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UNC ENVIRONMENTAL SURVEILLANCE REPORT
FOR THE 100 AREAS -- FY 1981

Author: E. M. Greager

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# UNC ENVIRONMENTAL SURVEILLANCE REPORT

# FOR THE 100 AREAS -- FY 1981

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## SUMMARY

The UNC Environmental Surveillance Program for the 100 Areas provides monitoring to assist in evaluating the environmental impact of 100-N Reactor facilities, the shutdown reactor facilities, and burial grounds in the retired 100 Areas. The major objectives of the program are to monitor radionuclide concentrations in radiological release pathways, maintenance of a data base for trend analyses, sampling and data for accidental release analyses, and demonstration of compliance with applicable regulations.

The surveillance program consists of sampling and monitoring of several environmental parameters. At 100-N Area, samples of ambient air, groundwater, vegetation, soil, and sediment are collected and analyzed along with direct radiation measurements around the 1301-N Facility and along the river shoreline. At the retired 100 Areas, soil and vegetation samples are collected and analyzed. Special samples to monitor the potential biotransport of radionuclides may also be included in the surveillance program.

Based on the sampling performed for the environmental surveillance program, 100 Area facilities are in compliance with applicable regulations and there is no significant adverse environmental impact from past or present reactor operations.

9413222.2018

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# 1.0 ENVIRONMENTAL SURVEILLANCE PROGRAM

## 1.1 Purpose of the Program

The UNC Environmental Surveillance Program for the 100 Areas provides monitoring to assist in evaluating the environmental impact of 100-N Reactor facilities, retired 100 Area facilities, and 100 Area burial grounds on the immediately surrounding environment. The program is designed to evaluate trend changes in releases to various pathways to the environs from reactor facilities. The major objectives of this program are:

- Detection of radionclide concentrations in identified radiological release pathways.
- Detection and evaluation of changes in the radionuclide concentrations discharged to or existing in the immediate environment. This will serve as a means of detecting system changes or failures, so that appropriate actions may be taken.
- Maintenance of a data base for trend analyses in order to provide the capability for evaluation and response to changes in radioactive material releases from any off-normal or accident condition.
- Provide samples and data to be used for "after-the-fact" accidental release analyses.
- Demonstrate compliance with applicable regulations.

The evaluation of the population dose resulting from the operation of N Reactor is the responsiblility of Pacific Northwest Laboratory (PNL). UNC Nuclear Industries supplies radionuclide discharge data to PNL for use in the preparation of these analyses.

In order to establish monitoring requirements, the radiological release pathways from 100-N Area facilities to the immediate environment were analyzed and a flow diagram produced (Figure 1.1). This pathway diagram was used as the basis for the monitoring at 100-N Area in the surveillance program. Similar types of pathway analyses were performed to determine the scope of environmental monitoring in the retired 100 Areas.

The UNC Environmental Surveillance Program for the 100 Areas is summarized in Table 1.1. In addition, special samples to monitor the potential biotransport of radionuclides may also be collected and included in the surveillance program.

The surveillance program for the 100 Areas is continually improved and upgraded. Sampling procedures, techniques, and frequencies are subject to change as more experience is gained in surveillance of the 100 Area environs.

