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UNC ENVIRONMENTAL SURVEILLANCE REPORT
FOR THE 100 AREAS --- FY 1985

Author

I. D. Jacques

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UNC ENVIRONMENTAL SURVEILLANCE REPORT
FOR THE 100 AREAS -- FY 1985

Prepared by: I. Duane Jacques Date: 2/18/86
I. D. Jacques
Assoc. Environmental Engineer

Reviewed by: L P Diediker Date: 2-18-86
L. P. Diediker, Manager
Radioactive Effluent Control

Reviewed by: Eric M. Greager Date: 2/19/86
E. M. Greager, Manager
Environmental Protection

Approved by: J J Dorian Date: 2/20/86
J. J. Dorian, Manager
Environmental and Emergency Preparedness

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SUMMARY

Results from the UNC Environmental Surveillance Program for the Hanford 100 Areas are discussed in this report. The surveillance program provides sampling and monitoring of several parameters in order to evaluate the environmental impact of 100-N Reactor facilities and the shutdown reactor facilities and burial grounds in the retired 100 Areas.

At 100-N Area, samples of ambient air, ground water, vegetation, and surface soil were collected and analyzed. Direct radiation levels were also monitored at several locations.

Samples of ambient air, vegetation, surface soil, and sediment were collected to monitor the operation and impact of the 1301-N and 1325-N Liquid Waste Disposal Facilities (LWDF). Direct radiation surveys were also conducted for each of the facilities.

At the retired 100 Areas, vegetation and surface soil samples were collected and analyzed. In addition, samples from ground-water monitoring wells located at 100-K Area were collected and analyzed.

Special samples collected during the fiscal year are also included in the appropriate sections of the report.

The results provided in this report are summarized by the following highlights.

- Environmental samples of ambient air, ground water, surface soil, vegetation, and direct radiation measurements collected near 100-N Area indicated no significant release or biotransport of radionuclides to the immediate environment.

- Vegetation samples collected near the N-Springs portion of the Columbia River shoreline contained above background levels of strontium-90.

- Radionuclides released to the 1301-N LWDF were detected in the surface soil and vegetation adjacent to the facility. Environmental samples of the deer mice residing near the 1301-N LWDF indicated uptake of the radionuclides discharged to the facility. The concentrations were similar to those reported in ERDA-1538, "Final Environmental Statement, Waste Management Operations, Hanford Reservation."

  At the present time the 1301-N LWDF is not receiving N-Reactor liquid effluent. Facility closure plans are being evaluated that will include barriers to intrusion by small mammals.

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- Sediment samples collected from the 1301-N LWDF trench and the 1325-N LWDF crib contained activation and fission products discharged from N Reactor. Discharges to the 1301-N LWDF were discontinued on September 19,1985. As the radionuclides decay, contamination levels in the 1301-N facility will decrease.

- Environmental samples of surface soil and vegetation collected near the retired 100 Area reactor facilities indicated no release or biotransport of radionuclides to the immediate environment.

- Vegetation sampled from selected 100 Area burial grounds indicated that radionuclides were being assimilated by the plants. The principle radionuclides detected were strontium-90 and cesium-137.

- Ambient air samples collected near the 183-H facility and air samples collected within basin #1 during cleanup indicated that there was no spread of the waste outside of the basin area.

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1.0 ENVIRONMENTAL SURVEILLANCE PROGRAM

1.1 Purpose of the Program

The UNC Environmental Surveillance Program for the 100 Areas provides monitoring of specific environmental media. The information is used to assist in evaluating the environmental impact of 100-N reactor facilities, the shutdown reactor facilities, and burial grounds in the retired 100 Areas. The major objectives of the monitoring program are:

- detection of radionuclides in identified radiological release pathways,
- detection and evaluation of changes in radionuclide concentrations discharged or existing in the immediate environment,
- maintenance of a data base for trend analyses,
- provision of data for after-the-fact release analyses, and
- demonstration of compliance with applicable regulations.

This document is used by UNC Nuclear Industries (UNC) primarily to evaluate facility operation and management practices. The report does not include estimates of radiation doses to the public resulting from the operation of 100 Area facilities. Reports of population dose commitments and other environmental information for the Hanford Site are prepared and issued by Battelle Pacific Northwest Laboratories (PNL). UNC provides radionuclide release information to PNL for the preparation of such documents.

The surveillance report is divided into four sections. Section 2.0 includes environmental information concerning 100-N Area. The majority of UNC's operations are at 100-N Area, making this the largest section of the report.

Section 3.0 includes data collected to monitor the operation and impact of the 1301-N and 1325-N Liquid Waste Disposal Facilities (LWDF).

Section 4.0 provides data from environmental samples collected at the retired 100 Areas.

Special samples collected during the fiscal year are also included in the appropriate sections of the report.

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1.2 Environmental Surveillance Program Procedures

The use of consistent sampling techniques is important if the data collected are to be used to evaluate year-to-year environmental impacts and trends. It is UNC policy to mimic PNL procedures and practices as much as possible in order to make the data from the two programs comparable. Procedures for collecting, preparing, and analyzing environmental samples are documented in UNI-M-76 REV 2, "Effluent Radioanalytical Program."

Radioanalyses conducted at the UNC radioanalytical laboratory are limited to the detection of gamma-emitting radionuclides. Other analyses, such as gross alpha/beta, strontium, and plutonium determinations were performed for UNC by the U.S. Testing Company in Richland, Washington.

Historically, the radioanalytical program at UNC has provided reliable and accurate analyses of gamma-emitting radionuclides. The laboratory has consistently performed well on inter-laboratory comparisons. The quality control program for the laboratory is documented in UNI-M-76 REV 2. Quality control for the U.S. Testing Company (UST) laboratory is overseen by PNL.

1.3 Data Analysis

Radionuclide concentrations in many environmental samples are very low. Concentrations may be so near zero that the uncertainty associated with the counting techniques may be greater than the actual counted values. In such cases, the radionuclide concentrations were too low to be measured by the analytical technique used. These results will be noted in the report with a less-than (<) symbol.

Numeric values stated in the report will generally include an accuracy of two significant figures. This is based on the accuracy of the analytical techniques used.

Values that are derived by averaging (mean) will include a statement of the standard deviation associated with that average. Standard deviation values will be noted with a plus-minus (±) symbol. In order to make the data comparable to previous environmental reports, values that have been designated as less than the associated analytical error (<) will not be included in calculations of the mean unless indicated.

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2.0 100-N AREA SURVEILLANCE PROGRAM

2.1 100-N Area Sampling Program

Environmental surveillance at 100-N Area is conducted primarily to monitor and document radionuclides detected in environmental media located near the 100-N Area facilities. The sampling program is designed to monitor the major radiological release pathways of N Reactor (Poppe 1979). The major release pathways of N Reactor are identified on figure 2.1.

As a result of release pathway analyses, two basic monitoring programs have been implemented at 100-N Area. Routine operational releases are monitored and reported separately as a part of the Effluent Release Program. Environmental media associated with N-Reactor release pathways are monitored as a part of the Environmental Surveillance Program. Within the scope of the two programs all environmental release pathways are monitored at one or more points.

The sampling program for 100-N Area is summarized on table 2.1. Sampling methods, frequencies, and analyses are based on characteristics of the environmental parameter being sampled.

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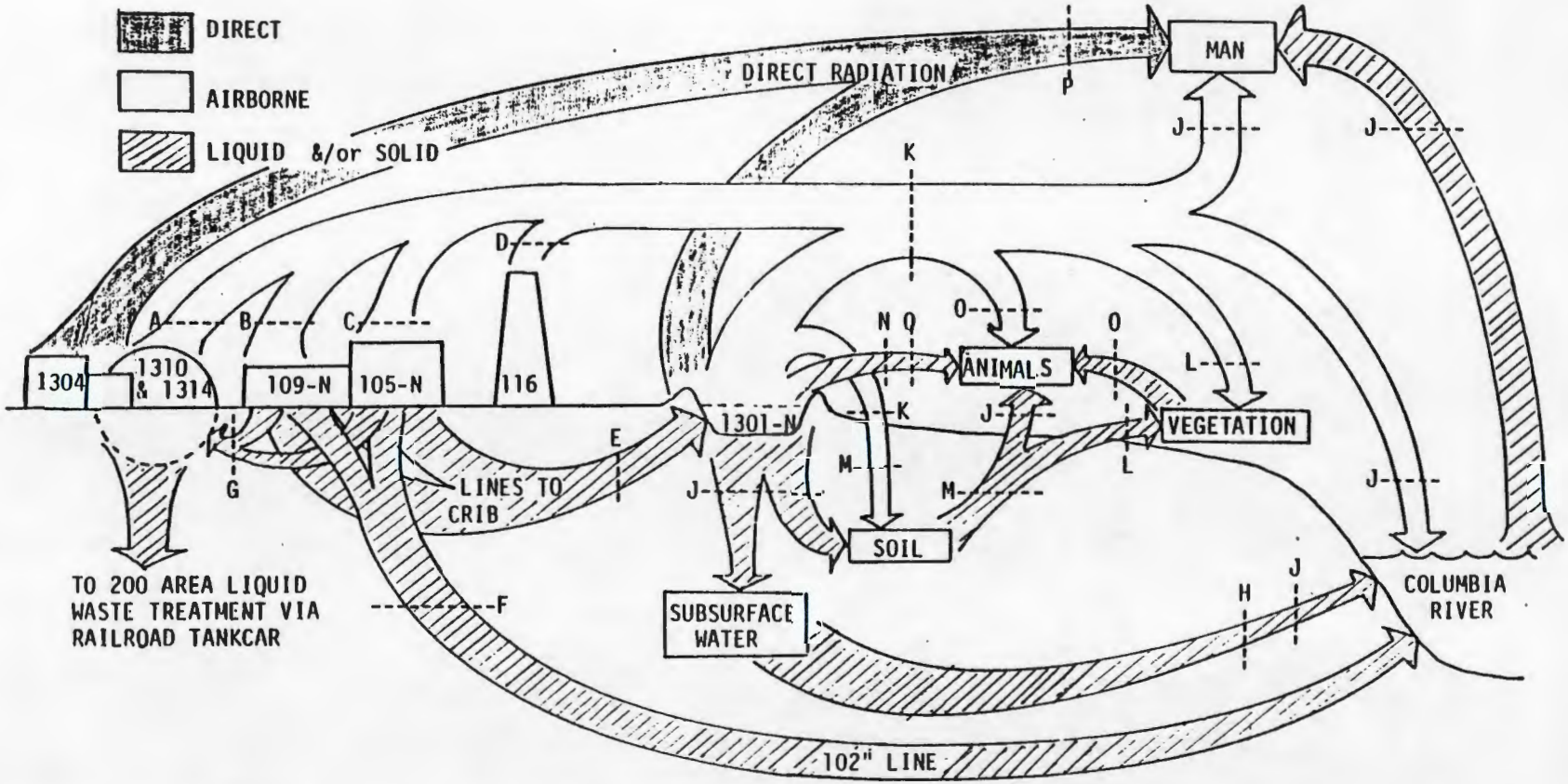

ENVIRONMENTAL MONITORING SYSTEMS

EFFLUENT RELEASE PROGRAM

- A Air sampler on tank vents
- B, C, & D Continuous air samplers
- E Flow proportional liquid sampler
- F Continuous large volume liquid sampler
- G Liquid samples during storage and shipment
- H Continuous composite liquid sampler

ENVIRONMENTAL SURVEILLANCE PROGRAM

- J PNL Environmental Program
- K Continuous air samplers
- L Vegetation samples
- M Soil samples
- N Sediment samples
- O Special environmental samples
- P Direct radiation measurements

Figure 2.1 Major Radiological Release Pathways Related to 100-N Area Facilities

Table 2.1 Summary of the UNC Environmental Surveillance Program for 100-N Area

Sample	Sampling Method	Number of Sample Locations	Sampling Frequency	Analysis
Air	Low-volume continuous sampler with particulate filter and charcoal bed	3	Monthly	Gamma-emitting radionuclides
Ground Water	Four-liter well samples provided by PNL	27	Quarterly	Gamma-emitting radionuclides
Ground Water	One-quart well sample	11	Dependent upon well	Oil and grease
Surface Soil	Composite sample of approximately 100 grams dry weight	7	Annually	Gamma-emitting radionuclides, strontium, and plutonium
Vegetation	Composite sample of approximately 500 grams dry weight	10	Annually	Gamma-emitting radionuclides, strontium, and plutonium
Direct Radiation	TLD-400 Dosimeters (CaF_2: Mn matrix)	36	Monthly	Dose rate and integrated dose
Direct Radiation (Columbia River Shoreline)	Dose rate using hand-held survey instrument	54	Annually	Dose rate

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2.2 Air Samples

Air sampling provides a means of evaluating and monitoring radionuclides released to the air from N Reactor facilities.

Environmental air samples are collected with continuously operating low-volume sample pumps. Ambient air is drawn through a one cubic-foot per minute orifice into a stainless steel sample cartridge containing a particulate filter (47mm millipore) and a bed of activated charcoal to collect specific radionuclides (i.e. halogens).

The sample cartridges are changed monthly and analyzed for gamma-emitting radionuclides at the UNC radioanalytical lab located in room 50 of the 105-N building. The 100-N Area sampling locations are shown on figure 2.2.1.

Average radionuclide concentrations detected in 100-N Area continuous air samples are shown on table 2.2. The averages were calculated using detectable concentrations only.

Some radionuclides were detected only once during the year. In these cases the average is the same as the single result. All averages calculated from two or more values include the standard deviation to indicate the distribution of the data. Minimum and maximum concentrations are also shown to indicate the sample variance.

The radionuclides identified in the 100-N ambient air samples are at or near the level of detection. Figure 2.2.2 shows average concentrations of cobalt-60 and iodine-131 detected in 100-N ambient air samples from 1981 to 1985.

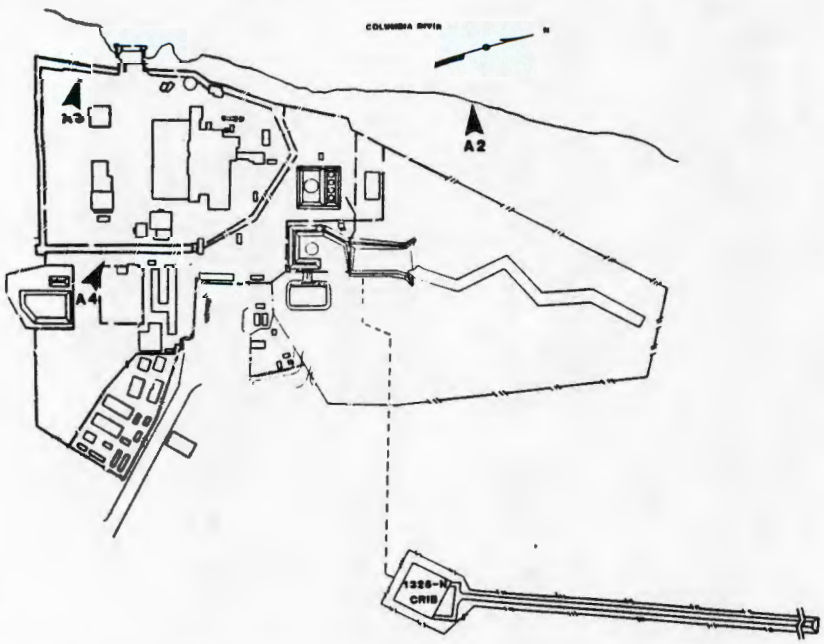

Figure 2.2.1 Ambient Air Sampling Locations at 100-N Area

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TABLE 2.2 Average Radionuclide Concentrations (pCi/m3) Detected in Air Samples at 100-N Area

Sample Location		Mn-54	Fe-59	Co-60	As-76	ZrNb-95	Ru-103	I-131	Ce-141	Ce-144
A2	Min	.015	<.025	.034	<.046	---	<.011	---	<.013	---
(N-Springs)	Max	.11	<.22	.99	<540	.043	<.18	.068	<.10	.027
	Ave	.052	---	.19	---	.043	---	.068	---	.027
	S.D.	±.051	---	±.29	---	---	---	---	---	---
A3	Min	.027	<.021	.081	<.011	<.032	<.011	<.023	<.011	<.034
(005 Outfall)	Max	.058	<.079	.36	<.86	<.086	<.028	<.084	<.032	<.13
	Ave	.040	---	.21	---	---	---	---	---	---
	S.D.	±.016	---	±.093	---	---	---	---	---	---
A4	Min	.016	<.015	.021	<.025	<.014	---	---	<.0056	<.026
(151-N)	Max	.031	<.11	.13	<22	<.18	.011	.048	<.019	<.078
	Ave	.024	---	.056	---	---	.011	.048	---	---
	S.D.	±.0075	---	±.031	---	---	---	---	---	---
Average		.039	---	.15	---	.043	.011	.058	---	.027
S.D.		±.014	---	±.084	---	---	---	±.014	---	---
DOE 5480.1 Onsite Concentration Guides		40,000	50,000	9,000	100,000	30,000	80,000	4,000	200,000	6,000
DOE 5480.1 Offsite Concentration Guides		1,000	2,000	300	4,000	1,000	3,000	100	5,000	200

Min - Minimum value reported during FY 1985
Max - Maximum value reported during FY 1985
Ave - Average
S.D. - Standard deviation

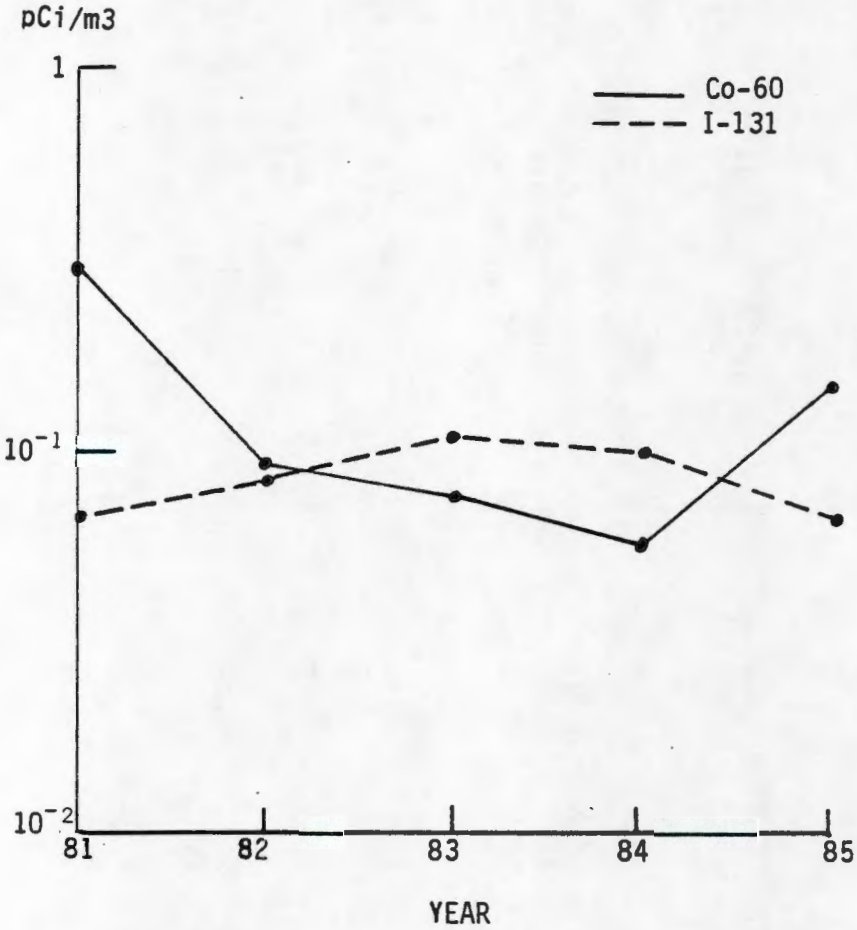

Figure 2.2.2 Average Concentrations of Cobalt-60 and Iodine-131 Detected in 100-N Area Ambient Air From 1981 to 1985

2.3 Ground-water Samples

Ground-water sampling is performed at 100-N Area to monitor radionuclide concentrations in the ground water adjacent to the 1301-N LWDF, the 1325-N LWDF, and the riverbank springs. These data are used to monitor the integrity of underground piping, basins, and tanks.

