67	16	+/-4
109	6/5/96	3669668	440840	69	211	+/-16
110	6/5/96	3669729	440828	67	95	+/-6
111	6/5/96	3669793	440762	68	167	+/-10
112	6/5/96	3669881	440812	60	7	+/-3
113	6/5/96	3669921	440640	65	105	+/-8
114	6/5/96	3669924	440728	67	13	+/-3
115	6/5/96	3670074	440631	66	172	+/-11
116	6/5/96	3670710	440646	55	11	+/-4
117	6/5/96	3670839	440664	60	272	+/-12
118	6/5/96	3670860	440784	49	15	+/-4
119	6/5/96	3670939	440694	56	279	+/-13
120	6/5/96	3671020	440667	58	8	+/-2
121	6/5/96	3671088	440726	55	28	+/-5
122	6/5/96	3671203	440725	51	5	+/-3
123	6/5/96	3671218	440890	42	7	+/-3
124	6/5/96	3669215	440999	74	45	+/-4
125	6/5/96	3671401	440866	33	10	+/-2
126	6/5/96	3671523	440637	52	144	+/-9
127	6/5/96	3671594	440700	54	70	+/-7
128	6/5/96	3671805	440746	45	11	+/-3
129	6/5/96	3671921	440827	40	23	+/-4
130	6/5/96	3671990	440941	46	206	+/-11
131	6/5/96	3672045	440993	37	4	+/-2
132	6/5/96	3672139	441023	44	257	+/-12
133	6/5/96	3672374	441059	42	86	+/-7
134	6/5/96	3672539	440904	32	8	+/-3
135	6/5/96	3672339	440993	42	31	+/-3
136	6/5/96	3672369	440984	40	15	+/-3
137	6/5/96	3672577	441030	39	2	+/-2
138	6/11/96	3674016	442470	3	3	+/-2

[a] See Appendix A for 1995 underwater HPGe data.
[b] Universal Transverse Mercator.
[c] Counts per minute.

Table 1 (continued). Cesium-137 count rate (counts per minute), depth, and UTM coordinates at each location sampled in L Lake. 1996.[a]

Waypoint	Date	UTM[b] north	UTM east	Depth (feet)	Cesium-137 (cpm)[c]	Error (cpm)
139	6/11/96	3673925	442166	4	4	+/-2
140	6/11/96	3673958	441818	3	3	+/-2
141	6/11/96	3673567	441751	11	4	+/-2
142	6/11/96	3673354	441607	7	9	+/-3
143	6/11/96	3673152	441587	10	6	+/-3
144	6/11/96	3673202	441304	3	3	+/-2
145	6/11/96	3673080	441262	9	3	+/-2
146	6/11/96	3672808	440853	9	2	+/-2
147	6/11/96	3672654	440841	8	4	+/-2
148	6/11/96	3672490	440747	6	4	+/-3
149	6/11/96	3672341	440630	10	1	+/-2
150	6/11/96	3671964	440346	7	6	+/-2
151	6/11/96	3671682	440318	6	1	+/-2
152	6/11/96	3671575	440476	35	3	+/-2
153	6/11/96	3671883	440571	42	9	+/-3
154	6/11/96	3672243	440717	14	10	+/-3
155	6/11/96	3672436	440823	10	2	+/-2
156	6/11/96	3672188	440883	23	9	+/-3
157	6/11/96	3671342	441175	3	2	+/-2
158	6/11/96	3671598	441031	13	2	+/-2
159	6/11/96	3671722	441241	7	4	+/-2
160	6/11/96	3671843	441382	6	1	+/-2
161	6/11/96	3672007	441263	6	2	+/-2
162	6/11/96	3672434	441143	14	3	+/-2
163	6/11/96	3672642	441306	3	4	+/-3
164	6/11/96	3672832	441450	8	3	+/-3
165	6/11/96	3672927	441617	5	0	+/-2
166	6/11/96	3673103	441807	16	1	+/-2
167	6/11/96	3673538	442311	4	4	+/-3
168	6/11/96	3673609	442427	11	6	+/-3
169	6/11/96	3673699	442642	7	19	+/-4
170	6/11/96	3673892	442658	6	7	+/-2
171	6/11/96	3671031	440976	23	5	+/-3

[a] See Appendix A for 1995 underwater HPGe data.
[b] Universal Transverse Mercator.
[c] Counts per minute.

