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Westinghouse Hanford Company Environmental Surveillance Annual Report--100 Areas Calendar Year 1990

C. J. Perkins

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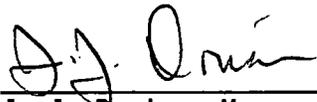
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WESTINGHOUSE HANFORD COMPANY
ENVIRONMENTAL SURVEILLANCE ANNUAL
REPORT--100 AREAS
CALENDAR YEAR 1990

C. J. PERKINS

ABSTRACT

Westinghouse Hanford Company (Westinghouse Hanford) performs the near-field environmental surveillance of the Hanford Site 100 Areas to assess and control the impacts of operations. This involves sampling and analysis from the major environmental pathways of exposure to onsite workers.

Results of the near-field environmental surveillance program for the Hanford Site 100 Areas are presented in this report. The environmental surveillance program provides sampling and monitoring of several parameters to evaluate the environmental impact of 100 N Area Reactor Facilities and the shutdown reactor facilities and burial grounds in the retired 100 Areas. Discharges to the environment are reported in annual effluent release reports.

At the 100 N Area, samples of ambient air, groundwater, vegetation, and surface soil were collected and analyzed. Direct radiation levels also were monitored at several locations. Samples of ambient air, vegetation, surface soil, and sediment were collected to monitor the environmental impact of the 1301-N and 1325-N Liquid Waste Disposal Facilities (LWDF). Direct radiation surveys were conducted for each LWDF and along the Columbia River shoreline.

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At the retired 100 Areas, vegetation and surface soil samples were collected and analyzed. In addition, samples from groundwater monitoring wells located at the 100 K Area were collected and analyzed. The results are provided in this report.

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EXECUTIVE SUMMARY

Westinghouse Hanford Company (Westinghouse Hanford) performs the near-field environmental surveillance of the Hanford Site 100 Areas to assess and control the impact of operations. This involves sampling and analysis from the major environmental pathways of exposure to onsite workers.

Results from the near-field environmental surveillance program for the Hanford Site 100 Areas are presented in this report. The environmental surveillance program provides sampling and monitoring of several parameters to evaluate the environmental impact of 100 N Area reactor facilities, the shutdown reactor facilities, and burial grounds in the retired 100 Areas. Discharges to the environment are reported in annual effluent release reports.

At the 100 N Area, samples of ambient air, groundwater, vegetation, and surface soil were collected and analyzed. Direct radiation levels also were monitored at several locations. Samples of ambient air, vegetation, surface soil, and sediment were collected to monitor the environmental impact of the 1301-N and 1325-N Liquid Waste Disposal Facilities (LWDF). Direct radiation surveys were conducted for each LWDF and along the Columbia River shoreline.

At the retired 100 Areas, vegetation and surface soil samples were collected and analyzed. In addition, samples from groundwater monitoring wells located at the 100 K Area were collected and analyzed. The results provided in this report are summarized by the following highlights.

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REGULATORY CONTROLS

The radiation dose to workers and the offsite population is regulated by a tiered system of controls. The U.S. Department of Energy (DOE) has established the occupational dose limit at 5,000 mrem/yr. The effective dose equivalent limits for any member of the public were set by the DOE at 500 mrem/yr for occasional annual exposures and 100 mrem/yr for continuous exposures. The DOE has identified administrative action level of 25 mrem/yr (to the maximum individual member of the public) to ensure that these dose limits are not exceeded.

Derived concentration guides (DCG) corresponding to the 100 mrem/yr effective dose equivalent standard are used for comparison purposes only in this report. It should be noted that the DCGs are applicable at the point of actual exposure to members of the public and are, therefore, not applicable onsite.

ANALYTICAL LABORATORY SUPPORT

In June 1990, the offsite analytical laboratory contract with United States Testing (UST) was terminated. In September 1990, as a result of decreased man-power requirements for N Reactor operations support, the 105-N analytical laboratory was closed down. As a result of these two closures, the 100 Areas Environmental Surveillance Program experienced significant delays in analytical reporting as well as permanent loss of some environmental data due to sample misplacement. The specific exceptions are discussed in their respective chapters.

GENERAL

The N Reactor was placed in a "standdown" mode on January 7, 1987, and did not operate during calendar years 1988, 1989, and 1990. The reactor was in "dry lay-up" mode in 1990 because of recent decisions affecting its role in the production of special nuclear materials.

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AMBIENT AIR MONITORING

Environmental samples of ambient air collected near the 100 N Area indicated that the concentrations of airborne radionuclides were less than the DCG and that there was no significant release to the environment. The only radionuclide detectable during 1990 was ^{60}Co .

Ambient air samples collected after August/September 1990 were inadvertently destroyed before their radio-analysis. These samples were once again collected and analyzed beginning in February 1991.

GROUNDWATER

Radionuclide concentrations in the groundwater exceeded the DCG for ^{90}Sr in monitoring sites near the 1301-N and 1325-N LWDFs during this reporting period. Concentrations of ^{90}Sr also exceeded the DCG at the N Springs. Groundwater tritium concentrations generally decreased, compared to 1989 in the 100 N and 100 K Areas, and did not exceed the DCG at any time during the reporting period.

SOIL AND VEGETATION

Environmental samples of vegetation collected at the 100 N Area indicated near-background levels of radionuclides in the immediate environment. Trend analysis revealed generally stable radionuclide concentrations in vegetation samples since 1980. Vegetation sampling locations along the N Springs shoreline historically have contained above-background levels of ^{90}Sr .

Residual concentrations of radionuclides released to the 1301-N LWDF were detected in the surface soil and vegetation adjacent to the facility. Since September 1985, the 1301-N LWDF has not received 100 N Reactor liquid effluent. Facility closure plans are being evaluated that will include biotransport and intrusion barriers.

Environmental samples of vegetation collected near the retired 100 Area reactor facilities indicated no significant release or biotransport of radionuclides to the immediate environment. Trend analysis, again, revealed generally stable radionuclide concentrations in vegetation samples since 1981.

Environmental soil samples collected in the retired 100 Areas 1990 had not been analyzed at the time of this printing. Once these data become available, they will be issued as an addendum to this report.

EXTERNAL RADIATION

External radiation levels were highest in radiologically controlled areas near the 1301-N and 1325-N LWDFs. Dose rates at thermoluminescent dosimeter locations near the 1301-N LWDF were slightly higher than the levels observed since 1989. Dose rates at locations near the 1325-N LWDF were significantly higher (approximately 400%) than those observed in 1989.

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RADIOLOGICAL SURVEYS

Direct radiation levels measured near the 1301-N LWDF were comparable to those measured in 1989. The 1301-N LWDF no longer is receiving liquid effluent from N Reactor. The absence of shielding (water) resulted in the measurable direct radiation levels.

Direct radiation levels measured near the 1325-N LWDF were significantly higher than those in 1989. Decreased effluent discharges resulted in increased direct radiation levels because of a reduction in the depth of water providing shielding of radiation from contaminated sediments.

Direct radiation levels measured along the Columbia River shoreline were lower than those observed since 1986. This decline is likely attributable to the radioactive decay of ^{60}Co (5.3 yr half-life) inventory in the 100 N waste handling, storage, and disposal facilities.

LIQUID WASTE DISPOSAL FACILITIES

Sediment samples collected from the 1325-N LWDF crib had not been analyzed at the time this report was issued. When these data are received, they will be issued as an addendum to this report. Discharges to the 1301-N LWDF were discontinued in September 1985; therefore, 1301-N sediment samples were not collected. Residual radionuclide levels will decline as the radionuclides decay.

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WESTINGHOUSE HANFORD COMPANY ENVIRONMENTAL
SURVEILLANCE ANNUAL REPORT--100 AREAS
CALENDAR YEAR 1990

1.0 INTRODUCTION

1.1 BACKGROUND

Westinghouse Hanford Company (Westinghouse Hanford), as a prime contractor to the U.S. Department of Energy (DOE) at the Hanford Site, manages N Reactor and the storage of spent fuel at 100 K Area and maintains the retired reactor facilities at 100B/C, D/DR, F, KE/KW, and H Areas.

The Hanford Site is located within the Pasco Basin in south-central Washington State, approximately 170 mi southeast of Seattle and 125 mi southwest of Spokane. The 100 Areas are located in the north-central part of the Hanford Site, along the southern bank of the Columbia River (Figure 1-1).

1.2 SCOPE OF THE ENVIRONMENTAL SURVEILLANCE PROGRAM

The near-field 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 Area reactor facilities and the shutdown reactor facilities in the retired 100 Area. (See Section 1.4, Facility Descriptions.) The major objectives of the monitoring program are as follows:

- Compliance with DOE and internal Westinghouse Hanford radiation protection guides
- Performance of radioactive waste confinement systems
- Long-term trends of radioactive materials in the environment at and adjacent to operating facilities and waste disposal sites.

Westinghouse Hanford uses this document to evaluate facility operation and management practices. This report does not include estimates of radiation doses to the public resulting from the operation of 100 Area facilities. Battelle's Pacific Northwest Laboratory (PNL) prepares and issues reports of population dose commitments and other environmental information for the Hanford Site. Westinghouse Hanford provides radionuclide release information to PNL for the preparation of such documents.

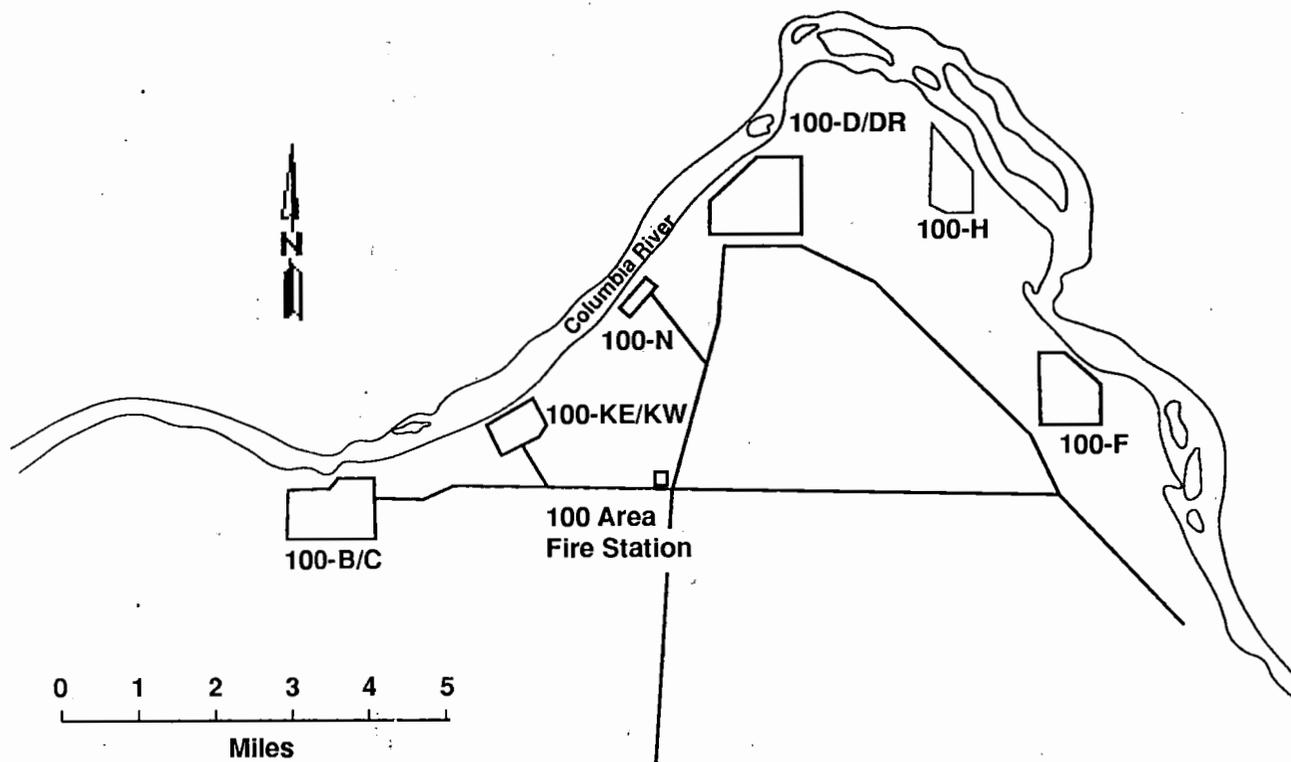


Figure 1-1. Map of the 100 Areas.

1.3 REGULATORY BASIS

A tiered system of controls regulates radiation exposure to workers and the offsite population. The DOE has established the occupational exposure limit at 5,000 mrem/yr. The DOE sets the exposure limits for any member of the public at 500 mrem/yr for occasional annual exposures and 100 mrem/yr for annual exposures expected to last longer than 5 yr. The DOE has identified an administrative action level of 25 mrem/yr (to the maximum individual member of the public) to ensure that these exposure limits are not exceeded.

Derived concentration guides (DCG) corresponding to the 100 mrem/yr effective dose equivalent standard are used as comparisons in this report. It should be noted that DCGs are applicable at the point of actual exposure to members of the public and are, therefore, not directly applicable onsite. In keeping with Westinghouse Hanford's philosophy to keep doses to workers as low as reasonably achievable (ALARA), the DCGs are compared to onsite data.

1.4 FACILITY DESCRIPTIONS

1.4.1 100 N Area Facilities

1. 105-N Reactor--The N Reactor is a graphite-moderated, pressurized light-water cooled reactor that uses slightly enriched uranium fuel in the production of special nuclear materials (SNM) and byproduct steam for use by the Washington Public Power Supply System in the generation of electric power. N Reactor was placed in a "standdown" mode on January 7, 1987, and retained a "dry lay-up" status during 1990.
2. Liquid Waste Disposal Facilities--Two liquid waste disposal facilities (LWDF), 1301-N and 1325-N, have been used to receive and treat N Reactor liquid wastes containing low-level fission and activation products. The 1301-N LWDF was permanently retired from service in September 1985. The 1325-N LWDF was the only LWDF receiving radioactive liquid waste discharges in 1990.

The LWDF, also referred to as crib and trench, allows influent to percolate downward into an engineered soil column, where a high percentage of radionuclides contained in the influent is removed by adsorption, filtration, and ion exchange.

3. 1314-N Liquid Waste Loadout Facility--The 1314-N Facility receives the radioactive liquid waste from the 1310-N Facility and the 107-N Facility and transfers it into a railway tank car that carries the liquid to the 200 West Area Tank Farms for processing and disposal. [See WHC-EP-0145, Section 1.4.2 (WHC 1988).] In 1990, only the wastes from the 107-N were handled at this facility.
4. 1310-N Radioactive Chemical Waste Storage Facility--The 1310-N Facility is used to temporarily store radioactive waste solution used in the internal decontamination of the N Reactor.

After cooling and neutralization, the solution subsequently is transferred through underground piping to the 1314-N Liquid Waste Loadout Facility. This facility has not received decontamination solution since February 1987.

5. 107-N Fuel Storage Basin Recirculation Facility--The 107-N Facility provides for N Reactor's irradiated fuel storage basin water recirculation and necessary filtration and demineralization to reduce radioactive effluent discharges to the 1325-N LWDF. Ion exchange system regeneration effluent and sand filter backwash water are transferred through underground piping to the 1314-N Liquid Waste Loadout Facility. The entire inventory of irradiated fuel elements in the 100 N fuel storage basin was transferred to the 100-KE/KW fuel storage basins in December 1989.
6. 1304-N Emergency Dump Tank--The 1304-N Emergency Dump Tank (EDT) is a 1,300,000-gal-capacity steel-walled vessel. In the extremely unlikely event that the thermally hot, pressurized reactor primary coolant system could have been dumped rapidly, this tank would have provided the necessary quenching to prevent the coolant from flashing to steam. A constant volume of 680,000 gal of unheated water was maintained in the tank. Because of small leakage in the primary coolant system dump valves, the quench water normally contained a small inventory of radioactive materials. As part of the plant configuration for cold standby, this tank was drained in May 1990.
7. 166-N Fuel Oil Storage Facility--The 166-N Facility is an above-ground, 1,135,000-gal-capacity storage tank. The tank is surrounded by an earthen berm capable of retaining approximately 2,300,000 gal. The fuel oil transfer piping is protected against corrosion. Fuel oil is used at the 100 N Area for the boiler system.
8. 1715-N Diesel Oil Storage Facility--The 1715-N Facility consists of four above-ground 105,000-gal-capacity storage tanks. The tanks are located within an earthen berm capable of retaining approximately 730,000 gal. All underground diesel oil transfer piping is protected against corrosion. Diesel oil is used at the 100 N Area to ignite the boiler systems and to fuel the diesel-driven, emergency cooling system pumps.

1.4.2 Retired 100 Area Facilities

1. 105-K East and West Fuel Storage Basins--These fuel storage basins, located in the retired 100 Areas, are 2 mi upstream of N Reactor. Irradiated N Reactor fuel elements are stored in these basins.
2. 100B, C, D, DR, F, H, KE, and KW Retired Reactor Sites--These eight retired reactors are located along the Columbia River in the northern-most portion of the Hanford Site (Figure 1-1). Several permanently deactivated liquid and solid waste disposal sites and burial grounds are associated with each facility. Characterization of the remaining radioactivity in the liquid disposal sites was

completed and reported in 1978 (*Radiological Characterization of the Retired 100 Areas*, Dorian 1978).

1.5 100 AREAS ENVIRONMENTAL SURVEILLANCE PROGRAM

1.5.1 100 N Area

Environmental surveillance at the 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. The major release pathways of N Reactor are identified in Figure 1-2.

As a result of release pathway analyses, two basic monitoring programs have been implemented at the 100 N Area. Routine effluent 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 part of the Environmental Surveillance Program. These two programs, along with portions of the PNL Environmental Surveillance Program, ensure that all environmental release pathways are monitored at one or more points.

The environmental surveillance sampling for the 100 N Area is summarized in Table 1-1. Sampling methods, frequencies, and analyses are based on characteristics of the environmental parameter being sampled.

The sampling program for the 1301-N and 1325-N LWDFs is summarized in Table 1-2. Sampling methods, frequencies, and analyses are based on characteristics of the parameter being sampled.

1.5.2 Retired 100 Areas

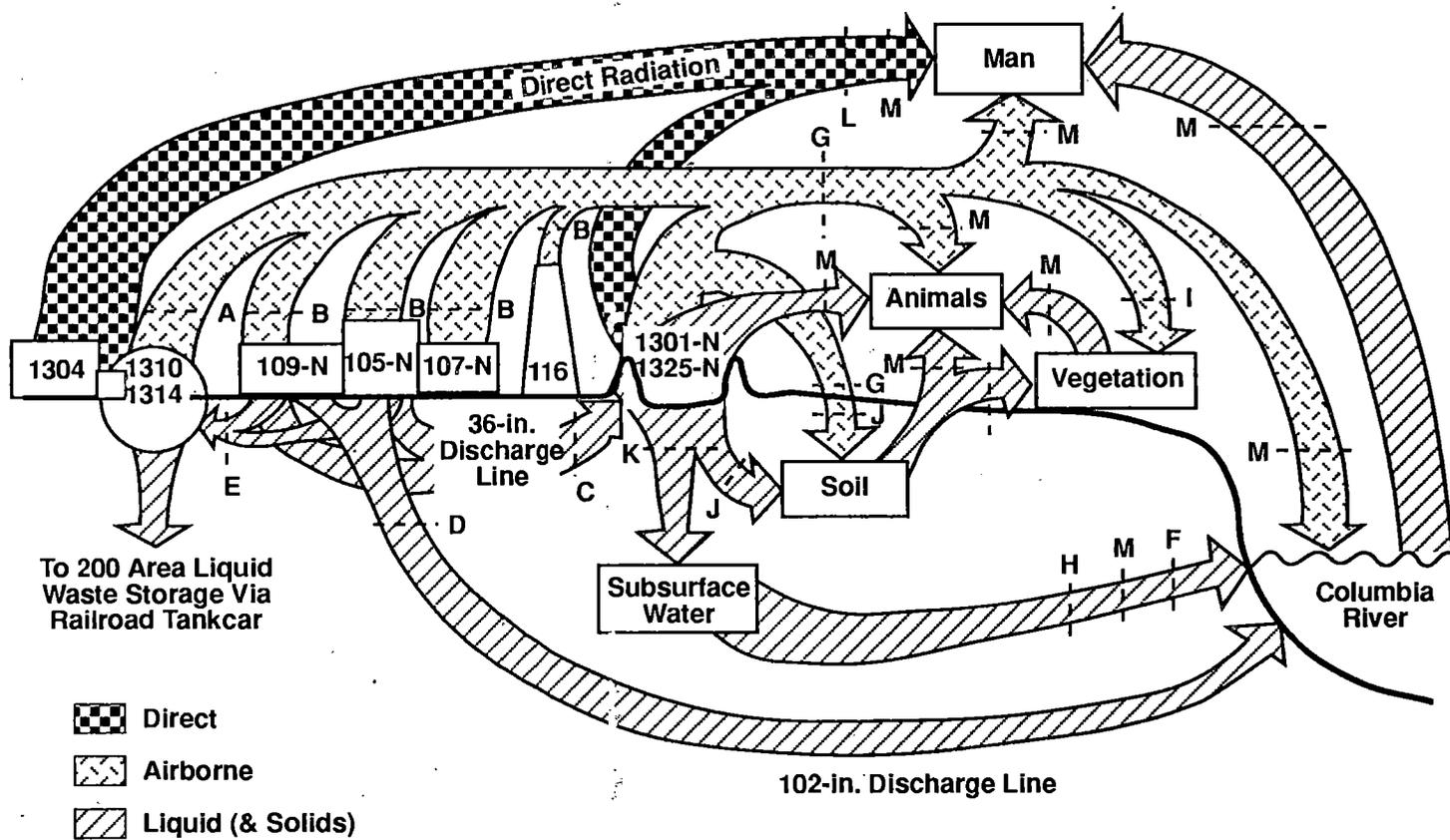
Environmental surveillance in the retired 100 Areas is conducted to monitor radionuclides detected in environmental media located near the retired reactor facilities and 100 Area burial grounds. The program consists primarily of soil and vegetation sampling in each of the retired areas. Groundwater sampling also is conducted at the 100 K Area.

The sampling program for the retired 100 Areas is summarized in Table 1-3. Sampling methods, frequencies, and analyses are based on characteristics of the environmental parameter being sampled.

Surface 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 at the 100 N Area. Soil samples consisting of 150 g each were collected from the top 2.5 cm of the soil surface. Vegetation samples of 500 g each were collected from the growing portions of perennial vegetation. Gray rabbitbrush (*Chrysothamnus nauseosus*) was the predominant species sampled.

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-  Direct
-  Airborne
-  Liquid (& Solids)

Environmental Monitoring Programs

Effluent Release Program

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

Environmental Surveillance Program

- G Continuous air samples
- H Groundwater samples
- I Vegetation samples
- J Soil samples
- K Sediment samples
- L Direct radiation measurements
- M Pacific Northwest Laboratories Environmental Program

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Figure 1-2. Major Radiological Release Pathways Related to 100 N Area Facilities.

Table 1-1. Summary of the Westinghouse Hanford Company Environmental Surveillance Program for the 100 N Area.

Sample	Sampling method	Number of sample locations	Frequency	Analyses
Air	Low-volume continuous sampler with particle filter and charcoal bed	3	Every 4 wk	Gamma-emitting radionuclides
Groundwater	Well samples (4-L) provided by PNL	32	Quarterly	Gamma-emitting radionuclides, strontium, and tritium
Groundwater	Well samples (1-qt)	11	Dependent on well	Oil and grease
Surface soil	Composite sample of about 150 g dry weight	12	Annually	Gamma-emitting radionuclides, strontium, and plutonium
Vegetation	Composite sample of about 500 g dry weight	20	Annually	Gamma-emitting radionuclides, strontium, and plutonium
Direct radiation	TLD-400 Dosimeters (CaF ₂ :Mn matrix)	41	Quarterly	Dose rate and integrated dose
Direct radiation (Columbia River shoreline)	Dose rate using hand-held survey instrument	94	Annually	Dose rate

PNL = Pacific Northwest Laboratory.
 TLD = thermoluminescent dosimeter.