The locations of the ground-water sampling wells are shown on figure 2.3.1. Four-liter samples of ground water were collected quarterly by PNL and analyzed for gamma-emitting radionuclides at the UNC radioanalytical lab.

Table 2.3.1 shows radionuclide concentrations detected in the routine ground-water samples. The samples contain radionuclides attributable to liquid effluents discharged to the 1301-N and 1325-N LWDFs (Rokkan 1985).

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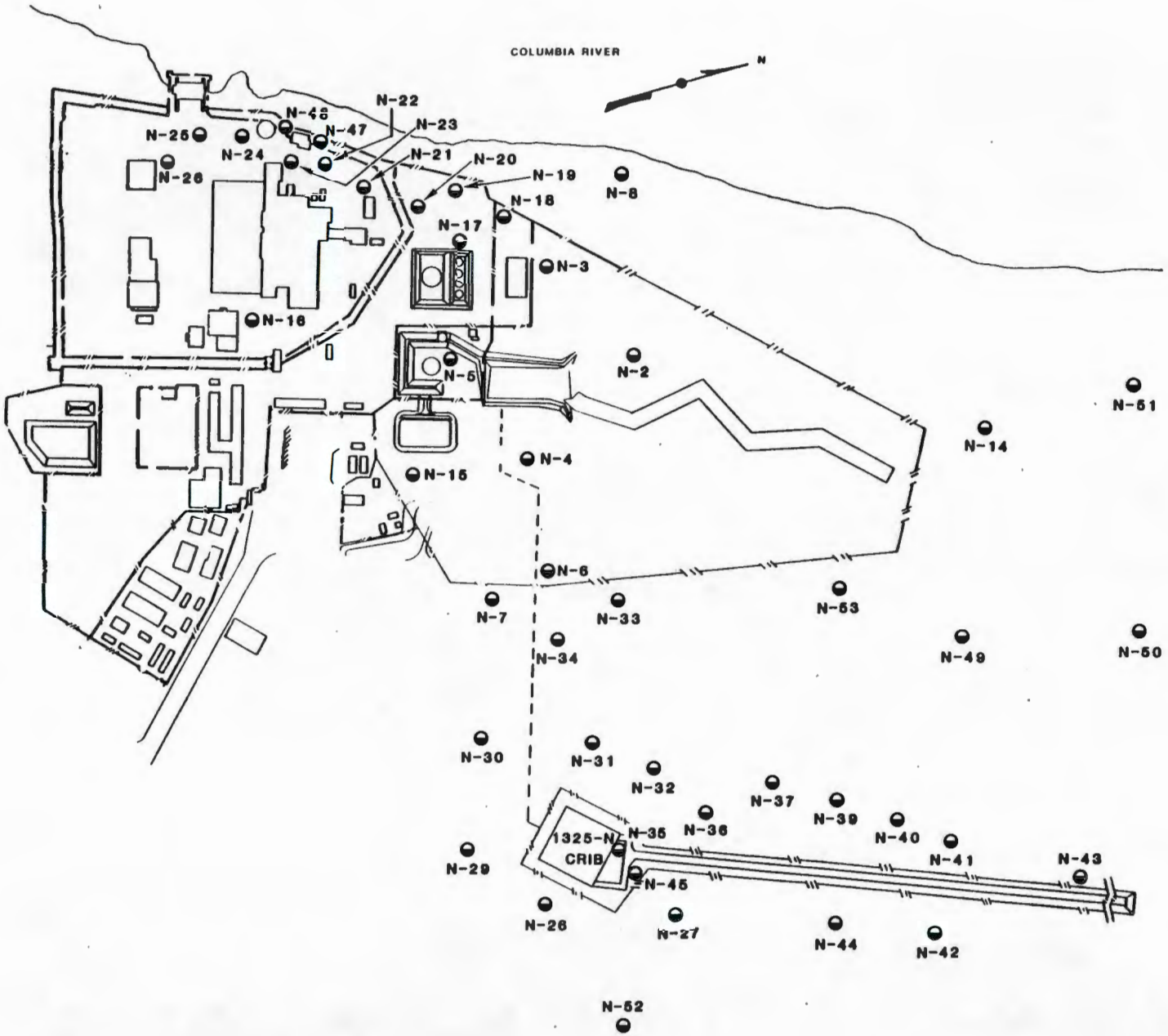

Figure 2.3.1 Location of Ground-water Wells at 100-N Area

Table 2.3.1 Radionuclide Concentrations (pCi/L) in 100-N Area Ground-water Samples

Well		Co-60	Ru-103	Ru-106	Sb-124	Sb-125	I-131
N-2	Min	150	100	160	---	270	950
	Max	220	210	310	24	670	2,700
	Ave	190	140	230	24	440	1,800
	S.D.	± 40	± 58	± 75	---	± 210	± 1,200
N-3	Min	98	44	88	<6.9	59	470
	Max	110	210	140	<8.1	76	900
	Ave	100	110	110	---	68	740
	S.D.	± 4.9	± 88	± 24	---	± 8.6	± 24
N-4	Min	90	8.6	48	<6.0	19	27
	Max	190	91	130	<9.7	36	67
	Ave	130	40	77	---	28	47
	S.D.	± 53	± 45	± 44	---	± 12	± 28
N-5	Min	120	41	---	<7.2	110	29
	Max	230	100	110	<26	140	240
	Ave	180	71	110	---	130	130
	S.D.	± 83	± 42	---	---	± 22	± 150
N-6	Min	88	21	91	<6.5	65	66
	Max	140	98	130	<8.8	70	210
	Ave	110	51	110	---	67	140
	S.D.	± 27	± 41	± 21	---	± 3.0	± 100
N-7	Min	200	22	120	<5.7	95	26
	Max	330	110	140	<7.1	210	44
	Ave	260	48	130	---	140	35
	S.D.	± 56	± 41	± 8.2	---	± 47	± 13
N-14	Min	95	59	90	<7.2	78	300
	Max	153	180	160	<8.2	120	490
	Ave	130	130	130	---	100	400
	S.D.	± 31	± 63	± 36	---	± 21	± 98
N-15	Min	55	8.7	44	---	13	---
	Max	180	39	75	6.1	23	11
	Ave	110	24	60	6.1	17	11
	S.D.	± 66	± 21	± 22	---	± 5.3	---
N-16	Min	4.9	<4.3	<35	<5.5	<11	<12
	Max	24	<10	<39	<10	<11	<569
	Ave	12	---	---	---	---	---
	S.D.	± 10	---	---	---	---	---

Min - Minimum value reported during FY 1985
Max - Maximum value reported during FY 1985
Ave - Average
S. D. - Standard deviation

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Table 2.3.1 (contd.)

Well		Co-60	Ru-103	Ru-106	Sb-124	Sb-125	I-131
N-17	Min	18	<3.9	<35	<5.4	<12	<4.5
	Max	23	<5.2	<38	<7.3	<13	<17
	Ave	21	---	---	---	---	---
	S.D.	± 2.0	---	---	---	---	---
N-18	Min	27	4.3	69	<5.1	12	<6.3
	Max	150	6.2	140	<10	170	<89
	Ave	79	5.0	110	---	68	---
	S.D.	± 54	± 1.0	± 52	---	± 72	---
N-19	Min	67	5.9	45	<4.8	12	---
	Max	77	33	93	<13	13	56
	Ave	72	15	65	---	13	56
	S.D.	± 5.0	± 16	± 25	---	± 1.0	---
N-20	Min	77	7.5	33	<6.5	9.0	---
	Max	140	87	94	<11	32	115
	Ave	110	47	59	---	17	115
	S.D.	± 34	± 56	± 31	---	± 13	---
N-21	Min	24	---	<36	<5.5	<11	---
	Max	42	9.2	<43	<8.7	<13	11
	Ave	33	9.2	---	---	---	11
	S.D.	± 9.0	---	---	---	---	---
N-22	Min	15	<4.4	<36	<6.8	<12	<6.1
	Max	28	<8.8	<39	<10	<12	<280
	Ave	20	---	---	---	---	---
	S.D.	± 6.0	---	---	---	---	---
N-23	Min	20	8.0	---	<6.3	<12	<8.7
	Max	41	26	42	<8.0	<13	<90
	Ave	31	15	42	---	---	---
	S.D.	± 8.6	± 9.6	---	---	---	---
N-24	Min	18	7.5	95	<6.6	10	---
	Max	35	41	200	<11	48	290
	Ave	25	24	150	---	35	290
	S.D.	± 8.7	± 24	± 73	---	± 21	---
N-25	Min	8.7	<4.3	<32	---	<11	<5.0
	Max	16	<5.3	<38	5.5	<12	<25
	Ave	11	---	---	5.5	---	---
	S.D.	± 4.1	---	---	---	---	---
N-26	Min	12	---	<30	---	<11	<7.2
	Max	22	14	<37	4.4	<12	<94
	Ave	15	14	---	4.4	---	---
	S.D.	± 4.7	---	---	---	---	---

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Table 2.3.1 (contd.)

Well		Co-60	Ru-103	Ru-106	Sb-124	Sb-125	I-131
N-27	Min	140	30	130	11	120	29
	Max	200	340	180	19	150	2,000
	Ave	170	160	160	15	140	850
	S.D.	± 30	± 150	± 29	± 5.7	± 12	± 960
N-28	Min	110	5.1	---	---	140	100
	Max	260	300	133	14	200	4,700
	Ave	190	107	133	14	170	3,000
	S.D.	± 60	± 130	---	---	± 32	± 2,500
N-29	Min	110	23	91	<7.0	84	89
	Max	440	290	200	<9.5	210	1,700
	Ave	230	100	140	---	160	1,100
	S.D.	± 150	± 130	± 58	---	± 57	± 860
N-30	Min	94	11	84	<6.4	43	30
	Max	190	110	140	<7.7	60	61
	Ave	140	66	110	---	53	42
	S.D.	± 41	± 48	± 24	---	± 7.0	± 17
N-31	Min	87	34	110	<6.4	85	28
	Max	400	790	410	<11	170	860
	Ave	190	240	220	---	110	380
	S.D.	± 150	± 370	± 160	---	± 39	± 360
N-32	Min	100	12	51	<5.2	50	19
	Max	220	110	150	<7.9	65	160
	Ave	180	42	85	---	55	90
	S.D.	± 53	± 43	± 43	---	± 6.9	± 71
N-33	Min	85	55	120	<6.2	89	90
	Max	140	200	160	<9.3	120	1,800
	Ave	120	110	140	---	110	760
	S.D.	± 28	± 77	± 24	---	± 18	± 920
N-34	Min	70	16	67	<7.9	51	25
	Max	240	490	300	<13	96	550
	Ave	140	180	160	---	68	290
	S.D.	± 91	± 270	± 120	---	± 24	± 370
DOE 5480.1 Onsite Concentration Guides		1,000,000	2,000,000	400,000	700,000	3,000,000	30,000
DOE 5480.1 Offsite Concentration Guides		50,000	80,000	10,000	20,000	100,000	300

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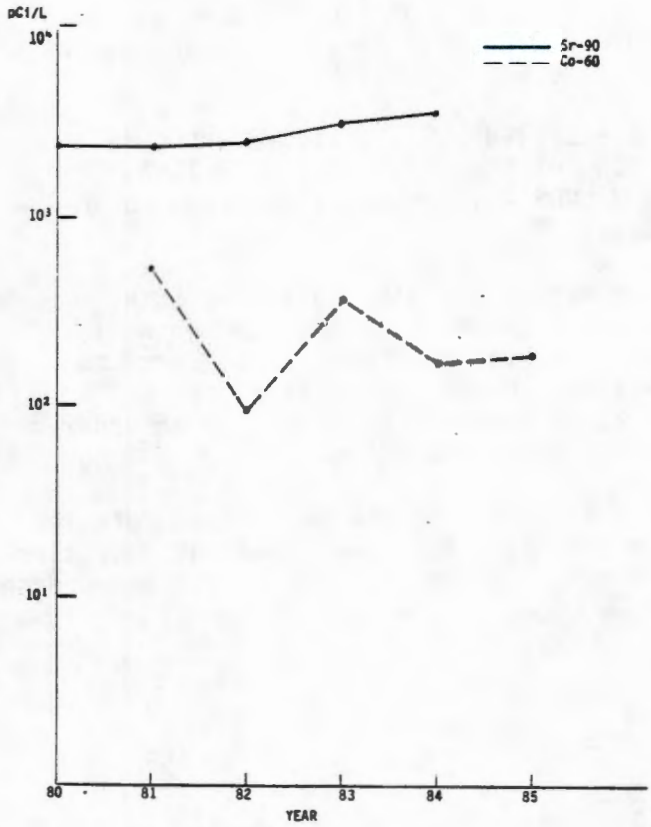

Figure 2.3.2 Average Concentrations of Cobalt-60 and Strontium-90* Detected in Well N-2 From 1980 to 1985

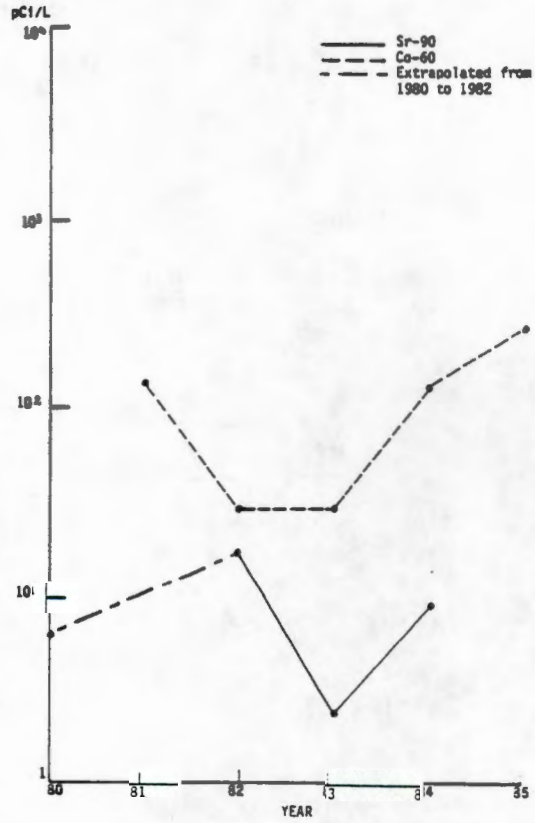

Figure 2.3.3 Average Concentrations of Cobalt-60 and Strontium-90* Detected in Well N-7 From 1980 to 1985

* Strontium-90 concentrations obtained from Hanford Site Ground-Water Surveillance Reports. 1980 to 1984. Battelle PNL.

9 3 1 2 8 7 2 0 6 7 4

Figure 2.3.2 shows average concentrations of cobalt-60 and strontium-90 detected in well N-2 from 1980 to 1985. These two radionuclides are useful as indicators of ground-water contamination and migration. Figure 2.3.3 shows average concentrations of the same two radionuclides detected in well N-7.

Located down-gradient of the 1301-N LWDF, well N-2 shows relatively greater concentrations of strontium-90 than well N-7. Continued use of the 1325-N LWDF will probably increase radionuclide concentrations in well N-7.

One-quart samples of ground water were also collected on a variable frequency from several ground-water monitoring wells. After visual inspection, the samples were sent to the Hanford Environmental Health Foundation (HEHF) and analyzed for oil and grease. These data are used to monitor the integrity of underground oil transfer lines and oil storage tanks at 100-N Area.

Table 2.3.2 shows average oil and grease concentrations detected in 100-N Area ground-water samples. The lower limit of detection is 1 mg/L. The samples contained concentrations of oil and grease at or near the level of detection.

9 3 1 2 8 7 2 0 6 7 5

Table 2.3.2 Average Oil and Grease Concentrations (mg/L) Detected in 100-N Area Ground-water Monitoring Wells

	Well #										
	N16	N17	N18	N19	N20	N21	N22	N23	N24	N25	N26
Min	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Max	<1.0	4.0	2.9	3.1	3.5	1.6	<1.0	2.8	4.9	2.5	1.2
Ave*	<1.0	1.4	1.3	1.5	1.4	1.1	<1.0	1.1	1.3	1.1	1.0
S.D.	---	± .94	± .59	± .85	± .79	± .23	---	± .46	± .46	± 1.0	± .063
# of Samples	10	13	12	11	11	9	7	15	16	23	13

Min - Minimum value
Max - Maximum value
Ave - Average
S.D. - Standard Deviation

* Less-than-detectable values are included in the average

2.4 Soil and Vegetation Samples

Surface soil and vegetation samples provide a means of evaluating the environmental distribution of radionuclides from releases to the air or liquid releases to the soil.