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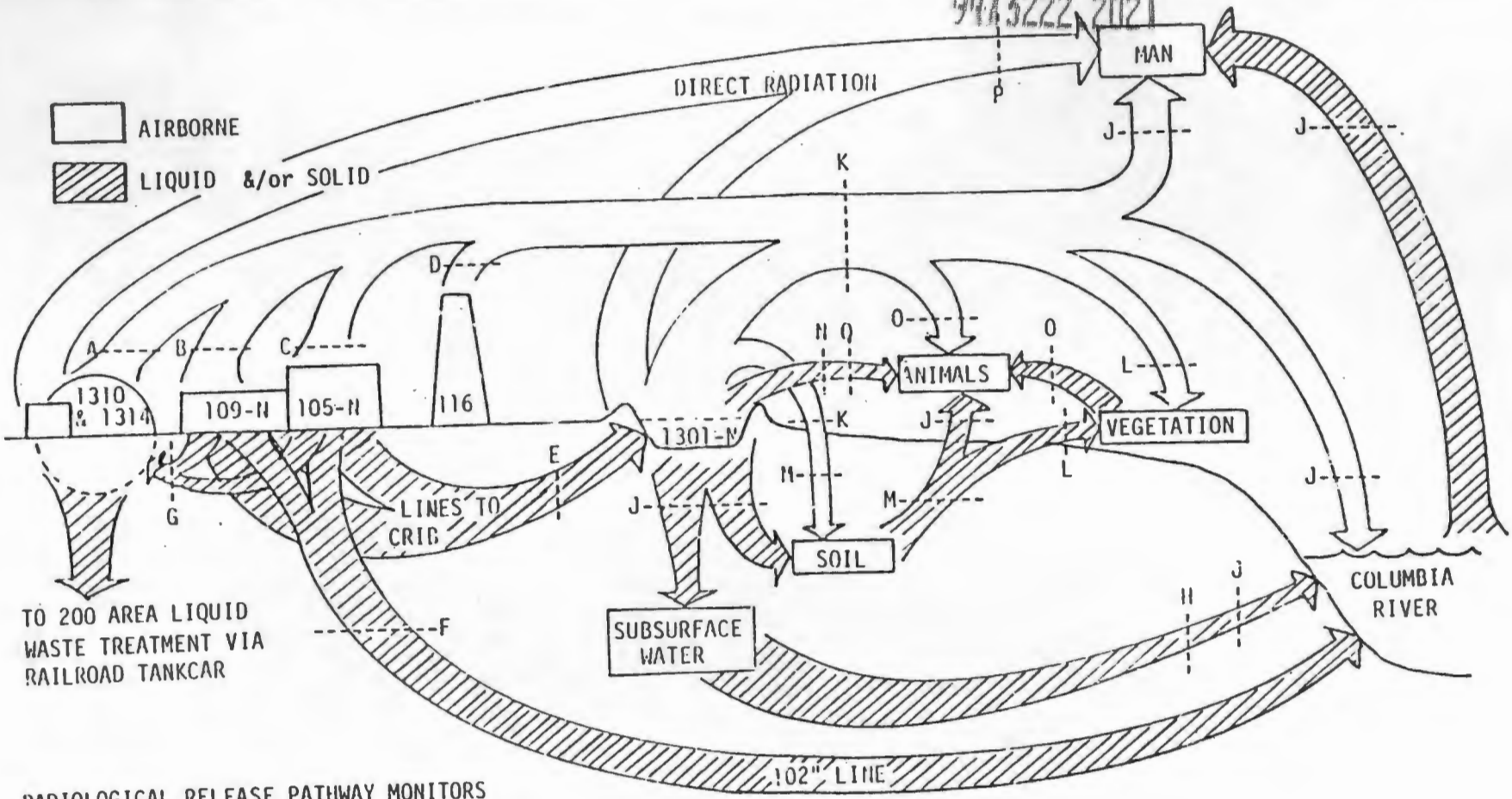


RADIOLOGICAL RELEASE PATHWAY MONITORS
(INDICATED BY DASHED LINES):

EFFLUENT RADIOANALYTICAL PROGRAM

- A AIRBORNE SAMPLER ON TANK VENTS
- B CONTINUOUS SAMPLING SYSTEM
- C CONTINUOUS SAMPLING SYSTEM
- D CONTINUOUS SAMPLING SYSTEM
- E FLOW PROPORTIONAL COMPOSITE SAMPLER
- F CONTINUOUS LARGE VOLUME SAMPLER
- G SAMPLE ANALYSIS DURING STORAGE & SHIPMENT
- H MULTIPLE CONTINUOUS COMPOSITE SAMPLERS

ENVIRONMENTAL SURVEILLANCE PROGRAM

- J PNL ENVIRONMENTAL PROGRAM
- K CONTINUOUS AIR SAMPLERS
- L VEGETATION SAMPLING
- M SOIL SAMPLING
- N WIRE MESH TRENCH COVER
- O 100-N AREA PERIMETER FENCE
- P TLDs AND DIRECT RADIATION MEASUREMENT

Figure 1.1. Major Radiological Release Pathways Between 100-N Facilities and the Environs

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Table 1.1. Summary of the UNC Environmental Surveillance Program for the 100 Area.