Table 1-2. Summary of the Westinghouse Hanford Company Liquid Waste Disposal Facilities Sampling Program.

Sample	Sampling method	Number of sample locations	Frequency	Analyses
Air	Low-volume continuous sampler with particle filter and charcoal bed	2	Every 4 wk	Gamma-emitting radionuclides
Surface soil	Composite sample of about 150 g dry weight	5	Annually	Gamma-emitting radionuclides, strontium, and plutonium
Vegetation	Composite sample of about 500 g dry weight	5	Annually	Gamma-emitting radionuclides, strontium, and plutonium
1325-N LWDF sediment	Dip samples of bottom sediment	12	Annually	Gamma-emitting radionuclides, and strontium
Direct radiation	Dose rates using hand-held survey instrument	80	Annually	Dose rate

NOTE: The monitoring parameters listed in Table 1-2 for the liquid waste disposal facility (LWDF) sampling program will be included in their respective sections, as listed in the contents. The exception to this listing will be the LWDF sediment sampling discussion in Chapter 6.0.

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Table 1-3. Summary of the Westinghouse Hanford Company Environmental Surveillance Program for the Retired 100 Areas.

Sample	Sampling method	Number of sample locations	Frequency	Analyses
Surface soil	Composite sample of about 150 g dry weight	20	Annually	Gamma-emitting radionuclides, strontium, and plutonium
Vegetation	Composite sample of about 500 g dry weight	20	Annually	Gamma-emitting radionuclides, strontium, and plutonium
Groundwater	Well samples (4-L) provided by PNL*	4	Quarterly	Gamma-emitting radionuclides and tritium

NOTE: The monitoring parameters listed in Table 1-3 for the retired 100 Areas sampling program will be included in their respective sections, as listed in the contents.

*Pacific Northwest Laboratory.

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2.0 AMBIENT AIR MONITORING

Air sampling provides a means of monitoring radionuclides released to the air from N Reactor facilities. The 100 N Area environmental air sampling stations are shown in Figure 2-1. Tables C-1 through C-6 list the radionuclide concentrations detected in the 100 N Area air samples for the reporting period.

Air samples were collected with continuously operating low-volume sample pumps. Ambient air was drawn through a 1 ft³/min orifice into a stainless steel sample cartridge containing a 47-mm millipore filter and a bed of activated charcoal to collect halogens. The sample cartridges were changed approximately every 4 wk and analyzed for gamma-emitting radionuclides at the Westinghouse Hanford radioanalytical laboratory located in the 105-N Reactor Building until its closure in the fall of 1990. Air samples collected during the remainder of the year were not analyzed. Air sample analysis resumed in February 1991.

In previous years, comparative data of airborne concentrations of ¹³¹I were presented in this report to provide simplified trend analysis of this contaminant. However, with the shutdown of N Reactor in January 1987, ¹³¹I concentrations in the air have been reduced to below detection limits and continued trend charting of this radionuclide is no longer warranted. Until such time as analysis results dictate otherwise, only ⁶⁰Co results will be presented in graph form for this report. The airborne concentrations of radionuclides of concern will continue to be reported in tabular form in Appendix C.

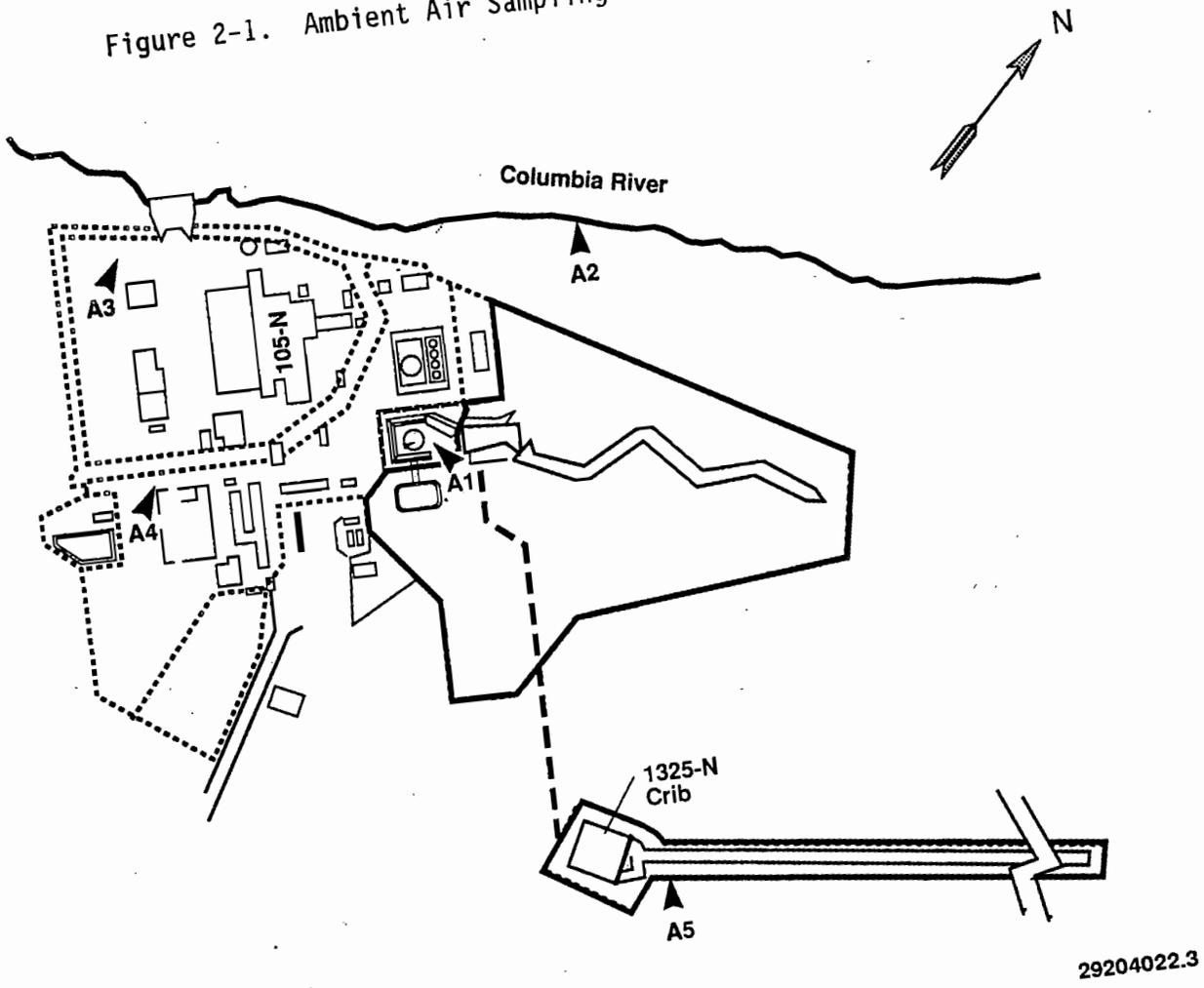
Average radionuclide concentrations detected in the 100 N Area air samples are listed in Table C-1. All averages calculated from two or more values include the standard deviation to indicate the distribution of the data. Minimum and maximum concentrations also are shown to indicate the sample range. All radionuclide concentrations were well below the DOE DCG.

The DCGs are shown for comparison at the bottom of the table. These concentration guides are applicable at the point of actual exposure to members of the public. The radionuclides identified in the 100 N Area ambient air samples are near or below detection limits. Average concentrations of ⁶⁰Co detected in the 100 N Area air samples from 1982 to 1990 are presented in Figure 2-2. Ambient air monitoring is conducted for the 1301-N LWDF at a location near the inlet end of the facility (station A1). Average concentration of ⁶⁰Co detected near the 1301-N Facility from 1982 to 1990 are presented in Figure 2-3.

An additional air sampling station was put into service during November 1989. This station is located near the 1325-N LWDF. The sample results indicate airborne radionuclide concentrations at or near detection limits.

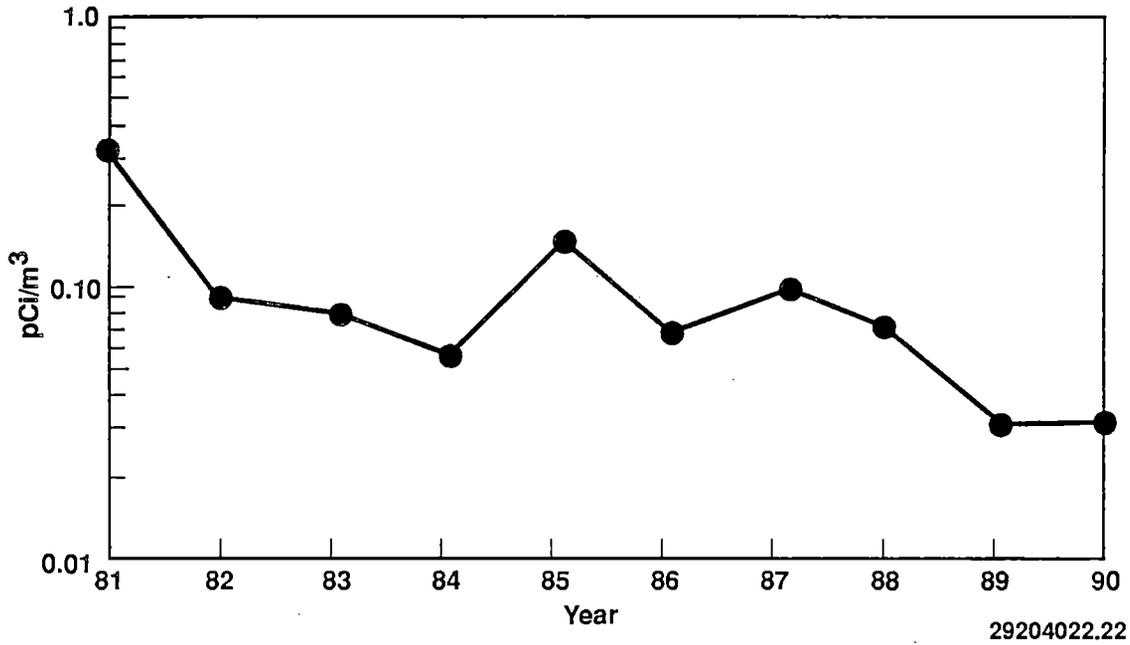
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Figure 2-1. Ambient Air Sampling Locations at 100 N Area.



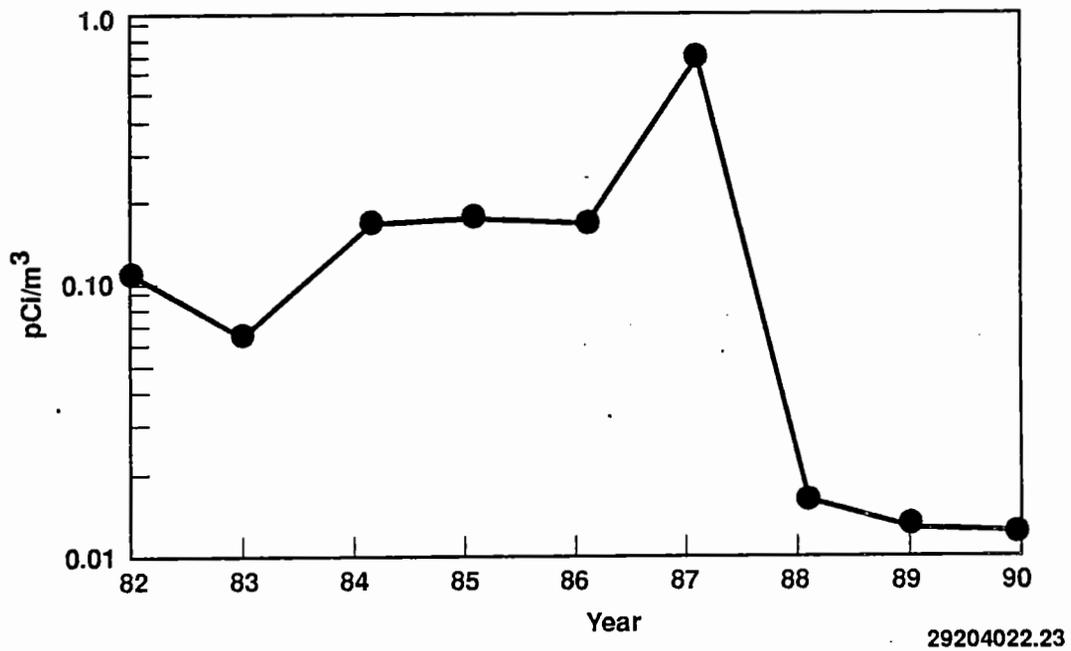
9 2 1 2 5 7 9 1 8 1 6

Figure 2-2. Average Concentrations of ⁶⁰Co Detected in 100 N Area Ambient Air from 1981 to 1990.



9 2 1 2 5 7 9 1 8 1 7

Figure 2-3. Average Concentrations of ^{60}Co Detected in 1301-N Air Samples from 1982 to 1990.



9 2 1 2 5 7 9 1 8 1 8

3.0 GROUNDWATER MONITORING

3.1 RADIOLOGICAL GROUNDWATER SAMPLING--100 N AREA

The 100 N Area groundwater sampling is performed to monitor radionuclide concentrations in the groundwater beneath the 1301-N LWDF, the 1325-N LWDF, and other 100 N Area facilities. Groundwater samples also are collected to monitor the integrity of underground piping, basins, and tanks. The locations of the groundwater sampling wells are shown in Figure 3-1. Samples of groundwater (4-L) were collected by PNL and analyzed for gamma-emitting radionuclides, tritium, and $^{89,90}\text{Sr}$.

Radionuclide concentrations detected in the quarterly groundwater samples are presented in Tables D-1 through D-7. The samples contain radionuclides attributable to liquid effluents discharged to the 1301-N and 1325-N LWDF. Radionuclides that are not retained in the soil column beneath the LWDFs ultimately are released to the Columbia River via the N Springs shoreline. This discharge is monitored at Well N-8T. The entire length (about 2 mi) of the shoreline between the 100 N and 100 D/DR Areas also is characterized annually. Detailed discussions of these sampling results are reported in annual effluent release reports and N Springs characterization reports, respectively. The only radionuclide with concentrations above the DCG at the N Springs is ^{90}Sr .

The average concentrations of ^{60}Co , ^{90}Sr , and ^{131}I detected in Well N-2 from 1981 to 1990 are presented in Figure 3-2. These radionuclides are useful as indicators of groundwater contamination and migration. Figure 3-3 shows average concentrations of the same radionuclides detected in Well N-33 from 1985 through 1990. These two wells were selected for comparison because of their positions relative to the 1301-N and 1325-N LWDFs.

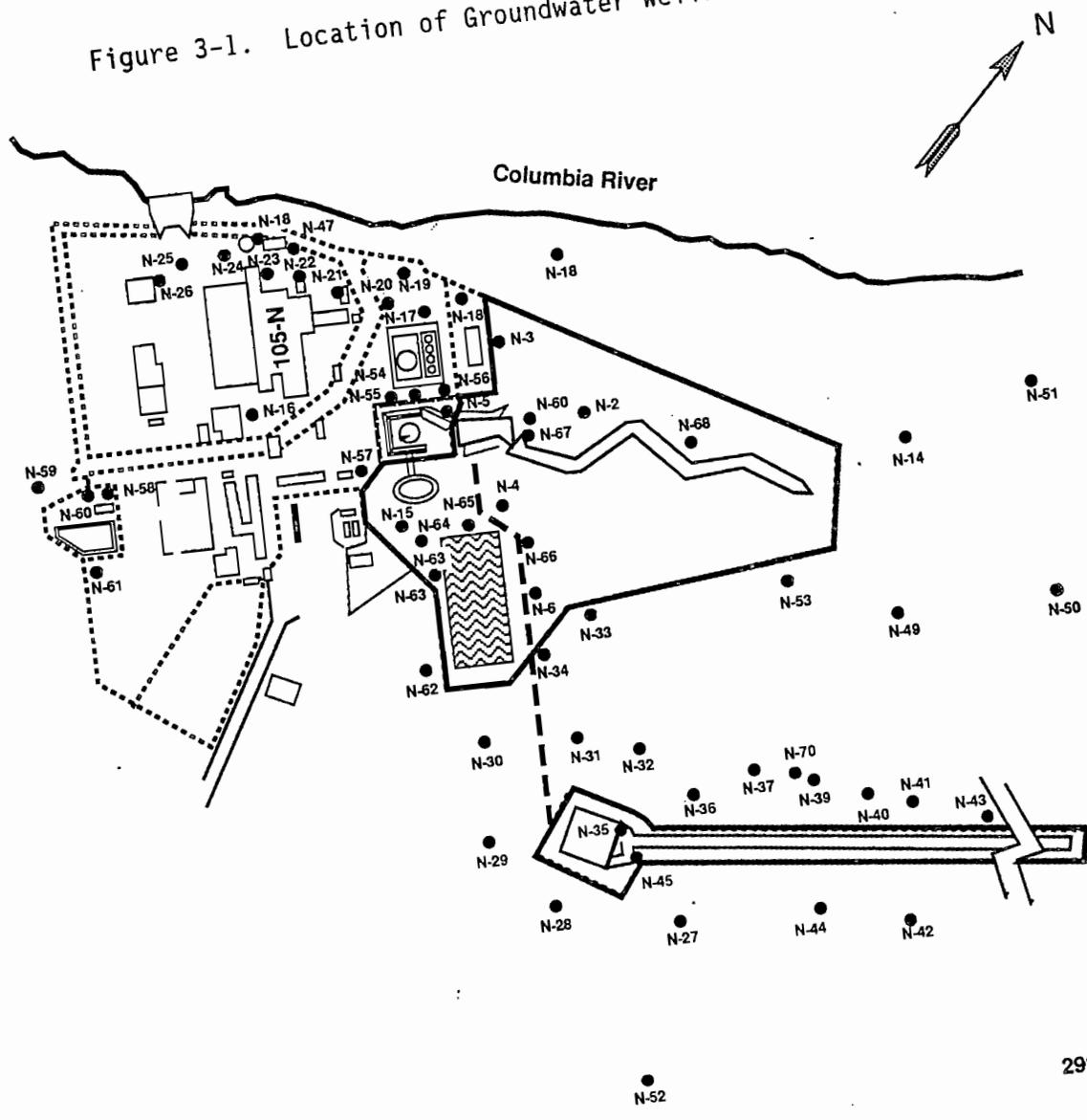
Concentrations of ^{60}Co and ^{131}I decreased in Well N-2 for this reporting period. This is to be expected because liquid effluent no longer is discharged to the 1301-N LWDF. Rather, the 1325-N LWDF has been receiving this effluent since September 1985. The minor increase in average ^{90}Sr concentrations (slightly higher than the DCG) in Well N-2 is attributable to the residual inventory of this radionuclide in the soil column beneath the 1301-N LWDF. The trend depicted in Well N-33 showed a continued decrease in concentrations. These reduced values are attributable to the decreased liquid effluent discharged to the 1325-N LWDF associated with the lay-up status of N Reactor. Average ^{90}Sr concentrations in Well N-33 remained below the DCG in 1990, and ^{131}I concentrations were below analytical detection limits. Cobalt-60 concentrations decreased during this period, with the 1990 average value falling below the historic range of Well N-33.

3.2 OIL AND GREASE SAMPLING--100 N AREA

Samples of groundwater (1 qt) were collected on a variable frequency from several oil detection wells. After organoleptic 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.

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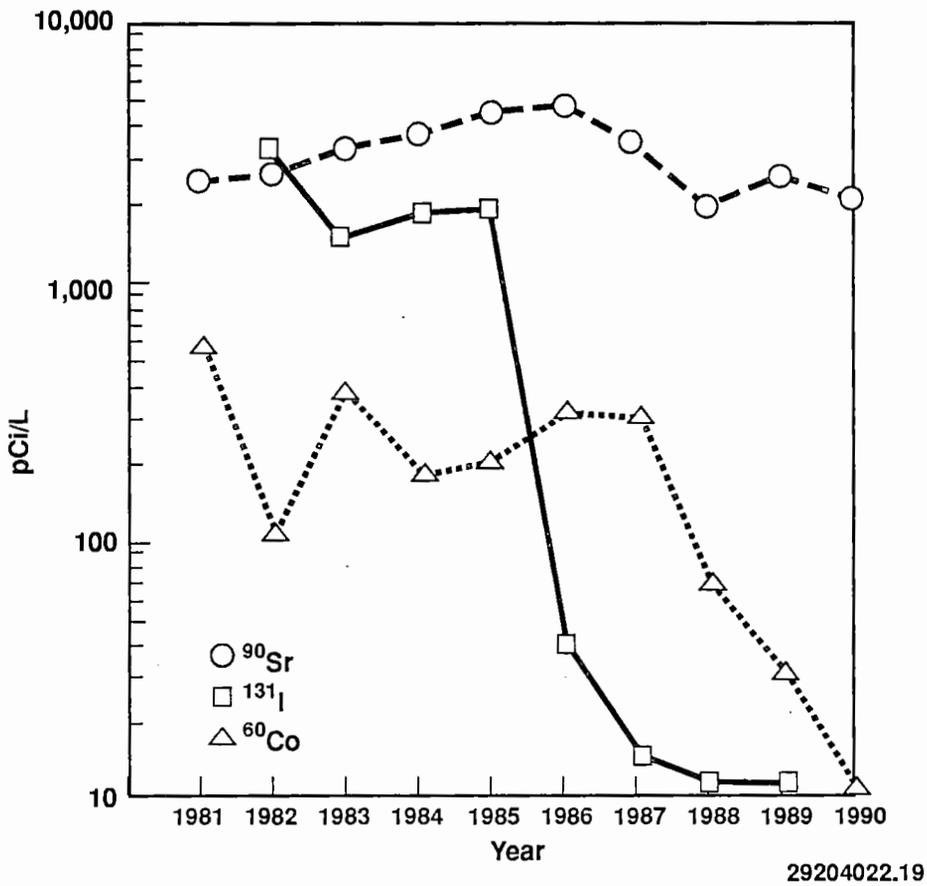
Figure 3-1. Location of Groundwater Wells at 100 N Area.



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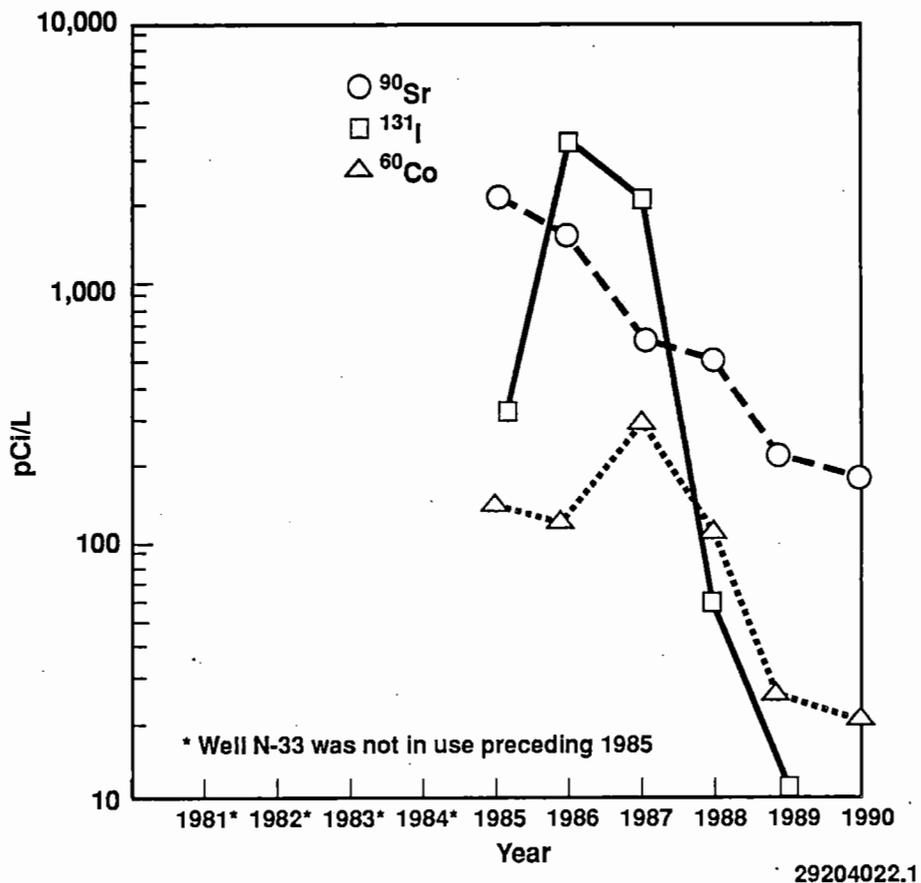
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Figure 3-2. Average Concentration of ^{60}Co , ^{90}Sr , and ^{131}I Detected in Well N-2 from 1981 through 1990.