Surface soil was sampled at each of the locations shown on figure 2.4. Duplicate samples of approximately 100 grams each were collected from the top 2.5 cm of the soil surface. One of each duplicate sample was sent to UST for strontium and plutonium analysis. Each remaining duplicate sample was analyzed for gamma-emitting radionuclides at the UNC radioanalytical lab.

Table 2.4.1 shows radionuclide concentrations detected in 100-N Area surface soil. Average radionuclide concentrations for the Hanford Site and offsite as reported by PNL for 1984 are included for comparison. The 100-N values are comparable to the Hanford Site averages.

Table 2.4.2 shows average radionuclide concentrations detected in 100-N Area surface soil from 1980 to 1985.

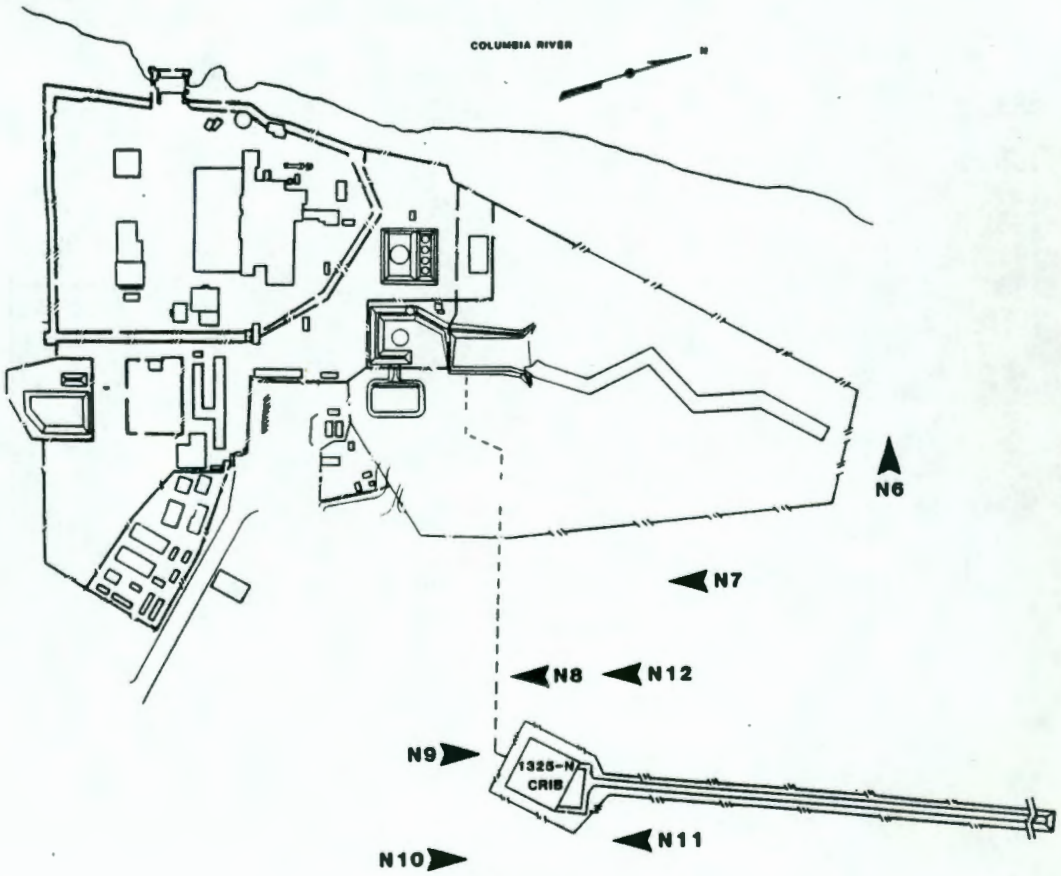

Figure 2.4.1 Surface Soil Sampling Locations at 100-N Area

9 3 1 2 8 7 2 0 6 7 6

Table 2.4.1 Radionuclide Concentrations (pCi/g, dry weight) Detected in 100-N Area Surface Soil

Location	Mn-54	Co-60	Sr-90	Cs-137	Pu-239/240
N6	<.076	.35	.12	.21	.0041
N7	.12	1.5	.23	1.0	.035
N8	.10	.64	.064	.058	.0017
N9	.050	.50	.078	.22	.0042
N10	<.084	.78	.099	.52	.0081
N11	NA	NA	.13	NA	.017
N12	.19	3.6	.18	1.1	.018
Average	.12	1.2	.13	.52	.013
S.D.	±.058	±1.2	±.059	±.44	±.012
Hanford Site*	NR	NR	.32	1.9	.016
Offsite*	NR	NR	.20	.44	.0084

Table 2.4.2 Average Radionuclide Concentrations (pCi/g, dry weight) Detected in 100-N Surface Soil from 1981 to 1985

Year	Mn-54	Co-60	Cs-137	Sr-90	Pu-239/240
1980	.24	.85	.18	.50	.018
1981	.16	1.3	.21	1.0	.011
1982	.13	1.6	.099	.34	.0050
1983	.21	2.7	.29	.44	.0085
1984	NR	.88	.28	.62	.014
1985	.12	1.2	.13	.52	.013

NA - Data not available (lost sample)
NR - Not reported
S.D. - Standard deviation
* - Average values obtained from PNL-5407, Environmental Monitoring at Hanford for 1984, Price et al.

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Duplicate 500 gram samples of green vegetation were collected from available perennial shrubs at the same general locations that surface soil samples were obtained (figure 2.4.2). The vegetation consisted mostly of gray rabbitbrush (Chrysothamnus nauseosus). Strontium and plutonium analyses were conducted by UST; gamma analyses were conducted at the UNC radioanalytical lab.

Table 2.4.3 shows radionuclide concentrations detected in the 100-N Area vegetation samples. The Hanford Site and offsite values are also shown for comparison.

Cesium-137 concentrations were higher in 100-N vegetation samples than those reported for the Hanford Site average. Cesium-137 is a fission product that is commonly detected in 100-N Area liquid releases (Rokkan 1984). This radionuclide may be assimilated from the soil by growing plants (Kathren 1984).

Table 2.4.4 shows average radionuclide concentrations detected in 100-N Area vegetation from 1980 to 1985.

Vegetation samples were also collected from three locations along the Columbia River shoreline (figure 2.4.2). This portion of the shoreline, "N-Springs", contains small springs caused by underground drainage of 1301-N LWDF effluent.

Shoreline vegetation growing near the N-Springs was sampled. The plants were growing through the cover of boulders along the shoreline. The samples were collected and analyzed using the methods previously described for 100-N Area vegetation.

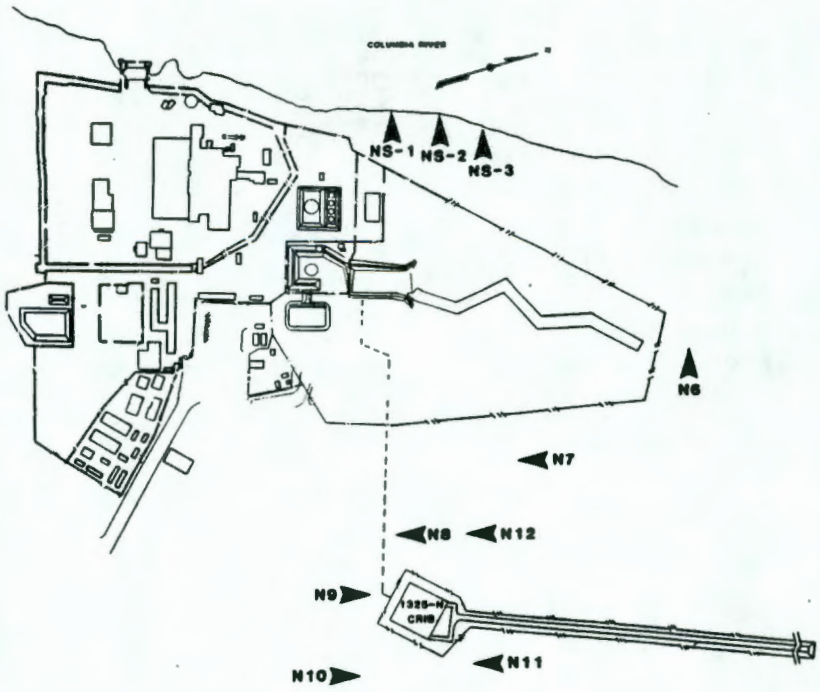

Figure 2.4.2 Vegetation Sampling Locations at 100-N Area

9 3 1 2 8 7 2 0 6 7 8

Table 2.4.3 Radionuclide Concentrations (pCi/g, dry weight) Detected in 100-N Area Vegetation

Location	Mn-54	Co-60	Sr-90	Cs-137	Pu-239/240
N6	<.12	.30	.046	<.085	.00048
N7	.22	.83	.050	<.072	.00066
N8	.36	.98	.12	<.13	<.00026
N9	.22	2.0	.041	.21	<.00076
N10	.60	1.8	.030	.16	.00094
N11	.37	1.7	.037	.12	.0014
N12	.41	2.2	.030	.14	<.00025
Average	.36	1.4	.051	.16	.00087
S.D.	±.14	±.70	±.032	±.039	±.00040
Hanford Site*	NR	NR	.19	.034	.0010
Offsite*	NR	NR	.057	.0078	.00022

Table 2.4.4 Average Radionuclide Concentrations (pCi/g, dry weight) Detected in 100-N Vegetation From 1981 to 1985

Year	Mn-54	Co-60	Sr-90	Cs-137	Pu-239/240
1980	.48	1.0	NR	.28	NR
1981	1.8	25	.58	.71	.021
1982	.49	1.5	.20	.13	.0078
1983	.36	1.0	.39	.090	.0086
1984	.13	.46	.081	.090	.0013
1985	.36	1.4	.051	.16	.00087

NA - Data not available (lost sample)
NR - Not reported
S.D. - Standard Deviation
* - Average Hanford Site and offsite values obtained from PNL-5407

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Table 2.4.5 shows radionuclide concentrations detected in the N-Springs vegetation samples. The average radionuclide concentrations detected for the Hanford site are again shown for comparison.

The samples contained above background concentrations of strontium-90. Growing plants will assimilate available strontium and cesium from the soil (Kathren 1984). Strontium-90 released to the 1301-N LWDF is discharged at the N-Springs. Use of the 1301-N LWDF was discontinued on September 19, 1985.

Table 2.4.6 shows average radionuclide concentrations detected in N-Springs vegetation from 1980 to 1985. The concentrations of strontium-90 detected in 1985 were comparable to levels reported in previous operating years.

Table 2.4.5 Radionuclide Concentrations (pCi/g, dry weight) Detected in Vegetation Samples Collected Near the N-Springs

Location	Mn-54	Co-60	Sr-90	Cs-137	Pu-239/240
NS-1	.076	.97	770	<.096	.00038
NS-2	<.16	.63	170	<.14	.00049
NS-3	<.16	2.0	330	.17	<.0013
Average	.076	1.2	420	.17	.00044
S.D.	---	±.71	±310	---	±.00078
Hanford Site*	NR	NR	.19	.034	.0010
Offsite*	NR	NR	.057	.0078	.00022

Table 2.4.6 Average Radionuclide Concentrations (pCi/g, dry weight) Detected in N-Springs Vegetation from 1980 to 1985

Year	Mn-54	Co-60	Sr-90	Cs-137	Pu-239/240
1980	.16	5.6	NR	.44	NR
1981	NR	3.3	200	NR	.0037
1982	.15	2.8	480	NR	.0083
1983	.070	3.0	330	.040	.0080
1984	NR	NR	NR	NR	NR
1985	.076	1.2	420	.17	.00044

NR - Not reported
S.D. - Standard deviation
* - Average Hanford Site and offsite values obtained from PNL-5407

9 3 1 2 8 7 2 0 6 3 0

2.5 Columbia River Shoreline Survey

Direct radiation levels are measured annually along the 100-N Area portion of the Columbia River shoreline.

Table 2.5 shows dose rates measured along the Columbia River shoreline starting near the 181-N facility and proceeding down stream past the N-Springs (refer to figure 2.6). The survey was taken on June 27, 1985 using a Bicron model 5050 portable micro-R meter. The micro-R meter had been calibrated by PNL to a cesium-137 source. The readings were taken at 50 foot intervals from a height of approximately one meter.

At the time of the survey, N Reactor was shut down. Flow to the 1301-N LWDF was about 1,000 gallons per minute. The 1304-N Emergency Dump Tank (EDT) contained N-Reactor liquid effluent. The 1310-N and 1314-N chemical waste facilities were empty. The average flow rate of the Columbia River was 124,000 cubic feet per second as measured at Priest Rapids Dam upstream of 100-N Area.

Figure 2.5 is a graphic representation of the shoreline survey data. The locations of 100-N Area facilities that potentially contribute to dose rates measured near the river shoreline are indicated.

Environmental dose rates were higher along the river shoreline near the 1304-N EDT. The dose rates along the river shoreline were similar to the levels normally detected along the Columbia River shoreline (Eddy 1984).

Table 2.5 Environmental Dose Rates (μR/hr) Detected at Survey Points Along the Columbia River Shoreline.

Sample Location	Dose Rate	Sample Location	Dose Rate	Sample Location	Dose Rate
1	70	19	55	37	31
2	85	20	55	38	29
3	105	21	55	39	27
4	95	22	45	40	29
5	85	23	45	41	26
6	70	24	45	42	24
7	65	25	45	43	25
8	60	26	45	44	24
9	60	27	38	45	22
10	55	28	37	46	24
11	55	29	36	47	24
12	55	30	40	48	18
13	50	31	37	49	15
14	55	32	35	50	15
15	55	33	34	51	13
16	60	34	33	52	14
17	60	35	33	53	13
18	55	36	33	54	12

9 3 1 2 8 7 2 0 6 8 1

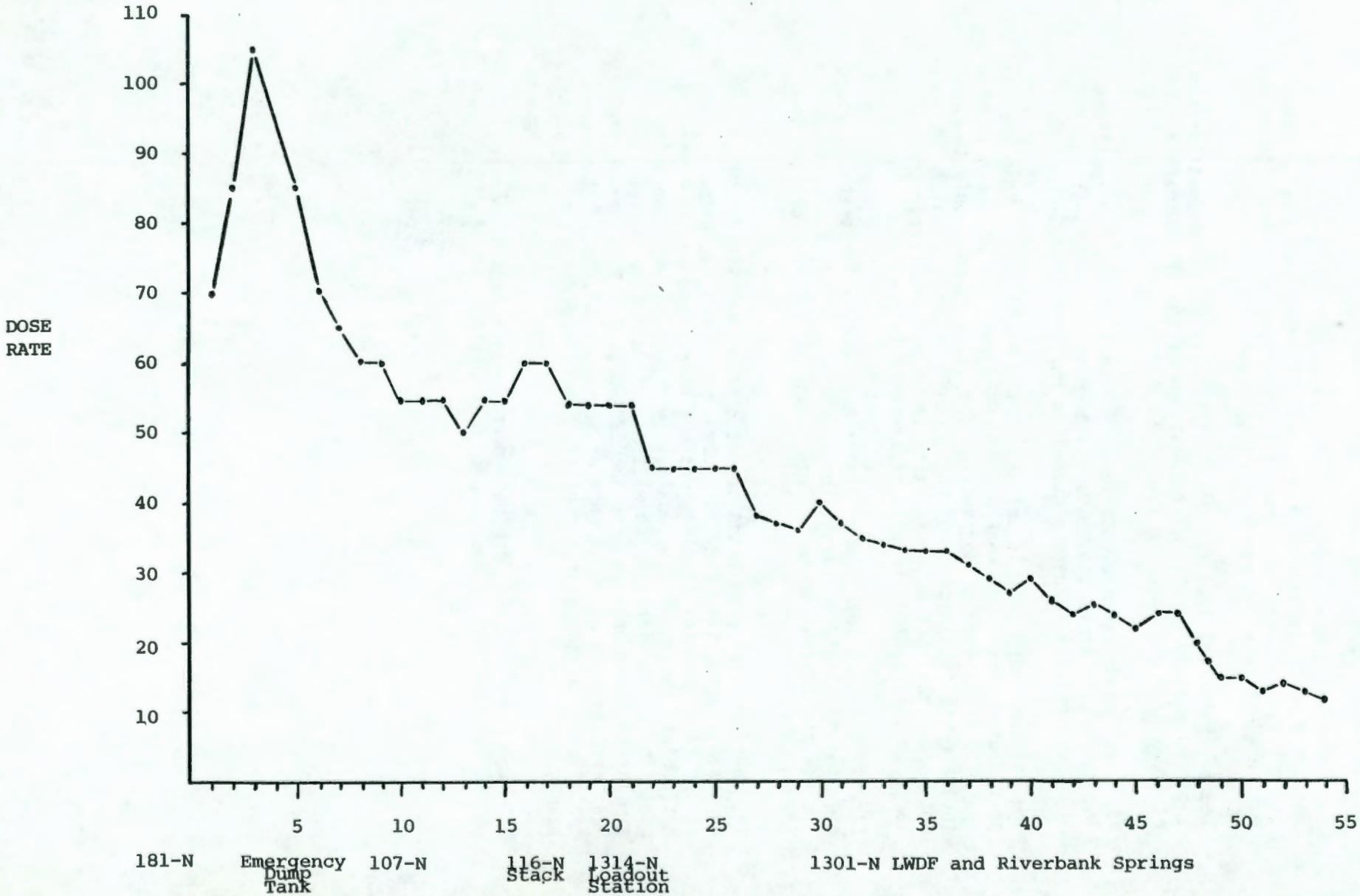

Figure 2.5 Environmental Dose Rates (μR/hr) Detected at 54 Survey Points Along the Columbia River Shoreline. The Distance Between Survey Points is Approximately 50 Feet

2.6 Environmental Dose Rate Measurements

Environmental thermoluminescent dosimeters (TLDs) are used to measure direct radiation levels at 100-N Area. The measurements are used to evaluate environmental dose rates at several locations within 100-N Area and along the 100-N fenceline.

The environmental TLDs (CaF_2:Mn matrix) are delivered, calibrated, and read monthly by PNL. The locations of the environmental TLDs at 100-N Area are shown on figure 2.6.

Table 2.6 shows average dose rates for each of the TLD locations. The table also shows the extrapolated dose per work year and the ALARA occupational exposure guideline for comparison.

The dose per work year is defined as the accumulative dose over a period of 40 hours per week and 52 weeks per year at the site of a specific environmental dosimeter. The value is used only to indicate the significance of background radiation levels. It does not show actual occupational exposure as workers rarely spend large amounts of time in most of these locations.