Table 1 (continued). Cesium-137 count rate (counts per minute), depth, and UTM coordinates at each location sampled in L Lake. 1996.[a]

Waypoint	Date	UTM[b] north	UTM east	Depth (feet)	Cesium-137 (cpm)[c]	Error (cpm)
173	6/11/96	3670865	440903	16	1	+/-2
174	6/11/96	3670649	440939	13	3	+/-2
175	6/11/96	3670473	440949	13	7	+/-3
176	6/11/96	3670289	441116	12	1	+/-2
177	6/11/96	3670157	441348	12	7	+/-2
178	6/11/96	3669974	441254	2	-1	+/-2
179	6/11/96	3669940	441179	21	18	+/-4
180	6/11/96	3670039	440979	31	4	+/-2
181	6/11/96	3670791	440410	14	4	+/-2
182	6/11/96	3670501	440390	22	8	+/-3
183	6/11/96	3670325	440365	14	5	+/-2
184	6/11/96	3670286	440504	55	7	+/-3
185	6/11/96	3670080	440359	13	3	+/-2
186	6/11/96	3669940	440233	10	1	+/-2
187	6/11/96	3669861	440397	19	16	+/-4
188	6/11/96	3669825	440583	31	5	+/-3
189	6/11/96	3669670	440509	10	9	+/-3
190	6/11/96	3669625	440688	27	5	+/-3
191	6/11/96	3669476	440797	28	4	+/-2
192	6/11/96	3669428	440570	13	3	+/-3
193	6/11/96	3669360	440523	9	4	+/-3
194	6/11/96	3669159	440663	23	2	+/-2
195	6/11/96	3669314	440756	32	2	+/-3

[a] See Appendix A for 1995 underwater HPGe data.
[b] Universal Transverse Mercator.
[c] Counts per minute.

Overall, the data show results similar to those from the 1995 survey (Dunn et al. 1995), with cobalt-60:cesium-137 ratios clustering near 1-2% but ranging up to 6%. As before, higher ratios are found primarily in the vicinity of the L-Reactor discharge canal; however, three higher values were recorded within the old Steel Creek floodplain. It should be noted that the August 1995 ratios require an 8% decay correction for comparison with the 1996 ratios.

Three locations associated with the Steel Creek floodplain had high cobalt-60:cesium-137 ratios. Waypoints 38, 43, and 68 had ratios of 4.7%, 6.6%, and 6.0%, respectively. Waypoint 43 is fairly close to the L-Reactor discharge canal and thus its ratio corresponds with previous results. However, waypoints 38 and 68 are near the north and south ends of the lake, within sampling regions that generally have cobalt to cesium ratios measured at less than 2%. No such aberrant ratios were observed

Table 2. Results of cobalt-60:cesium-137 ratio analysis at 76 waypoints in L Lake. All results are decay corrected to April 24, 1996.[a]

Waypoint	UTM[b] North	UTM East	Cobalt-60 concentration pCi/kg	Error[c]	Cesium-137 concentration pCi/kg	Error	Cobalt-60: cesium-137 ratio Percent	Error
6	3669715.68	441305.44	<8.1	MDA	711	8	<1.14	MDA
7	3669425.43	441267.33	8.1	1.1	1093	7	0.74	0.10
8	3671142.87	440881.41	<18.6	MDA	1053	22	<1.77	MDA
9	3671063.04	440882.79	<23.3	MDA	1184	28	<1.97	MDA
10	3669415.55	440702.17	18.3	4.8	2071	2	0.88	-0.05
11	3669436.85	440844.97	<3.4	MDA	138	4	<2.46	MDA
14	3670200.41	441080.84	6.5	1.8	1245	11	0.52	0.15
15	3670251.66	441222.88	<8.2	MDA	442	8	<1.86	MDA
16	3670168.22	441270.86	12.0	4.4	1509	24	0.80	0.29
17	3670186.50	441365.15	16.1	4.0	1402	23	1.15	0.29
19	3670106.74	441354.41	<16.5	MDA	990	20	<1.67	MDA
21	3669857.10	441017.23	75.1	15.5	3788	88	1.98	0.41
22	3669947.92	441032.69	<8.0	0.0	435	7	<1.84	MDA
23	3670074.72	441149.08	16.0	2.7	1361	13	1.18	0.20
24	3670013.03	441266.20	<6.4	MDA	590	7	<1.08	MDA
25	3669920.93	441279.63	<2.6	MDA	511	3	<0.51	MDA
26	3673650.89	442327.39	225.5	6.3	13031	54	1.73	0.05
27	3673711.94	442315.63	11.6	1.8	877	8	1.32	0.20
28	3673802.25	442229.48	29.8	3.0	2662	24	1.12	0.11
30	3673827.30	442118.71	38.9	4.0	3368	25	1.15	0.12
31	3673852.13	442043.36	<4.5	MDA	516	27	<0.87	MDA
32	3673924.63	441970.16	4.8	1.9	310	6	1.55	0.61
33	3673866.82	441996.84	599.5	9.3	11573	46	5.18	0.08
34	3673736.96	442022.17	131.1	3.9	4517	29	2.90	0.09
35	3673641.68	442010.42	190.7	10.8	11557	49	1.65	0.09
36	3673667.49	441959.30	62.0	2.3	3919	34	1.58	0.06
37	3673756.42	441919.75	58.1	4.3	2799	20	2.08	0.15
38	3673842.34	441827.06	120.2	7.9	2573	39	4.67	0.32
39	3673842.60	441782.32	161.0	6.7	4149	31	3.88	0.16
40	3673712.72	441810.44	125.8	7.5	6430	38	1.96	0.12

[a] Any comparison to the 1995 data will require a decay correction to the August 1995 sample collection date.