9 2 1 2 5 7 9 1 8 2 1

Figure 3-3. Average Concentration of ^{60}Co , ^{90}Sr , and ^{131}I Detected in Well N-33 from 1985 through 1990.



9 2 1 2 3 7 9 1 8 2 2

During routine sampling of the oil and grease detection wells in late January, an oil layer was discovered in Well N-18. Operations isolated the diesel fuel lines in the area and proceeded to hydrotest them. Results of the testing indicated no line ruptures, and the inventory in the storage tanks was accounted for.

One possible source of the oil was residual oil from past leaks in the area that was driven hydraulically from a leaking fire protection water line located upgradient of Well N-18.

None of the other nearby wells had any indication of oil, and no oil was released to the river. Samples then were collected daily and visually inspected. The well was fitted with a "skimmer" pump to retrieve the oil on March 1 and was pumped daily until April 1, 1990.

Elevated levels of oil and grease were detected in Well N-16 during late October and early November 1990. This well is located near the 184-N diesel oil day tank, which experienced occasional leaks during its operational lifetime. It is believed that heavier-than-normal rains during this period caused the residual contaminants in the affected vadose zone to be driven hydraulically into the groundwater. As the rains diminished, oil and grease concentrations at this well also decreased.

Average oil and grease concentrations detected in the 100 N Area groundwater samples are presented in Table 3-1. Most samples contained concentrations of oil and grease less than or near the level of detection. Table D-6 lists the oil and grease concentrations detected in 100 N Area groundwater monitoring wells.

3.3 RADIOLOGICAL GROUNDWATER SAMPLING--100 K AREA

A leak was detected in the 105-KE Reactor Fuel Storage Basin during the 1970's. The leak was repaired in 1980 and water levels in the basin now are monitored continuously and reveal no detectable leakage. In addition, Westinghouse Hanford samples four groundwater wells located near the 105-KE Reactor Building to provide detection of leakage from the storage basin.

Samples (4-L) were collected by PNL and analyzed for gamma-emitting radionuclides and for tritium. The sampling locations are shown on Figure 3-4. Radionuclide concentrations detected in the 100 K Area groundwater samples are presented in Tables D-1 through D-5. The concentrations of ^{125}Sb detected in samples from wells K-27 and K-28 indicate residual contamination from past leaks of storage basin water.

Average radionuclide concentrations detected in Well K-27 from 1982 through 1990 are presented in Table D-7. The data indicate that concentrations of ^{125}Sb (2.7-yr half-life) in Well K-27 have stabilized.

Tritium concentrations detected in Well K-30 have exceeded those of any other 100 Area groundwater monitoring well since 1982. The range of tritium concentrations at this well is large for this period, with the 1990 results showing a increase of approximately 14%. Well K-27 showed a large increase in

tritium concentrations during 1990. Wells K-28 and K-29, located between K-27 and K-30, showed relatively stable concentrations. The explanation for these changes is not known.

The most probable source of tritium in the K Area wells is from the nearby 115-KE crib (Figure 3-4), which received significant amounts of tritium from the dryer room condensate in the 100 KE Reactor (operated from 1955 to 1971). Table 3-2 lists average tritium concentrations in each of these 100 K Area wells from 1982 through 1990.

3.4 RESOURCE CONSERVATION AND RECOVERY ACT GROUNDWATER MONITORING--100 N AREA

In the 100 Areas, Westinghouse Hanford's Geosciences Group administers the *Resource Conservation and Recovery Act* (RCRA) groundwater monitoring program. The results of this monitoring program are published quarterly and annually.

9 2 1 2 5 7 9 1 8 2 4

Table 3-1. Oil and Grease Concentrations Detected in 100 N Area Groundwater (mg/L).

Well*	Number of Samples	Maximum	Minimum	Average	Standard Deviation
N-16	11	360.0	0.9	46.9	103.2
N-17	10	30.3	<0.5	4.5	8.6
N-18	6	15,290	1,309	5,887	4,804
N-19	11	1.6	<0.6	1.0	0.3
N-20	11	1.9	<0.6	1.1	0.4
N-21	9	2.2	0.5	0.9	0.5
N-22	1	1.1	1.1	1.1	0.0
N-23	20	16.9	<0.6	1.9	3.5
N-24	16	1.8	<0.6	1.1	0.3
N-25	27	15.8	<0.6	1.7	2.8
N-26	20	12.2	<0.6	1.6	2.5

*Locations identified in Figure 3-1.

9 2 1 2 5 7 9 1 8 2 5

Table 3-2. Tritium Concentrations Detected in 100 KE Area Groundwater (pCi/L) from 1982 through 1990.

Year	Wells			
	K-27	K-28	K-29	K-30
1982	4.5 E+03	3.4 E+03	8.5 E+03	8.8 E+05
1983	3.1 E+03	2.1 E+03	2.0 E+04	6.8 E+05
1984	3.0 E+03	2.5 E+03	4.9 E+04	4.3 E+05
1985	1.8 E+03	3.6 E+03	4.9 E+04	4.2 E+05
1986	1.5 E+03	3.1 E+01	3.7 E+04	6.4 E+05
1987	1.5 E+03	4.2 E+03	9.9 E+03	8.3 E+05
1988	2.3 E+03	3.2 E+03	1.4 E+04	1.2 E+06
1989	9.2 E+04	2.3 E+03	1.0 E+04	6.8 E+05
1990	7.8 E+04	2.0 E+03	7.2 E+03	7.8 E+05

Note: derived concentration guides = 2.0 E+06 pCi/L.
Locations identified in Figure 3-4.

9 2 1 2 5 7 9 1 8 2 6

9 2 1 2 5 7 9 11 8 2 7

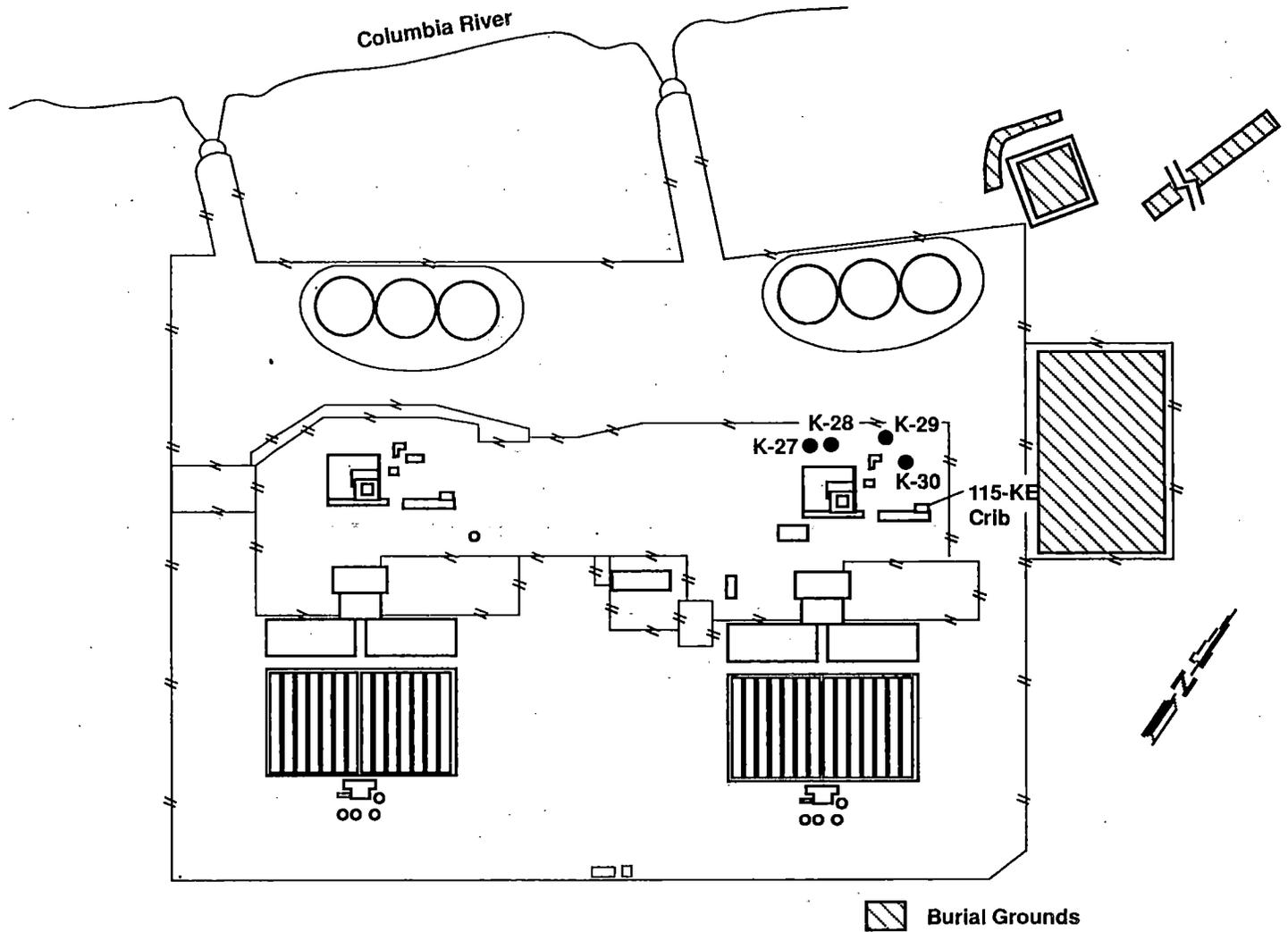


Figure 3-4. Location of Groundwater Wells at 100 K Area.

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9 2 1 2 5 7 9 1 3 2 9

4.0 SOIL AND VEGETATION MONITORING

4.1 SOIL SAMPLING

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

Surface soil samples of about 150 g each were collected from the top 2.5 cm of the soil surface at the locations shown in Figure 4-1. Each sample was sent to International Technology Analytical Services - Richland Laboratory (ITAS-RL) for analysis.

4.1.1 100 N Area

Five of the surface soil samples (N1 through N5) were collected at locations near the 1301-N LWDF. Radionuclides contained in the LWDF effluent were detected in the samples. As the data indicate, the concentrations show a large degree of variance depending on sample location. In general, the samples collected nearer the 1301-N crib portion of the facility contained relatively higher concentrations of the contaminants. Average radionuclide concentrations detected in the 100 N Area surface soil from 1980 through 1990 in locations near the 1301-N LWDF (sites N1 through N5) are presented in Table 4-1. Average radionuclide concentrations detected in the 100 N Area surface soil from 1980 through 1990 in locations N6 through N12 are presented in Table 4-2.

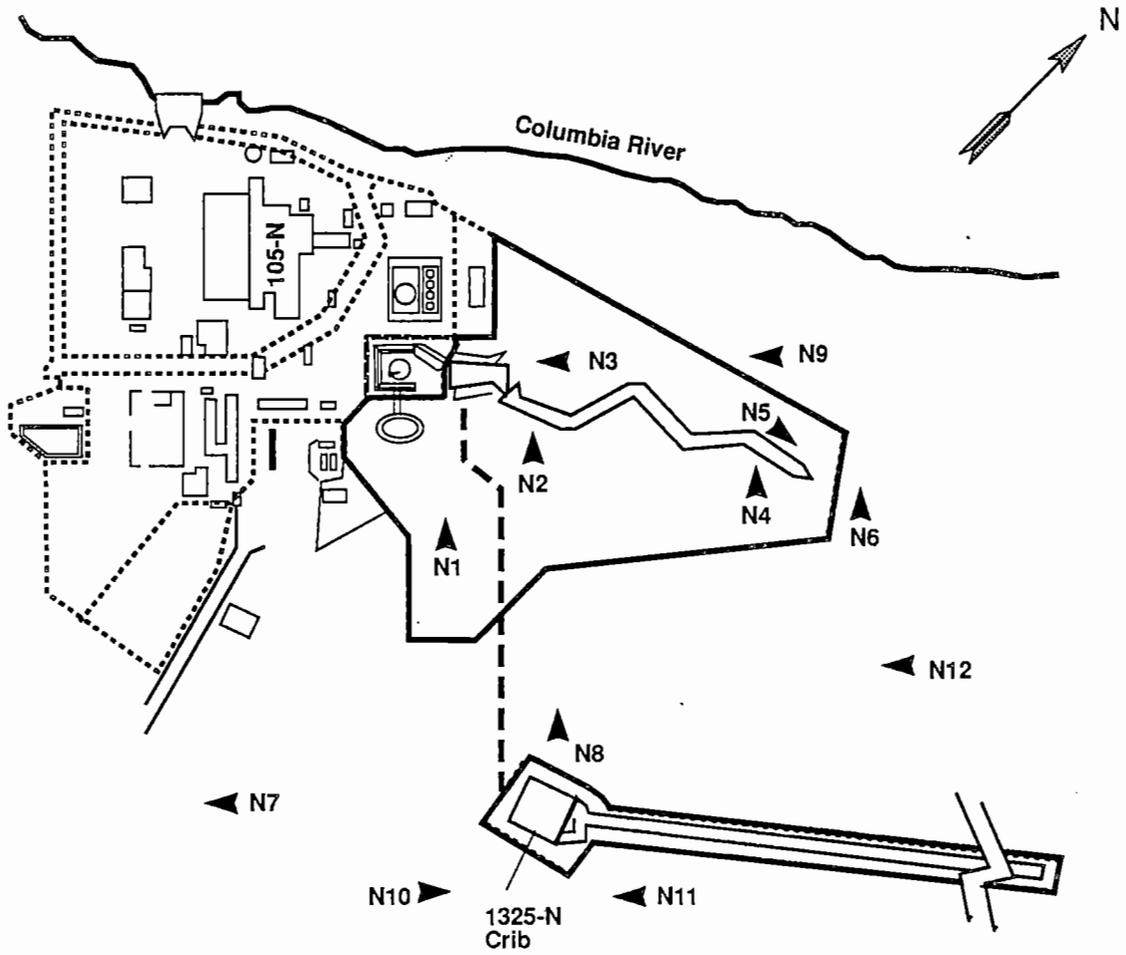
Radionuclide concentrations detected in the 100 N Area surface soil are presented in Tables E-1 and E-2. Average radionuclide concentrations for the Hanford Site and offsite, as reported by PNL for 1989, are included for comparison. The 100 N values are comparable to Hanford Site averages.

4.1.2 Retired 100 Areas

Environmental surveillance in the retired 100 Areas is conducted to monitor radionuclides detected in environmental media located near the retired reactor sites and waste disposal facilities. The program consists primarily of soil and vegetation sampling in each of the retired areas. Sample locations were chosen immediately adjacent to retired waste disposal facilities in a manner to maximize the potential for detecting contamination. Environmental samples of surface soil collected near the retired 100 Area reactor facilities had not been analyzed at the time of this reporting. These results will be issued as an addendum once they become available. Surface soil and vegetation sampling locations for the retired 100 Areas are presented in Figures 4-2 through 4-6.

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Figure 4-1. Surface Soil Sampling Locations at 100 N Area.



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9 2 1 2 3 7 9 1 8 3 0

Table 4-1. Average Radionuclide Concentrations (pCi/g) Detected in Soil Samples Near the 1301-N Liquid Waste Disposal Facility from 1980 through 1990.

Year	⁵⁴ Mn	⁶⁰ Co	⁹⁰ Sr	¹³⁷ Cs	²³⁸ Pu	^{239,240} Pu
1980	2.5 E+00	1.3 E+01	3.5 E-01	4.1 E+00	NR	2.5 E-02
1981	6.6 E+00	4.0 E+00	7.0 E-01	6.1 E+00	NR	4.4 E-02
1982	6.6 E-01	6.3 E+00	2.7 E-01	2.7 E+00	NR	1.8 E-02
1983	4.1 E-01	5.4 E+00	1.3 E+00	3.8 E+00	NR	4.3 E-02
1984	1.8 E-01	2.8 E+00	2.1 E-01	1.1 E+00	NR	1.7 E-02
1985	1.5 E+00	1.3 E+01	6.5 E-01	3.9 E+00	NR	3.2 E-02
1986	1.6 E-01	4.5 E+00	2.2 E-01	2.5 E+00	NR	1.7 E-02
1987	3.2 E-01	5.1 E+00	3.4 E-01	1.6 E+00	5.4 E-03	2.2 E-02
1988	1.4 E-01	7.8 E+00	3.5 E-01	2.0 E+00	2.3 E-03	1.7 E-02
1989	6.5 E-02	2.3 E+00	1.5 E-01	5.0 E-01	6.4 E-03	4.0 E-02
1990	NR	4.7 E+00	3.2 E-01	1.7 E+00	4.6 E-03	3.5 E-02

NR = Not reported.
 Note: Table E-1 lists the results of the 1989 analysis of 1301-N Liquid Waste Disposal Facility surface soil samples.

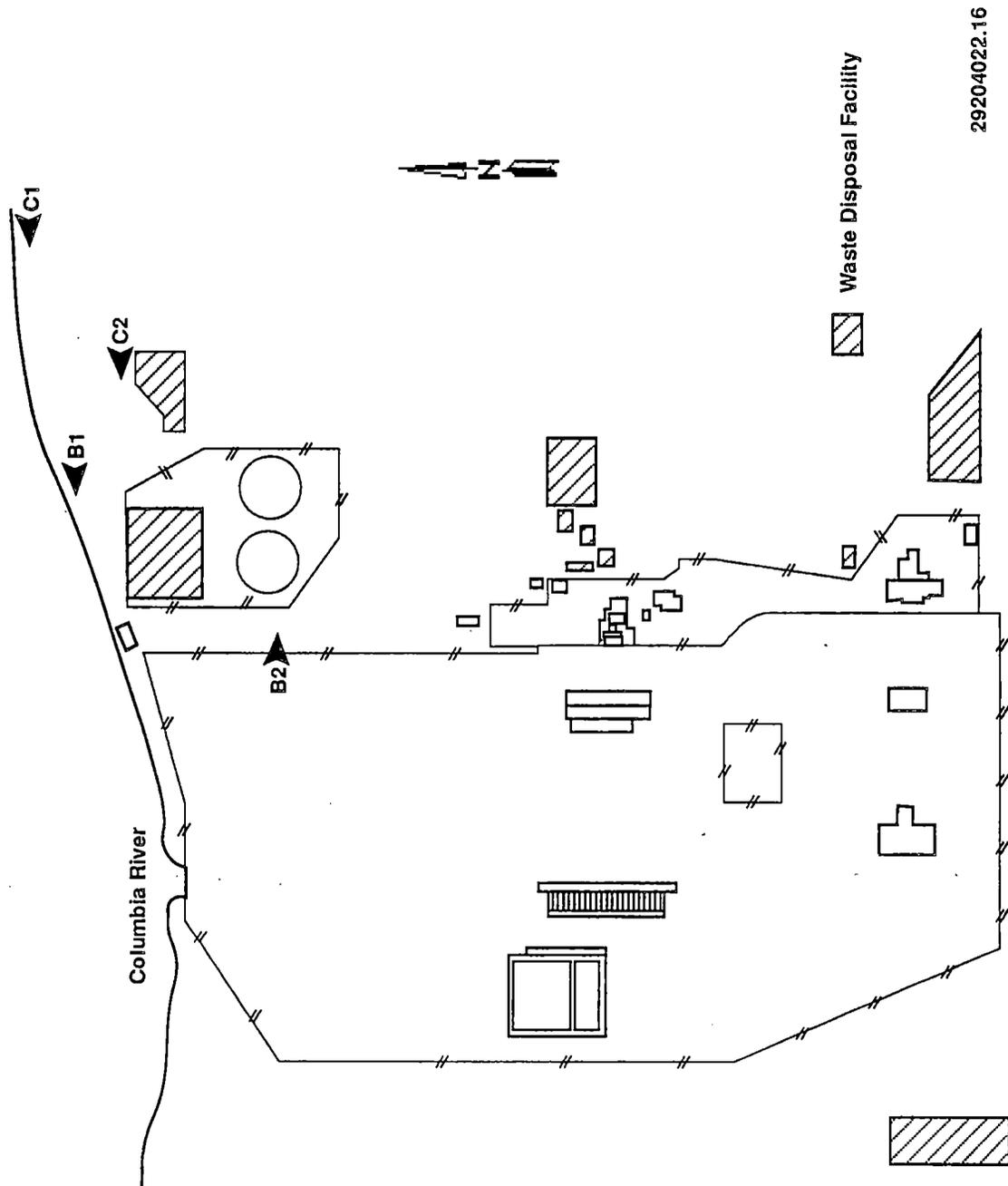
Table 4-2. Average Radionuclide Concentrations (pCi/g) Detected in 100 N Area Surface Soil Samples from 1980 through 1990.

Year	⁵⁴ Mn	⁶⁰ Co	⁹⁰ Sr	¹³⁷ Cs	²³⁸ Pu	^{239,240} Pu
1980	2.4 E-01	8.5 E-01	1.8 E-01	5.0 E-01	NR	1.8 E-02
1981	1.6 E-01	1.3 E+00	2.1 E-01	1.0 E+00	NR	1.1 E-02
1982	1.3 E-01	1.6 E+00	9.9 E-02	3.4 E-01	NR	5.0 E-03
1983	2.1 E-01	2.7 E+00	2.9 E-01	4.4 E-01	NR	8.5 E-03
1984	NR	8.8 E-01	2.8 E-01	6.2 E-01	NR	1.4 E-02
1985	1.2 E-01	1.2 E+00	1.3 E-01	5.2 E-01	NR	1.3 E-02
1986	1.1 E-01	4.1 E-01	8.3 E-02	5.0 E-01	NR	8.2 E-03
1987	9.1 E-02	4.1 E-01	1.1 E-01	3.9 E-01	1.1 E-03	6.7 E-03
1988	6.7 E-02	3.4 E-01	1.6 E-01	3.9 E-01	4.5 E-04	9.5 E-03
1989	<4.2 E-02	1.4 E-01	2.1 E-01	1.3 E-01	1.1 E-03	1.3 E-02
1990	NR	3.0 E-01	1.2 E-01	4.4 E-01	6.7 E-04	1.0 E-02

NR = Not reported.
 NOTE: Table E-2 lists the results of the 1990 analysis of 100 N Area surface soil samples.