Direct radiation levels were higher near facilities that contained or received liquid effluent from N Reactor. These facilities include the 1304-N Emergency Dump Tank, the 1301-N LWDF, and the 1325-N LWDF.

The environmental dose rates detected near the 1325-N LWDF were unusually higher than previous years. This was due primarily to the fact that the facility was not being used and therefore did not contain water. The approximately 3 feet of water normally contained by the facility shields direct radiation to levels similar to those observed for the 1301-N LWDF. N-Reactor effluent was rerouted to the 1325-N LWDF on September 19, 1985. Environmental dose rates near the facility have since decreased to normal levels.

A table of the monthly dose rate measurements for each environmental TLD location is included in Appendix A.

9 3 1 2 8 7 2 0 6 8 3

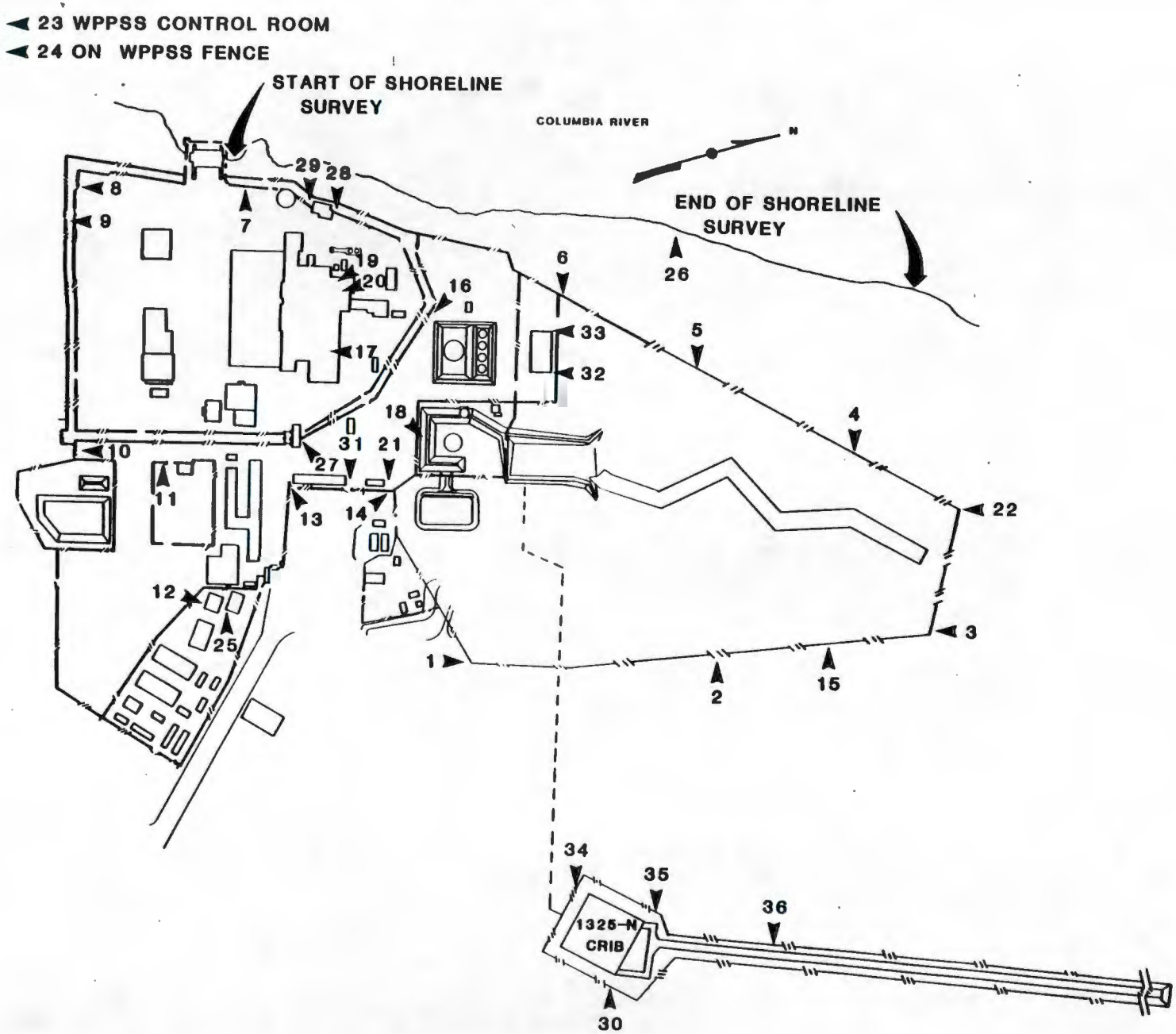

Figure 2.6 Location of Environmental Dosimeters and Shoreline Survey Points at 100-N Area

Table 2.6 Average Dose Rate and Dose per Work Year for TLD Locations at 100-N Area

TLD Location	Dose Rate (mrem/hr) Minimum	Maximum	Average	± S.D.	Dose per Work Year (mrem/yr)
1	.015	.041	.027	.009	54
2	.014	.044	.029	.010	58
3	.009	.032	.016	.006	32
4	.013	.042	.026	.007	52
5	.022	.036	.026	.004	52
6	.011	.084	.042	.019	84
7	.089	.118	.106	.007	210 **
8	.005	.011	.008	.002	16
9	.005	.013	.008	.003	16
10	.005	.009	.007	.002	14
11	.006	.011	.009	.002	18
12	.004	.007	.006	.001	12
13	.008	.014	.011	.002	22
14	.033	.042	.037	.003	74
15	.013	.025	.019	.004	38
16	.033	.076	.047	.014	94
17	.004	.007	.006	.001	12
18	.034	.054	.042	.006	84
19	.004	.009	.008	.001	16
20	.004	.008	.005	.001	10
21	.027	.041	.033	.003	66
22	.011	.017	.013	.002	26
23	.004	.008	.006	.001	12
24	.002	.005	.004	.001	8
25	.003	.007	.005	.001	10
26	.006	.014	.009	.002	18
27	.006	.008	.007	.001	14
28	.058	.227	.145	.055	290 **
29	.309	.459	.409	.048	820 **
30	.014	.357	.193	.138	390 **
31	.023	.033	.029	.003	58
32	.028	.029	.029	.001	58
33	.018	.018	.018	.001	36
34	.746	.804	.775	.041	1,600 **
35	.329	.338	.334	.006	670 **
36	.324	.332	.328	.006	660 **

ALARA guideline for occupational exposure to non-zone workers* 240

** - Area controlled as a radiation zone
S.D. - Standard Deviation

*U.S. Department of Energy. 1980. A Guide to Reducing Radiation Exposure to As Low As Reasonably Achievable (ALARA). DOE/EV/1830-75

9 3 1 2 8 7 2 0 6 8 5

2.7 Special Environmental Samples

Cliff swallows (*Petrochelidon pyrrhonota*) use the northwest side of the 109-N building for nesting during the spring and summer months. The birds have been observed feeding on insects inhabiting the 1300-N Emergency Dump Basin (EDB). The 1300-N EDB contains low concentrations of radionuclides detected in N-Reactor liquid effluent.

Samples of cliff swallow nests, excrement, and eggs were collected during June 1985. The samples were analyzed for gamma-emitting radionuclides at the UNC radioanalytical lab.

Table 2.7 shows radionuclide concentrations detected in the samples. The concentrations detected in the samples are near the levels of detection associated with the analytical techniques used. The data indicate that swallows nesting on the 109-N building were not contacting contaminated food sources or nesting mud in significant amounts.

Table 2.7

Radionuclide Concentrations (pCi/g, wet weight) of Cliff Swallow Nest, Excrement, and Shell/Embryo Samples Collected Near the 1300-N EDB

Radionuclide	Nest Samples 1	Nest Samples 2	Excrement	Shell/Embryo
Mn-54	.26	.29	---	---
Co-60	1.2	1.1	5.1	4.2
Cs-137	.31	.29	---	---

9 3 1 2 8 7 2 0 6 8 6

3.0 LIQUID WASTE DISPOSAL FACILITY SURVEILLANCE

3.1 LWDF Sampling Program

Environmental surveillance of the 1301-N and 1325-N LWDFs is performed to monitor and document any environmental impact associated with operation of the disposal facilities. Several parameters including ambient air, vegetation, surface soil, and facility bottom sediments are sampled and analyzed. Surrounding environmental dose rates are also monitored annually.

The 1301-N and 1325-N LWDFs are secured facilities posted as radiation zones. Due to the potential for radionuclide contamination and exposure to direct radiation, the facilities are surrounded by a security fence. Only trained personnel are allowed access to the disposal facilities. Even then, workers do not spend large amounts of time in these areas.

Because these facilities are located in controlled areas, separated from the local environs, the LWDFs are addressed separately in this section of the annual surveillance report. The sampling program for the 1301-N and 1325-N LWDFs is summarized on table 3.1. Sampling methods, frequencies, and analyses are based on characteristics of the parameter being sampled.

Table 3.1 Summary of the UNC LWDF Sampling Program

Sample	Sampling Method	Number of Sample Locations	Sampling Frequency	Analysis
Air	Low-volume continuous sampler with particulate filter and charcoal bed	1	Monthly	Gamma-emitting radionuclides
Surface Soil	Composite sample of approximately 100 grams dry weight	5	Annually	Gamma-emitting radionuclides, strontium, and plutonium
Vegetation	Composite sample of approximately 500 grams dry weight	5	Annually	Gamma-emitting radionuclides, strontium, and plutonium
LWDF Sediment	Dip samples of LWDF bottom sediment	21	Annually	Gamma-emitting radionuclides, strontium, and plutonium
Direct Radiation	Dose rates using hand-held survey instrument	62	Annually	Dose rate

9 3 1 2 8 7 2 0 6 8 7

The 1301-N LWDF was taken out of service on September 19, 1985. At that time N-Reactor liquid effluent was routed to the 1325-N LWDF.

3.2 Air Samples

Ambient air monitoring for the 1301-N LWDF is conducted at a single location near the inlet end of the facility (figure 3.2.1, station A1). Air samples were collected and analyzed using the equipment and methods described in section 2.2.

Table 3.2.1 shows radionuclide concentrations detected in the ambient air samples. The samples contained detectable concentrations of activation and fission products routinely discharged to the 1301-N LWDF. The concentrations are well below applicable air quality concentration guides.

Figure 3.2.2 shows average concentrations of cobalt-60 and iodine-131 detected near the 1301-N facility from 1981 to 1985.

A continuous air monitor is being installed near the 1325-N LWDF (station A5). Results from this station will be reported in the FY 1986 surveillance report.

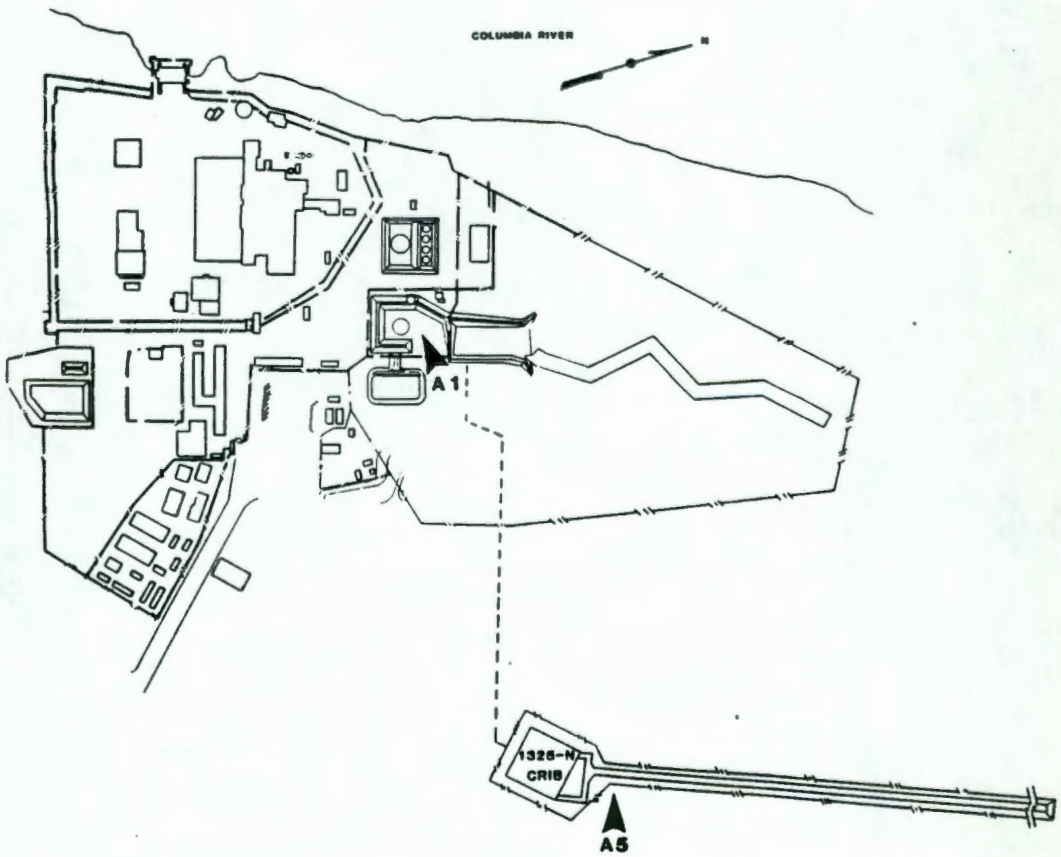

Figure 3.2.1 Location of Continuous Air Samplers for the 1301-N and 1325-N LWDFs

9 3 1 2 8 7 2 0 6 8 8

Table 3.2 Radionuclide Concentrations (pCi/m) Detected in Air Samples Collected Near the 1301-N LWDF

	Mn-54	Fe-59	Co-60	As-76	ZrNb-95	Ru-103	I-131	Ce-144
Minimum value	.025	.026	.045	---	.025	.019	.071	---
Maximum value	.088	.30	.48	3.8	.052	.027	.87	.12
Average	.048	.095	.17	3.8	.040	.023	.35	.12
Standard deviation	±.020	±.093	±.14	---	±.012	±.0057	±.31	---
Onsite Concentration Guides*	40,000	50,000	9,000	100,000	30,000	80,000	4,000	6,000
Offsite Concentration Guides*	1,000	2,000	300	4,000	1,000	3,000	100	200

* - DOE 5480.1

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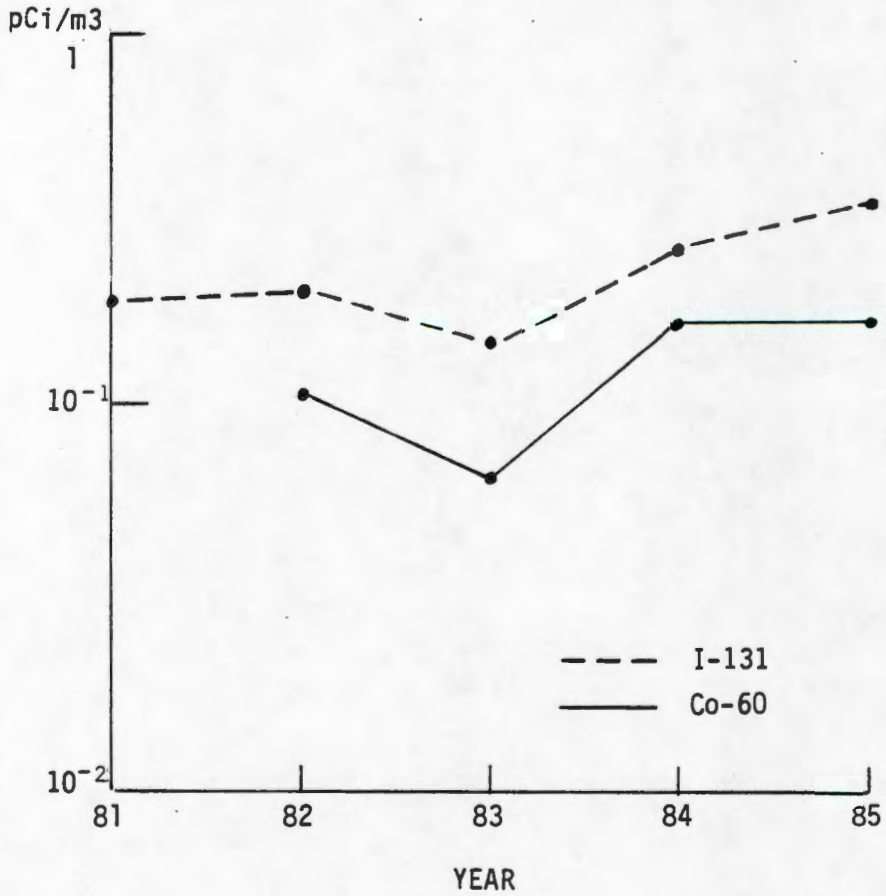

Figure 3.2.2 Average Concentrations of Cobalt-60 and Iodine-131 Detected in 1301-N Air Samples From 1981 to 1985

3.3 Soil and Vegetation Samples

Surface soil and vegetation samples were collected at five locations near the 1301-N LWDF (figure 3.3). The samples were collected and analyzed following the procedures previously specified in section 2.4.

Radionuclide concentrations detected in the surface soil samples are shown on table 3.3.1. Radionuclides contained in the LWDF effluent were detected in the samples. As the data indicate, the concentrations show a large degree of variance depending upon sample location. In general, the samples collected nearer the 1301-N crib portion of the facility contained relatively higher concentrations of the contaminants.

Table 3.3.2 shows average radionuclide concentrations for this area from 1980 to 1985.