[b] Universal Transverse Mercator.

[c] All less than (<) values correspond to the Minimum Detectable Activities (MDA).

Table 2 (continued). Results of cobalt-60:cesium-137 ratio analysis at 76 waypoints in L Lake. All results are decay corrected to April 24, 1996.[a]

Waypoint	UTM[b] North	UTM East	Cobalt-60 concentration pCi/kg	Error[c]	Cesium-137 concentration pCi/kg	Error	Cobalt-60: cesium-137 ratio Percent	Error
41	3673640.55	441828.65	19.3 +/-	1.8	1419 +/-	12	1.36 +/-	0.13
42	3673479.37	441899.46	56.5 +/-	3.4	3659 +/-	26	1.54 +/-	0.09
43	3673503.20	441992.81	880.0 +/-	9.9	13387 +/-	41	6.57 +/-	0.08
44	3674047.39	442771.53	19.5 +/-	2.1	1266 +/-	11	1.54 +/-	0.17
45	3674075.51	442702.72	50.0 +/-	7.0	5765 +/-	50	0.87 +/-	0.12
46	3674042.67	442632.62	404.9 +/-	8.3	9163 +/-	43	4.42 +/-	0.09
47	3673970.91	442580.00	57.6 +/-	4.2	4589 +/-	27	1.26 +/-	0.09
48	3673882.52	442528.22	25.3 +/-	4.7	1446 +/-	24	1.75 +/-	0.32
49	3673864.50	442388.30	36.0 +/-	8.4	3357 +/-	42	1.07 +/-	0.25
50	3673658.47	442170.84	81.5 +/-	3.4	4552 +/-	23	1.79 +/-	0.08
52	3673134.05	441614.96	114.8 +/-	8.3	11815 +/-	59	0.97 +/-	0.07
53	3672978.42	441315.74	61.8 +/-	4.0	3209 +/-	30	1.93 +/-	0.13
54	3672714.13	441018.64	302.7 +/-	9.3	14412 +/-	78	2.10 +/-	0.07
55	3672375.99	441018.46	7.3 +/-	0.3	1139 +/-	4	0.64 +/-	0.02
56	3672063.69	440960.64	87.6 +/-	2.3	5473 +/-	15	1.60 +/-	0.04
57	3671590.24	440785.30	237.5 +/-	5.1	10906 +/-	41	2.18 +/-	0.05
58	3671443.47	440857.13	<2.4 +/-	MDA	301 +/-	3	<0.80 +/-	MDA
59	3671326.48	440769.71	18.8 +/-	2.9	1788 +/-	14	1.05 +/-	0.16
60	3671001.36	440632.55	730.1 +/-	10.9	47137 +/-	154	1.55 +/-	0.02
62	3670526.60	440674.42	183.5 +/-	10.9	14448 +/-	75	1.27 +/-	0.08
63	3670345.04	440813.18	6.1 +/-	1.5	678 +/-	8	0.90 +/-	0.22
64	3670233.20	440609.23	116.5 +/-	9.6	5669 +/-	39	2.06 +/-	0.17
65	3670074.59	440620.39	<129.7 +/-	MDA	7095 +/-	148	<1.83 +/-	MDA
67	3670123.98	440702.74	37.8 +/-	4.5	2956 +/-	30	1.28 +/-	0.15
68	3669794.31	440767.88	887.5 +/-	14.2	14699 +/-	69	6.04 +/-	0.10
69	3669427.80	440875.69	19.4 +/-	1.2	1338 +/-	7	1.45 +/-	0.09
70	3669219.32	440883.75	10.0 +/-	2.0	1000 +/-	13	1.00 +/-	0.21
71	3669178.14	440910.55	65.2 +/-	5.8	3793 +/-	26	1.72 +/-	0.15
72	3669172.08	440995.37	23.3 +/-	7.3	1581 +/-	29	1.47 +/-	0.47
73	3669249.67	440997.70	90.1 +/-	9.1	5315 +/-	50	1.70 +/-	0.17
74	3669238.63	440990.18	92.2 +/-	10.2	5044 +/-	50	1.83 +/-	0.20
75	3669240.86	440988.33	97.4 +/-	4.7	5277 +/-	24	1.85 +/-	0.09
76	3669330.25	441056.94	63.0 +/-	11.2	3654 +/-	49	1.72 +/-	0.31

[a] Any comparison to the 1995 data will require a decay correction to the August 1995 sample collection date.

[b] Universal Transverse Mercator.

[c] All less than (<) values correspond to the Minimum Detectable Activities (MDA).

in the 1995 survey (Appendix B). Since the present study had more than three times as many sediment samples as the 1995 survey, it may be that a larger number of samples provides a better opportunity to capture such anomalies. The 1985 overflight measurements were apparently not precise enough to locate such relatively infrequent variations in concentration.