| Type Sample | Sampling Method | Number of Sample Locations | Sampling Frequency | Type Analysis |
|---|---|---|---|---|
| Air Samples | Low volume continuous sampler with particulate filtration and charcoal filter. (100-N Area only) | 4 | Monthly | Particulate - Gross alpha and beta and major gamma emitters Charcoal - major gamma emitters. |
| Ground Water Samples | Sample provided to UNC by PNL. (100-N Area only) | 18 | Quarterly | Major gamma emitters. |
| Soil Samples | Surface soil, approximately 100 cc (All 100 Areas) | 28 | Annually | Major gamma emmitters. Sr and Pu. |
| Trench Sediment | Dip samples of ∿25 cc of trench bottom sediment. (100-N Area only) | 9 | Annually | Major gamma emitters. Sr and Pu. |
| Vegetation Samples | ∿One pound (500 g) sample of vegetation, collected and dried. (all 100 Areas) | 31 | Annually | Major gamma emitters. Sr and Pu. |
| Riverbank Springs Vegetation Samples | Same as above (100-N Area only) | 4 | Annually | Major gamma emitters. Sr and Pu. |
| Gamma Radiation, 100-N | $CaF_2$:Mn (TLD-400) Dosimeters (100-N only) | 22 | Monthly | --- |
| Gamma Radiation Crib/ Trench | Integrated count using hand-held survey instrument (100-N Area only) | 27 | Annually | --- |
| Gamma Radiation River Shoreline | Same as above (100-N Area only) | 50 | Annually | --- |

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## 1.2 Surveillance Program Procedures

Measurements in the UNC radioanalytical lab are limited to gamma scans of samples containing varying and unknown concentrations of fission and activation products. To perform the analyses, three lithium-drifted, germainium (Ge-Li) detectors are used. Sample analysis procedures have been established by UNC and documented in Section 2.0 of UNI-M-76 REV1, "Effluent Radioanalytical Program". Strontium and plutonium analyses are performed by the U.S. Testing Company.

The precision and accurancy of radioanalytical instrumentation is maintained thru a laboratory Quality Control Program. The procedures for this Quality Control Program are included in Section 5.0 of UNI-M-76, REV1.

Consistency in sample collection techniques is important in comparing different sets of data and validating trend analyses. Sample collection procedures are described in the following sections.

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## 2.0 AIR SAMPLING

Environmental air sampling is conducted as a means of evaluating radionuclide discharges which could result in radiation exposures to N Reactor personnel and trend changes which could be an indication of variations in either the input to a facility or in the functioning of some part of the facility.

A "sampling train", consisting of collection devices, an air mover, and an air flow system is used. The collection device is a standard cartridge sampler (UNC Print H-1-39022). This cartridge contains a 1 cfm orifice, particulate filtration, and a charcoal absorber for halogens. A continuous duty, low volume air pump is installed, along with the cartridge, in a weatherproof enclosure.

Four continuous air sampling stations monitor 100-N Area as shown in Figure 2.1. Samples are collected monthly and analyzed for gamma emitters. The particulate filter is also analyzed for gross alpha and beta. Radionulide concentrations detected in the air samples are listed in Table 2.1

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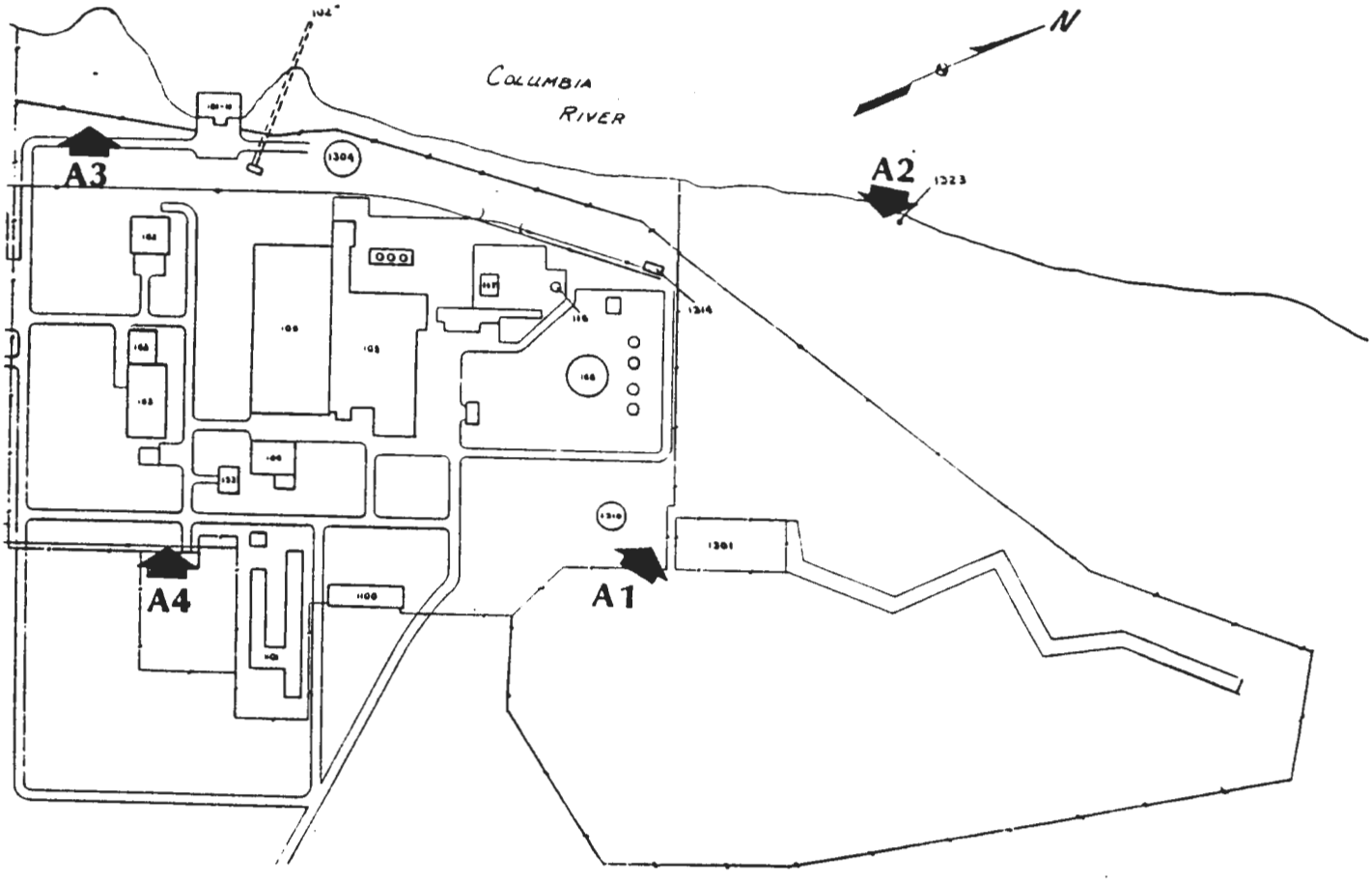