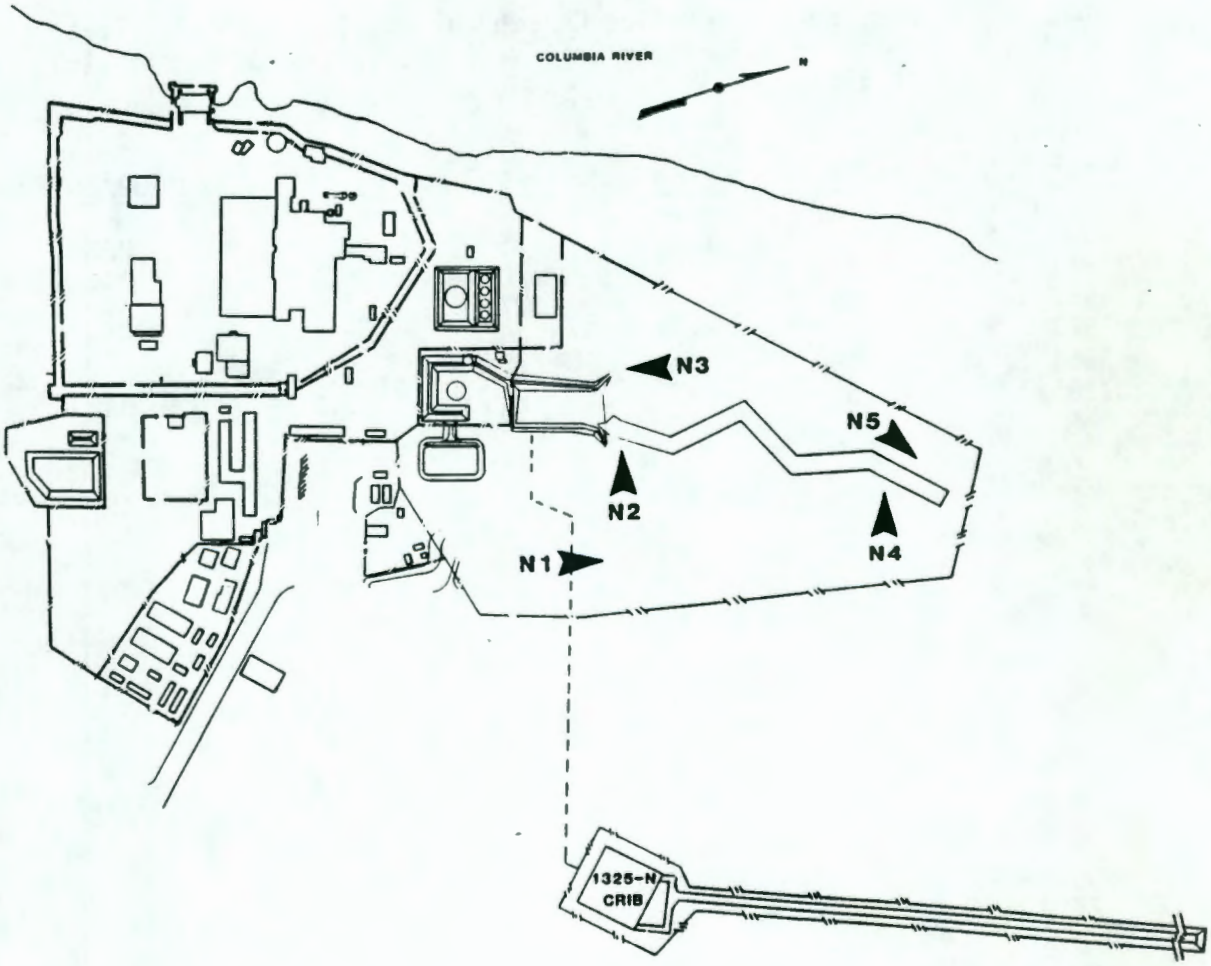

Figure 3.3 Surface Soil and Vegetation Sampling Locations Near the 1301-N LWDF

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Table 3.3.1 Radionuclide Concentrations (pCi/g, dry weight) Detected in Surface Soil Near the 1301-N LWDF

Location	Mn-54	Co-60	Sr-90	Cs-137	Pu-239/240
N1	<.13	4.2	.15	.56	.013
N2	4.2	17	.28	2.5	.021
N3	1.4	38	2.6	14	.11
N4	.13	1.9	.15	1.6	.0096
N5	.14	1.2	.094	.64	.0051
Average	1.5	13	.65	3.9	.032
S.D.	±1.9	±16	±1.1	±5.7	±.044

S.D. - Standard deviation

Table 3.3.2 Average Radionuclide Concentrations (pCi/g, dry weight) Detected in Surface Soil Near the 1301-N LWDF From 1980 to 1985

Year	Mn-54	Co-60	Sr-90	Cs-137	Pu-239/240
1980	2.5	13	.35	4.1	.025
1981	6.6	4.0	.70	6.1	.044
1982	.66	6.3	.27	2.7	.018
1983	.41	5.4	1.3	3.8	.043
1984	.18	2.8	.21	1.1	.017
1985	1.5	13	.65	3.9	.032

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Radionuclide concentrations detected in vegetation samples collected near the 1301-N LWDF are shown in table 3.3.3. A high degree of sample variance is also evident in these data.

Table 3.3.4 shows average radionuclide concentrations detected in the vegetation from 1980 to 1985.

Table 3.3.3 Radionuclide Concentrations (pCi/g, dry weight) Detected in Vegetation Near the 1301-N LWDF

Location	Mn-54	Co-60	Sr-90	Cs-137	Pu-239/240
N1	.66	2.5	.23	<.073	.0011
N2	.81	2.3	.064	.14	.0028
N3	.29	<.15	.74	.15	.0016
N4	<0.0	<.0064	9.0	.016	<.00016
N5	< .070	.26	.13	<.052	.00056
Average	.59	1.7	1.9	.10	.0015
S.D.	±.27	±1.2	±4.0	±.075	±.00096

S.D.- Standard deviation

Table 3.3.4 Average Radionuclide Concentrations (pCi/g, dry weight) Detected in Vegetation Near the 1301-N LWDF From 1980 to 1985

Year	Mn-54	Co-60	Sr-90	Cs-137	Pu-239/240
1980	1.4	4.0	NR	1.1	NR
1981	2.5	12	1.8	1.8	.0071
1982	.46	1.6	.12	.26	.0026
1983	.45	1.9	.60	.39	.0032
1984	.29	1.0	.12	.083	.00085
1985	.59	1.7	1.9	.10	.0015

NR - Not reported

9 3 1 2 8 7 2 0 6 9 2

3.4 LWDF Sediment Samples

The 1301-N and 1325-N LWDFs receive liquid effluent from N Reactor. The liquid effluent is discharged to a soil column that retains the radionuclides as the effluent percolates through the subsoil.

Samples of surface sediment were obtained from the bottoms of the 1301-N and 1325-N LWDFs on August 1, 1985. The samples, approximately 10 grams each, were collected by means of several sampling ports located on each of the disposal facilities (figure 3.4). At the time of sampling, the 1301-N facility was receiving liquid effluent from N Reactor. The 1325-N LWDF did not contain any liquid.

The samples were analyzed for gamma-emitting radionuclides at the UNC radioanalytical lab. The samples were then shipped to UST for strontium and plutonium analyses.

Table 3.4.1 shows radionuclide concentrations (uCi/g, wet weight) detected in sediments sampled from the 1325-N LWDF crib. This is the first year that sediment samples from the 1325-N LWDF have been included in the surveillance report.

Table 3.4.2 shows radionuclide concentrations (uCi/g, wet weight) detected in the 1301-N trench sediment samples. Table 3.4.3 shows a comparison of radionuclide concentrations (uCi/g, wet weight) detected in the 1301-N sediments from 1975 to 1985.

Concentrations of cobalt-60 and cesium-137 were much lower in 1985 than in previous years. Given the small sample volume it is likely that the low values are the result of sample variance. Historically the concentrations have shown a high degree of variance from year to year.

Use of the 1301-N LWDF was discontinued on September 19, 1985.

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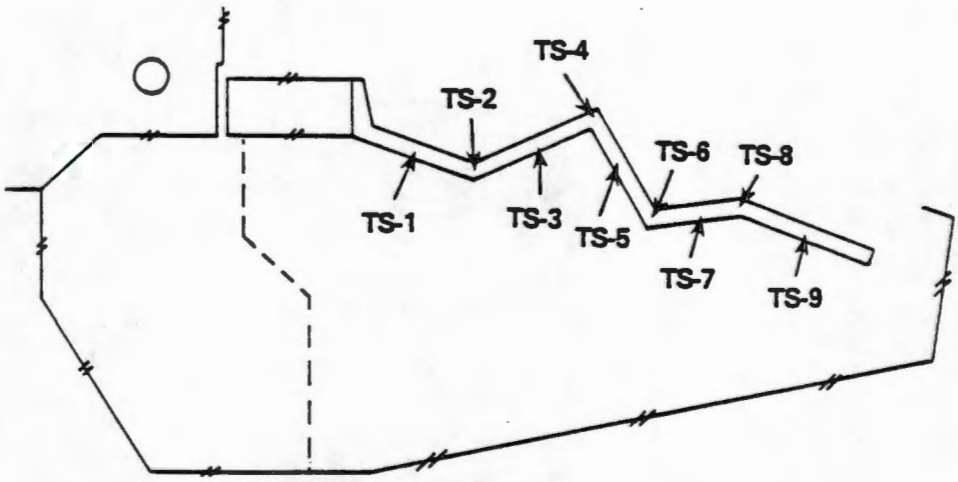
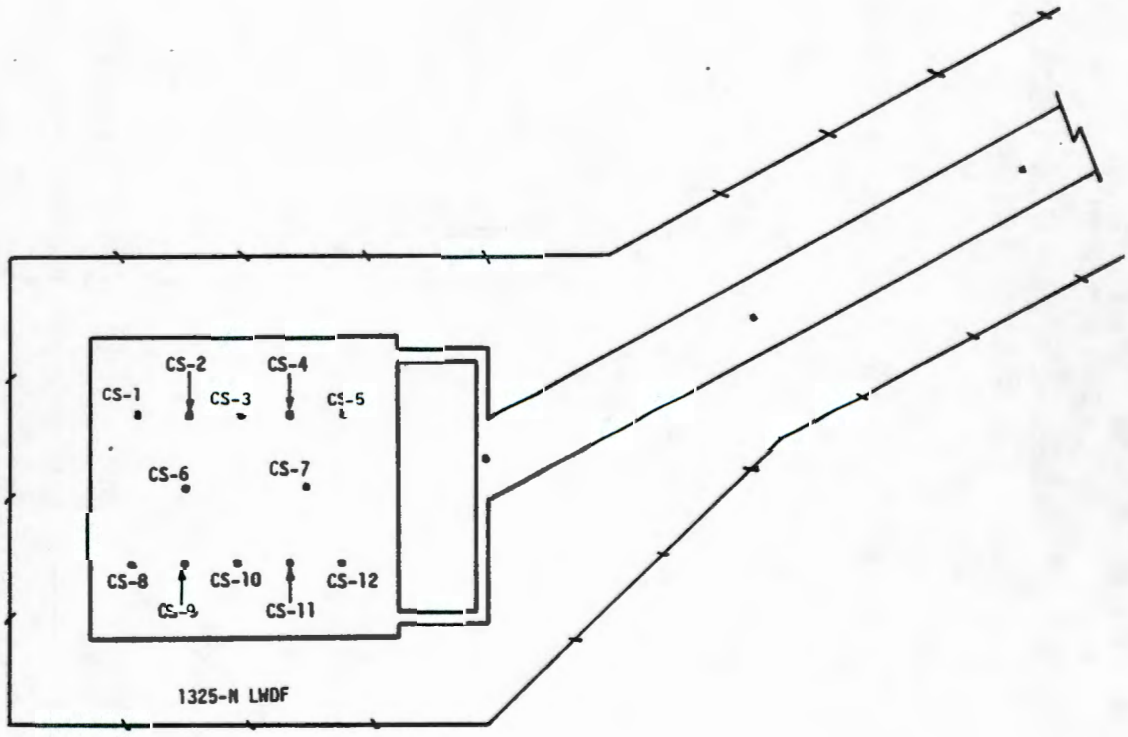


1301-N LWDF



1325-N LWDF

Figure 3.4 Sediment Sampling Locations for the 1301-N and 1325-N LWDFs

9 3 1 2 8 7 2 0 6 9 4

Table 3.4.1 Radionuclide Concentrations (μCi/g, wet weight) Detected in 1325-N LWDF Sediment

Sample Location	Gross Alpha	Gross Beta	Mn-54	Co-60	Sr-90	Cs-137	Ce-144	Pu-238	Pu-239/240
CS-1	.018	2.3	.27	1.3	.088	.041	.12	.0020	.012
CS-2	.0070	3.1	.19	.66	.026	.049	.064	.00074	.0050
CS-3	.018	1.6	.28	1.1	.089	.049	.094	.0020	.013
CS-4	.0060	.83	.16	.60	.027	.035	.041	.00066	.0043
CS-5	.0047	.40	.052	.18	.015	.013	.0058	.00046	.0028
CS-6	No Sample Taken	---	---	---	---	---	---	---	---
CS-7	.044	15	.26	1.6	.20	.011	<.10	.0050	.030
CS-8	.026	2.4	.36	1.7	.10	.029	.10	.0086	.056
CS-9	.018	2.2	.032	.14	.017	.0050	.015	.0018	.012
CS-10	.012	1.1	.15	.52	.013	.056	.067	.00035	.0023
CS-11	.0097	1.5	.24	.80	.012	.048	.076	.0011	.0069
CS-12	.0061	.62	.17	.58	.0058	.071	.040	.00053	.034
Average	.015	2.8	.20	.83	.054	.037	.062	.0021	.013
S.D.	± .012	± 4.1	± .099	± .53	± .060	± .021	± .031	± .0025	± .016

S.D. - Standard Deviation

Table 3.4.2 Radionuclide Concentrations (μCi/g, wet weight) Detected in 1301-N LWDF Sediment

Sample Location	Gross Alpha	Gross Beta	Mn-54	Co-60	Sr-90	Cs-137	Ce-144	Pu-238	Pu-239/240
TS-1	.035	1.9	.054	1.3	.093	.029	<.087	.0046	.026
TS-2	.028	19	.017	1.1	.077	.026	<.067	.0029	.016
TS-3	.052	13	<.023	1.6	.21	.037	<.084	.0051	.027
TS-4	.038	6.5	.10	1.2	.11	.028	<.085	.0040	.023
TS-5	.034	5.0	.056	.95	.19	.055	<.069	.0039	.021
TS-6	.042	10	<.018	1.1	.12	.068	<.079	.0042	.024
TS-7	.019	6.0	.15	1.3	.12	.056	.050	.0023	.014
TS-8	.018	2.8	.028	.26	.070	.022	<.011	.0018	.011
TS-9	.028	2.3	.040	.64	.11	.025	<.063	.0034	.020
Average	.033	7.4	.064	1.1	.12	.038	.050	.0036	.020
S.D.	± .011	± 5.7	± .046	± .40	± .048	± .017	---	± .0011	± .0055

S.D. - Standard Deviation

Table 3.4.3 Average Radionuclide Concentrations (µCi/g, wet weight) Detected in 1301-N LWDF Sediment from 1975 to 1985

Year	Co-60	Cs-137	Sr-90	Pu-239/240
1975	5.2	1.1	.0024	.00098
1976	2.0	.18	.027	.0037
1977	.71	.079	.021	.0046
1978	5.2	.22	.025	.0052
1979	26	.81	.042	.0062
1980	6.4	.28	.11	.040
1981	9.1	.45	.15	.018
1982	15	.66	.16	.42
1983	12	.62	.028	.0078
1984	22	1.2	.12	.021
1985	1.1	.038	.12	.020

3.5 Direct Radiation Surveys

Annual environmental radiation surveys are conducted at intersecting points of survey grids established around the 1301-N and 1325-N LWDFs. The surveys are conducted in order to monitor direct radiation levels associated with the disposal facilities.

The methods and equipment used for the dose rate surveys were similar to those described for the Columbia River shoreline survey in section 2.5.

Figure 3.6.1 shows environmental dose rates detected around 1301-N LWDF. N Reactor was operating during the time of the survey. The 1301-N LWDF was receiving approximately 2,000 gallons of liquid effluent per minute. The nearby 1310-N Chemical Waste Tank and 1314-N Waste Loadout Station Tank were empty.

The data indicate that the areas near the "box weir" (inlet) portion of the 1301-N crib and the first leg of the 1301-N trench have the highest background dose rates.

Figure 3.6.2 shows environmental dose rates detected around the 1325-N LWDF on June 17, 1985. The figure also shows direct radiation levels measured along the length of the 1325-N trench. At the time of the survey the 1325-N LWDF was not receiving liquid effluent from N Reactor. The 1325-N trench had been excavated but not graded or covered.

The dose rates were highest near the 1325-N crib. The absence of water from the crib is the major factor contributing to the readings. Water levels in the crib normally shield much of the radiation emitted by the contaminated sediments. N-Reactor liquid effluent has since been routed to the 1325-N facility, thereby lowering dose rates to normal levels.

Dose rates measured at the far end of the 1325-N trench are similar to background levels detected in this environment.