Excluding the high ratios found at the L-Reactor discharge canal and the three high ratios in the Steel Creek floodplain, the remaining 57 samples averaged a cobalt-60:cesium-137 ratio of 1.47% ± 0.06%, which, when decay-corrected to 1995 concentrations, yields a ratio of 1.59% ± 0.07%; this correlates with the 1.47% ± 0.08%, measured for August 1995 (Dunn et al. 1995). Uncertainty in the 1996 value can be attributed to including the larger minimal detectable activity values in the calculation of the average (causing the value to be higher), while at the same time omitting the high,outlier values from the Steel Creek floodplain in the calculation of the average (causing the value to be low).

The underwater HPGe detector did not count long enough to detect the lower cobalt-60 activities and produce a count-rate contour map; however, a map of cobalt-60 concentrations was produced from the 1985 overflight data (Figure 6; from Feimster 1992). Overall, the cobalt-60 and cesium-137 contour maps are similar. This is consistent with the relative uniformity of the majority of cobalt-60:cesium-137 ratios of 1-2% shown in Figure 5. However, an exception to this is noted in the vicinity of the L-Reactor discharge channel, where the observed cobalt-60:cesium-137 ratios range up to 6%.

The 1995 and 1996 measurements of cobalt-60 and cesium-137 ratios appear to be consistent with the 1985 EG&G overflight results. The 1985 overflight results show relatively more cobalt-60 than cesium-137 near the L-Reactor discharge canal. This is consistent with the observed cobalt-60/cesium-137 ratio (based on 1995/1996 data) ranging to 6% near the discharge canal.

Most of the activation products released into SRS surface waters were transported directly to the Savannah River, although some cobalt-60 was deposited in stream beds, floodplains, and reservoirs (Gladden et al. 1985). L-Reactor basin purges were discharged to Steel Creek, L Lake, and a seepage basin designated 904-64G. The estimated aqueous release of cobalt-60 from L Reactor to Steel Creek during the reactor's operational lifetime was 15 curies. Cumulative releases to seepage basins totaled 3.8 curies of cobalt-60 (Carlton et al. 1996).

Dissolved cobalt is relatively mobile, but migration can be attenuated by factors such as pH and coprecipitation with iron, manganese, or organic phases within the contaminant plume. It is reasonable to assume that cobalt-60 may have preferentially accumulated near the L discharge canal.

Summary

This study was conducted on L Lake on the SRS. L Lake was created in 1985 to dissipate heated effluent from L Reactor. Water from the Savannah River continues to be pumped to L Lake at a rate of 1.5 cubic meters per second in order to maintain the current water level. Pumping river water may no longer be needed to support current missions at SRS. Hydrologic models predict that L Lake would eventually drain if the river water pumping system is decommissioned.

In order to assess and understand the environmental impacts of lowering the L-Lake water level and exposing surface sediments, a four phase L-Lake site characterization plan was developed and implemented. Phase 3 involved the *in situ* measurement of gamma-emitting radionuclides in the submerged surface sediments of L Lake. Surface sediment samples also were collected for higher sensitivity HPGe gamma spectrometry in the Savannah River Technology Center.