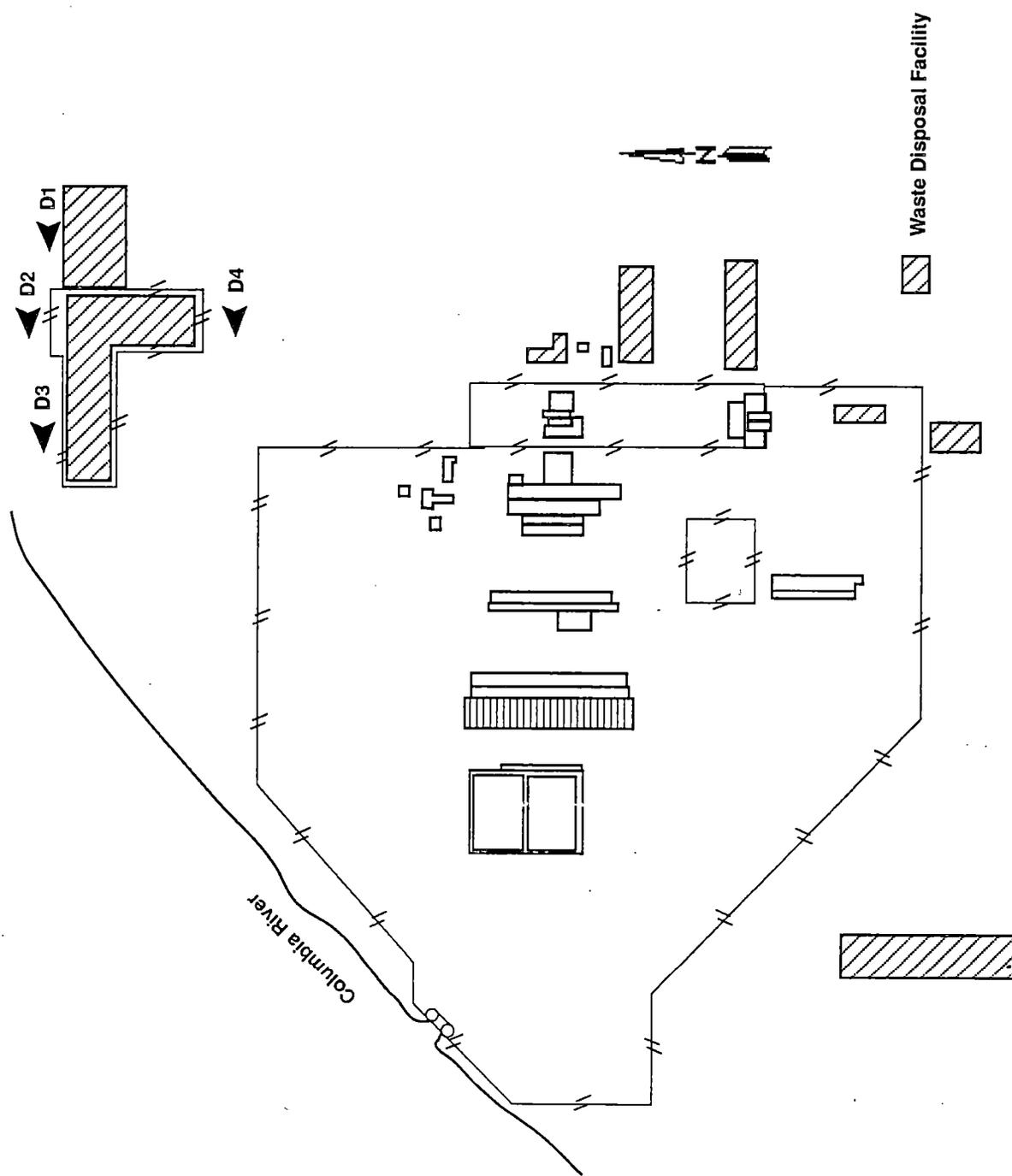
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Figure 4-2. Soil and Vegetation Sampling Locations at 100 B/C Area.



9 2 1 2 5 7 9 1 8 3 2

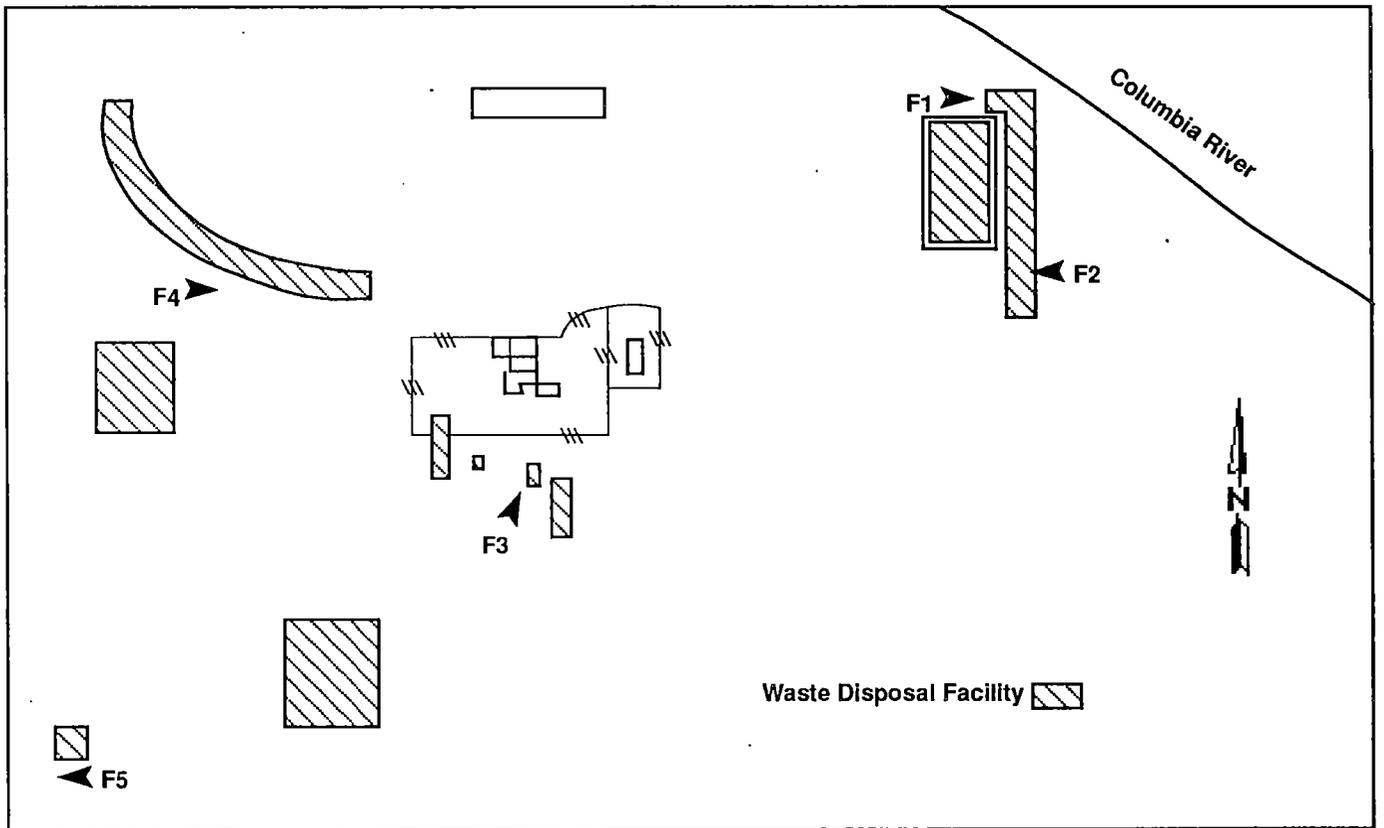
Figure 4-3. Soil and Vegetation Sampling Locations at 100 D/DR Area.



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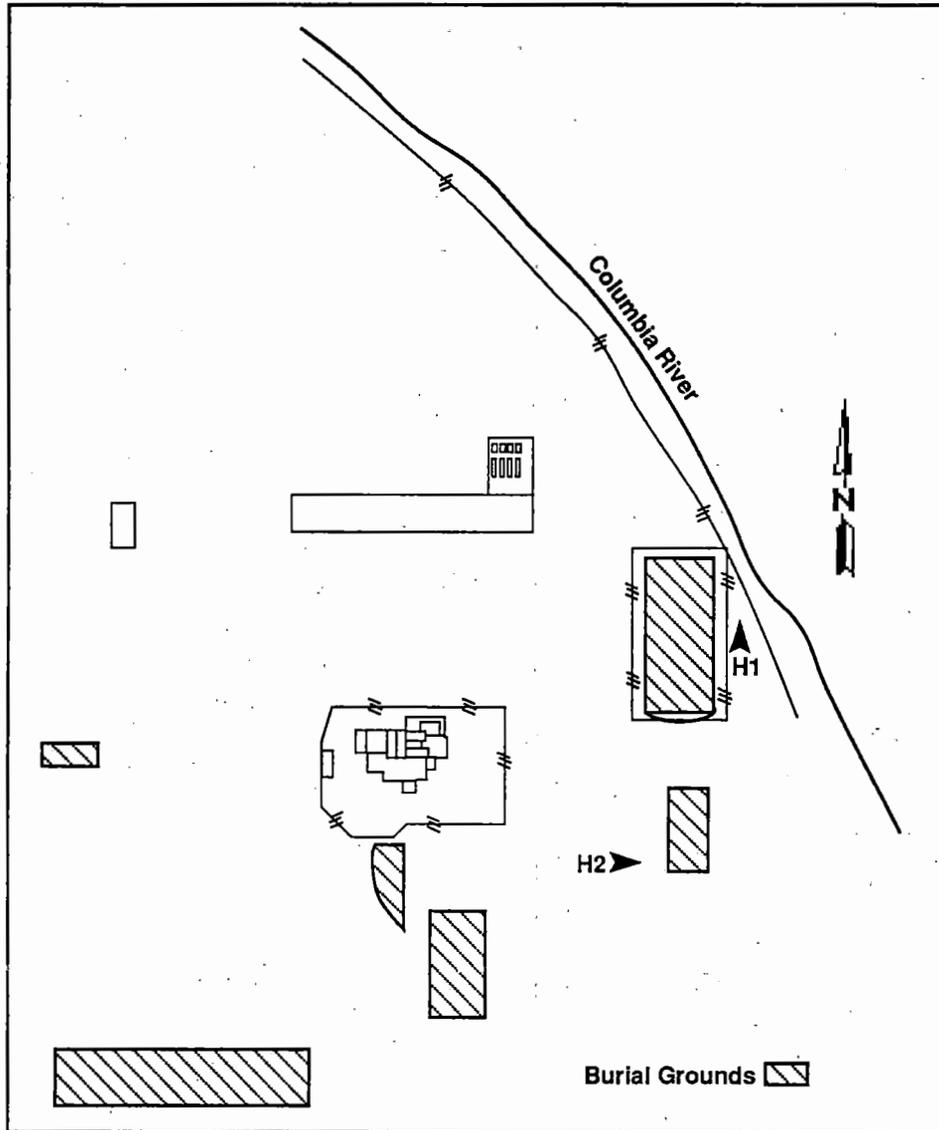
9 2 1 2 5 7 9 1 8 3 3

Figure 4-4. Soil and Vegetation Sampling Locations at 100 F Area.



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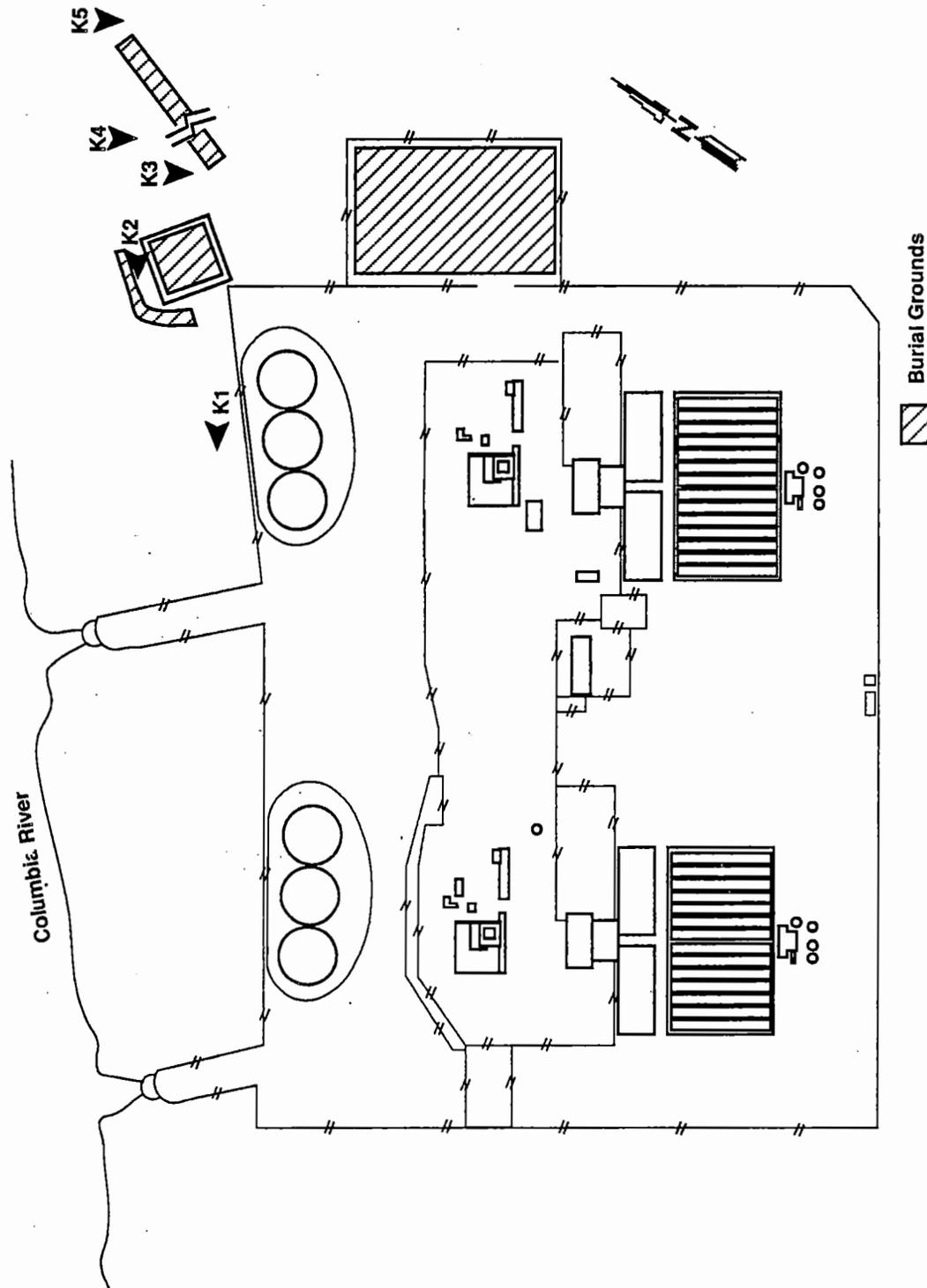
Figure 4-5. Soil and Vegetation Sampling Locations at 100 H Area.



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9 2 1 2 5 7 9 1 8 3 5

Figure 4-6. Soil and Vegetation Sampling Locations at 100 K Area.



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9 2 1 2 5 7 9 1 8 3 6

4.2 VEGETATION SAMPLING

Vegetation samples provide a means of evaluating the distribution of radionuclides deposited on vegetation from airborne releases or the uptake of radionuclides from the soil. Samples of green vegetation (about 500 g each) were collected from available perennial shrubs at the same locations from which surface soil samples were obtained (Figure 4-7). The vegetation consisted of gray rabbitbrush (*Chrysothamnus nauseosus*). All analyses were conducted by ITAS-RL.

4.2.1 100 N Area

Five of the vegetation samples (N1 through N5) were collected at locations near the 1301-N LWDF. Radionuclide concentrations detected in vegetation samples collected near the 1301-N LWDF are listed in Table E-8. Average radionuclide concentrations detected in the vegetation from 1980 through 1990 are presented in Table 4-3. The concentrations can be attributed to uptake of the radionuclides from the contaminated soil near the 1301-N LWDF.

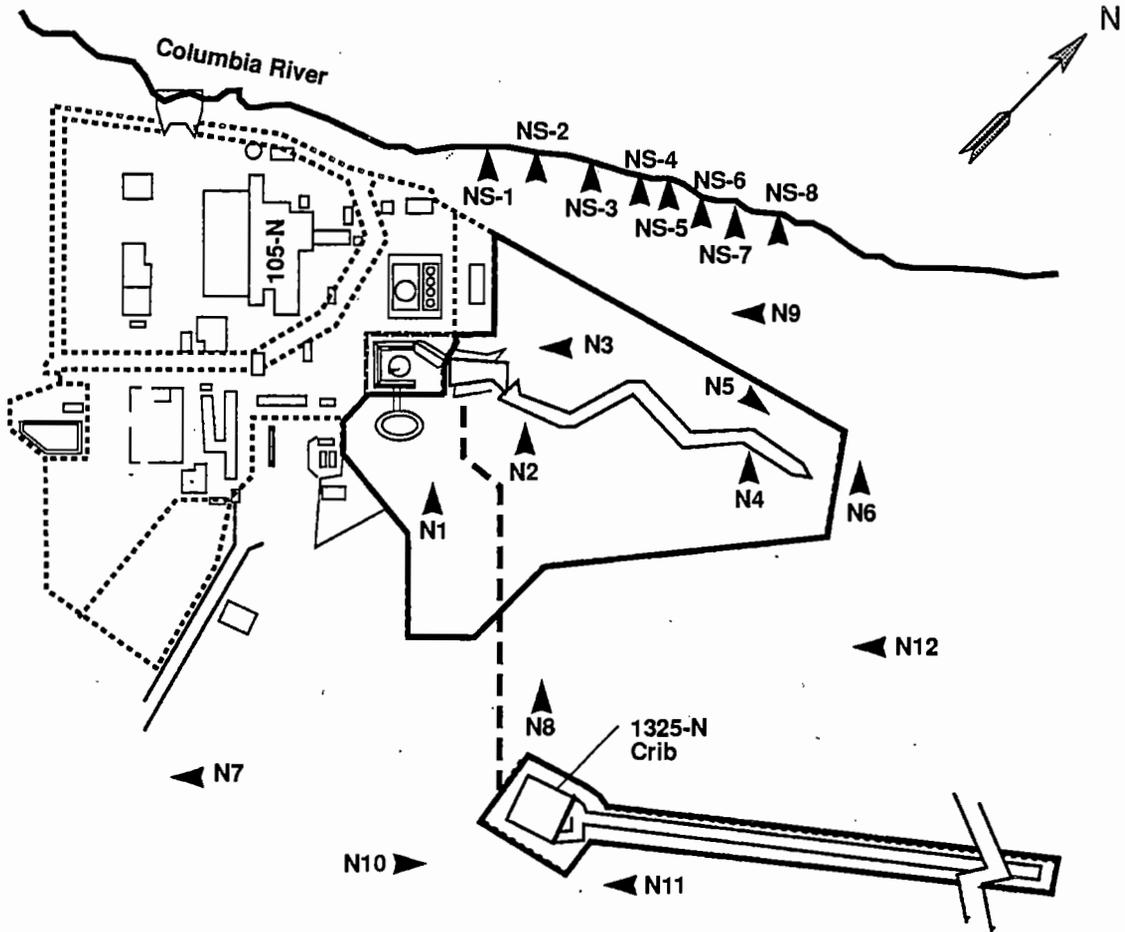
Radionuclide concentrations detected in the 100 N Area vegetation samples outside the 1301-N LWDF area are presented in Table E-9. Concentrations in 100 N Area vegetation samples were comparable to those reported for the Hanford Site average. Average radionuclide concentrations detected in 100 N Area vegetation from 1980 through 1990, from sampling sites N6 through N12, are presented in Table 4-4.

Vegetation samples collected from the 100 N Area shoreline were lost before being analyzed. For reference, average annual radionuclide concentrations detected in shoreline vegetation from 1980 through 1989 are presented in Table 4-5.

4.2.2 Retired 100 Areas

Vegetation sampling locations in the retired 100 Areas coincide with the surface soil locations shown in Figures 4-2 through 4-6. Average radionuclide concentrations detected in vegetation samples for each of the retired 100 Areas from 1980 through 1990 are presented in Tables 4-6 through 4-10. The results of the 1990 vegetation sample analysis for each sample location in the retired 100 Areas are presented in Tables E-11 through E-15. Environmental samples of vegetation collected near the retired 100 Area reactor facilities indicated no elevated levels of radionuclides when compared to the Hanford Site average concentrations.

Figure 4-7. Vegetation Sampling Locations at 100 N Area.



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9 2 1 2 5 7 9 1 6 3 8

Table 4-3. Average Radionuclide Concentrations (pCi/g) Detected in Vegetation Samples Near the 1301-N Liquid Waste Disposal Facility from 1980 to 1990.

Year	⁵⁴ Mn	⁶⁰ Co	⁹⁰ Sr	¹³⁷ Cs	²³⁸ Pu	^{239,240} Pu
1980	1.4 E+00	4.0 E+00	NR	1.1 E+00	NR	NR
1981	2.5 E+00	1.2 E+01	1.8 E+00	1.8 E+00	NR	7.1 E-03
1982	4.6 E-01	1.6 E+00	1.2 E-01	2.6 E-01	NR	2.6 E-03
1983	4.5 E-01	1.9 E+00	6.0 E-01	3.9 E-01	NR	3.2 E-03
1984	2.9 E-01	1.0 E+00	1.2 E-01	8.3 E-02	NR	8.5 E-04
1985	5.9 E-01	1.7 E+00	1.9 E+00	1.0 E-01	NR	1.5 E-03
1986	6.8 E-01	3.5 E+00	7.3 E-02	6.5 E-01	NR	2.6 E-03
1987	4.9 E-01	2.8 E+00	6.3 E-02	2.0 E-01	1.2 E-03	5.6 E-03
1988	1.5 E-01	2.0 E+00	1.2 E-01	1.3 E-01	4.3 E-04	1.7 E-03
1989	<1.1 E-01	1.3 E+00	3.8 E-02	1.5 E-01	2.8 E-04	2.0 E-03
1990	NR	1.3 E+00	3.1 E-02	1.2 E-01	2.7 E-04	1.1 E-03

NR = Not reported.

Note: Table E-8 lists the results of the analysis of 1301-N LWDF vegetation samples.

Table 4-4. Average Radionuclide Concentrations (pCi/g) Detected in 100 N Vegetation Samples from 1980 to 1990.

Year	⁵⁴ Mn	⁶⁰ Co	⁹⁰ Sr	¹³⁷ Cs	²³⁸ Pu	^{239,240} Pu
1980	4.8 E-01	1.0 E+00	NR	2.8 E-01	NR	NR
1981	1.8 E+00	2.5 E+01	5.8 E-01	7.1 E-01	NR	2.1 E-02
1982	4.9 E-01	1.5 E+00	2.0 E-01	1.3 E-01	NR	7.8 E-03
1983	3.6 E-01	1.0 E+00	2.9 E-01	9.0 E-02	NR	8.6 E-03
1984	1.3 E-01	4.6 E-01	8.1 E-02	9.0 E-02	NR	1.3 E-03
1985	3.6 E-01	1.4 E+00	5.1 E-02	1.6 E-01	NR	8.7 E-04
1986	2.6 E-01	9.5 E-01	2.2 E-01	7.9 E-01	NR	1.1 E-03
1987	1.1 E-01	7.0 E-01	2.6 E-01	9.4 E-02	1.3 E-04	5.7 E-04
1988	1.3 E-01	8.0 E-01	2.5 E-01	1.6 E-01	1.7 E-04	6.6 E-04
1989	<7.8 E-02	3.2 E-01	6.8 E-02	1.5 E-01	1.1 E-04	8.7 E-04
1990	NR	1.1 E-01	9.3 E-03	3.6 E-02	<9.6 E-05	1.7 E-04

NR = Not reported.

Note: Table E-9 lists the results of the analysis of 100 N Area vegetation samples.

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Table 4-5. Radionuclide Concentrations (pCi/g) Detected in N-Springs Vegetation Samples from 1980 to 1989.