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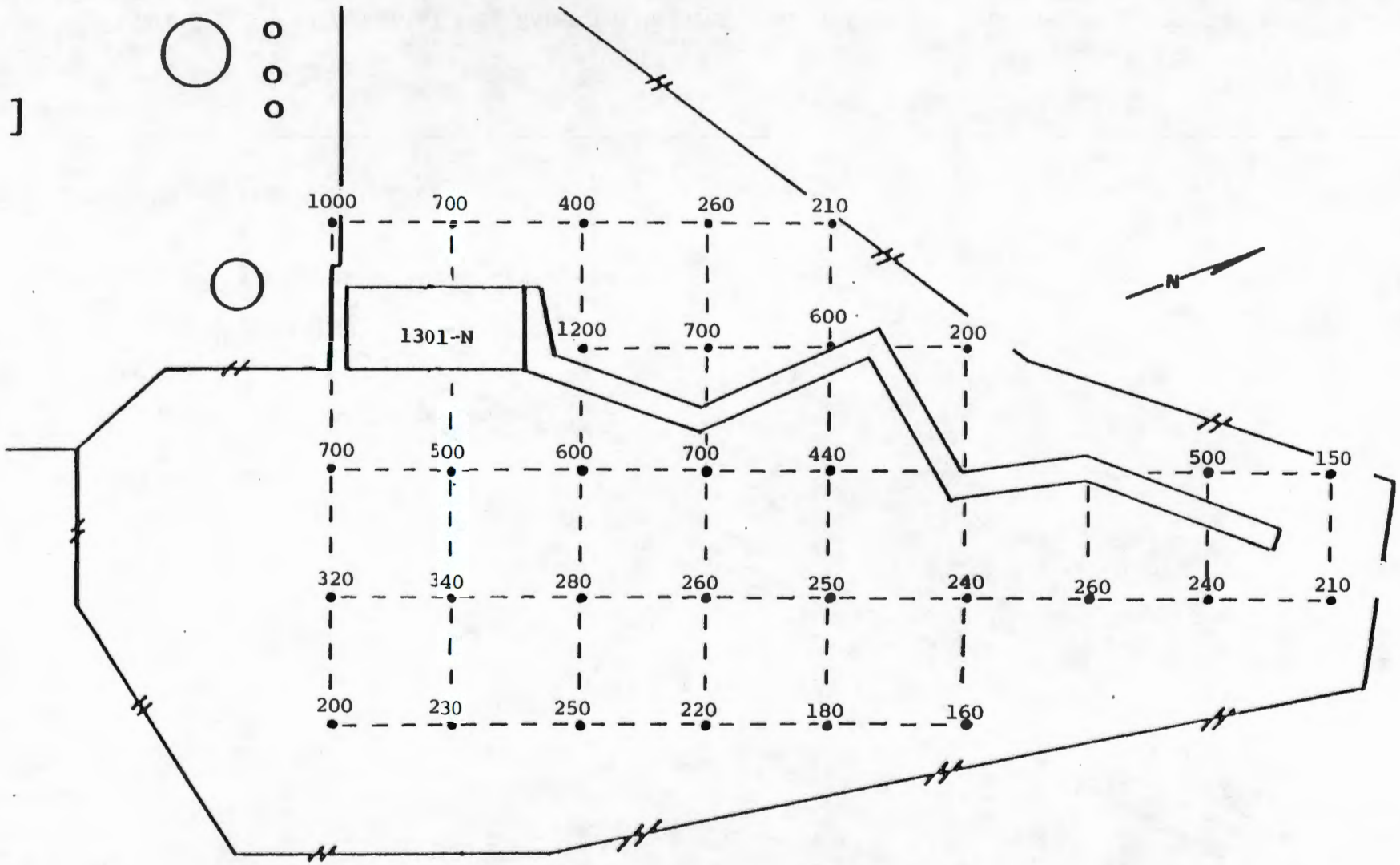

Figure 3.5.1 Environmental Dose Rates (μR/hr) Detected at Survey Points Around the 1301-N LWDF

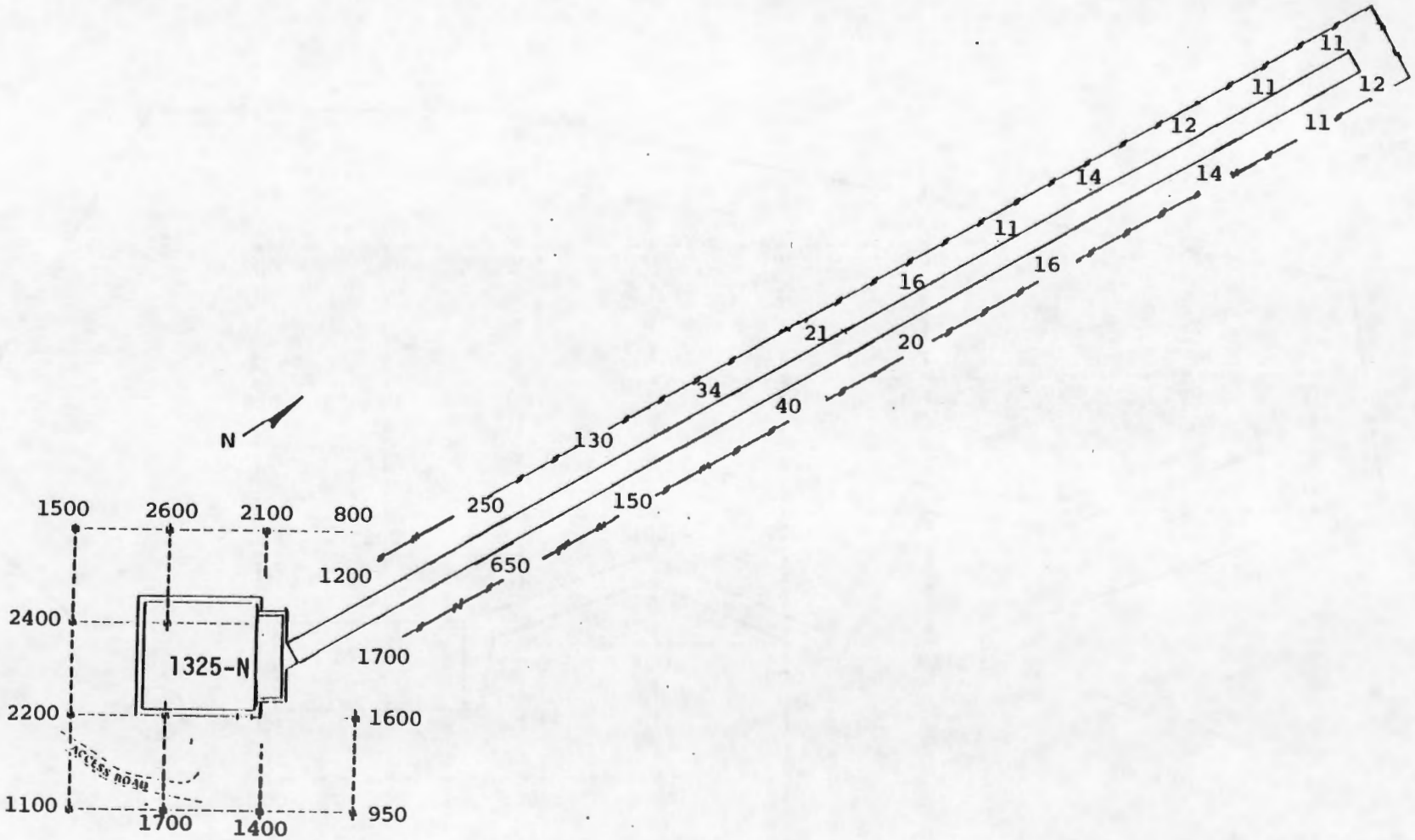

Figure 3.5.2 Environmental Dose Rates (μR/hr) Detected at Survey Points Around the 1325-N LWDF

3.6 Special Environmental Samples

Deer mice (Peromyscus maniculatus) inhabiting the area around the 1301-N LWDF were sampled during May 1985. The samples were collected to evaluate the effectiveness of the concrete cover that was placed over the 1301-N trench in 1982.

Sixteen deer mice were collected and analyzed for gamma-emitting radionuclides at the UNC radioanalytical lab. Three of the specimens were also dissected and analyzed for gamma-emitting radionuclides in selected tissues.

Table 3.6.1 shows radionuclide concentrations detected in whole body analyses of the deer mice. Many of the mice sampled contained relatively high concentrations of cobalt-60, iron-59, and manganese-54. Iodine-131 and cesium-137 were also detected in the mice. The concentrations detected in the deer mice were similar to levels previously reported in ERDA-1538, "Final Environmental Statement, Waste Management Operations, Hanford Operations, Richland, Washington."

The tissue samples (table 3.6.2) revealed radionuclide concentrations similar to those commonly detected in liquid effluent discharged to the 1301-N facility (Rokkan 1985). The concentrations of iodine-131 (eight day half-life) detected in the tissues suggests that the mice were obtaining the radionuclides directly from the liquid effluent.

At the present time the 1301-N LWDF is not receiving N-Reactor liquid waste. Facility closure plans are being evaluated that will include barriers to intrusion by small animals. The proposed barriers will also be designed to prevent uptake of radionuclides by plants.

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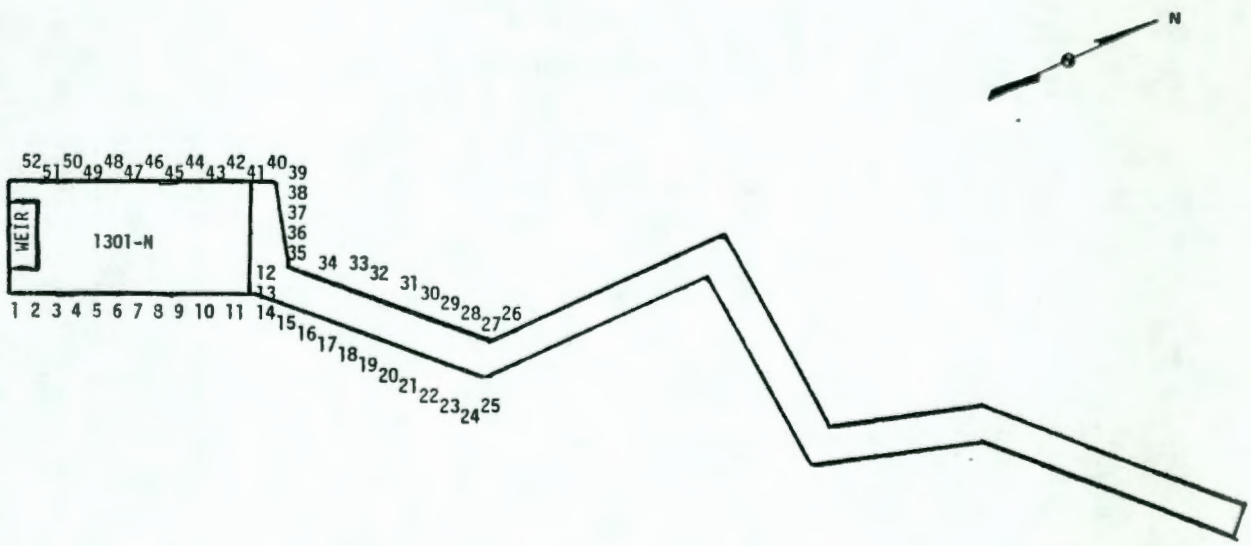

Figure 3.6 Mouse Trap Locations Near the 1301-N LWDF

Table 3.6.1 Whole Body Radionuclide Concentrations (nCi/g, wet weight) Detected in Deer Mice Collected Near the 1301-N LWDF

Trap #	Weight (g)	Sex	Cr-51	Mn-54	Co-58	Fe-59	Co-60	Zr/Nb-95	I-131	Cs-137	Ce-141	Ce-144
1	20.3	M	.82	3.3	.25	3.1	7.1	1.1	.29	2.5	.035	.49
6	16.3	M	.68	1.7	.23	2.1	5.7	.64	.16	.70	.044	.35
9	19.8	F	.98	3.5	.35	3.3	11	1.1	.17	.37	.040	.42
10	16.1	F	.053	.22	.021	.30	.74	.077	.054	.18	.0028	.046
11	15.8	F	.77	2.5	.34	2.6	9.7	.80	.31	.35	.058	.50
12	21.7	M	.23	.47	.075	.65	1.7	.18	.047	.24	.014	.073
14	18.2	F	.26	.95	.081	.75	2.6	.52	.19	.23	.037	.29
25	19.6	M	<.014	<.0019	<.0017	<.0029	.0083	<.0047	<.0026	.0022	ND	<.0097
30	20.1	M	<.021	.041	.0045	.059	.098	.012	.028	.10	<.0025	<.011
39	16.2	F	.019	.10	.011	.11	.24	.019	.037	.053	<.0041	<.017
40	17.4	F	1.2	4.1	.48	4.3	15	1.4	.20	.97	.15	.86
42	14.0	F	2.7	12	.99	13	36	3.6	.25	1.0	.30	1.7
44	19.3	M	.59	2.0	.20	2.5	4	.93	.039	.045	.064	.30
45	14.4	F	<.026	.016	<.0039	.013	.081	<.0097	<.0048	.017	<.0033	<.015
47	17.7	F	.93	4.5	.30	4.7	11	1.6	.23	2.7	.049	.56
50	15.2	M	2.0	9.1	.76	11	23	5.3	.23	.76	.29	1.6
Average	17.6		.86	3.0	.29	3.2	8.0	1.2	.16	.64	.090	.60
S.D.	±2.3		±.77	±3.5	±.29	±3.9	±9.9	±1.5	±.10	±.83	±.10	±.54

S.D. - Standard deviation
ND - Not detected

Underlined values indicate the range (high and low value) for each radionuclide.

Table 3.6.2 Radionuclide Concentrations (nCi/g) Detected in Selected Tissues of Three Deer Mice Collected Near the 1301-N LWDF

	Animal #1				Animal #9				Animal #14			
Radionuclide	L[a]	GI[b]	MB[c]	SF[d]	L	GI	MB	SF	L	GI	MB	SF
Cr-51	<.50	.65	<.10	2.0	<.48	.82	.11	3.6	<.31	.85	<.058	.78
Mn-54	.65	11	.13	8.1	.73	2.7	.24	12	.48	2.2	.096	2.2
Co-58	<.046	.88	.0088	.55	<.055	.32	.027	1.0	<.034	.22	<.0078	.23
Fe-59	.39	11	.16	7.0	.84	2.8	.51	11	.36	1.9	.11	1.3
Co-60	1.1	22	.21	19	1.3	10	.76	38	.40	6.3	.16	6.5
Zn-65	<.094	.40	<.017	<.23	<.12	<.13	.014	<.36	<.079	.12	<.015	<.15
Zr/Nb-95	<.13	3.5	.018	2.5	<.15	1.0	.060	3.3	.039	1.5	.025	1.0
Ru-103	<.055	.45	<.013	.23	<.055	.075	<.012	.33	<.036	.17	.010	.12
Sb-124	<.041	.18	<.0076	.12	<.088	.075	<.012	.22	<.41	.033	<.0049	<.046
I-131	<.20	.26	.42	<.26	<.21	.16	.18	<.38	<.13	.19	.25	<.18
Cs-137	3.1	4.4	1.7	1.8	.46	.27	.24	.58	.23	.25	.16	.30
Ce-141	<.058	.30	<.011	.15	<.054	.054	<.011	.30	<.041	.15	<.0069	.11
Ce-144	<.19	1.2	<.033	1.7	<.19	.43	.058	1.5	<.13	.84	.024	.41

a - Liver
b - Gastro-Intestinal Tract
c - Muscle/Bone
d - Skin/Fur

4.0 RETIRED 100 AREAS SURVEILLANCE PROGRAM

4.1 Retired 100 Areas Sampling Program

Environmental surveillance in the retired 100 Areas is conducted to monitor and document radionuclides detected in environmental media located near the shut-down reactor facilities and 100 Area burial grounds. At the present time the program consists primarily of soil and vegetation sampling in each of the retired areas. Ground-water sampling is also conducted at 100-K Area.

The sampling program for the retired 100 Areas is summarized in table 4.1. Sampling methods, frequencies, and analyses are based on characteristics of the environmental parameter being sampled.

Table 4.1 Summary of the UNC Environmental Surveillance Program for the Retired 100 Areas

Sample	Sampling Method	Number of Sample Locations	Sampling Frequency	Analysis
Surface Soil	Composite sample of approximately 100 grams dry weight	20	Annually	Gamma-emitting radionuclides, strontium, and plutonium
Vegetation	Composite sample of approximately 500 grams dry weight	20	Annually	Gamma-emitting radionuclides, strontium, and plutonium
Ground Water	Four-liter well samples provided by PNL	4	Quarterly	Gamma-emitting radionuclides

9 3 1 2 8 7 2 0 7 0 3

4.2 Summary of FY 1985 Decommissioning and Surveillance Activities

The environmental impact of decommissioning the retired 100 Area reactor ancillary facilities is mostly beneficial, since decommissioning will remove and/or stabilize potentially contaminated structures. However, activities conducted to dismantle and decommission the retired 100 Area facilities may disturb radionuclides contained in or on the structures. These disturbances could potentially release radioactivity to the immediate environment.

The following information provides a brief description of major decommissioning activities completed during FY 1985.

105-D and 105-DR Reactor Fuel Storage Basins

Contaminated water and sludge was removed from the 105 storage basins. Residual contamination in the basins was fixed in place.

105-D and 105-DR Asbestos Removal

Asbestos was removed from the 105-D and 105-DR buildings. Of the total asbestos removed, approximately 10% from 105-D and 50% from 105-DR was disposed of as contaminated solid waste.

107-B, 107-D, and 107-DR Retention Basins

The concrete walls were knocked into each basin and buried in place under at least one foot of clean fill.

107-C Monitoring Buildings

The monitoring buildings adjacent to the 107-C retention basin were dismantled and disposed of as contaminated solid waste.

108-B Tritium Separation Facility

Contaminated facilities and equipment within the 108-B building were removed for disposal as contaminated solid waste. The building was demolished and buried as non-contaminated waste.

115-B/C and 115-D/DR Gas Recirculation Facilities

Contaminated facilities and equipment were removed from the 115 buildings and disposed of as solid waste.

117-B and 117-D Filtration Facilities

Contaminated facilities and equipment were removed from the 117 buildings and disposed of as solid waste.

9 3 1 2 8 7 2 0 7 0 4

Retired 100 Area Burial Grounds Surveillance

Burial ground areas in need of vegetation control were sprayed with the herbicide Spike 80 (TM). The spraying took place from November 1984 to May 1985. Spike 80 (TM) acts a soil sterilant, preventing growth of deep-rooted vegetation that may assimilate buried contamination. Because of the late spray application and below average amounts of rainfall, some of the nuisance vegetation had to be removed by hand.

4.3 Soil and Vegetation Samples

Soil and vegetation samples provide a means of evaluating the distribution of radionuclides from current and past releases to the environment.

The sampling techniques used for the retired 100 Areas samples were identical to those used in 100-N Area. Soil samples consisting of 100 grams each were collected from the the top 2.5 cm of the soil surface. Vegetation samples of 500 grams each were collected from the growing portions of perennial vegetation. Gray rabbitbrush (*Chrysothamnus nauseosus*) was the predominant species that was sampled.

Duplicate samples of both media were collected. One of each duplicate sample was analyzed for gamma-emitting radionuclides at the UNC radioanalytical lab. The remaining duplicate samples were analyzed for strontium and plutonium by UST.

The following figures and tables show sampling locations and radionuclide concentrations detected in soil and vegetation samples collected at each of the retired 100 Areas. Soil and vegetation samples are listed together for comparison.