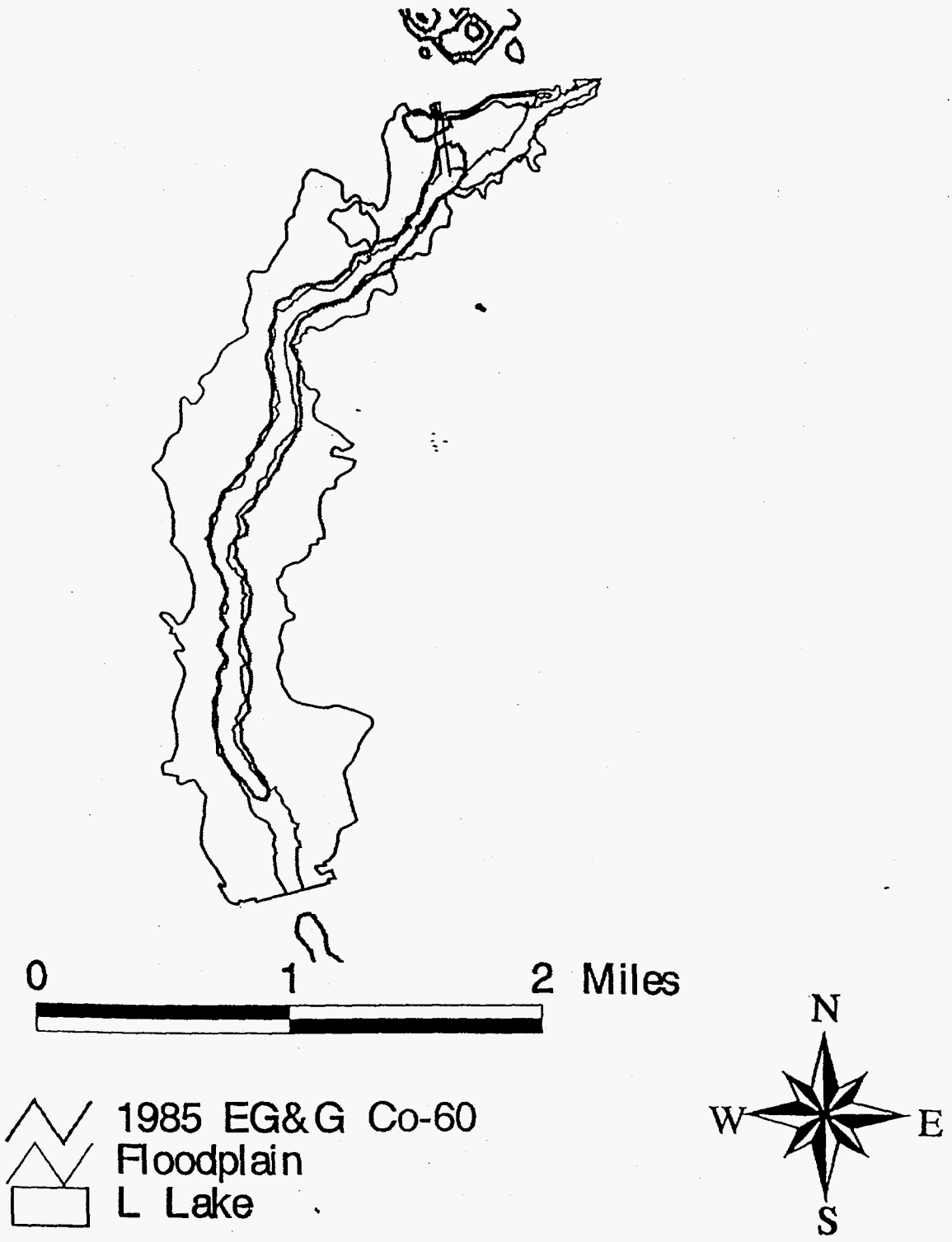

Figure 6. Cobalt-60 isodose contours from 1985 EG&G overflight sodium iodide mapping (from Feimster 1992).

The gamma spectral analysis results for all collected sediments and for all L-Lake measurements with the underwater HPGe detector are included in this report. The L-Lake cesium-137 activity is primarily located in the submerged Steel Creek floodplain. The collected sediment data show most cobalt-60:cesium-137 ratios near 1-2% but ranging up to 6%. The higher ratios are found primarily in the vicinity of the L-Reactor discharge canal, but some higher cobalt-60:cesium-137 ratios also are evident further downstream in the submerged Steel Creek floodplain. These data are made available for a baseline risk assessment to evaluate potential human health risks of exposure to L-Lake sediments.

References

Brisbin, I. L., Jr., R. J. Beyers, R. W. Dapson, R. A. Geiger, J. B. Gentry, J. W. Gibbons, M. H. Smith, and S. K. Woods. 1974. Patterns of Radiocesium in the Sediments of a Stream Channel Contaminated by Production Reactor Effluent. *Health Physics.* 27:19-27.

Carlton, W. H., L. R. Bauer, A. G. Evans, L. A. Geary, C. E. Murphy, Jr., J. E. Pinder, and R. N. Strom. 1992. *Cesium in the Savannah River Site Environment.* WSRC-RP-92-250. Westinghouse Savannah River Company, Savannah River Site, Aiken, SC.

DOE (U.S. Department of Energy). 1984. *Final Environmental Impact Statement L-Reactor Operation Savannah River Plant.* Vols 1-3. DOE/EIS-0108. Savannah River Operations Office, Savannah River Plant, Aiken, SC.

DOE (U.S. Department of Energy). 1995. *Environmental Assessment for the Natural Fluctuation of Water Level in Par Pond and Reduced Water Flow in Steel Creek Below L Lake at The Savannah River Site.* DOE/EA-1070. Savannah River Operations Office, Aiken, SC.

D. L. Dunn, W. G. Winn, and P. J. Bresnahan. 1995. *Scoping Measurements of Radionuclides in L Lake with an Underwater HPGe Detector (U).* WSRC-TR-95-0397. Westinghouse Savannah River Company, Savannah River Technology Center, Aiken, SC.

Feimster, E. L. 1992. *An Aerial Radiological Survey of the L Lake and Steel Creek, Savannah River Plant, Date of Survey: July 1986.* EGG-10617-1146. EG&G Energy Measurements, Inc., Las Vegas, NV.

Gladden, J. B., K. L. Brown, M. H. Smith, and A. Towns. 1985. Distribution of Gamma Exposure Rates in a Reactor Effluent Stream Flood Plain. *Health Physics.* 48:49-59.

Gladden, J. B., W. L. Specht, J. A. Bowers, N. V. Halverson, H. E. Mackey, and E. W. Wilde. 1989. *Compliance of the Savannah River Plant L-Reactor Cooling System with Environmental Regulations (U)—Demonstration in Accordance with Section 316(a) of the Clean Water Act, November 1985-December 1987.* DP-1766 Rev. 1. E. I. du Pont de Nemours & Co., Savannah River Laboratory, Aiken, SC.