Year	⁵⁴ Mn	⁶⁰ Co	⁹⁰ Sr	¹³⁷ Cs	²³⁸ Pu	^{239,240} Pu
1980	1.5 E-01	5.6 E+00	NR	4.4 E-01	NR	NR
1981	NR	3.3 E+00	2.0 E+02	NR	NR	3.7 E-03
1982	1.5 E-01	2.8 E+00	4.8 E+02	NR	NR	8.3 E-03
1983	7.0 E-02	3.0 E+00	3.3 E+02	4.0 E-02	NR	8.0 E-03
1984	NR	NR	NR	NR	NR	NR
1985	7.6 E-02	1.2 E+00	4.2 E+02	1.7 E-01	NR	4.4 E-04
1986	1.6 E-01	1.1 E+00	2.2 E+02	2.1 E-01	NR	4.2 E-04
1987	2.0 E-01	9.0 E-01	2.9 E+02	1.1 E-01	<1.3 E-04	7.6 E-04
1988	2.4 E-01	1.4 E+00	1.2 E+02	2.0 E-01	8.5 E-05	2.0 E-04
1989	<1.3 E-01	4.3 E-01	8.0 E+01	1.5 E-01	1.1 E-03	4.5 E-04

NR = Not reported.

Table 4-6. Average Radionuclide Concentrations (pCi/g) Detected in 100B/C Area Vegetation Samples from 1981 to 1990.

Year	⁶⁰ Co	⁹⁰ Sr	¹³⁷ Cs	²³⁸ Pu	^{239,240} Pu
1981	3.6 E+00	NR	3.6 E-01	NR	NR
1982	1.9 E-01	NR	1.1 E-01	NR	NR
1983	1.8 E-01	NR	8.0 E-02	NR	NR
1984	1.3 E-01	1.4 E+00	8.7 E-02	2.4 E-04	6.0 E-04
1985	4.6 E-01	1.4 E+00	1.2 E-01	2.5 E-04	1.0 E-03
1986	2.5 E-01	2.0 E-01	2.8 E+00	2.5 E-05	6.2 E-04
1987	1.5 E-01	2.3 E-01	1.0 E-01	4.6 E-04	6.5 E-04
1988	3.5 E-01	2.6 E-01	2.1 E-01	1.4 E-04	3.1 E-04
1989	3.2 E-01	1.6 E-01	1.8 E-01	6.5 E-05	2.4 E-04
1990	4.5 E-02	9.1 E-02	6.7 E-02	<2.5 E-05	3.0 E-04

NR = Not reported.

Note: Table E-11 lists the results of the analysis of 100B/C Area vegetation samples.

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Table 4-7. Average Radionuclide Concentrations (pCi/g) Detected in 100D/DR Area Vegetation Samples from 1981 to 1990.

Year	⁶⁰ Co	⁹⁰ Sr	¹³⁷ Cs	²³⁸ Pu	^{239,240} Pu
1981	1.2 E+00	NR	1.6 E-01	NR	NR
1982	1.1 E-01	NR	2.7 E+00	NR	NR
1983	9.5 E-02	NR	1.4 E-01	NR	NR
1984	2.1 E-01	2.8 E-01	1.7 E+00	1.8 E-03	5.8 E-04
1985	2.4 E-01	6.9 E-02	6.8 E-01	1.2 E-04	7.0 E-04
1986	2.7 E-01	1.5 E-01	1.7 E+00	0.0	3.1 E-04
1987	2.5 E-01	9.5 E-02	6.3 E-01	1.6 E-04	2.8 E-04
1988	2.8 E-01	1.8 E-01	9.6 E-02	3.8 E-05	1.9 E-04
1989	2.6 E-01	1.5 E-01	2.8 E-01	9.6 E-05	1.2 E-04
1990	6.1 E-02	9.5 E-02	6.2 E-01	<2.4 E-05	2.6 E-04

NR = Not reported.

Note: Table E-12 lists the results of the analysis of 100D/DR Area vegetation samples.

Table 4-8. Average Radionuclide Concentrations (pCi/g) Detected in 100F Area Vegetation Samples from 1981 to 1990.

Year	⁶⁰ Co	⁹⁰ Sr	¹³⁷ Cs	²³⁸ Pu	^{239,240} Pu
1981	9.2 E-01	NR	2.2 E+00	NR	NR
1982	1.6 E-01	NR	7.9 E-01	NR	NR
1983	2.8 E-01	NR	1.0 E+00	NR	NR
1984	2.2 E+00	7.6 E+00	2.0 E+01	4.9 E-04	3.9 E-03
1985	3.3 E-01	1.4 E+00	5.8 E-01	4.9 E-05	5.3 E-04
1986	1.7 E-01	9.3 E-02	1.1 E+00	8.3 E-05	1.2 E-04
1987	2.4 E-01	1.8 E-01	1.8 E-01	3.8 E-04	1.7 E-04
1988	9.9 E-01	8.9 E-02	3.1 E-01	3.3 E-05	1.1 E-04
1989	2.8 E-01	9.6 E-02	2.0 E+00	5.2 E-05	1.4 E-04
1990	5.0 E-02	2.7 E-01	4.2 E-01	<4.9 E-05	3.6 E-04

NR = Not reported.

Note: Table E-13 lists the results of the analysis of 100F Area vegetation samples.

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Table 4-9. Average Radionuclide Concentrations (pCi/g) Detected in 100H Area Vegetation Samples from 1981 to 1990.

Year	⁶⁰ Co	⁹⁰ Sr	¹³⁷ Cs	²³⁸ Pu	^{239,240} Pu
1981	6.8 E-01	NR	1.5 E-01	NR	NR
1982	NR	NR	NR	NR	NR
1983	1.3 E-01	NR	9.0 E-02	NR	NR
1984	1.8 E-01	2.0 E+00	1.3 E-01	2.0 E-04	1.7 E-03
1985	2.0 E-01	6.0 E-02	4.5 E-02	1.0 E-04	5.1 E-04
1986	2.2 E-01	5.3 E-01	1.3 E+00	1.3 E-04	4.4 E-05
1987	2.6 E-01	2.6 E-01	1.0 E-01	3.5 E-05	2.7 E-04
1988	9.0 E-01	3.9 E-01	1.5 E-01	2.0 E-04	1.5 E-04
1989	6.5 E-01	5.2 E-02	2.1 E-01	8.5 E-05	1.5 E-04
1990	<1.3 E-01	1.1 E-02	6.6 E-02	<1.4 E-04	3.0 E-04

NR = Not reported.

NOTE: Table E-14 lists the results of the analysis of 100H Area vegetation samples.

Table 4-10. Average Radionuclide Concentrations (pCi/g) Detected in 100 K Area Vegetation Samples from 1981 to 1990.

Year	⁶⁰ Co	⁹⁰ Sr	¹³⁷ Cs	²³⁸ Pu	^{239,240} Pu
1981	1.2 E+00	NR	1.0 E-01	NR	NR
1982	2.4 E-01	NR	9.7 E-01	NR	NR
1983	1.5 E-01	NR	2.5 E-01	NR	NR
1984	1.8 E-01	1.3 E+00	1.3 E-01	2.9 E-04	6.9 E-04
1985	4.6 E-01	3.9 E-01	1.3 E-01	1.9 E-04	7.1 E-04
1986	2.8 E-01	4.0 E-01	1.5 E+00	2.5 E-04	7.9 E-04
1987	2.3 E-01	1.3 E+00	1.1 E-01	1.9 E-04	2.2 E-04
1988	4.9 E-01	1.2 E+00	1.8 E-01	5.2 E-05	3.8 E-04
1989	3.1 E-01	1.3 E+00	1.6 E-01	1.1 E-04	1.5 E-04
1990	4.5 E-02	8.0 E+00	4.1 E-02	<1.7 E-04	2.5 E-04

NR = Not reported.

Note: Table E-15 lists the results of the analysis of 100 K Area vegetation samples.

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5.0 EXTERNAL RADIATION MONITORING

Environmental thermoluminescent dosimeters (TLD) are used to measure direct radiation and evaluate environmental dose rates at several locations at 100 N Area.

The environmental TLDs (CaF₂:Mn matrix) are delivered, calibrated, and read every 4 wk by PNL. The locations of the environmental TLDs at the 100 N Area are shown in Figure 5-1. The average dose rate in mrem/h, extrapolated dose rate per work year for each of the TLD locations, and the ALARA occupational exposure guideline for comparison are presented in Table F-1.

The dose per work year is defined as the accumulated dose over a period of 40 h/wk and 52 wk/yr 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 at most of these locations, especially inside established radiation zones. The 1990 results indicate that the ALARA exposure guidelines for nonradiation zone workers (240 mrem/yr) were not exceeded in any nonradiologically controlled areas and there is an apparent, overall decreasing trend in dose rates at these locations.

The environmental dose rates detected near the 1325-N LWDF were significantly higher in 1990 than in 1989. Beginning in the fall of 1989, liquid effluent discharges to the facility were decreased following the completion of reactor de-fueling activities. An initial increase in dose rates of approximately 300% was observed between August and November 1989 because of a decrease in the depth of water which provided shielding of the radiation from the contaminated sediments.

In December 1989 the operational status of the reactor went from "wet-standby" to "dry lay-up," whereupon, effluent discharges were reduced to extremely low volumes and had discontinued completely by April 1990. This led to an additional maximum increase in the dose rates of approximately 800% between November 1989 and September 1990.

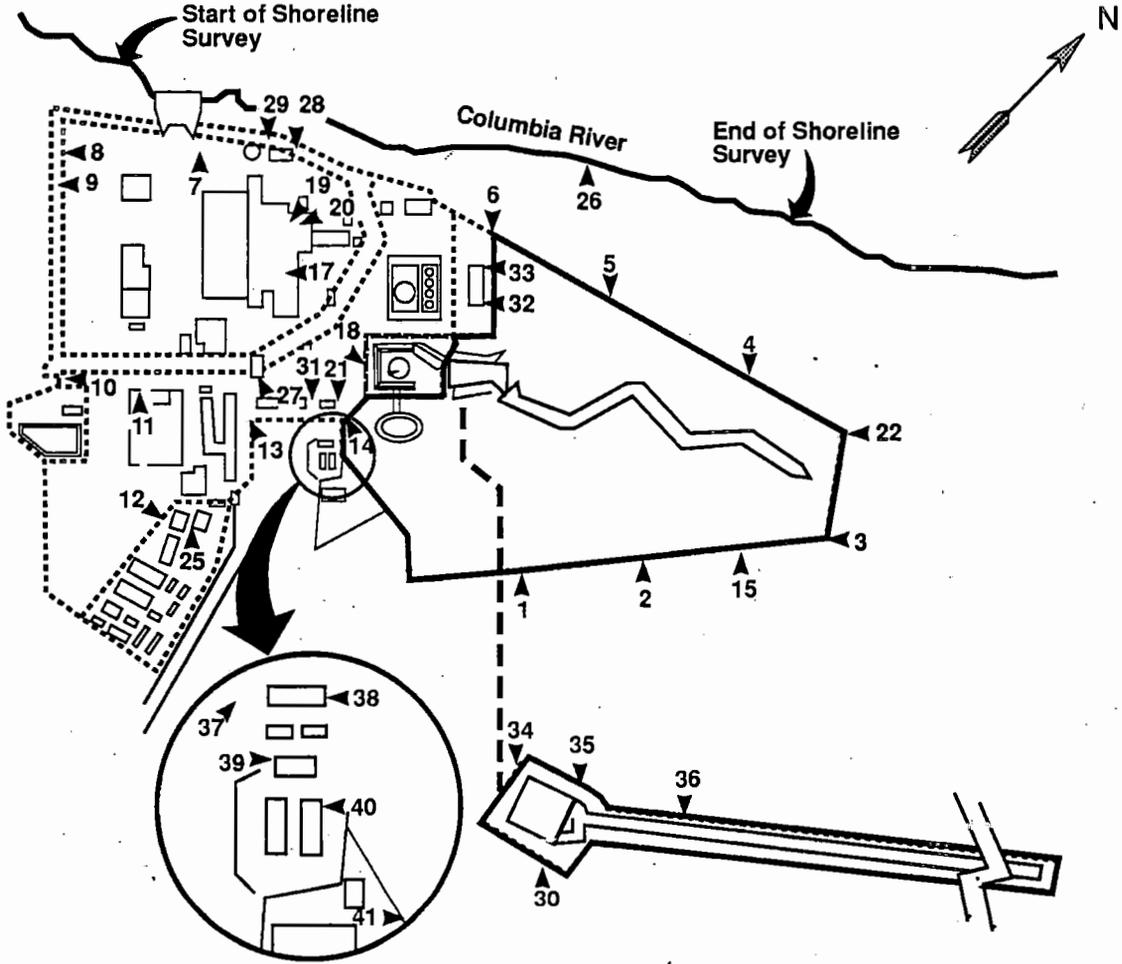
By December 1990, the dose rate levels exhibited a slight decrease and are expected to continue to decline. Overall, the dose rates near the 1325-N increased approximately 400% in 1990 compared to the average 1989 levels. This sharp increase also affected the dose rates observed near the 1301-N LWDF. Dose rates measured along the trench portion of this facility showed an annual average increase of approximately 45% in 1990 compared to 1989 levels. Before 1990, there had been a steady, decreasing trend in dose rate levels at this facility because of the continued decay of ⁶⁰Co (5.3-yr half life).

Dose rates measured near the 1304-N EDT (Locations 7 and 29) in 1990 were comparable to the 1989 levels.

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Figure 5-1. Location of Environmental Dosimeters and the Columbia Shoreline Survey at 100 N Area.

- ◀ 23 Supply System Control Room
- ◀ 24 On Supply System Fence



Supply System = Washington Public Power Supply System

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

A table of the monthly dose rate measurements for each environmental TLD location is included in Table F-2.

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6.0 LIQUID WASTE DISPOSAL FACILITY MONITORING

Environmental surveillance of the 1301-N and 1325-N LWDFs is performed to monitor and document the environmental impact associated with these disposal facilities. Several parameters including ambient air, vegetation, surface soil, and bottom sediments are sampled and analyzed. Ambient environmental dose rates also are monitored annually. Ambient air, vegetation, surface soil, and external radiation monitoring for the LWDFs have been included in their respective sections previously. Section 7.0, Radiological Surveys, will address the annual dose rate surveys associated with LWDF monitoring. This section, LWDF monitoring, will discuss the sampling and analysis of the 1325-N LWDF bottom sediments.

The 1325-N LWDF receives 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 bottom of the 1325-N LWDF on November 18, 1990. The samples, about 10 g each, were collected by means of several sampling ports located in the cover over the disposal facility (Figure 6-1). At the time of sampling, the 1325-N LWDF was receiving liquid effluent from N Reactor.

Analysis results for the 1990 samples had not been received as of the time of this report.

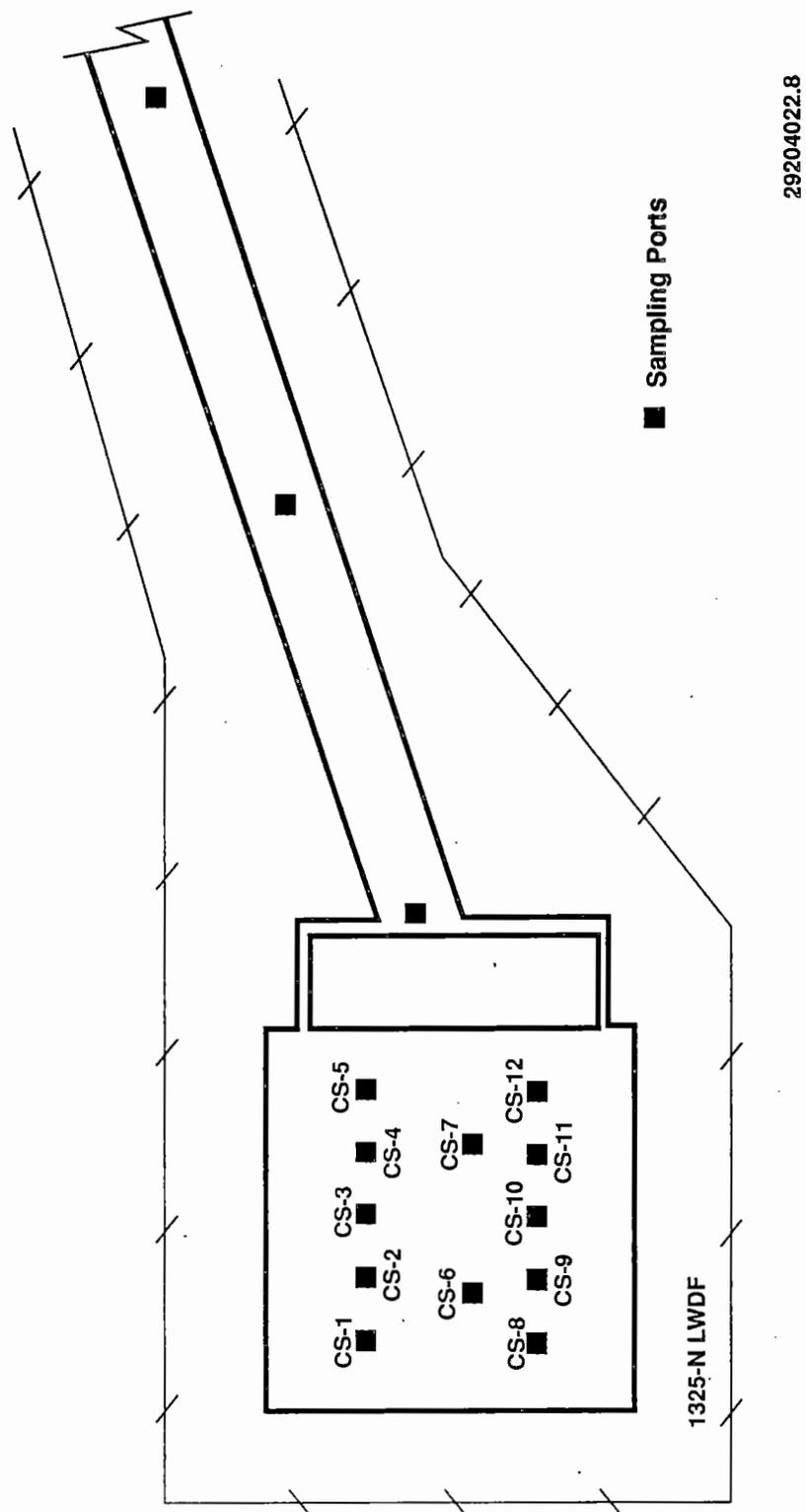
Table 6-1. Average Radionuclide Concentrations (pCi/g)
Detected in 1325-N Liquid Waste Disposal Facility
Sediment Since 1985.

Year	⁶⁰ Co	⁹⁰ Sr	¹³⁷ Cs	^{239,240} Pu
1985	8.3 E+05	5.4 E+04	3.7 E+04	1.3 E+04
1986	2.8 E+06	5.9 E+03	9.3 E+04	NR
1987	8.7 E+05	9.7 E+04	2.3 E+04	3.3 E+04
1988	1.3 E+06	2.3 E+04	5.1 E+04	1.4 E+04
1989	1.3 E+07	NR	3.2 E+05	NR

NR = Not reported.

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Figure 6-1. Sediment Sampling Locations for the 1325-N Liquid Waste Disposal Facility.



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7.0 RADIOLOGICAL SURVEYS

7.1 INTRODUCTION

Direct radiation levels are measured annually along the 100 N Area portion of the Columbia River shoreline. Annual environmental radiation surveys also are conducted at intersecting points of survey grids established around the 1301-N and 1325-N LWDFs to monitor direct radiation levels associated with the disposal facilities.

Each of the surveys relied on the use of a Bicron Model 5050 portable micro-R meter. The meter was calibrated by PNL to a ^{137}Cs source and the readings were taken at a height of 1 m at 50-ft intervals. The micro-R readings obtained for these surveys reflect relative (to each other) dose rates only and do not indicate actual whole body penetrating dose rates, as this type of instrument is overly sensitive to nonpenetrating radiation sources.

7.2 COLUMBIA RIVER SHORELINE SURVEY

On May 21, 1990, relative dose rates were measured along the Columbia River shoreline starting near the 005 outfall and proceeding downstream past the N Springs. (Refer to Figure 5-1.) A graphic representation of the shoreline survey data is presented in Figure 7-1. The locations of the 100 N Area facilities that potentially contribute to dose rates measured near the river shoreline are shown. At the time of the survey, N Reactor was shut down. The 1304-N EDT was empty. Flow to the 1325-N LWDF was about 200 gal/min. The 1310-N Radioactive Chemical Waste Storage Facility was empty.

Graphs depicting the relative environmental dose rates from annual surveys along the Columbia River shoreline opposite the 1301-N LWDF were similar in shape, but lower in 1990 than the 1989 measurements. The decrease is attributable to the continuing decay of ^{60}Co (5.3-yr half life), one of the major residual radionuclides in the 1301-N Facility. As of September 19, 1985, this facility no longer was used and no longer contained water that, during operation, shielded direct radiation levels.

The readings at each location obtained during this survey are presented in Table H-1.

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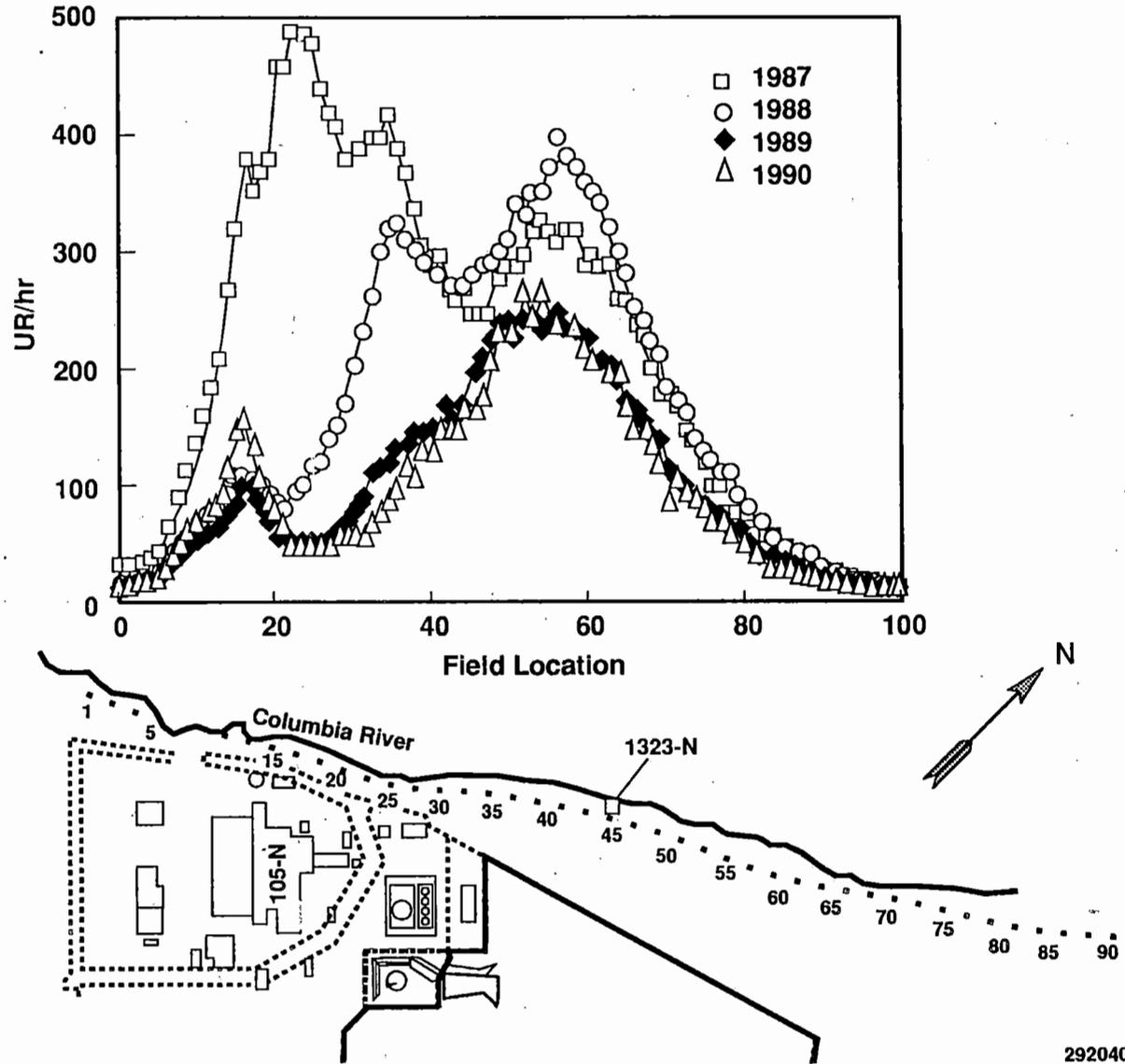


Figure 7-1. Environmental Dose Rates Detected at Survey Points along the Columbia River Shoreline.