TM - Registered trademark of the Elanco Products Company, Division of Eli Lilly and Company

9 3 1 2 8 7 2 0 7 0 5

Table 4.3.1 Radionuclide Concentrations (ρCi/g, dry weight) Detected in Soil (S) and Vegetation (V) Samples Collected at 100-B/C Area

Location	Sample Type	Co-60	Sr-90	Cs-137	Pu-238	Pu-239/240
B1	S	.13	.014	<.076	.00019	.00058
	V	1.4	.27	.30	.00059	.0019
B2	S	.49	.017	.85	.00041	.0010
	V	.11	.054	.050	<.00018	.00067
C1	S	.28	.015	.25	<.00014	.0011
	V	.19	5.2	<.070	<.000071	.00071
C2	S	.18	.050	.64	.00040	.00082
	V	.15	.11	.049	<.00016	.00073

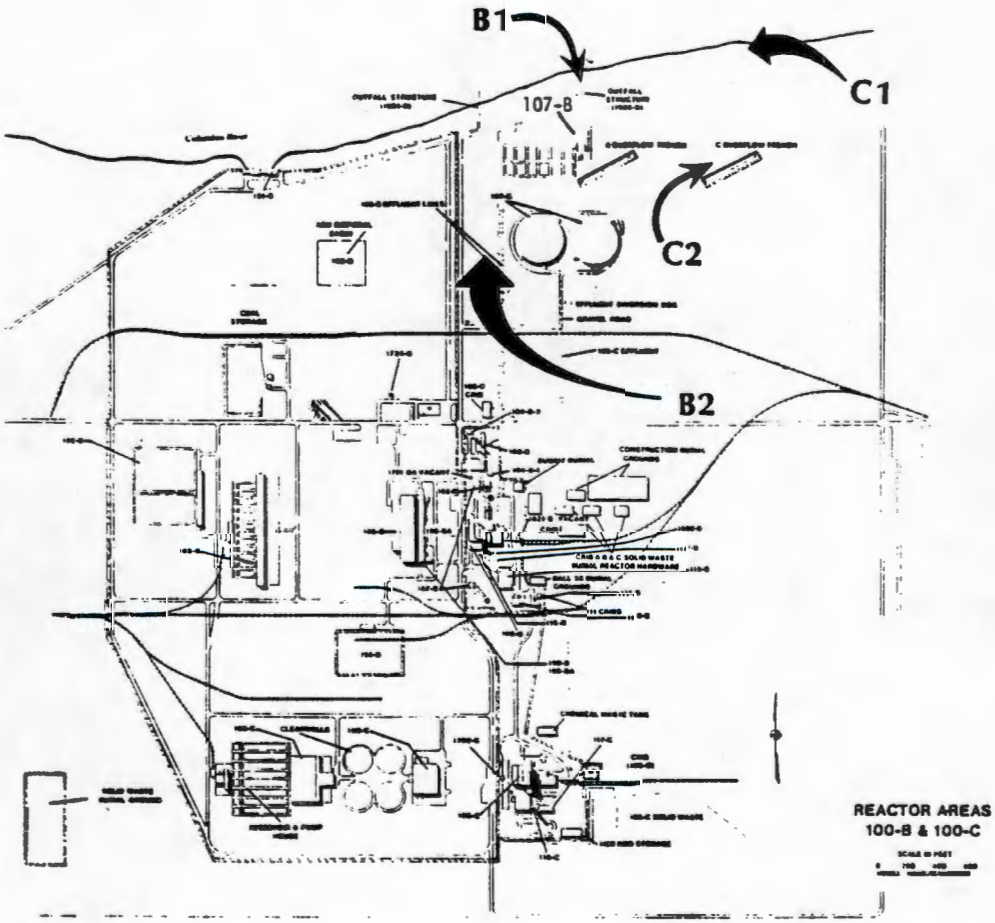

Figure 4.3.1 Soil and Vegetation Sampling Locations at 100-B/C Area

9 3 1 2 8 7 2 0 7 0 6

Table 4.3.2 Radionuclide Concentrations (ρCi/g, dry weight) Detected in Soil (S) and Vegetation (V) Samples Collected at 100-D/DR Area

Location	Sample Type	Co-60	Sr-90	Cs-137	Pu-238	Pu-239/240
D1	S	.36	.033	.27	.00031	.0015
	V	.16	.046	.053	<.00015	<.00021
D2	S	.26	.071	.31	<.00012	.0052
	V	.14	.060	<.046	<.000068	.00048
D3	S	.15	.043	.058	.00023	.0021
	V	.45	.050	.034	<.00015	.0012
D4	S	.18	.075	.44	<.00019	.0033
	V	.20	.12	2.6	<.00013	.00090

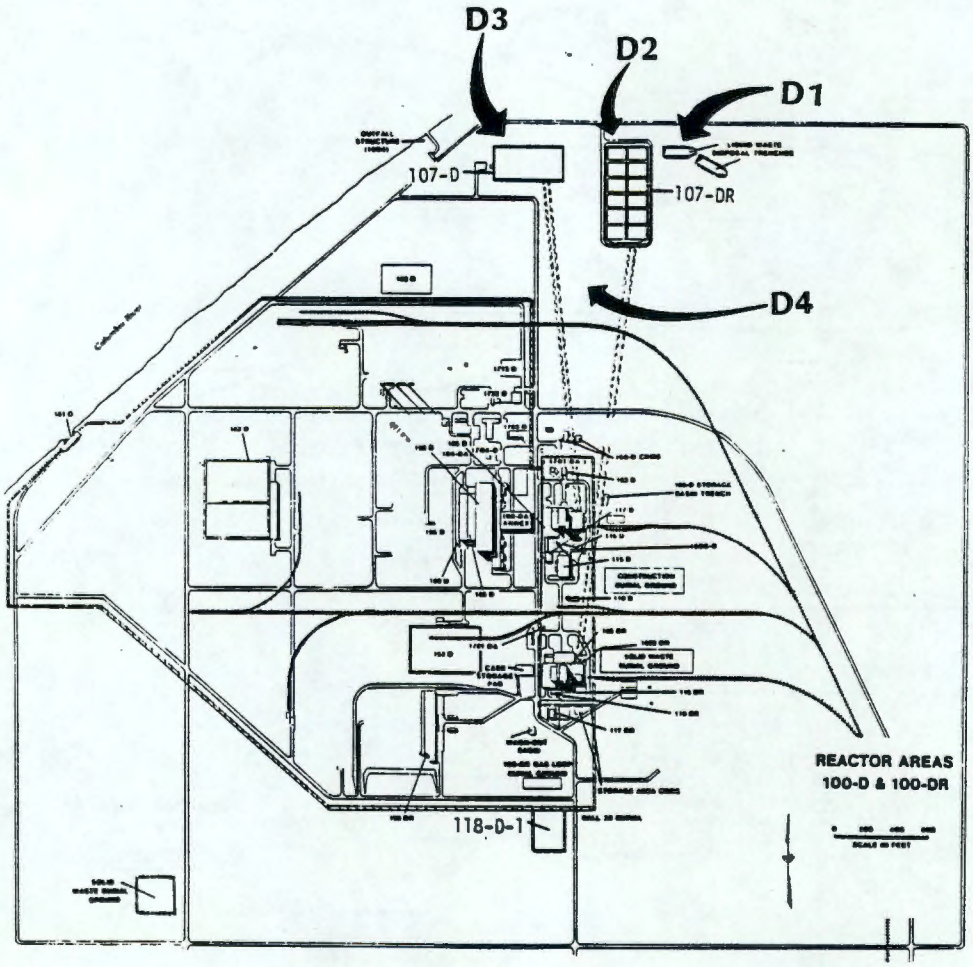

Figure 4.3.2 Soil and Vegetation Sampling Locations at 100-D/DR Area

9 3 1 2 8 7 2 0 7 0 7

Table 4.3.3 Radionuclide Concentrations (ρCi/g, dry weight) Detected in Soil (S) and Vegetation (V) Samples Collected at 100-F Area

Location	Sample Type	Co-60	Sr-90	Cs-137	Pu-238	Pu-239/240
F1	S	.23	.48	.25	<.00037	.0039
	V	.18	.20	<.067	<.00012	.00030
F2	S	.29	.11	.19	.00030	.0093
	V	.029	.72	.10	0.0	<.00063
F3	S	.64	.56	2.8	.0021	.032
	V	.97	5.8	2.2	<.000024	.00084
F4	S	.17	.050	.23	<.00017	.0015
	V	.22	.039	.15	<.000045	.00045
F5	S	.16	.27	.69	.00030	.0025
	V	.25	.46	.36	<.000054	.00043

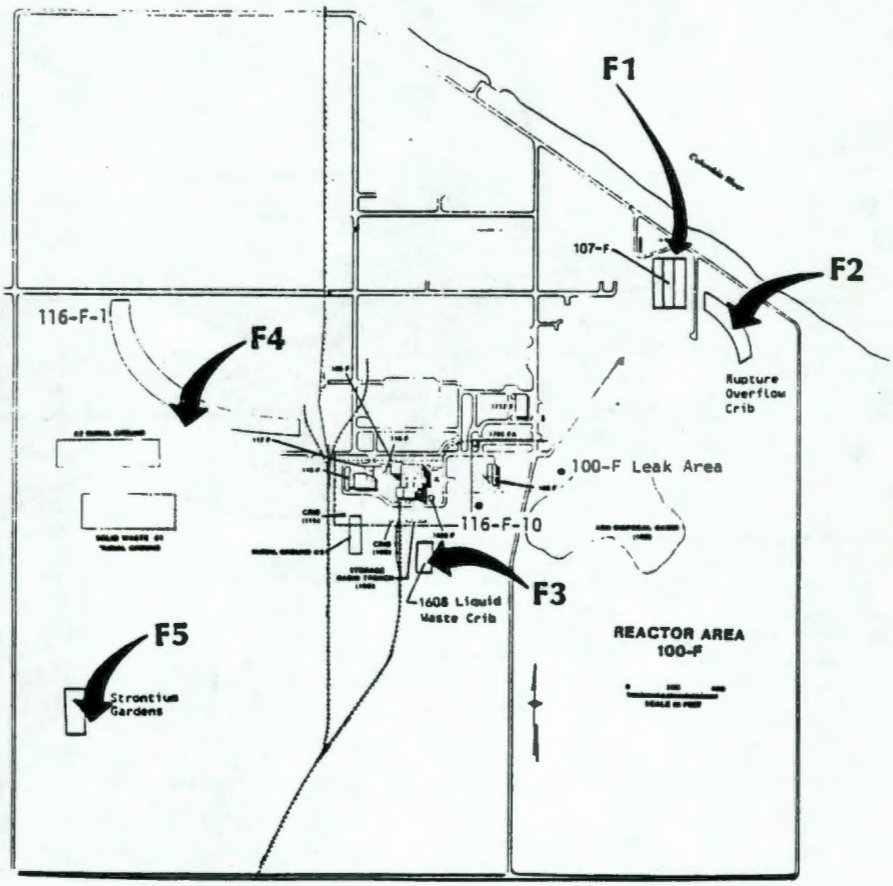

Figure 4.3.3 Soil and Vegetation Sampling Locations at 100-F Area

9 3 1 2 8 7 2 0 7 0 8

Table 4.3.4 Radionuclide Concentrations (pCi/g, dry weight) Detected in Soil (S) and Vegetation (V) Samples Collected at 100-H Area

Location	Sample Type	Co-60	Sr-90	Cs-137	Pu-238	Pu-239/240
H1	S	.14	.086	.23	.00025	.0074
	V	.13	.080	.036	0.0	<.00044
H2	S	NA	.11	NA	<.00013	.0039
	V	.27	.040	<.054	<.00020	.00057

NA-Data not available (lost sample)

9 3 1 2 8 7 2 0 7 0 9

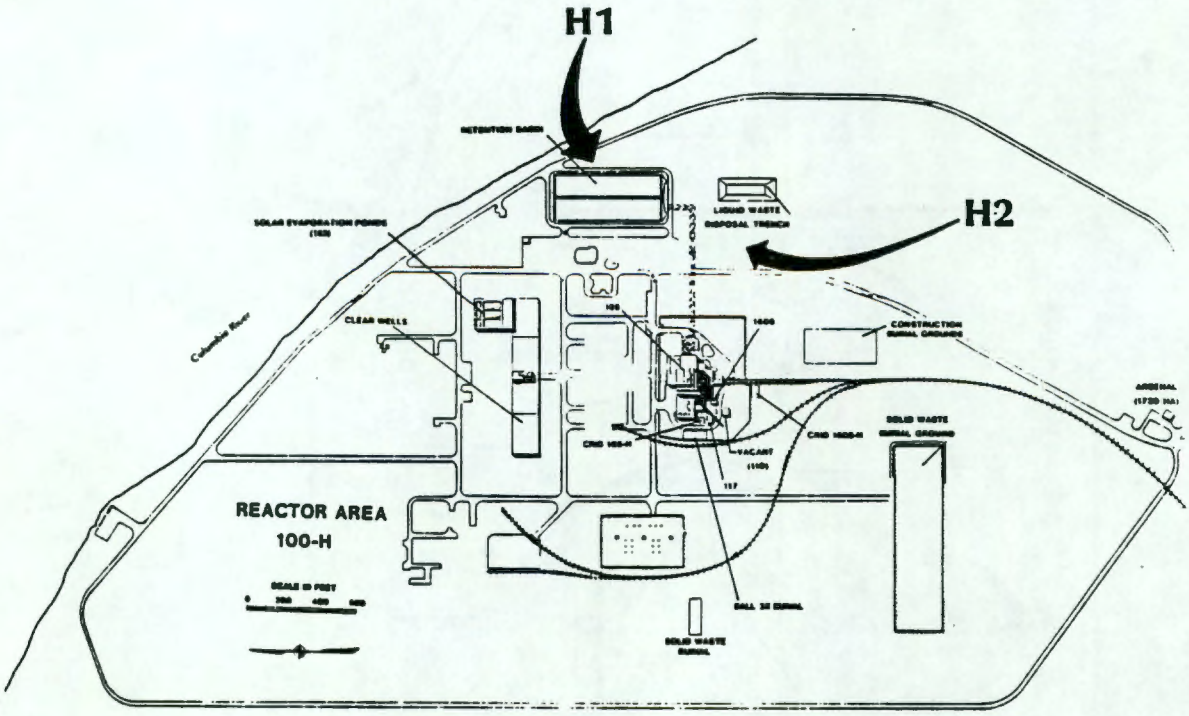

Figure 4.3.4 Soil and Vegetation Sampling Locations at 100-H Area

Table 4.3.5 Radionuclide Concentrations (pCi/g, dry weight) Detected in Soil (S) And Vegetation (V) Samples Collected at 100-K Area

Location	Sample Type	Co-60	Sr-90	Cs-137	Pu-238	Pu-239/240
K1	S	1.4	.66	1.7	.0051	.12
	V	.19	.15	.088	<.00012	.0011
K2	S	1.6	.37	2.0	.00053	.015
	V	.078	1.5	.039	<.00020	.00077
K3	S	.11	.071	.092	<.00025	.0018
	V	.21	.035	.064	<.000047	.00077
K4	S	.33	.056	.19	<.00019	.0012
	V	1.5	.15	.17	<.00042	<.000060
K5	S	.28	.31	1.3	.00081	.023
	V	.30	.11	.27	<.00015	.00084

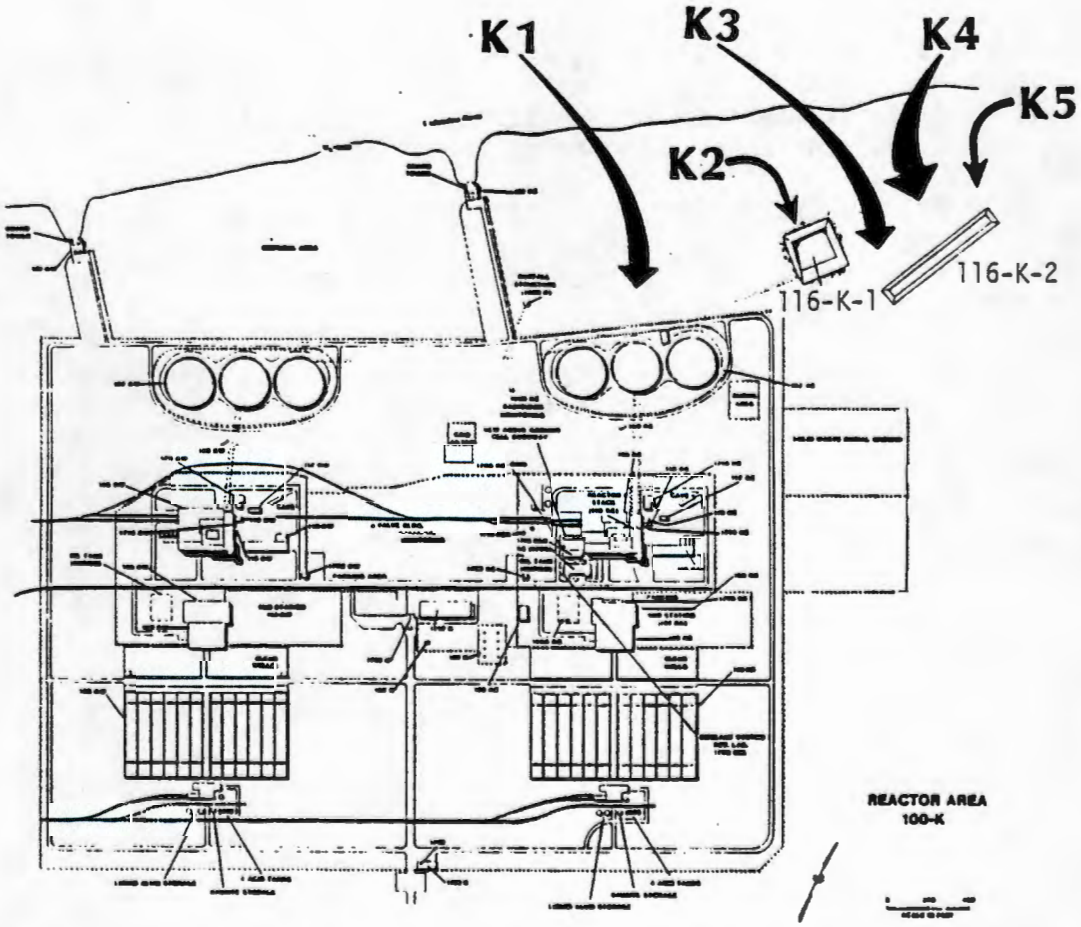

Figure 4.3.5 Soil and Vegetation Sampling Locations at 100-K Area

9 3 1 2 8 7 2 0 7 1 0

4.4 Non-routine Vegetation Samples

Special samples of vegetation growing on or near retired 100 Area burial grounds were collected to monitor potential uptake of the buried contamination. The samples were also collected to evaluate the vegetation spray program and identify areas in need of future spraying.

Samples of approximately 500 grams each were collected from perennial and annual vegetation growing on selected 100 Area burial grounds. The areas sampled were determined by their potential for uptake and the extent of vegetative growth.

The growing portions of established gray rabbitbrush (*Chrysothamnus nauseosus*) and Russian thistle (*Salsola kali*) were sampled. Both species have root systems capable of reaching and assimilating buried radionuclides.