Tinney, L. R., C. E. Ezra, and H. E. Mackey, Jr. 1986. Stream Corridor and Delta Wetlands Change Assessments, Savannah River Plant, Aiken, SC. DOE (ONS-SRL)-8604. EG&G/EM Letter Report, EG&G Inc., Las Vegas, NV.

Winn, W. G., 1992. Evaluation of ^{137}Cs in Pond Sediment with an Underwater HPGe Detector, *Trans. Amer. Nuc. Soc.* 66:32-34.

Winn, W. G., 1993. *Measurements of Radionuclides in Par Pond Sediments with an Underwater HPGe Detector.* WSRC-TR-93-0209. Westinghouse Savannah River Company, Aiken, SC.

Winn, W. G., 1995a. Environmental Measurements at the Savannah River Site with Underwater Gamma Detectors. *Radioanalytical and Nuclear Chemistry.* 194(2):345-350.

Winn, W. G., 1995b. *Measurements of Radionuclides in Pond C with an Underwater HPGe Detector.* WSRC-TR-95-0272. Westinghouse Savannah River Company, Aiken, SC.

Winn, W. G., W. W. Bowman, and A. L. Boni. 1987. *Ultraclean Underground Counting Facility for Low-Level Environmental Samples.* DP-1747. E. I. du Pont de Nemours & Co., Aiken, SC.

Zeigler, C. C., I. B. Lawrimore, and W. E. O'Rear. 1985. *Environmental Monitoring at the Savannah River Plant, Annual Report–1984.* DPSPU 85-302. Health Protection Department, Savannah River Plant, E. I. du Pont de Nemours & Co., Aiken, SC.

Appendix A
1995 Underwater HPGe Data from L-Lake Sediments

All entries are essentially self-explanatory; however, the following provides additional "Depth/ Loc" column information. The depth in feet may be translated to mean-sea-level (msl) depth by noting that the lake level is about 190 ft msl; more exact levels may be deduced by checking the recorded lake level during the dates of the measurements. The location is given as "N," "S," "E," and "W" to denote relative compass directions relative to the deepest point of a transect; an "M" denotes measurements near the lake middle. Notations "a" and "b" identify regions where additional dips (relative maximum depths) were observed.

Underwater HPGe Data – L Lake Surface Sediments (1995)

Transect	Date	UTM north	UTM east	Depth/ Location	Cesium-137 rate cpm		
1	8/1/95	3673842.88	441775.79	3.5ft/W	1	+/-	4
1	8/1/95	3673863.54	441823.04	8ft/W	88	+/-	11
1	8/1/95	3673779.89	441855.94	12ft/W	11	+/-	5
1	8/1/95	3673727.43	441925.01	16ft/W	6	+/-	4
1	8/1/95	3673552.06	441948.83	20ft/W	257	+/-	30
1	8/1/95	3673514.72	442012.56	24ft/W	122	+/-	20
1	8/1/95	3673533.15	442021.21	25ft/W	117	+/-	24
1	8/1/95	3673510.77	442055.00	20ft/E	8	+/-	4
1	8/1/95	3673514.46	442108.36	12ft/E	-2	+/-	4
2	8/1/95	3673123.38	441075.23	3ft/W	-1	+/-	3
2	8/1/95	3673048.37	441103.26	11ft/W	0	+/-	3
2	8/1/95	3673015.01	441120.92	20ft/W	4	+/-	3
2	8/1/95	3673096.62	441120.12	24ft/W	1	+/-	3
2	8/1/95	3673021.62	441402.42	12ft/Wa	7	+/-	4
2	8/1/95	3673064.60	441374.46	20ft/Wa	13	+/-	5
2	8/1/95	3673013.61	441351.63	30ft/Wa	15	+/-	5
2	8/1/95	3672962.16	441406.73	36ft/Wa	2	+/-	3
2	8/1/95	3673034.88	441502.45	34ft/Wb	39	+/-	8
2	8/1/95	3672989.73	441482.76	30ft/Wb	381	+/-	35
2	8/1/95	3672960.73	441531.70	26ft/Eb	48	+/-	7
2	8/1/95	3672970.27	441569.67	22ft/Eb	8	+/-	3
2	8/1/95	3672935.46	441604.48	16ft/Eb	5	+/-	3
2	8/1/95	3672941.79	441648.78	8ft/Eb	8	+/-	3
3	8/1/95	3672615.03	441109.96	4ft/E	-2	+/-	3
3	8/1/95	3672579.35	441051.23	12ft/E	2	+/-	1
3	8/1/95	3672555.83	441018.72	24ft/E	12	+/-	4
3	8/1/95	3672546.12	440994.83	38ft/E	260	+/-	16
3	8/1/95	3672472.18	440999.31	42ft/E	115	+/-	12
3	8/1/95	3672393.74	440933.84	32ft/W	19	+/-	5
3	8/1/95	3672550.88	440869.53	18ft/W	0	+/-	2
3	8/1/95	3672631.51	440828.85	10ft/W	3	+/-	3
3	8/1/95	3672545.00	440874.42	24ft/W	4	+/-	2
4	8/1/95	3671934.33048	441331.15817	8ft/E	2	+/-	1
4	8/1/95	3671862.48114	441142.19979	11ft/E	4	+/-	3
4	8/1/95	3671884.66765	441088.98696	21ft/E	7	+/-	3
4	8/1/95	3671973.74580	441025.30219	30ft/E	14	+/-	4
4	8/1/95	3671958.56581	440989.21466	45ft/E	150	+/-	12
4	8/1/95	3671836.22426	441002.45894	39ft/E	9	+/-	3
4	8/1/95	3672057.33501	440851.00951	37ft/W	5	+/-	5
4	8/1/95	3672036.16944	440786.40004	30ft/W	4	+/-	4
4	8/1/95	3672040.96456	440554.91848	29ft/W	2	+/-	3
4	8/1/95	3672178.62697	440503.96580	16ft/W	4	+/-	4