Figure 2.1. Continuous Air Sampling Locations at 100-N Area.

Table 2.1. Radionuclide Concentrations Detected in Air Samples at 100-N Area. Concentrations are in pCi/L.

| Sample Location | Month* | Particulate | Charcoal | | |
|---|---|---|---|---|---|
| | | Co-60 | As-76 | I-131 | I-133 |
| A1 | September | ND | $9.0 \times 10^{-2}$ | $2.0 \times 10^{-4}$ | $3.0 \times 10^{-3}$ |
| A2 | September | $3.1 \times 10^{-4}$ | ND | $6.8 \times 10^{-5}$ | ND |
| A3 | September | ND | ND | ND | ND |
| A4 | September | ND | ND | ND | ND |

*The continuous air monitoring phase of the surveillance program was initiated in September, 1981.

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## 3.0 GROUNDWATER SAMPLING

Groundwater sampling is performed at 100-N Area to monitor the movement of radionuclides between the 1301-N crib/trench and the riverbank springs. This monitoring aids in determining the effectiveness of the soil column for entrapping radionuclides. Groundwater monitoring is also used to help determine the integrity of underground piping, basins, tanks, and other structures holding radioactive liquids.

Eighteen groundwater monitoring wells at 100-N Area are sampled by PNL (Figure 3.1). These wells are sampled once every quarter and analyzed for beta emitters and tritium. Semi-annually, the samples are analyzed for stontium and gamma emitters.

Each quarter, PNL provides a one gallon sample of water from each well to UNC. These quarterly samples are analyzed for concentrations of gamma-emitting radionuclides. Detectable concentrations of radionuclides in the groundwater samples are listed in Table 3.1.