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7.3 LIQUID WASTE DISPOSAL FACILITY RADIATION SURVEYS

7.3.1 Introduction

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

For convenience of reference, the 1989 LWDF survey results are included in Figures H-1 and H-2. The methods and equipment used for the annual dose rate surveys conducted at the 1301-N and 1325-N LWDFs were identical to those described for the annual Columbia River shoreline survey.

7.3.2 1301-N Liquid Waste Disposal Facility Survey Results

Figure 7-2 shows the relative environmental dose rates detected around the 1301-N LWDF on June 26, 1990. The N Reactor was not operating at the time of the survey. The 1325-N LWDF was receiving liquid effluent from the N Reactor at a rate of about 200 gal/min. The 1310-N Radioactive Chemical Treatment Facility was empty.

The data indicate that the areas near the "box weir" (inlet) portion of the 1301-N LWDF and the first leg of the 1301-N trench have the highest background dose rates. The absence of water from the LWDF is the major factor contributing to the dose rates. During operation, water levels in the crib shielded much of the radiation emitted by the contaminated sediments.

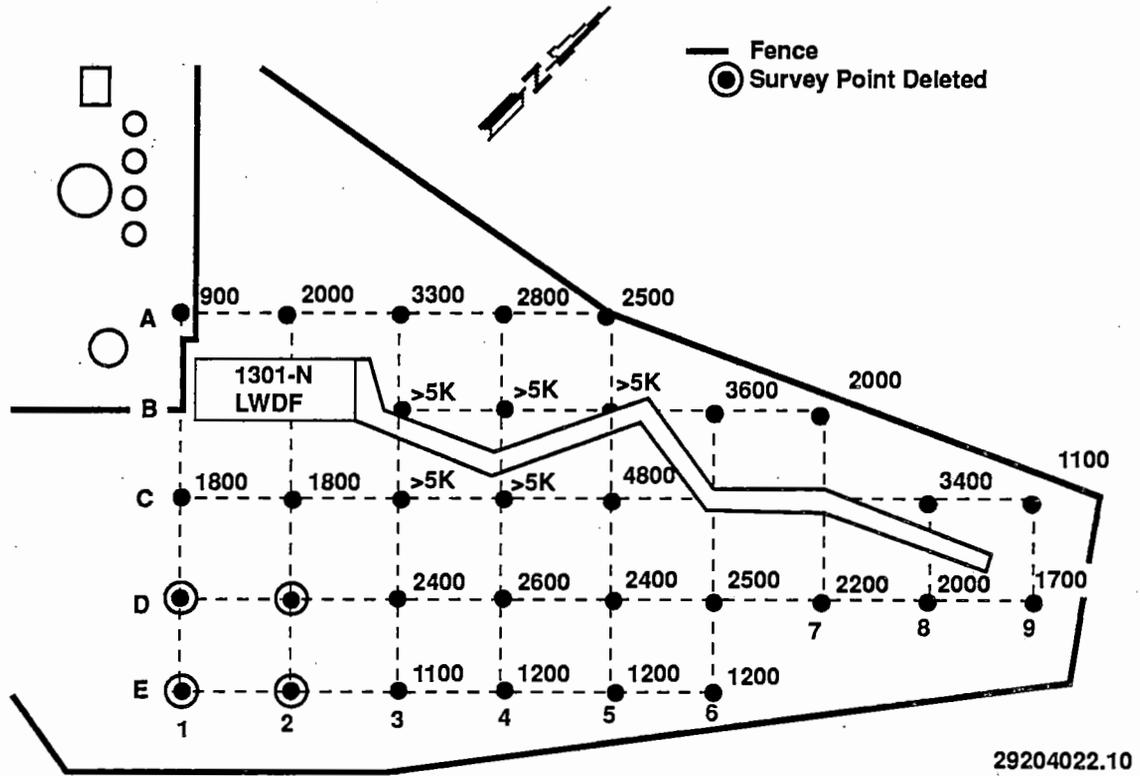
An overall decrease in the relative dose rates measured at this facility was indicated in 1990. The continued decay of the radionuclide inventory contained in the 1301-N LWDF is the apparent cause of this reduction.

7.3.3 1325-N Liquid Waste Disposal Facility

The relative environmental dose rates detected around the 1325-N LWDF on May 21, 1990, are presented in Figure 7-3. The N Reactor was not operating at the time and the 1325-N LWDF was receiving about 200 gal/min of liquid effluent from N Reactor. The 1310-N Radioactive Chemical Waste Storage Facility was empty. The 1301-N LWDF did not contain liquid effluent.

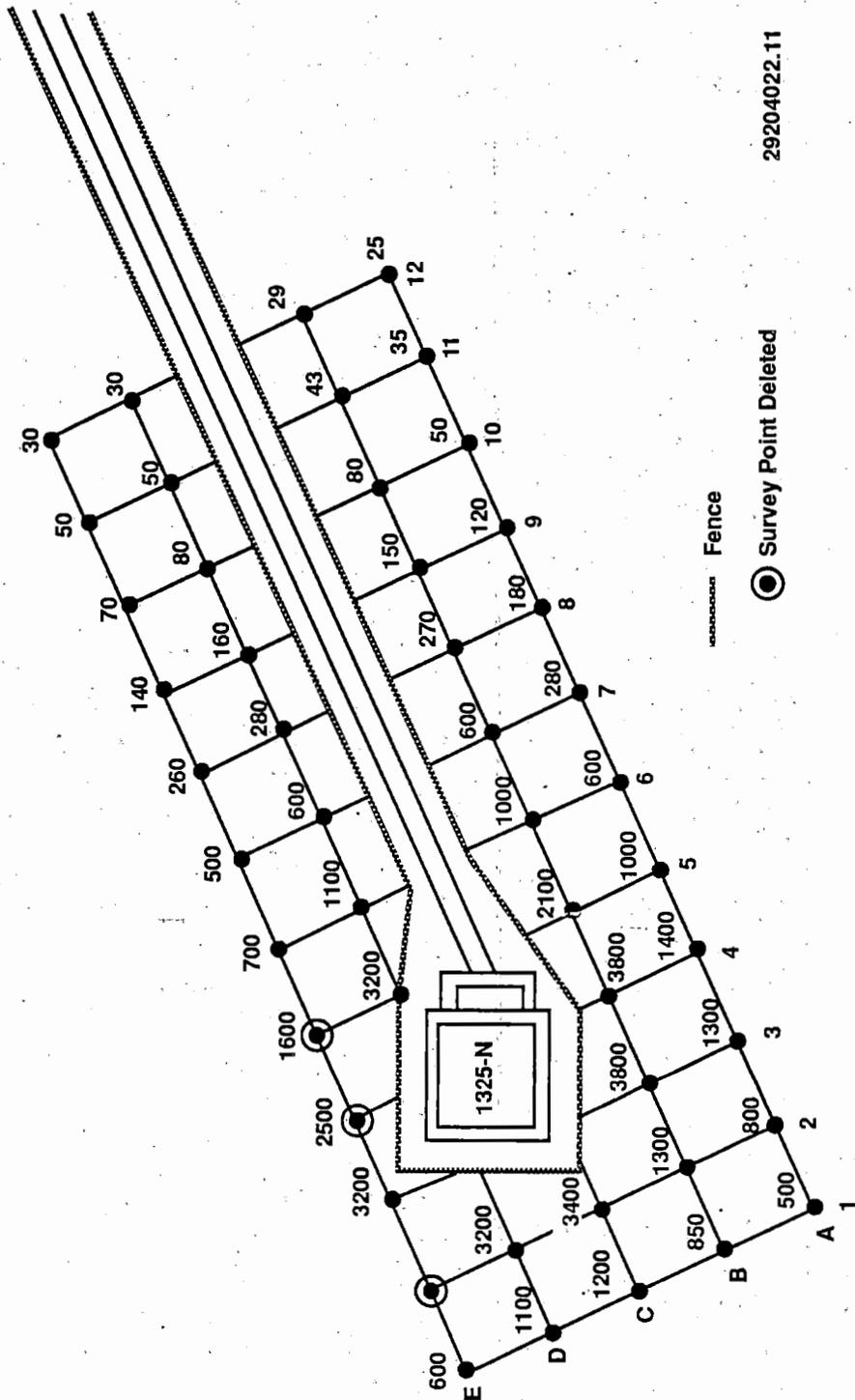
In 1990, the 1325-N LWDF showed an 2 to 3 times increase in relative dose rates compared to the 1989 survey. This coincides with the TLD measurements obtained during this period. This increase is attributable to the decreased (compared to 1989) effluent discharge to the facility and the reduced shielding thereby provided.

Figure 7-2. 100 N Environmental Dose Rates Measured at Survey Points Around the 1301-N Liquid Waste Disposal Facility in 1989 ($\mu\text{rem/h}$).



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Figure 7-3. 100 N Environmental Dose Rates Survey Around the 1325-N Liquid Waste Disposal Facility ($\mu\text{rem/h}$).



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APPENDIX A
QUALITY ASSURANCE

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INTRODUCTION

The Westinghouse Hanford Company (Westinghouse Hanford) surveillance program for the 100 Areas provides monitoring to assist in evaluating the environmental impact of N Reactor facilities, the retired reactor facilities, and burial grounds in the retired 100 Areas. The major objectives of the program are to monitor radionuclide concentrations in radiological release pathways, maintain a database for trend analyses, provide data for accidental release analyses, and demonstrate compliance with applicable regulations.

At the 100N Area, samples of ambient air, groundwater, vegetation, soil, and sediment are collected and analyzed along with direct radiation measurements around the 1301-N and 1325-N Liquid Waste Disposal Facilities (LWDF) and along the river shoreline. At the retired 100 Areas, soil, vegetation, and groundwater samples are collected and analyzed. Special samples to monitor the potential biotransport of radionuclides also may be included in the surveillance program.

Procedures and guidelines are used to ensure that near-field environmental monitoring techniques and analyses are conducted within established limits of acceptance. The essential components of these manuals as they apply to the 100 Areas environmental surveillance quality assurance program are briefly outlined below.

DOCUMENTATION

Record keeping is a vital requirement of the 100 Areas near-field environmental monitoring program. Each phase of the program is documented to ensure regulatory compliance, accurate trend analysis, and optimal monitoring procedures. Pertinent documentation is listed below.

- Sampling Logs--Records of all environmental samples collected by Operational Health Physics and N Reactor Operations personnel are kept in these log books.
- Data Records--All analytical data received by Environment Assurance from the radioanalytical laboratories are recorded on magnetic media and hard-copy printouts.
- Environmental Surveillance Requirements--The procedures and reporting guidelines for these requirements are provided in various company manuals.
- Chain-of-Custody Log--This log records custody of the environmental samples from collection through disposal.

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Various reports are generated to document, control, and report the condition of, and impact to, the near-field environment. These reports are listed below.

- 100 Areas Annual Environmental Release Report--This report covers atmospheric and liquid releases of radionuclides and chemicals from the 100 Area facilities.
- Environmental Surveillance Report for the 100 Areas--This annual report summarizes sampling and monitoring completed during the previous year to fulfill the requirements of the Westinghouse Hanford 100 Areas Environmental Surveillance Program.
- Westinghouse Hanford Release Report for the Hanford Site--This monthly report shows the total amounts of potentially hazardous materials released from Westinghouse Hanford facilities for the previous month. Unplanned releases and spills to the environment are included in this report.
- National Pollutant Discharge Elimination System (NPDES) Effluent Monitoring Report--The NPDES Effluent Monitoring Report summarizes the sampling data required by the NPDES permit. The U.S. Department of Energy transmits the report to the Environmental Protection Agency as required by NPDES regulations.
- Environmental Radiological Survey Summary for the 100 Area--This quarterly report summarizes the environmental radiation surveys conducted in the 100 Areas. These surveys are conducted to detect surface contamination at the inactive waste sites located in the 100 Areas.

DATA ANALYSIS

Environmental data are reviewed to determine compliance with applicable federal, state, local, and Westinghouse Hanford guidelines. These data are analyzed both graphically and by standard statistical tests to determine trends and impacts on the environment. Newly acquired data are compared with historical data and natural background levels. Routine environmental data are stored on both magnetic media (i.e., in a microcomputer environment) and on hard-copy printouts.

TRAINING

To ensure quality and consistency in sample collection and handling, all personnel performing such work receive formal training. Personnel involved in sample analyses receive formal initial and annual followup training in the operation of the radioanalytical laboratory equipment located in the 105-N Building.

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SAMPLE FREQUENCY

The sampling schedules and types are established by 100 Areas Environmental Protection on the basis of detailed review of each effluent stream to ensure that all samples accurately represent the types and concentrations of radionuclides that are being discharged in that effluent stream. The routine monitoring schedule is provided in the applicable company manual. A brief description of the sampling program is presented below.

1. Ambient air sample filters are collected weekly.
2. Liquid effluent samples are composited and collected weekly.
3. Environmental thermoluminescent dosimeters (TLD) are exchanged monthly.
4. Groundwater samples for radiological analysis are collected quarterly. Samples from oil and grease monitoring wells are collected on a location-dependent frequency.
5. Radiological surveys of the LWDFs and Columbia River shoreline are performed annually.
6. The soil, vegetation, and 1325-N LWDF sediment samples are collected annually.

ANALYTICAL PROCEDURES

Four laboratories provided analytical support to the 100 Areas Environmental Surveillance Program: the U. S. Testing Company, Inc. (UST), International Technology Analytical Services-Richland Laboratory (ITAS-RL), the Radiation Standards and Engineering Laboratory at Pacific Northwest Laboratory (PNL), and the 100-N Westinghouse Hanford radioanalytical laboratory. The environmental samples are analyzed in accordance with prescribed procedures and quality control guides.

Radioanalyses were conducted at the 100-N Westinghouse Hanford radioanalytical laboratory through September 1990. Historically, the radioanalytical program at 105-N provided reliable and accurate analyses of gamma-emitting radionuclides. The laboratory consistently performed well on Environmental Protection Agency interlaboratory comparisons. The quality control program for the laboratory is documented in the applicable company manual. The 105-N laboratory was closed in September when the reactor shut down and the Westinghouse Hanford laboratory personnel were relocated.

The UST provided analytical support for the 100 Area Environmental Surveillance Program until May 1990, when UST's contract was terminated. Samples were archived until ITAS-RL's services were contracted in February 1991. Both UST and ITAS-RL provided analyses for gross alpha-beta, tritium, strontium, and plutonium.

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The engineering laboratory at PNL provided TLD calibration, annealing, and analyses. All TLD work is performed in accordance with the procedures and specific guides from the American National Standards Institute and PNL.

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APPENDIX B

GLOSSARY

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ACRONYMS

ALARA	as low as reasonably achievable
DCG	derived concentration guide
DOE	U.S. Department of Energy
EA	Environmental Assurance
EDB	emergency dump basin
EDT	emergency dump tank
HEHF	Hanford Environmental Health Foundation
ICRP	International Commission on Radiological Protection
LWDF	liquid waste disposal facility
NPDES	national pollutant discharge elimination system
OHP	Operational Health Physics
PNL	Pacific Northwest Laboratory
PUREX	Plutonium Uranium Extraction (Plant)
SNM	special nuclear material
Supply System	Washington Public Power Supply System
TLD	thermoluminescent dosimeter
UST	U.S. Testing Company Inc.
Westinghouse Hanford	Westinghouse Hanford Company

DEFINITIONS

Biological Transport. Concerns one or more of the following processes:

- Movement of subsurface radioactivity to the surface by physiological plant processes
- Dispersion of such plants by the wind
- Contaminated urine and feces deposited by animals that have gained access to and ingested radioactivity
- Contaminated animals themselves that have ingested radioactivity directly or ingested other contaminated animals or plants
- Physical displacement of radioactivity by burrowing animals
- Nests built using contaminated materials.

Background Radiation. Refers to regional levels of radioactivity produced by sources other than those of specific interest (e.g., the nuclear activities at the Hanford Site).

Biota. The plant and animal life of a specific region.

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Chemical Processing. Chemical treatment of material to selectively separate desired components. At the Hanford Site, plutonium, uranium, and fission products are chemically separated from irradiated fuels.

Controlled Area. An area where access is controlled to protect individuals from extra exposure to radiation and radioactive materials.

Crib. A subsurface low-level liquid-waste disposal site that allows liquid waste to percolate into surrounding soil.

Decommissioning. The process of removing a facility or area from operation, often involving decontamination and/or disposal, plus incorporating appropriate controls and safeguards.

Decontamination. The removal of radioactivity from a surface or from within another material.

Environmental Surveillance. A survey and sampling program designed to determine radiological impact due to site operations.

Groundwater. Water that exists below ground surface (i.e., within the zone of saturation).

Less Than Detectable. An analytical term for a radionuclide concentration in a sample that is lower than the minimum detection capabilities of that analytical equipment or process.

Quality Assurance. A program designed to maintain the quality of the results of a program within established limits of acceptance.

Radiation Survey. Evaluation of an area or object with portable instruments to identify radioactive materials and radiation fields present.

Radiological Control Area. An area where access is controlled to protect individuals from exposure to radiation and/or radioactive materials. In the Separations Area, control areas include, but are not limited to, areas posted as Radiation Area, Surface Contamination, and Underground Radioactive Materials--all describing the radiological condition of the area within.

Retired Waste Site. A waste site that is isolated and no longer available to receive waste in any form.

Surface Contamination. A radiological control status that refers to radioactivity on the surface of the ground that exceeds the Soil Contamination Standard.

Thermoluminescent Dosimeter. A chip or series of chips used for measuring external gamma radiation. It consists of a material capable of absorbing energy imparted by ionizing radiation, then emitting light as a result of thermal stimulation. A measure of that light is proportional to the radioactivity absorbed.

Water Table. The upper boundary of an unconfined aquifer below which saturated groundwater occurs.

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APPENDIX C
AMBIENT AIR MONITORING

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Table C-1. Concentrations of Radionuclides Detected 100N (pCi/m3).

Number of Samples		⁵⁴ Mn	⁶⁰ Co	¹⁰³ Ru	¹³⁷ Cs
SAMPLE LOCATION * A-1					
9	Maximum	<6.9 E-02	6.6 E-02	<5.1 E-02	<4.8 E-02
	minimum	<9.4 E-03	1.2 E-02	<1.0 E-02	<1.0 E-02
	average	<2.0 E-02	1.4 E-02	<1.7 E-02	<1.8 E-02
	stan. dev.	1.8 E-02	1.9 E-02	1.2 E-02	1.1 E-02
SAMPLE LOCATION * A-2					
10	Maximum	<1.8 E-02	4.5 E-02	<1.4 E-02	<2.4 E-02
	minimum	<1.2 E-02	<1.3 E-02	<9.1 E-03	<9.9 E-03
	average	<1.5 E-03	3.5 E-02	<1.2 E-02	<1.5 E-02
	stan. dev.	1.9 E-03	6.2 E-03	2.0 E-03	3.9 E-03
SAMPLE LOCATION * A-3					
10	Maximum	<1.8 E-02	3.2 E-02	<1.4 E-02	<1.8 E-02
	minimum	<9.3 E-03	<1.6 E-02	<1.0 E-02	<1.2 E-02
	average	<1.4 E-02	3.0 E-02	<1.2 E-02	<1.5 E-02
	stan. dev.	2.7 E-03	2.0 E-03	1.3 E-03	1.4 E-03
SAMPLE LOCATION * A-4					
9	Maximum	<1.9 E-02	4.6 E-02	<1.5 E-02	<1.9 E-02
	minimum	<1.1 E-02	<1.4 E-02	<8.3 E-03	<1.2 E-02
	average	<1.5 E-02	4.2 E-02	<1.2 E-02	<1.5 E-02
	stan. dev.	3.2 E-03	1.7 E-02	2.0 E-03	2.2 E-03
SAMPLE LOCATION * A-5					
10	Maximum	<2.4 E-02	4.9 E-02	<1.8 E-02	<3.5 E-02
	minimum	<1.0 E-02	<1.4 E-02	<9.3 E-03	<1.2 E-02
	average	<1.6 E-02	2.5 E-02	<1.3 E-02	<1.8 E-02
	stan. dev.	3.8 E-03	1.2 E-02	2.5 E-03	6.2 E-03
DCG**		2.0 E+03	8.0 E+01	2.0 E+03	4.0 E+02

*Locations identified in Figure 2-1.

**DCG = Derived concentration guides (US-DOE).

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Table C-2. Concentrations of Radionuclides Detected in 100 Area Air Samples (pCi/m3).

SAMPLE LOCATION * A-1				
Date	⁵⁴ Mn	⁶⁰ Co	¹⁰³ Ru	¹³⁷ Cs
01/12/90	<1.4 E-02	1.4 E-02	<1.1 E-02	<1.2 E-02
02/09/90	<6.9 E-02	<9.9 E-02	<5.1 E-02	<4.8 E-02
03/07/90	<1.6 E-02	1.2 E-02	<1.6 E-02	<1.8 E-02
04/05/90	<1.4 E-02	2.6 E-02	<1.1 E-02	<1.0 E-02
05/08/90	<1.1 E-02	3.0 E-02	<1.1 E-02	<1.6 E-02
05/31/90	<1.7 E-02	NR	<1.5 E-02	<1.6 E-02
06/27/90	<9.4 E-03	2.8 E-02	<1.3 E-02	<1.3 E-02
07/25/90	<1.4 E-02	<6.6 E-02	<1.1 E-02	<1.6 E-02
08/22/90	<1.4 E-02	<1.7 E-02	<1.0 E-02	<1.5 E-02

*Location identified in Figure 2-1.
NR = Not reported.

Table C-3. Concentrations of Radionuclides Detected in 100 N Area Air Samples (pCi/m3).

SAMPLE LOCATION * A-2				
Date	⁵⁴ Mn	⁶⁰ Co	¹⁰³ Ru	¹³⁷ Cs
01/11/90	<1.2 E-02	3.7 E-02	<9.1 E-03	<1.1 E-02
02/07/90	<1.7 E-02	3.5 E-02	<1.4 E-02	<1.4 E-02
03/08/90	<1.4 E-02	<2.2 E-02	<1.1 E-02	<1.2 E-02
04/04/90	<1.5 E-02	NR	<1.4 E-02	<1.3 E-02
05/07/90	<1.4 E-02	<1.3 E-02	<1.0 E-02	<9.9 E-03
05/30/90	<1.5 E-02	<2.3 E-02	<1.4 E-02	<1.8 E-02
06/27/90	<1.8 E-02	4.5 E-02	<1.4 E-02	<2.4 E-02
07/25/90	<1.6 E-02	3.2 E-02	<1.4 E-02	<1.3 E-02
08/22/90	<1.3 E-02	<2.0 E-02	<1.4 E-02	<1.5 E-02
09/21/90	<1.2 E-02	2.6 E-02	<1.0 E-02	<1.6 E-02

*Location identified in Figure 2-1.
NR = Not reported.