Underwater HPGe Data – L Lake Surface Sediments (1995) (continued)

Transect	Date	UTM north	UTM east	Depth/ Location	Cesium-137 rate cpm		
5	8/2/95	3670406.33355	440397.07040	14ft/W	2	+/-	3
5	8/2/95	3670519.89952	440459.40598	24ft/W	12	+/-	4
5	8/2/95	3670368.05560	440715.41278	32ft/W	0	+/-	2
5	8/2/95	3670542.46213	440496.58064	40ft/W	1	+/-	2
5	8/2/95	3670564.80687	440518.99081	45ft/W	7	+/-	3
5	8/2/95	3670502.48435	440588.28246	51ft/W	3	+/-	3
5	8/2/95	3670412.49317	440751.16612	55ft/W	6	+/-	3
5	8/2/95	3670537.14348	440662.04950	56ft/W	3	+/-	2
5	8/2/95	3670497.77084	440705.06342	59ft/W	29	+/-	6
5	8/2/95	3670455.32201	440747.54101	56ft/E	49	+/-	7
5	8/2/95	3670428.62194	440884.65062	36ft/E	3	+/-	2
5	8/2/95	3670514.23194	440732.87650	54ft/M	5	+/-	3
5	8/2/95	3670526.46220	440848.98300	36ft/Ea	11	+/-	4
5	8/2/95	3670546.21797	440790.56870	44ft/Ea	5	+/-	3
5	8/2/95	3670585.82781	440860.73866	12ft/E	7	+/-	3
6	8/2/95	3669389.80954	440488.00177	6ft/W	1	+/-	2
6	8/7/95	3669423.09775	440685.84449	15ft/W	3	+/-	2
6	8/7/95	3669423.90202	440807.07534	36ft/W	4	+/-	3
6	8/7/95	3669432.52253	440909.18523	45ft/W	2	+/-	4
6	8/7/95	3669443.76550	441036.17754	68ft/W	142	+/-	13
6	8/7/95	3669411.24503	440862.94913	63ft/W	15	+/-	4
6	8/7/95	3669359.51351	441065.71649	54ft/E	2	+/-	2
6	8/7/95	3669292.11342	441160.63395	23ft/E	0	+/-	4
6	8/7/95	3669305.02714	441266.39708	15ft/E	3	+/-	3
6	8/7/95	3669424.24271	441311.92612	4ft/E	2	+/-	3
7	8/2/95	3669217.27	440856.07	48ft/M	5	+/-	3
7	8/2/95	3669195.12	440902.82	45ft/W	6	+/-	4
7	8/2/95	3669248.39	440902.89	68ft/W	5	+/-	3
7	8/2/95	3669269.46	440984.61	68ft/E	6	+/-	3
7	8/2/95	3669218.61	441040.77	70ft/E	3	+/-	4
8	8/7/95	3670854.35	440762.65	42ft/E	12	+/-	4
8	8/7/95	3670823.94	440697.46	48ft/E	7	+/-	3
8	8/7/95	3670755.32	440689.79	57ft/E	9	+/-	5
8	8/7/95	3670795.60	440547.07	47ft/E	8	+/-	4
8	8/7/95	3670763.46	440769.09	51ft/E	7	+/-	5
9	8/7/95	3671500.59	440486.36	32ft/W	12	+/-	4
9	8/7/95	3671421.32	440608.89	47ft/W	8	+/-	4
9	8/7/95	3671516.82	440654.53	49ft/W	194	+/-	19
9	8/7/95	3671530.06	440805.60	27ft/E	10	+/-	3
10	8/7/95	3673204.26	441967.47	5ft/S	0	+/-	3
10	8/7/95	3673299.24	441997.29	4ft/N	3	+/-	2
10	8/7/95			8ft/N	6	+/-	3
10	8/7/95	3673241.60	442004.98	12ft/S	0	+/-	3
11	8/7/95	3669807.37	441154.67	21ft/E	13	+/-	4
11	8/7/95	3669788.13	441178.64	13ft/E	8	+/-	4
11	8/7/95	3669815.76	441244.34	10ft/E	0	+/-	2
11	8/7/95	3669718.05	441207.23	23ft/E	2	+/-	4
11	8/7/95	3669558.69	441230.88	18ft/E	1	+/-	1