Table 4.4.1 shows radionuclide concentrations detected in vegetation collected in October 1984. The sample locations are shown on figures 4.3.1, 4.3.2, 4.3.3, and 4.3.5. The samples were analyzed for carbon-14, strontium-90, and plutonium isotopes by UST. Gamma-emitting radionuclides were analyzed at the UNC radioanalytical lab.

The data indicate uptake of radionuclides by the vegetation growing directly over the buried waste. The samples obtained from the 116-K-1 overflow basin and the retention basin areas contained above background concentrations of strontium-90 and cesium-137.

Table 4.4.2 shows radionuclide concentrations detected in vegetation collected in August 1985. The sample locations are shown on figures 4.3.3 and 4.3.5. These samples were analyzed for gamma-emitting radionuclides only.

Samples collected from the 116-K-1 overflow basin continued to contain above background concentrations of cesium-137. These shrubs have since been removed from the bottom of the basin and disposed of as radioactive waste.

9 3 1 2 8 7 2 0 7 1 1

Table 4.4.1 Radionuclide Concentrations (ρCi/g, dry weight) Detected in Vegetation Collected During October 1984

Sample Location	C-14	Co-60	Sr-90	Cs-137	Pu-238	Pu-239/240
107-B (Retention Basin)	---	4.8	32	5.6	.00030	.0015
107-D (Retention Basin)	---	---	54	62	.00022	.0036
107-DR (Retention Basin)	---	---	16	19	.00020	.0048
118-D-1 (Burial Ground)	---	---	.35	.53	.0011	.0084
116-K-1 (Overflow Basin)	4.2	25	4.3	300	.0087	.050

Table 4.4.2 Radionuclide Concentrations (ρCi/g, dry weight) Detected in Vegetation Collected During August 1985

Location	Sample #	Co-60	Cs-137	Eu-152	Eu-154
100-F Effluent Line Leakage Area	1	.22	.21	---	---
	2	.37	1.5	---	---
116-F-1 (Lewis Canal)	1	.27	.091	---	---
	2	.34	.23	---	---
116-F-10 (Decontamination Pit)	1	.96	6.1	1.0	---
116-K-1 (Overflow Basin)	1	12	340	2.9	.68
	2	18	1,000	6.1	1.3
116-K-2 (Mile-long Trench)	1	.37	.71	---	---

9 3 1 2 8 7 2 0 7 1 2

4.5 Ground-water Samples

Ground water is routinely sampled from four wells located near the 105-KE building. The samples are collected to detect potential leakage from the 105-KE reactor fuel storage basin.

Four-liter samples were collected quarterly and analyzed for gamma-emitting radionuclides at the UNC radioanalytical lab. The sampling locations are shown on figure 4.5.

Table 4.5.1 shows radionuclide concentrations detected in the ground-water samples. The concentrations of antimony-125 detected in samples from wells K-27 and K-28 indicate residual contamination from past leaks of basin effluent to ground water.

Table 4.5.2 shows average radionuclide concentrations detected in well K-27 from 1982 to 1985.

The data indicate that concentrations of antimony-125 (2.7 year half-life) in well K-27 have stabilized and are declining. A leak in the 105-KE reactor fuel storage basin was repaired in 1981. Water levels in the basin are continuously monitored and reveal no detectable amounts of leakage.

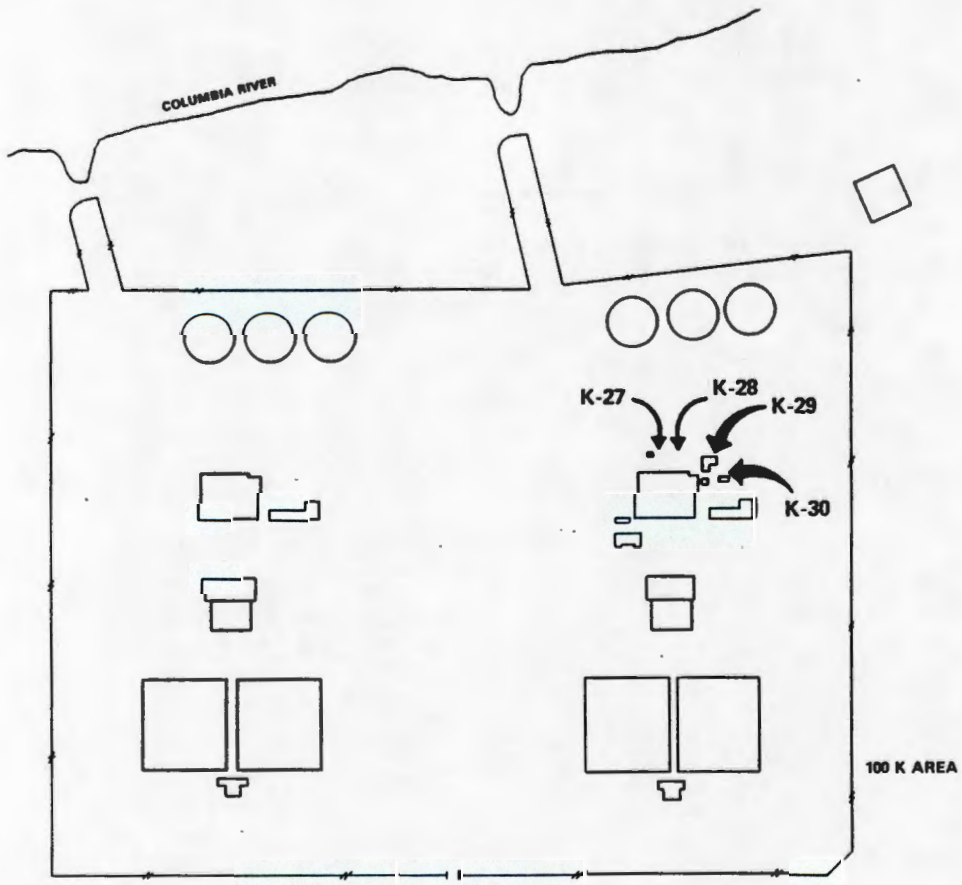

Figure 4.5 Location of Ground-water Wells at 100-K Area

9 3 1 2 8 7 2 0 7 1 3

Table 4.5.1 Radionuclide Concentrations (pCi/L) in 100-KE Ground-water Samples

Well		Co-60	Ru-103	Sb-124	Sb-125
K-27	Min	9.5	---	<6.7	370
	Max	18	3.1	<7.8	430
	Ave	14	3.1	---	400
	S.D.	± 6.0	---	---	± 28
K-28	Min	7.8	<4.8	<5.6	31
	Max	18	<6.5	<7.5	45
	Ave	13	---	---	40
	S.D.	± 4.2	---	---	± 6.0
K-29	Min	6.7	---	<5.9	<11
	Max	35	5.1	<8.0	<13
	Ave	17	5.1	---	---
	S.D.	± 13	---	---	---
K-30	Min	3.5	<4.7	<6.3	<11
	Max	61	<10	<12	<23
	Ave	25	---	---	---
	S.D.	± 25	---	---	---
DOE 5480.1 Onsite Concentration Guides		1,000,000	2,000,000	700,000	3,000,000
DOE 5480.1 Offsite Concentration Guides		50,000	80,000	20,000	100,000

Min - Minimum value
Max - Maximum value
Ave - Average
S.D. - Standard deviation

Table 4.5.2 Radionuclide Concentrations (pCi/L) Detected in Well K-27 Ground-water Samples From 1982 to 1985

Year	Co-60	Ru-103	Ru-106	Sb-125
1982	14	---	110	100
1983	7.3	---	---	640
1984	9.7	---	---	520
1985	14	3.1	---	400

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4.6 Special Environmental Samples

Contaminated chemical sludge was removed from the 183-H solar evaporation basin #1 during July, August, and September 1985. Continuous air samples were collected inside the basin while the sludge was being removed. Ambient air samples were also collected at several locations outside the basin. The sampling locations varied, depending upon prevailing wind conditions at the time.

The samples were obtained using a low-volume sample pump and a 47mm filter as the collection medium. The filters were analyzed by HEHF for particulates and specific ions contained in the chemical waste.

Table 4.6.1 shows average concentrations of particulates and ions detected in the air samples from basin #1.

Table 4.6.2 shows average concentrations of particulates and ions detected in the ambient air samples. Applicable ambient air quality standards are also included in the table. The sampling locations are shown on figure 4.6.

The data indicate that some basin sediments were resuspended while the sludge was being removed. The ambient air samples contained less-than-detectable or very low concentrations of the chemical components of the sludge.

Resuspension of the chemical waste was primarily limited to the immediate basin air. This would indicate that the chemical waste was contained within the basin during the cleanup work. The concentrations released to the general environment were well below applicable ambient air standards.

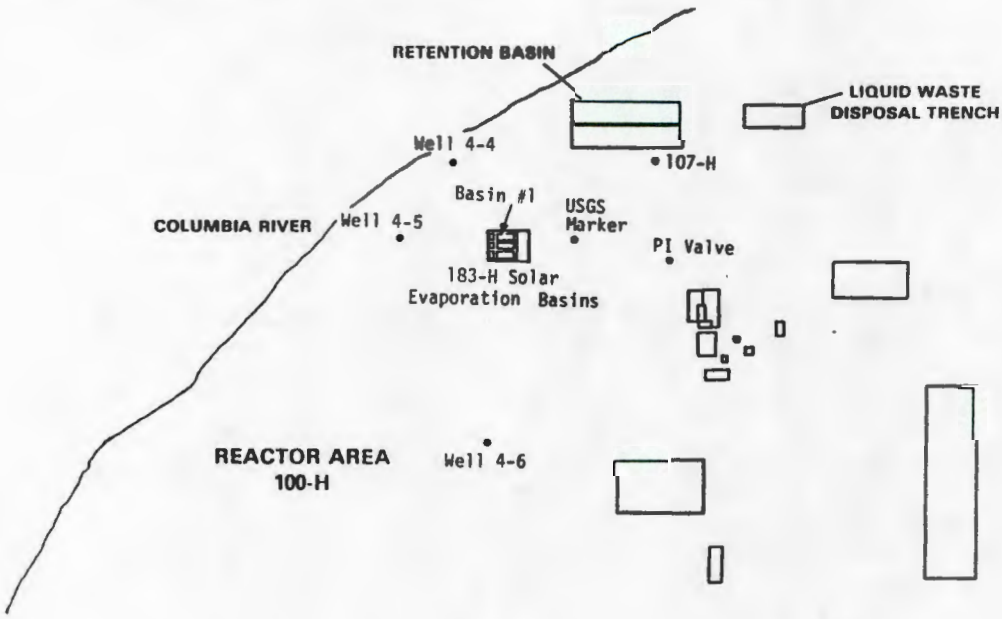

Figure 4.6 Ambient Air Sampling Locations at 100-H Area

9 3 1 2 8 7 2 0 7 1 5

Table 4.6.1 Average Concentrations (mg/m^3) of Particulates and Ions Detected in 183-H Solar Evaporation Basin #1 Air Samples

Sample Date	Particulate	Cu^{+2}	F^-	NO_3^-	SO_4^{-2}
7-17-85	.11	---	.0012	.00090	.0090
7-18-85	.12	.00070	.00080	.00030	.0026
7-19-85	.084	.0011	<.00040	.00060	.0019
7-24-85	.062	---	---	---	---
7-25-85	.095	.0038	---	---	---
7-26-85	.17	.0041	.0020	.0030	.014
7-29-85	.14	---	---	---	---
8-12-85	.045	---	---	---	---
8-13-85	.070	.00060	---	---	---
8-14-85	.045	---	<.0010	<.0020	.0040
8-15-85	.013	---	---	---	---
8-16-85	.083	.0013	<.0010	.0010	.0090
8-19-85	.15	.00030	.0010	.0030	.016
8-20-85	.035	---	---	---	---
8-21-85	.063	.00010	---	---	---
8-22-85	.035	---	---	---	---
8-26-85	.055	---	---	---	---
8-27-85	.038	---	---	---	---
8-28-85	.053	.0019	---	---	---
8-29-85	.050	---	---	---	---
9-3-85	.080	.00080	<.0010	.0010	.0040
9-4-85	.058	.0024	<.0010	.0010	.0060
9-9-85	.033	.00050	<.0010	.0010	.0050
9-10-85	.013	---	---	---	---
9-11-85	.018	.0029	<.0010	.0040	.0020

--- Not Analyzed

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Table 4.6.2 Concentrations (mg/m^3) of Particulates and Ions Detected in Ambient Air Samples Collected at 100-H Area

Sample Date	Sample Location	Particulate	Cu^{+2}	F^-	NO_3^-	SO_4^{-2}
7-26-85	Well 4-4	<.10	<.00060	<.0030	<.0070	<.020
	Well 4-5	<.10	---	<.0040	<.0080	<.020
	PI Valve	.22	---	<.0030	<.0070	<.020
8-15-85	183-H	.030	<.00060	<.0030	<.0060	<.020
	Well 4-4	.040	<.00060	<.0030	<.0060	<.020
	Well 4-6	.040	<.00060	<.0030	<.0060	<.020
8-21-85	USGS Mark	.060	<.00060	<.0030	<.0070	<.020
	107-H	.010	<.00060	<.0030	<.0060	<.020
	Well 4-5	<.010	<.00060	<.0030	<.0060	<.020
8-29-85	183-H	.010	<.00070	<.0040	.012	.034
	Well 4-4	.14	---	<.0040	<.0090	<.020
	USGS Mark	< .010	<.00070	<.0040	.010	<.020
9-5-85	183-H	.12	<.00060	<.0040	.0060	<.010
	Well 4-4	.19	<.00060	<.0030	<.0070	<.010
	Well 4-6	.080	<.00060	<.0030	<.0070	<.010
WAC Title 18 Air Standards	Ambient	150	---	2.9	---	---

---Not analyzed

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APPENDIX A - Environmental Dose Rate Measurements (mrem/hr) for FY 1985

Time Periods

TLD Locations	On Off	9/21/84 10/19/84	10/19/84 11/15/84	11/15/84 12/14/84	12/14/84 1/11/85	1/11/85 2/8/85	2/8/85 3/8/85	3/8/85 4/5/85	4/5/85 5/3/85	5/3/85 5/31/85	5/31/85 6/28/85	6/28/85 7/26/85	7/26/85 8/23/85	8/23/85 9/20/85
1		.015	.015	.019	.019	.021	.021	.027	.026	.031	.041	.041	.035	.033
2		.014	.016	.018	.018	.023	.026	.029	.033	.042	.044	.041	.034	.034
3		.009	.011	.014	.015	.017	.013	.012	.025	.032	.015	.019	.012	.014
4		.021	.025	.024	.031	.042	.028	.023	.013	.016	.025	.033	.022	.028
5		.022	.022	.028	.036	.029	.024	.022	.026	.028	.028	.025	.025	.028
6		.011	.021	.031	.084	.057	.046	.039	.052	.048	.058	.031	.038	.035
7		.101	.103	.104	.105	.111	.101	.089	.104	.105	.108	.108	.116	.118
8		.007	.007	.009	.009	.011	.007	.005	.008	.008	.008	.011	.009	.008
9		.011	.005	.008	.008	.009	.006	.005	.006	.007	.007	.013	.012	.009
10		.005	.006	.008	.009	.008	.005	.005	.006	.007	.009	.008	.007	.006
11		.008	.009	.009	.011	.011	.006	.006	.008	.008	.011	.009	.008	.009
12		.004	.004	.006	.007	.006	.004	.004	.005	.006	.007	.006	.006	.006
13		.009	.008	.011	.014	.012	.009	.008	.012	.012	.013	.014	.012	.009
14		.035	.034	.036	.041	.038	.035	.033	.038	.036	.042	.039	.033	.034
15		.013	.016	.014	.019	.023	.017	.019	.019	.022	.021	.025	.017	.021
16		.035	.042	.041	.076	.053	.033	.033	.048	.039	.059	.067	.051	.036
17		.005	.005	.006	.007	.007	.004	.004	.005	.006	.007	.005	.007	.005
18		.042	.043	.041	.048	.044	.034	.035	.045	.042	.054	.038	.035	.039
19		.008	.008	.009	.008	.008	.007	.007	.006	.008	.009	.004	.008	.008
20		.006	.005	.006	.005	.006	.005	.005	.004	.005	.006	.008	.005	.004
21		.032	.031	.033	.034	.035	.027	.029	.032	.035	.041	.034	.032	.035
22		.011	.012	.012	.014	.017	.011	.011	.012	.014	.012	.012	.011	.014
23		.005	.006	.008	.006	.007	.004	.004	.004	.006	.005	.004	.007	.005
24		.004	.004	.005	.004	.005	.003	.004	.003	.004	.004	.002	.004	.004
25		.005	.004	.005	.007	.006	.004	.004	.006	.005	.006	.003	.005	.007
26		.009	.009	.009	.014	.011	.007	.008	.009	.009	.011	.006	.011	.009
27		.007	.007	.007	.008	.008	.006	.006	.007	.008	.008	.006	.007	.007
28		.145	.065	.061	.069	.087	.058	.064	.069	.068	.151	.227	.179	.115
29		.447	.427	.456	.444	.459	.396	.392	.434	.379	.418	.309	.435	.323
30		.019	.014	.035	.018	.114	.162	.352	.273	.342	.357	.246	.249	.326
31		.028	.033	.032	.031	.028	.025	.023	.028	.026	.031	.029	.029	.031
32													.028	.029
33													.018	.018
34													.746	.804
35													.338	.329
36													.324	.332

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APPENDIX B - Acronyms and Abbreviations

Acronyms

ALARA	As Low As Reasonably Achievable
CY	Calendar Year
EDB	Emergency Dump Basin
EDT	Emergency Dump Tank
FY	Fiscal Year
HEHF	Hanford Environmental Health Foundation
LWDF	Liquid Waste Disposal Facility
PNL	Battelle, Pacific Northwest Laboratories
TLD	Thermoluminescent Dosimeter
UNC	UNC Nuclear Industries
USDOE	U.S. Department of Energy
USERDA	U.S. Energy Research and Development Administration
UST	U.S. Testing Company, Inc.

Basic Units

Radioactivity -	Ci	Curie
	R	Roentgen
	rem	Roentgen equivalent man
Mass -	g	gram
Length -	m	meter
	ft	foot
Volume -	L	liter
	m3	cubic meter
Time -	min	minute
	hr	hour
	yr	year

Metric Prefixes and Uses

m	milli (10E-3);	millirem (mrem), milligram (mg), millimeter (mm)
u	micro (10E-6);	microcurie (uCi), microroentgen (uR), microgram (ug)
n	nano (10E-9);	nanocurie (nCi)
p	pico (10E-12);	picocurie (pCi)

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