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Table C-4. Concentrations of Radionuclides Detected in 100N Area Air Samples (pCi/m³).

SAMPLE LOCATION * A-3				
Date	⁵⁴ Mn	⁶⁰ Co	¹⁰³ Ru	¹³⁷ Cs
01/10/90	<1.1 E-02	3.2 E-02	<1.1 E-02	<1.2 E-02
02/07/90	<9.3 E-03	<1.6 E-02	<1.2 E-02	<1.4 E-02
03/08/90	<1.3 E-02	<2.0 E-02	<1.4 E-02	<1.4 E-02
04/06/90	<1.8 E-02	<2.3 E-02	<1.4 E-02	<1.8 E-02
05/04/90	<1.4 E-02	<1.7 E-02	<1.3 E-02	<1.5 E-02
06/01/90	<1.4 E-02	<2.2 E-02	<1.4 E-02	<1.5 E-02
07/02/90	<1.5 E-02	NR	<1.1 E-02	<1.4 E-02
07/26/90	<1.8 E-02	2.8 E-02	<1.2 E-02	<1.5 E-02
08/23/90	<1.7 E-02	<2.1 E-02	<1.2 E-02	<1.5 E-02
09/24/90	<1.5 E-02	NR	<1.0 E-02	<1.5 E-02

*Location identified in Figure 2-1.
NR = Not reported.

Table C-5. Concentration of Radionuclides Detected in 100N Area Air Samples (pCi/m³).

SAMPLE LOCATION * A-4				
Date	⁵⁴ Mn	⁶⁰ Co	¹⁰³ Ru	¹³⁷ Cs
01/10/90	<1.1 E-02	3.8 E-02	<1.0 E-02	<1.2 E-02
02/07/90	<1.5 E-02	NR	<1.3 E-02	<1.5 E-02
03/07/90	<1.7 E-02	NR	<1.4 E-02	<1.8 E-02
04/04/90	<1.2 E-02	NR	<1.1 E-02	<1.4 E-02
05/04/90	<1.3 E-02	NR	<1.2 E-02	<1.5 E-02
06/01/90	<1.9 E-02	4.6 E-02	<1.4 E-02	<1.9 E-02
07/02/90	<1.1 E-02	<1.4 E-02	<8.3 E-03	<1.3 E-02
07/26/90	<1.8 E-02	<1.7 E-02	<1.5 E-02	<1.7 E-02
08/23/90	<1.9 E-02	NR	<1.3 E-02	<1.6 E-02

*Location identified in Figure 2-1.
NR = Not required.

Table C-6. Concentration of Radionuclides Detected in 100N Area Air Samples (pCi/m3).

SAMPLE LOCATION * A-5				
Date	⁵⁴ Mn	⁶⁰ Co	¹⁰³ Ru	¹³⁷ Cs
01/11/90	<1.0 E-02	1.4 E-02	<9.3 E-03	<1.2 E-02
02/07/90	<1.7 E-02	2.3 E-02	<1.7 E-02	<1.6 E-02
03/07/90	<1.3 E-02	NR	<1.2 E-02	<2.0 E-02
04/05/90	<1.3 E-02	NR	<1.2 E-02	<1.5 E-02
05/07/90	<1.7 E-02	2.1 E-02	<1.2 E-02	<1.6 E-07
05/30/90	<2.4 E-02	4.9 E-02	<1.8 E-02	<3.5 E-02
06/27/90	<1.5 E-02	<2.9 E-02	<1.2 E-02	<1.6 E-02
07/25/90	<1.3 E-02	1.8 E-02	<1.3 E-02	<1.3 E-02
08/22/90	<1.9 E-02	NR	<1.2 E-02	<2.1 E-02
09/21/90	<1.9 E-02	NR	<1.4 E-02	<1.8 E-02

*Locaton identified in Figure 2-1.
 NR = Not required.

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APPENDIX D
GROUNDWATER MONITORING

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Table D-1. Concentrations of ^3H Detected in 100-Area Groundwater (pCi/L) in 1990.

Well	No. of Samples	Maximum	Minimum	Average	Std. Dev.
N-2	1	6.0 E+04	6.0 E+04	6.0 E+04	
N-3	2	2.5 E+04	2.4 E+04	2.4 E+04	7.0 E+02
N-4	2	4.4 E+04	4.3 E+04	4.4 E+04	5.0 E+02
N-8T	31	4.3 E+04	3.4 E+04	3.8 E+04	2.2 E+03
N-14	1	4.4 E+04	4.4 E+04	4.4 E+04	
N-27	1	1.9 E+05	1.9 E+05	1.9 E+05	
N-29	2	8.1 E+04	4.0 E+04	6.1 E+04	2.0 E+04
N-31	1	2.6 E+05	2.6 E+05	2.6 E+05	
N-32	1	1.3 E+05	1.3 E+05	1.3 E+05	
N-33	2	2.1 E+05	2.1 E+05	2.1 E+05	1.0 E+03
N-41	1	8.4 E+03	8.4 E+03	8.4 E+03	
N-42	1	9.5 E+03	9.5 E+03	9.5 E+03	
N-52	1	4.2 E+04	4.2 E+04	4.2 E+04	
N-57	1	1.4 E+04	1.4 E+04	1.4 E+04	
N-66	1	4.3 E+04	4.3 E+04	4.3 E+04	
N-67	2	4.7 E+04	3.7 E+04	4.2 E+04	5.0 E+03
N-69	1	9.0 E+04	9.0 E+04	9.0 E+04	
N-70	1	3.5 E+04	3.5 E+04	3.5 E+04	
K-27	3	1.3 E+05	4.0 E+04	7.8 E+04	4.8 E+04
K-28	3	2.3 E+03	1.8 E+03	2.0 E+03	1.8 E+03
K-29	3	9.7 E+03	5.7 E+03	7.2 E+03	1.8 E+03
K-30	3	8.2 E+05	7.0 E+05	7.8 E+05	5.1 E+04

DCG = 2.0 E+6 pCi/l

Table D-2. Concentrations of ⁶⁰Co Detected in 100-Area Groundwater (pCi/L) in 1990.

Well	No. of Samples	Maximum	Minimum	Average	Std. Dev.
N-2	1	5.2 E+00	5.2 E+00	5.2 E+00	
N-3	2	1.3 E+01	7.2 E+00	1.0 E+01	2.8 E+00
N-4	2	1.4 E+01	1.1 E+01	1.3 E+01	1.2 E+00
N-8T	44	3.4 E+01	<2.9 E+00	1.9 E+01	7.0 E+00
N-14	1	8.9 E+00	8.9 E+00	8.9 E+00	
N-27	1	1.6 E+01	1.6 E+01	1.6 E+01	
N-29	2	2.9 E+01	1.5 E+01	2.2 E+01	6.8 E+00
N-31	1	3.4 E+01	3.4 E+01	3.4 E+01	
N-32	1	1.8 E+01	1.8 E+01	1.8 E+01	
N-33	2	2.2 E+01	1.5 E+01	1.8 E+01	3.6 E+00
N-41	1	1.1 E+01	1.1 E+01	1.1 E+01	
N-47	3	5.8 E+00	<3.1 E-01	<3.3 E+00	2.3 E+00
N-48	3	5.3 E+00	<6.6 E-01	<2.2 E+00	2.2 E+00
N-52	1	1.3 E+01	1.3 E+01	1.3 E+01	
N-57	1	4.6 E+00	4.6 E+00	4.6 E+00	
N-66	1	1.2 E+01	1.2 E+01	1.2 E+01	
N-67	2	1.4 E+01	8.8 E+00	1.1 E+01	2.5 E+00
N-70	1	1.8 E+01	1.8 E+01	1.8 E+01	
K-27	2	<9.0 E-01	<2.0 E-01	<5.5 E+00	3.5 E-01
K-28	3	<4.2 E+00	<4.0 E-01	<1.8 E+00	1.7 E+00
K-29	4	<2.2 E+00	<2.0 E-01	<9.5 E-01	8.0 E-01
K-30	3	<5.4 E+00	<1.3 E+00	<3.0 E+00	1.7 E+00

DCG = 5.0 E+3 pCi/l

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Table D-3. Concentrations of ⁹⁰Sr Detected in 100-Area Groundwater (pCi/L) in 1990.

Well	No. of Samples	Maximum	Minimum	Average	Std. Dev.
N-2	1	2.0 E+03	2.0 E+03	2.0 E+03	
N-3	2	6.1 E+02	5.5 E+02	5.8 E+02	3.0 E+01
N-4	2	7.8 E+00	7.7 E+00	7.8 E+00	5.0 E-02
N-8T	37	8.7 E+03	3.7 E+03	4.7 E+03	8.3 E+02
N-14	1	9.9 E+02	9.9 E+02	9.9 E+02	
N-27	1	2.8 E+02	2.8 E+02	2.8 E+02	
N-29	2	1.3 E+03	1.2 E+03	1.3 E+03	3.0 E+01
N-31	1	4.5 E+01	4.5 E+01	4.5 E+01	
N-32	1	9.6 E+00	9.6 E+00	9.6 E+00	
N-33	2	2.0 E+02	1.9 E+02	1.9 E+02	5.0 E+00
N-41	1	<1.0 E-01	<1.0 E-01	<1.0 E-01	
N-47	1	<3.3 E+01	<3.3 E+01	<3.3 E+01	
N-48	1	<7.3 E+01	<7.3 E+01	<7.3 E+01	
N-52	1	<1.7 E-03	<1.7 E-03	<1.7 E-03	
N-57	1	3.5 E+01	3.5 E+01	3.5 E+01	
N-58	1	<1.0 E-01	<1.0 E-01	<1.0 E-01	
N-60	1	<4.0 E-01	<4.0 E-01	<4.0 E-01	
N-61	1	<1.0 E-01	<1.0 E-01	<1.0 E-01	
N-66	1	2.7 E+00	2.7 E+00	2.7 E+00	
N-67	2	9.0 E+03	6.1 E+03	7.5 E+03	1.5 E+03
N-69	1	<1.0 E-01	<1.0 E-01	<1.0 E-01	
N-70	1	<3.0 E-01	<3.0 E-01	<3.0 E-01	
K-27	1	5.0 E-01	5.0 E-01	5.0 E-01	
K-28	1	8.0 E-01	8.0 E-01	8.0 E-01	
K-29	2	2.0 E-01	1.8 E-01	1.9 E-01	7.5 E-03
K-30	1	2.0 E-01	2.0 E-01	2.0 E-01	

DCG = 1.0 E+3 pCi/l

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Table D-4. Concentrations of ¹⁰⁶Ru Detected in 100-Area Groundwater (pCi/L) in 1990.

Well	No. of Samples	Maximum	Minimum	Average	Std. Dev.
N-2	1	<2.2 E+01	<2.2 E+01	<2.2 E+01	
N-3	2	<3.2 E+01	<1.8 E+01	<2.5 E+01	6.9 E+00
N-4	2	<2.2 E+01	<1.3 E+01	<1.8 E+01	4.5 E+00
N-8T	44	1.0 E+02	<1.7 E+00	<3.6 E+01	1.4 E+01
N-14	1	<1.6 E+00	<1.6 E+00	<1.6 E+00	
N-27	1	<9.4 E+00	<9.4 E+00	<9.4 E+00	
N-29	2	5.8 E+01	<9.9 E-01	<2.9 E+01	2.8 E+01
N-31	1	<4.2 E+00	<4.2 E+00	<4.2 E+00	
N-32	1	5.0 E+01	5.0 E+01	5.0 E+01	
N-33	2	<8.3 E+00	<4.5 E+00	<6.4 E+00	1.9 E+00
N-41	1	<4.0 E+01	<4.0 E+01	<4.0 E+01	
N-47	3	<3.2 E+01	<1.0 E+01	<1.8 E+01	9.7 E+00
N-48	3	<3.6 E+01	<1.6 E+01	<2.7 E+01	8.2 E+00
N-57	1	2.0 E+01	2.0 E+01	<2.0 E+01	
N-67	1	1.0 E+01	<1.0 E+01	<1.0 E+01	
N-70	1	<3.7 E+00	<3.7 E+00	<3.7 E+00	
K-27	3	<1.8 E+01	<1.0 E+01	<1.4 E+01	3.1 E+00
K-28	3	2.1 E+01	4.0 E+00	<1.0 E+01	7.5 E+00
K-29	4	8.5 E+00	<8.0 E-01	<4.0 E+00	2.9 E+00
K-30	3	3.5 E+00	<2.2 E+01	<1.6 E+01	9.1 E+00

DCG = 6.0 E+3 pCi/l

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Table D-5. Concentrations of ^{125}Sb Detected in 100-Area Groundwater (pCi/L) in 1990.

Well	No. of Samples	Maximum	Minimum	Average	Std. Dev.
N-3	1	9.0 E+00	9.0 E+00	9.0 E+00	
N-8T	43	5.8 E+01	1.8 E+00	2.4 E+01	1.1 E+01
N-31	1	8.7 E+01	8.7 E+01	8.7 E+01	
N-47	3	1.5 E+01	1.4 E+00	6.9 E+00	5.8 E+00
N-48	3	2.0 E+01	3.0 E+00	1.1 E+01	6.9 E+00
N-57	1	<5.0 E-01	<5.0 E-01	<5.0 E-01	
N-67	1	2.6 E+01	2.6 E+01	2.6 E+01	
K-27	2	1.0 E+02	7.6 E+01	8.9 E+01	1.4 E+01
K-28	2	2.0 E+01	6.4 E+00	1.3 E+01	6.9 E+00
K-29	2	1.5 E+00	<1.1 E+00	<1.3 E+00	2.0 E-01
K-30	2	5.6 E+00	2.4 E+00	4.0 E+00	1.6 E+00

DCG = 5.0 E+4 pCi/l

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Table D-6. Concentrations of Oil and Grease Detected in 100-N Area Groundwater (mg/L). (2 sheets)

Date	N-16	N-17	N-18	N-19	N-20	N-21	N-22	N-23	N-24	N-25	N-26
01/02/90				1.1	<1.0					<1.0	
01/09/90						<1.0			<1.0		
01/16/90								<1.0		<1.0	2.2
01/23/90	3.9							<1.0		<1.0	<1.0
01/30/90		1.4	8,660						<1.0		
01/30/90			4,096								
02/06/90				<1.0	<1.0					1.7	
02/13/90						2.2			<1.0		
02/20/90								2.5		1.2	1.6
02/27/90	2.4							<1.0		1.3	<1.0
03/06/90		30.3	15,290						1.3		
03/13/90				<1.0	1.9					<1.0	
03/20/90						<1.0			<1.0		
03/27/90								<1.0		<1.0	<1.0
04/03/90	2.3							<1.0		<1.0	<1.0
04/10/90		1.3	3,795						<1.0		
04/17/90				<1.0	<1.0					<1.0	
04/24/90						<1.0			<1.0		
05/01/90								<1.0		<1.0	<1.0
05/08/90	3.4							<1.4		<1.0	<1.0
05/15/90		<1.0	2,170						<1.0		
05/22/90				1.1	<1.0					<1.9	
05/29/90				<1.0					<1.0		
06/05/90								1.4		<1.0	<1.0
06/12/90	2.9							<1.0		<1.0	<1.0
06/19/90		2.2	1,309						<1.0		
06/26/90				1.1	1.1					1.0	
07/03/90							1.1		1.5		
07/10/90								16.9		<1.0	12.2
07/17/90	4.6							1.2		4.2	1.3
07/24/90		1.4							1.5		
07/31/90				1.6	1.9					15.8	
08/07/90						<0.6			0.9		
08/14/90								1.2		1.7	1.5
08/21/90								1.8			1.6
08/28/90		1.5							1.8		

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Table D-6. Concentrations of Oil and Grease Detected in 100-N Area Groundwater (mg/L). (2 sheets)

Date	N-16	N-17	N-18	N-19	N-20	N-21	N-22	N-23	N-24	N-25	N-26
09/04/90	0.9				0.8						
09/11/90						0.5					
09/18/90								0.7			0.6
09/25/90	3.6							1.0			1.1
10/02/90		1.7									
10/09/90				<0.6	<0.6						
10/16/90						<0.5					
10/23/90								0.9		<0.6	<0.6
10/30/90	104							<0.6		<0.6	<0.6
11/06/90	360	3.5									
11/13/90				<0.6	<0.7					<0.7	
11/20/90						<0.6				2.1	
11/27/90								<0.6		<0.6	<0.6
12/04/90	28							0.7		<0.6	0.7
12/11/90		<0.5							<0.6		
12/18/90				<0.6	<0.6					<0.6	
12/26/90						<0.6			<0.6		
# Samples	11	10	6	11	11	9	1	20	16	27	20
Maximum	360	30.3	15,290	1.6	1.9	2.2	1.1	16.9	1.8	15.8	12.2
Minimum	0.9	<0.5	1,309	<0.6	<0.6	0.5	1.1	<0.6	<0.6	<0.6	<0.6
Average	46.9	4.5	5,887	1.0	1.1	0.9	1.1	1.9	1.1	1.7	1.6
Stan. Dev.	103	8.6	4,804	0.3	0.4	0.5	0.0	3.5	0.3	2.8	2.5

Locations identified in Figure 3-1.

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Table D-7. Average Radionuclide Concentrations Detected in Well K-27* from 1982 through 1990 (pCi/L).

Year	⁶⁰ Co	¹²⁵ Sb
1982	1.4 E+00	1.0 E+02
1983	7.3 E+00	6.4 E+02
1984	9.7 E+00	5.2 E+02
1985	1.4 E+01	4.0 E+02
1986	6.6 E+00	3.3 E+02
1987	5.0 E+00	4.2 E+02
1988	8.0 E+00	2.0 E+02
1989	9.7 E+00	1.6 E+02
1990	<5.5 E-00	8.9 E+01
DCG	5.0 E+03	6.0 E+04

*Location identified in Figure 3-4.
 DCG = Derived concentration guides (US-DOE).
 NR = Not reported.

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APPENDIX E
SOIL AND VEGETATION MONITORING

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Table E-1. Concentrations of Radionuclides Detected in Surface Soil Samples Near the 1301-N Liquid Waste Disposal Facility (pCi/g, dry weight).

Sample Location*	Sample Type	Isotopes				
		⁶⁰ Co	⁹⁰ Sr	¹³⁷ Cs	²³⁸ Pu	^{239,240} Pu
N-1	S	1.7 E+00	7.6 E-02	2.7 E-01	1.1 E-03	7.5 E-03
N-2	S	4.8 E+00	6.7 E-02	3.8 E+00	4.4 E-03	4.6 E-02
N-3	S	1.6 E+01	1.3 E+00	4.0 E+00	1.6 E-02	1.1 E-01
N-4	S	7.9 E-01	1.1 E-01	2.7 E-01	8.3 E-04	7.4 E-03
N-5	S	3.8 E-01	5.6 E-02	2.9 E-01	4.2 E-04	3.1 E-03
Average		4.7 E+00	3.2 E-01	1.7 E+00	4.6 E-03	3.5 E-02
Std. Dev.		5.8 E+00	4.9 E-01	1.8 E+00	5.9 E-03	4.1 E-02
Hanford Site**		NR	2.3 E-01	2.1 E+00	NR	5.1 E-02
Offsite**		NR	1.3 E-01	7.4 E-01	NR	1.3 E-02

NR = Not reported.

*Locations identified in Figure 4-1.

**Average values obtained from Pacific Northwest Laboratory (PNL)-7346.

Table E-2. Concentrations of Radionuclides Detected in 100-N Surface Soil Samples (pCi/g, dry weight).

Sample Location*	Sample Type	Isotopes				
		⁶⁰ Co	⁹⁰ Sr	¹³⁷ Cs	²³⁸ Pu	^{239,240} Pu
N-6	S	4.6 E-01	1.1 E-01	3.7 E-01	2.4 E-04	8.4 E-03
N-7	S	1.5 E-01	2.2 E-01	9.9 E-01	7.2 E-04	2.3 E-02
N-8	S	7.2 E-01	2.3 E-01	1.0 E+00	1.7 E-03	2.2 E-02
N-9	S	7.2 E-02	4.5 E-02	1.1 E-01	<4.0 E-05	1.2 E-03
N-10	S	2.9 E-01	9.8 E-02	3.1 E-01	9.0 E-04	6.1 E-03
N-11	S	3.6 E-01	1.1 E-01	2.9 E-01	1.0 E-03	8.3 E-03
N-12	S	8.1 E-02	1.6 E-02	<3.0 E-02	<9.5 E-05	9.0 E-04
Average		3.0 E-01	1.2 E-01	4.4 E-01	6.7 E-04	1.0 E-02
Std. Dev.		2.2 E-01	7.5 E-02	3.7 E-01	5.5 E-04	8.4 E-03
Hanford Site**		NR	2.3 E-01	2.1 E+00	NR	5.1 E-02
Offsite**		NR	1.3 E-01	7.4 E-01	NR	1.3 E-02

NR = Not reported.

*Location identified in Figure 4-1.

**Average values obtained from Pacific Northwest Laboratory (PNL)-7346.

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Table E-3. Radionuclide Concentrations (pCi/g, dry weight) Detected in 100-K Area Surface Soil Samples.

Sample Location*	Sample Type	Isotopes				
		⁶⁰ Co	⁹⁰ Sr	¹³⁷ Cs	²³⁸ Pu	^{239,240} Pu
K-1	S	3.3 E+00	1.8 E+00	3.6 E+01	1.3 E-02	3.5 E-01
K-2	S	1.6 E-01	7.4 E-01	2.8 E-01	2.4 E-04	1.1 E-02
K-3	S	2.1 E-01	3.8 E-01	6.5 E-01	4.8 E-04	1.5 E-02
K-4	S	<4.9 E-02	1.0 E-01	2.7 E-01	6.0 E-05	5.7 E-03
K-5	S	1.1 E-0	1.1 E-01	2.6 E-01	3.3 E-04	1.0 E-02
Average		7.7 E-01	6.3 E-01	7.5 E+00	2.8 E-03	7.8 E-02
Std. Dev.		1.3 E+00	6.3 E-01	1.4 E+01	5.1 E-03	1.4 E-01
Hanford Site**		NR	3.1 E-01	2.9 E+00	NR	1.0 E-01
Offsite**		NR	1.6 E-01	5.9 E-01	NR	1.0 E-02

NR = Not reported.

*Locations identified in Figure 4-6.

**Average values obtained from Pacific Northwest Laboratory (PNL)-6825.

Table E-4. Radionuclide Concentrations (pCi/g, dry weight) Detected in Vegetation Samples Near the 1301-N LWDF 1990.

Sample Location*	Sample Type	⁶⁰ Co	⁹⁰ Sr	¹³⁷ Cs	²³⁸ Pu	^{239,240} Pu
N-1	V	1.3 E-01	1.1 E-02	<4.6 E-02	<8.9 E-06	3.4 E-04
N-2	V	3.3 E+00	7.0 E-02	2.1 E-01	3.9 E-04	2.2 E-03
N-3	V	2.8 E+00	4.1 E-02	<2.1 E-03	8.4 E-04	2.3 E-03
N-4	V	2.1 E-01	2.3 E-02	2.6 E-01	<8.0 E-05	<2.4 E-04
N-5	V	<2.4 E-02	1.2 E-02	<6.7 E-02	<2.3 E-05	4.2 E-04
Average		1.3 E+00	3.1 E-02	1.2 E-01	2.7 E-04	1.1 E-03
Std. Dev.		1.4 E+00	2.2 E-02	1.0 E-01	3.2 E-04	9.4 E-04
Hanford Site**		NR	1.2 E-02	4.1 E-02	NR	1.0 E-03
Offsite**		NR	5.2 E-02	7.0 E-03	NR	1.0 E-04

NR = Not reported.

*Locations identified in Figure 4-7.

**Average values obtained from Pacific Northwest Laboratory (PNL)-7346.

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Table E-5. Radionuclide Concentrations (pCi/g, dry weight) Detected in 100-N Vegetation Samples 1990.