Underwater HPGe Data – L Lake Surface Sediments (1995) (continued)

Transect	Date	UTM north	UTM east	Depth/ Location	Cesium-137 rate cpm		
12-1	8/9/95	3670026.42	440883.51	25ft/M	-1	+/-	2
12-2	8/9/95	3670017.61	440863.77	30ft/M	13	+/-	5
12-3	8/9/95	3670113.85	440838.45	20ft/M	-4	+/-	3
12-4	8/9/95	3670096.01	440988.05	17ft/M	1	+/-	1
12-5	8/9/95	3670035.33	440989.24	25ft/M	2	+/-	2
12-6	8/9/95	3669948.18	441040.25	48ft/M	1	+/-	2

Appendix B
1995 Gamma Spectrometry Data from L-Lake Sediments

The 1995 sediment data analyzed in the Underground Counting Facility are summarized below. The table gives the following for each measurement:

All entries are essentially self-explanatory; however, it should be pointed out that the concentrations are for the undried sediments. (The dried sediments would have somewhat greater concentrations). In the interest of providing timely results for the 1995 scoping study, it was recognized that the data from the undried samples would be sufficient, as the prime interest was in examining the cobalt-60:cesium-137 ratio; however, even the absolute cobalt-60 and cesium-137 concentrations display the overall order-of-magnitude variations in the distribution, as the moisture content has a relatively minor effect on these trends.

An average of all the cobalt-60:cesium-137 ratios yields 1.79% ± 0.24%, where the error is the standard deviation of the mean. (The corresponding sample standard deviation is 1.08%). It should be noted that two ratios at 3.27% and 5.98% are significantly larger than the mean. Both values are in the vicinity of the L-Reactor discharge canal, where the earlier EG&G overflight studies indicated relatively greater amounts of cobalt-60. Excluding these two values, the cobalt-60:cesium-137 average is 1.47% ± 0.08% (sample standard deviation of 0.32%). This average value is considered more representative of the bulk of the lake, as the values making up this average span most locations of the lake and also cluster within a fairly narrow band about the average.

Gamma Spectrometry Data – L Lake Sediments[a] (1995)

Sample ID	UTM north	UTM east	Depth	Cobalt-60 pCi/kg		Cesium-137 pCi/kg		Cobalt-60/ Cesium-137 percent	
12-2	3670017.61	440863.77	30ft/M	10.8 +/-	1.5	823 +/-	8	1.31 +/-	0.18
12-4	3670096.01	440988.05	17ft/M	3.0	MDA	242 +/-	4	1.24	MDA
12-6	3669948.18	441040.25	48ft/M	9.5 +/-	1.4	593 +/-	6	1.60 +/-	0.23
13-1	3669811.31	441061.96	28 feet	3.3 +/-	0.8	179 +/-	2	1.84 +/-	0.43
13-2	3669484.36	441299.59	56 feet	12.6 +/-	1.6	836 +/-	10	1.51 +/-	0.19
13-3	3669613.33	441260.22	32 feet	3.0	MDA	194 +/-	4	1.55	MDA
13-4	3669697.57	441335.32	14 feet	5.3 +/-	0.9	338 +/-	5	1.57 +/-	0.28
13-5	3669608.87	440572.74	14 feet	2.9	MDA	268 +/-	2	1.08	MDA
14-1	3674125.94	442967.14	10 feet	91.7 +/-	2.5	8190 +/-	20	1.12 +/-	0.03
14-2	3674026.77	442600.99	16 feet	330.7 +/-	3.7	10100 +/-	200	3.27 +/-	0.07
14-3	3673397.66	442121.90	22 feet	152.0 +/-	2.7	18100 +/-	100	0.84 +/-	0.02
14-4	3673711.47	441812.81	12 feet	71.8 +/-	2.2	1200 +/-	10	5.98 +/-	0.19
14-5[b]	3673014.20	441561.37	32 feet	636.7 +/-	6.0	34400 +/-	100	1.85 +/-	0.02
14-6	3672614.21	441041.60	40 feet	284.8 +/-	4.6	16200 +/-	200	1.76 +/-	0.04
14-7	3671917.03	440930.17	55 feet	22.3 +/-	0.8	1550 +/-	10	1.44 +/-	0.05
14-8	3671796.54	441097.01	15 feet	5.8 +/-	0.9	292 +/-	6	1.99 +/-	0.32
14-9	3672103.96	440576.27	35 feet	25.3 +/-	1.8	1370 +/-	10	1.85 +/-	0.13
14-10	3671090.01	440497.84	15 feet	3.9 +/-	0.8	250 +/-	4	1.56 +/-	0.31
14-11	3670789.16	440796.96	54 feet	23.2 +/-	1.6	1700 +/-	10	1.36 +/-	0.09
14-12	3669415.33	440747.71	24 feet	7.5 +/-	1.2	742 +/-	7	1.01 +/-	0.17

a Analysis decay-corrected to sample collection date of August 9, 1995.
b Sample 14-5 indicated 28±5 pCi/kg for europium-154.