Sample Location*	Sample Type	⁶⁰ Co	⁹⁰ Sr	¹³⁷ Cs	²³⁸ Pu	^{239,240} Pu
N-6	V	<7.8 E-02	9.8 E-03	1.6 E-02	<4.0 E-05	<2.4 E-04
N-7	V	<3.3 E-02	<4.2 E-03	<6.8 E-02	<2.5 E-05	<5.0 E-05
N-8	V	2.3 E-01	9.1 E-03	<3.4 E-02	<9.2 E-05	3.2 E-04
N-9	V	<6.8 E-02	6.7 E-03	<6.2 E-03	<2.3 E-05	<1.4 E-04
N-10	V	<4.3 E-02	1.3 E-02	1.1 E-01	<2.6 E-04	<1.5 E-04
N-11	V	2.5 E-01	2.2 E-02	<1.5 E-02	<1.7 E-04	<1.7 E-04
N-12	V	<9.2 E-02	<2.9 E-04	<4.2 E-03	<5.9 E-05	<1.0 E-04
Average		1.1 E-01	9.3 E-03	3.6 E-02	<9.6 E-05	1.7 E-04
Std. Dev.		8.2 E-02	6.4 E-03	3.6 E-02	8.2 E-05	8.3 E-05
Hanford Site**		NR	1.2 E-02	4.1 E-02	NR	1.0 E-03
Offsite**		NR	5.2 E-02	7.0 E-03	NR	1.0 E-04

NR = Not reported.

*Locations identified in Figure 4-7.

**Average values obtained from Pacific Northwest Laboratory (PNL)-7346.

9 2 1 2 5 7 9 1 8 8 7

Table E-6. Radionuclide Concentrations (pCi/g, dry weight) Detected in 100-B/C Area Vegetation Samples.

Sample Location*	Sample Type	⁶⁰ Co	⁹⁰ Sr	¹³⁷ Cs	²³⁸ Pu	^{239,240} Pu
B-1	V	8.2 E-02	1.3 E-02	7.5 E-02	<2.2 E-05	<4.6 E-05
B-2	V	<2.9 E-02	1.1 E-02	<1.4 E-02	<4.8 E-05	4.8 E-04
C-1	V	<4.3 E-02	2.9 E-01	1.0 E-01	<1.3 E-05	<2.5 E-04
C-2	V	<2.7 E-02	5.1 E-02	8.0 E-02	<1.8 E-05	4.1 E-04
Average		4.5 E-02	9.1 E-02	6.7 E-02	2.5 E-05	3.0 E-04
Std. Dev.		2.2 E-02	1.2 E-01	3.2 E-02	1.4 E-05	1.7 E-04
Hanford Site**		NR	1.2 E-02	4.1 E-02	NR	1.0 E-03
Offsite**		NR	5.2 E-02	7.0 E-03	NR	1.0 E-04

NR = Not reported.

*Locations identified in Figure 4-2.

**Average values obtained from Pacific Northwest Laboratory (PNL)-7346.

Table E-7. Radionuclide Concentrations (pCi/g, dry weight) Detected in 100-D/DR Area Vegetation Samples.

Sample Location*	Sample Type	⁶⁰ Co	⁹⁰ Sr	¹³⁷ Cs	²³⁸ Pu	^{239,240} Pu
D-1	V	<4.4 E-02	7.1 E-03	<6.6 E-03	<1.9 E-05	2.4 E-04
D-2	V	<3.3 E-02	3.7 E-02	<1.8 E-02	<5.0 E-05	<2.3 E-04
D-3	V	<8.0 E-03	1.7 E-02	<4.4 E-02	<2.9 E-06	<8.0 E-05
D-4	V	1.6 E-01	3.2 E-01	2.4 E+00	<2.6 E-05	4.8 E-04
Average		6.1 E-02	9.5 E-02	6.2 E-01	2.4 E-05	2.6 E-04
Std. Dev.		5.8 E-02	1.3 E-01	1.0 E+00	1.7 E-05	1.4 E-04
Hanford Site**		NR	1.2 E-02	4.1 E-02	NR	1.0 E-03
Offsite**		NR	5.2 E-02	7.0 E-03	NR	1.0 E-04

NR = Not reported.

*Locations identified in Figure 4-2.

**Average values obtained from Pacific Northwest Laboratory (PNL)-7346.

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Table E-8. Radionuclide Concentrations (pCi/g, dry weight) Detected in 100-F Area Vegetation Samples.

Sample Location*	Sample Type	⁶⁰ Co	⁹⁰ Sr	¹³⁷ Cs	²³⁸ Pu	^{239,240} Pu
F-1	V	<4.3 E-02	3.1 E-01	4.5 E-01	<4.4 E-05	<2.0 E-04
F-2	V	1.3 E-01	9.3 E-01	1.5 E+00	<7.3 E-05	6.1 E-04
F-3	V	<6.4 E-02	8.9 E-02	1.4 E-01	<5.4 E-05	<4.0 E-04
F-4	V	<3.4 E-03	1.4 E-02	<1.3 E-02	<4.8 E-05	<1.9 E-04
F-5	V	<1.1 E-02	2.5 E-02	<1.5 E-02	<2.5 E-05	<4.0 E-04
Average		5.0 E-02	2.7 E-01	4.2 E-01	4.9 E-05	3.6 E-04
Std. Dev.		4.5 E-02	3.5 E-01	5.6 E-1	1.6 E-05	1.6 E-04
Hanford Site**		NR	1.2 E-02	4.1 E-02	NR	1.0 E-03
Offsite**		NR	5.2 E-02	7.0 E-03	NR	1.0 E-04

NR = Not reported.

*Locations identified in Figure 4-2.

**Average values obtained from Pacific Northwest Laboratory (PNL)-7346.

Table E-9. Radionuclide Concentrations (pCi/g, dry weight) Detected in 100-H Area Vegetation Samples.

Sample Location*	Sample Type	⁶⁰ Co	⁹⁰ Sr	¹³⁷ Cs	²³⁸ Pu	^{239,240} Pu
H-1	V	<1.7 E-01	1.5 E-02	1.2 E-01	<1.8 E-04	<2.0 E-04
H-2	V	<8.8 E-02	<6.9 E-03	<1.1 E-02	<9.0 E-05	4.0 E-04
Average		1.3 E-01	1.1 E-02	6.6 E-02	1.4 E-04	3.0 E-04
Std. Dev.		4.1 E-02	4.1 E-03	5.4 E-02	4.5 E-05	1.0 E-04
Hanford Site**		NR	1.2 E-02	4.1 E-02	NR	1.0 E-03
Offsite**		NR	5.2 E-02	7.0 E-03	NR	1.0 E-04

NR = Not reported.

*Locations identified in Figure 4-2.

**Average values obtained from Pacific Northwest Laboratory (PNL)-7346.

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Table E-10. Radionuclide Concentrations (pCi/g, dry weight) Detected in 100-K Area Vegetation Samples.

Sample Location*	Sample Type	⁶⁰ Co	⁹⁰ Sr	¹³⁷ Cs	²³⁸ Pu	^{239,240} Pu
K-1	V	<1.6 E-02	3.8 E+01	<1.8 E-02	<1.0 E-04	<1.4 E-04
K-2	V	1.2 E-01	7.9 E-01	<3.1 E-02	<1.2 E-04	<2.0 E-04
K-3	V	<2.4 E-02	6.0 E-01	<3.6 E-02	<2.9 E-04	<3.1 E-04
K-4	V	<3.0 E-03	5.0 E-01	<1.1 E-02	<1.6 E-04	<2.6 E-04
K-5	V	<6.1 E-02	1.9 E-02	1.1 E-01	<1.8 E-04	3.6 E-04
Average		4.5 E-02	8.0 E+00	4.1 E-02	1.7 E-04	2.5 E-04
Std. Dev.		4.2 E-02	1.5 E+01	3.6 E-02	6.6 E-05	7.8 E-05
Hanford Site**		NR	1.2 E-02	4.1 E-02	NR	1.0 E-03
Offsite**		NR	5.2 E-02	7.0 E-03	NR	1.0 E-04

NR = Not reported.

*Locations identified in Figure 4-2.

**Average values obtained from Pacific Northwest Laboratory (PNL)-7346.

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APPENDIX F
EXTERNAL RADIATION MONITORING

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Table F-1. The 1990 Thermoluminescent Dosimeter Results from 100N Area. (2 sheets)

Location ^a	Number of samples	Dose Rate - mrem/hr ^b			mrem/work year ^c
		Maximum	Minimum	Average	
1 RA	4	0.170	0.137	0.156	324
2 RA	4	0.170	0.145	0.156	325
3 RA	4	0.075	0.063	0.069	143
4 RA	4	0.339	0.278	0.315	655
5 RA	4	0.117	0.098	0.104	217
6 RA	4	0.040	0.033	0.036	75
7 RA	4	0.157	0.130	0.148	307
8	4	0.009	0.007	0.008	17
9	4	0.011	0.010	0.010	21
10	4	0.009	0.007	0.008	17
11	4	0.011	0.007	0.010	20
12	4	0.011	0.008	0.010	20
13	4	0.015	0.014	0.015	31
14	4	0.056	0.041	0.051	107
15 RA	4	0.130	0.120	0.126	262
16	4	0.039	0.034	0.037	77
17	4	0.005	0.004	0.005	10
18 RA	4	0.100	0.072	0.086	178
19	4	0.195	0.005	0.067	138
20	4	0.006	0.001	0.005	10
21	4	0.051	0.047	0.049	101
22 RA	4	0.092	0.074	0.082	170
23	4	0.004	0.001	0.003	7
24	4	0.007	0.003	0.006	11
25	3	0.008	0.005	0.005	11
26	4	0.035	0.031	0.033	69
27	4	0.010	0.007	0.009	18
28	4	0.042	0.032	0.036	75
29 RA	4	0.322	0.254	0.297	617

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Table F-1. The 1990 Thermoluminescent Dosimeter Results from 100N Area. (2 sheets)

Location ^a	Number of samples	Dose Rate - mrem/hr ^b			mrem/work year ^c
		Maximum	Minimum	Average	
30 RA	4	1.073	0.502	0.888	1846
31	4	0.037	0.030	0.032	67
32	4	0.048	0.046	0.047	99
33	4	0.029	0.022	0.027	57
34 RA	4	2.022	0.985	1.552	3229
35 RA	4	1.888	0.852	1.536	3194
36 RA	4	0.058	0.042	0.053	110
37	4	0.045	0.043	0.044	91
38	4	0.049	0.045	0.047	97
39	4	0.027	0.025	0.026	55
40	4	0.044	0.040	0.042	87
41	4	0.055	0.053	0.054	113
ALARA guideline for occupational exposure to nonradiation zone workers.					240

^aLocations identified in Figure 5-1.

^bMonthly integrated readings in mrem were converted to hourly dose equivalent rates.

^cMonthly integrated readings in mrem were converted to work year dose equivalent rates.

RA = Area controlled as a radiation area.

ALARA = as low as reasonably achievable.

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9 2 1 2 5 7 9 1 8 9 5

Date	Thermoluminescent Dosimeter Location (mrem/hr)*										
	1	2	3	4	5	6	7	8	9	10	11
22-Dec-89 to 19-Mar-90	0.137	0.145	0.075	0.339	0.117	0.040	0.130	0.007	0.010	0.007	0.007
19-Mar-90 to 15-Jun-90	0.156	0.155	0.070	0.336	0.100	0.037	0.152	0.008	0.010	0.008	0.010
15-Jun-90 to 28-Sep-90	0.170	0.170	0.068	0.307	0.103	0.035	0.152	0.008	0.010	0.008	0.011
28-Sep-90 to 14-Dec-90	0.160	0.155	0.063	0.278	0.098	0.033	0.157	0.009	0.011	0.009	0.011
No. of samples	4	4	4	4	4	4	4	4	4	4	4
Maximum	0.170	0.170	0.075	0.339	0.117	0.040	0.157	0.009	0.011	0.009	0.011
Minimum	0.137	0.145	0.063	0.278	0.098	0.033	0.130	0.007	0.010	0.007	0.007
Average	0.156	0.156	0.069	0.315	0.104	0.036	0.148	0.008	0.010	0.008	0.010

Date	Thermoluminescent Dosimeter Location (mrem/hr)*										
	12	13	14	15	16	17	18	19	20	21	22
22-Dec-89 to 19-Mar-90	0.008	0.014	0.056	0.128	0.039	0.004	0.072	0.195	0.001	0.051	0.092
19-Mar-90 to 15-Jun-90	0.010	0.015	0.053	0.130	0.038	0.005	0.092	0.060	0.006	0.049	0.083
15-Jun-90 to 28-Sep-90	0.010	0.015	0.055	0.126	0.037	0.005	0.100	0.005	0.005	0.048	0.078
28-Sep-90 to 14-Dec-90	0.011	0.015	0.041	0.120	0.034	0.005	0.079	0.006	0.006	0.047	0.074
No. of samples	12	12	12	12	12	12	12	12	12	12	12
Maximum	0.011	0.015	0.056	0.130	0.039	0.005	0.100	0.195	0.006	0.051	0.092
Minimum	0.008	0.014	0.041	0.120	0.034	0.004	0.072	0.005	0.001	0.047	0.074
Average	0.010	0.015	0.051	0.126	0.037	0.005	0.086	0.067	0.005	0.049	0.082

Table F-2. The 1990 Monthly Thermoluminescent Dosimeter Results From 100N Area. (2 sheets)

WHC-EP-0258-2

Table F-2. The 1990 Monthly Thermoluminescent Dosimeter Results From 100N Area. (2 sheets)

WHC-EP-0258-2

Date	Thermoluminescent Dosimeter Location (mrem/hr)*										
	23	24	25	26	27	28	29	30	31	32	33
22-Dec-89 to 19-Mar-90	0.001	0.003	0.005	0.034	0.007	0.042	0.254	0.502	0.031	0.047	0.029
19-Mar-90 to 15-Jun-90	0.004	0.007	0.008	0.035	0.010	0.037	0.308	0.937	0.037	0.048	0.028
15-Jun-90 to 28-Sep-90	0.004	0.005	-0.003	0.031	0.009	0.032	0.322	1.038	0.031	0.048	0.029
28-Sep-90 to 14-Dec-90	0.004	0.006	0.008	0.032	0.009	0.034	0.304	1.073	0.030	0.046	0.022
No. of samples	4	4	4	4	4	4	4	4	4	4	4
Maximum	0.004	0.007	0.008	0.035	0.010	0.042	0.322	1.073	0.037	0.048	0.029
Minimum	0.001	0.003	-0.003	0.031	0.007	0.032	0.254	0.502	0.030	0.046	0.022
Average	0.003	0.006	0.004	0.033	0.009	0.036	0.297	0.888	0.032	0.047	0.027

Date	Thermoluminescent Dosimeter Location (mrem/hr)*							
	34	35	36	37	38	39	40	41
22-Dec-89 to 19-Mar-90	0.985	0.852	0.042	0.044	0.049	0.025	0.041	0.054
19-Mar-90 to 15-Jun-90	2.002	1.660	0.054	0.045	0.048	0.027	0.041	0.055
15-Jun-90 to 28-Sep-90	2.022	1.888	0.058	0.044	0.045	0.027	0.044	0.055
28-Sep-90 to 14-Dec-90	1.201	1.743	0.058	0.043	0.045	0.026	0.040	0.053
No. of samples	4	4	4	4	4	4	4	4
Maximum	2.022	1.888	0.058	0.045	0.049	0.027	0.044	0.055
Minimum	0.985	0.852	0.042	0.043	0.045	0.025	0.040	0.053
Average	1.552	1.536	0.053	0.044	0.047	0.026	0.042	0.054

*Locations identified in Figure 5-1.

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APPENDIX G
RADIOLOGICAL SURVEYS

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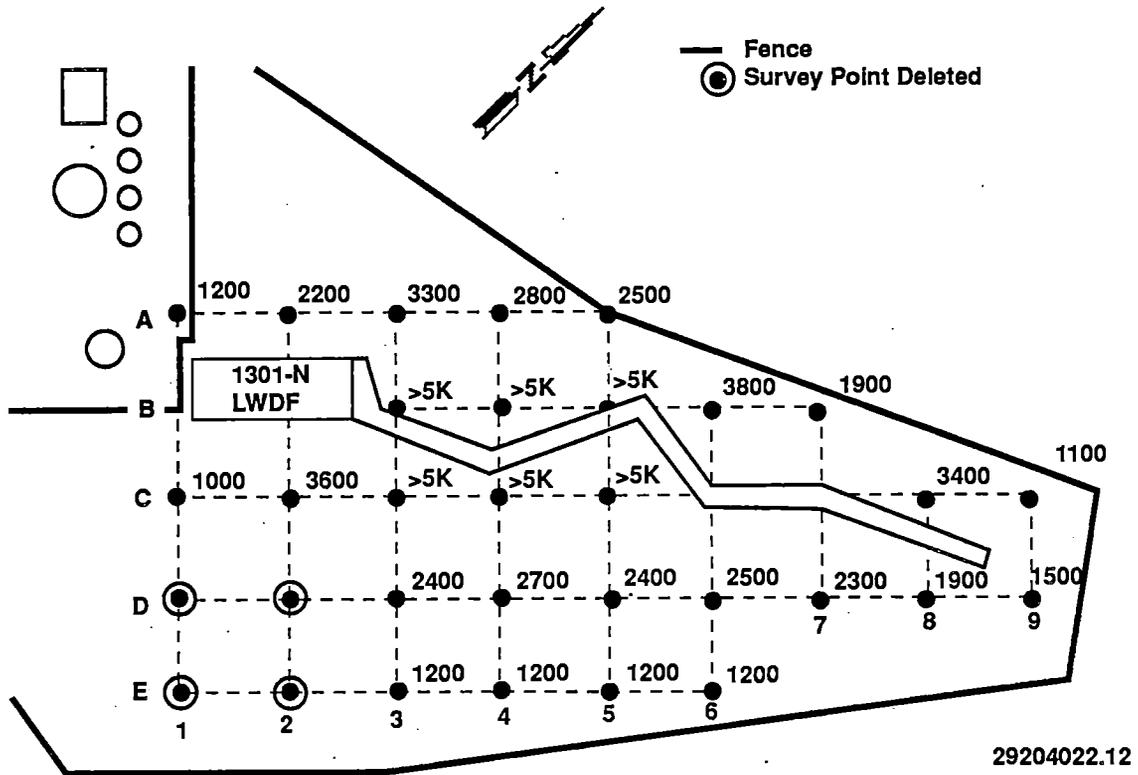
Table G-1. Environmental Dose Rates (relative $\mu\text{rem/h}$)
Measured at the 100-N Area Shoreline.

Location*	Relative Dose	Location*	Relative Dose	Location*	Relative Dose
1	11	33	120	65	140
2	13	34	130	66	115
3	17	35	135	67	110
4	18	36	145	68	100
5	19	37	145	69	90
6	25	38	150	70	85
7	31	39	150	71	80
8	36	40	170	72	75
9	43	41	160	73	65
10	49	42	170	74	65
11	55	43	195	75	55
12	60	44	210	76	55
13	65	45	225	77	40
14	75	46	240	78	40
15	85	47	240	79	35
16	100	48	225	80	33
17	105	49	240	81	30
18	85	50	240	82	30
19	70	51	230	83	25
20	55	52	240	84	23
21	50	53	245	85	20
22	55	54	235	86	18
23	55	55	230	87	18
24	50	56	230	88	17
25	60	57	225	89	16
26	60	58	210	90	15
27	65	59	205	91	15
28	70	60	190	92	13
29	80	61	175	93	13
30	90	62	165		
31	110	63	160		
32	115	64	145		

*Locations identified in Figure 7-1.

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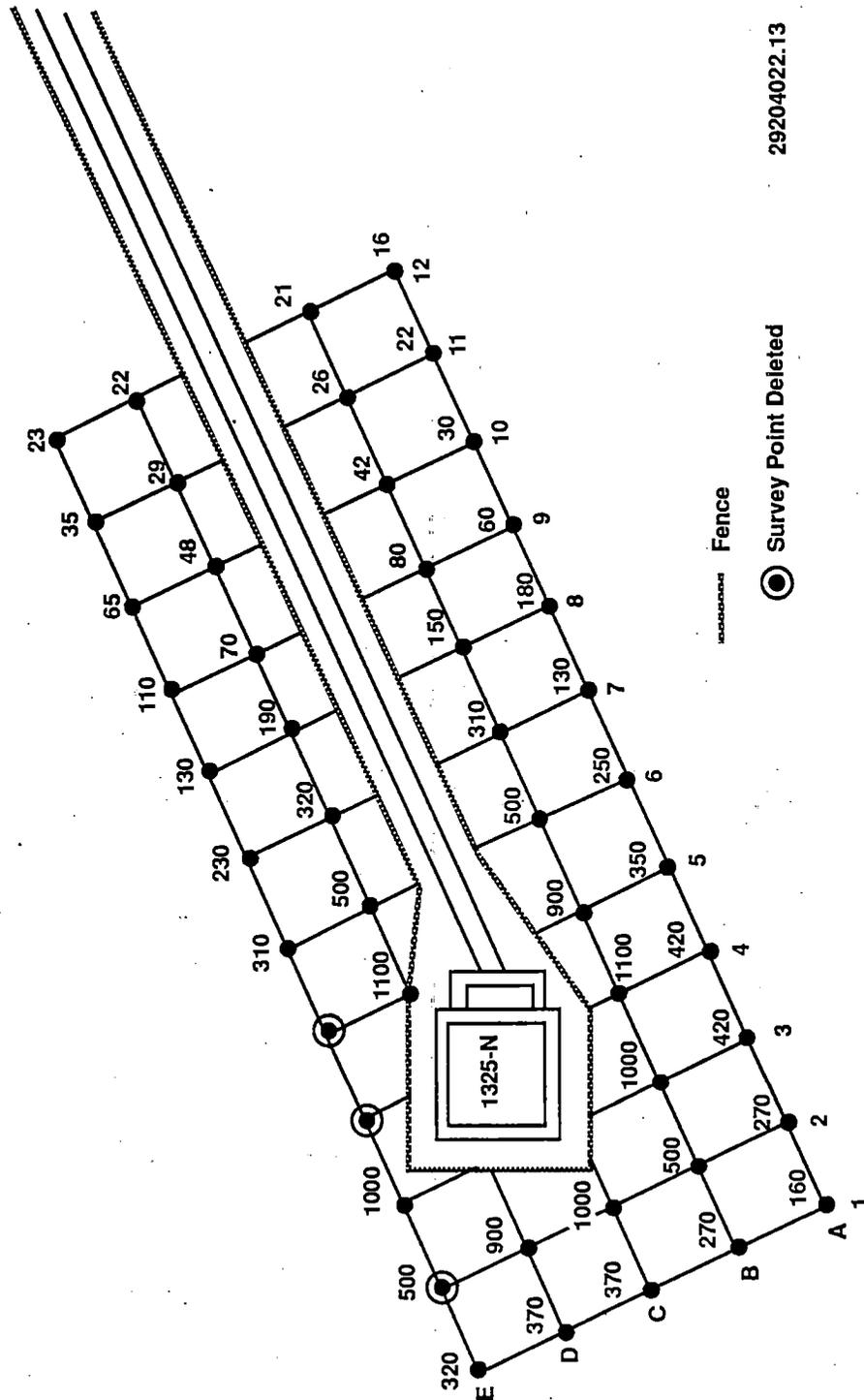
Figure G-1. Environmental Dose Rates ($\mu\text{rem/h}$) Measured at Survey Points Around the 1301-N Liquid Waste Disposal Facility in 1989.



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Figure G-2. Environmental Dose Rates ($\mu\text{rem/h}$) Measured at Survey Points Around the 1325-N Liquid Waste Disposal Facility in 1989.



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