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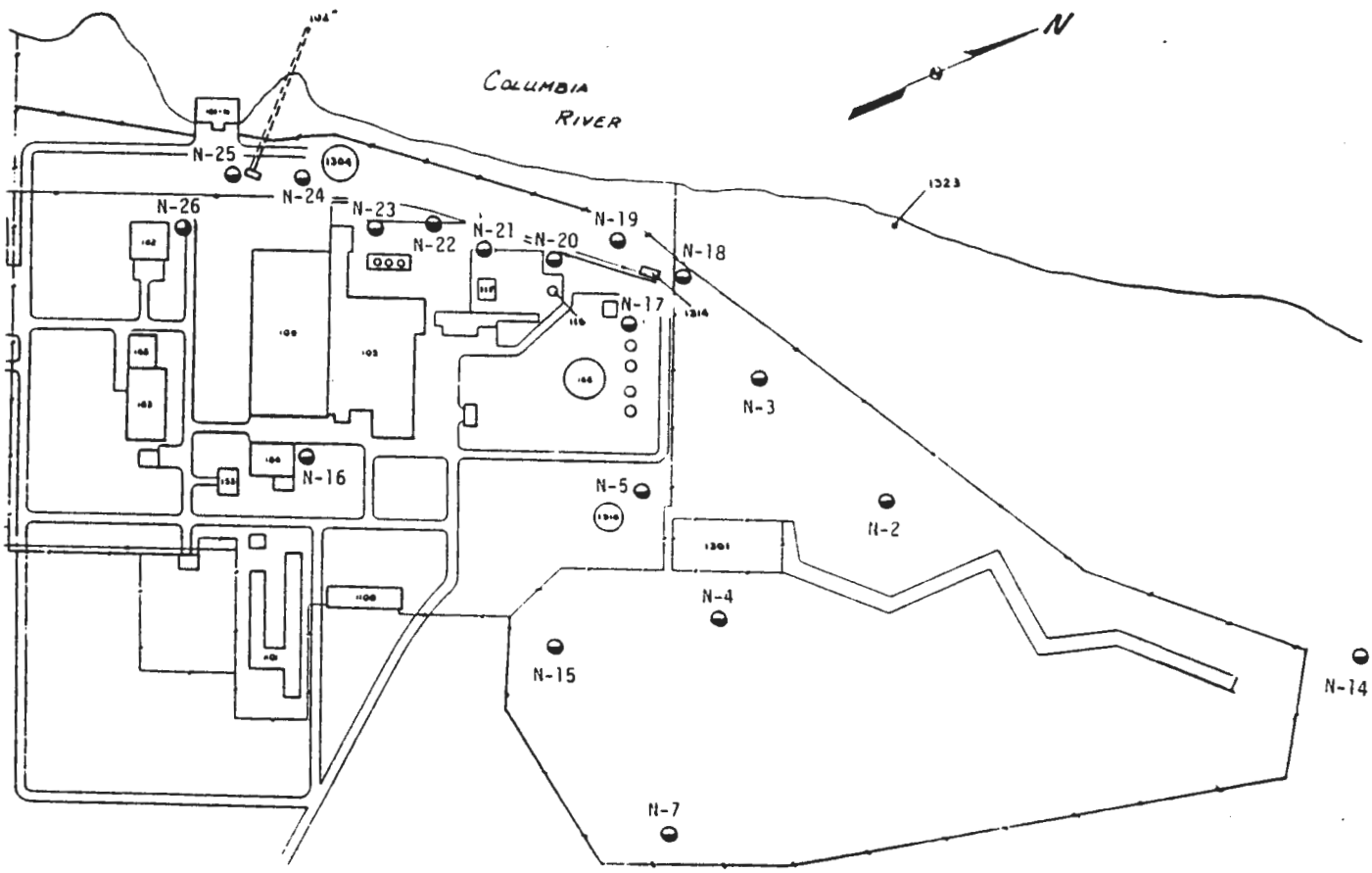


Figure 3.1. Location of Groundwater Monitoring Wells at 100-N Area.

Table 3.1. Average Radionuclide Concentrations Detected in Groundwater Samples Collected at 100-N Area. Concentrations are in pCi/L.

| Well Number | Co-60 | Ru-103 | Ru-106 | Sb-125 | Nd-147 |
|---|---|---|---|---|---|
| N-2 | 530 | 81 | 370 | 270 | ND |
| N-3 | 260 | 49 | 250 | 46 | ND |
| N-4 | 43 | ND | 75 | 6 | 570 |
| N-5 | 310 | 26 | 240 | 200 | ND |
| N-7 | 140 | 46 | 140 | 33 | ND |
| N-14 | 200 | 54 | 150 | 40 | ND |
| N-15 | 60 | ND | 72 | 8 | ND |
| N-20 | 10 | ND | ND | 9 | ND |

ND = Not Detected

Due to the completion schedule of the new wells for diesel oil detection, samples from wells N-16 through N-19 and N-21 through N-26 were not analyzed in time for this report.

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## 4.0 SOIL SAMPLING

Soil sampling provides a means to evaluate radionuclides which settle out of the air, are absorbed from liquid releases to the soil, or spread due to the burial of radioactive solid waste. Soil samples were collected once during 1980 at each of the 100 Areas. Sample locations are indicated on Figures 4.1 - 4.6. Soil sampling locations were selected to maximize the potential for detecting radionuclides from either airborne deposition, past leakage or disposal of radioactive liquid effluents, or past disposal of radioactive solid waste.

Soil samples consisted of surface soil (top 2.5 cm) collected with a small trowel. Approximately 100 cc of soil was collected at each location. Radionuclide concentrations detected in these soil samples are listed in Table 4.1.

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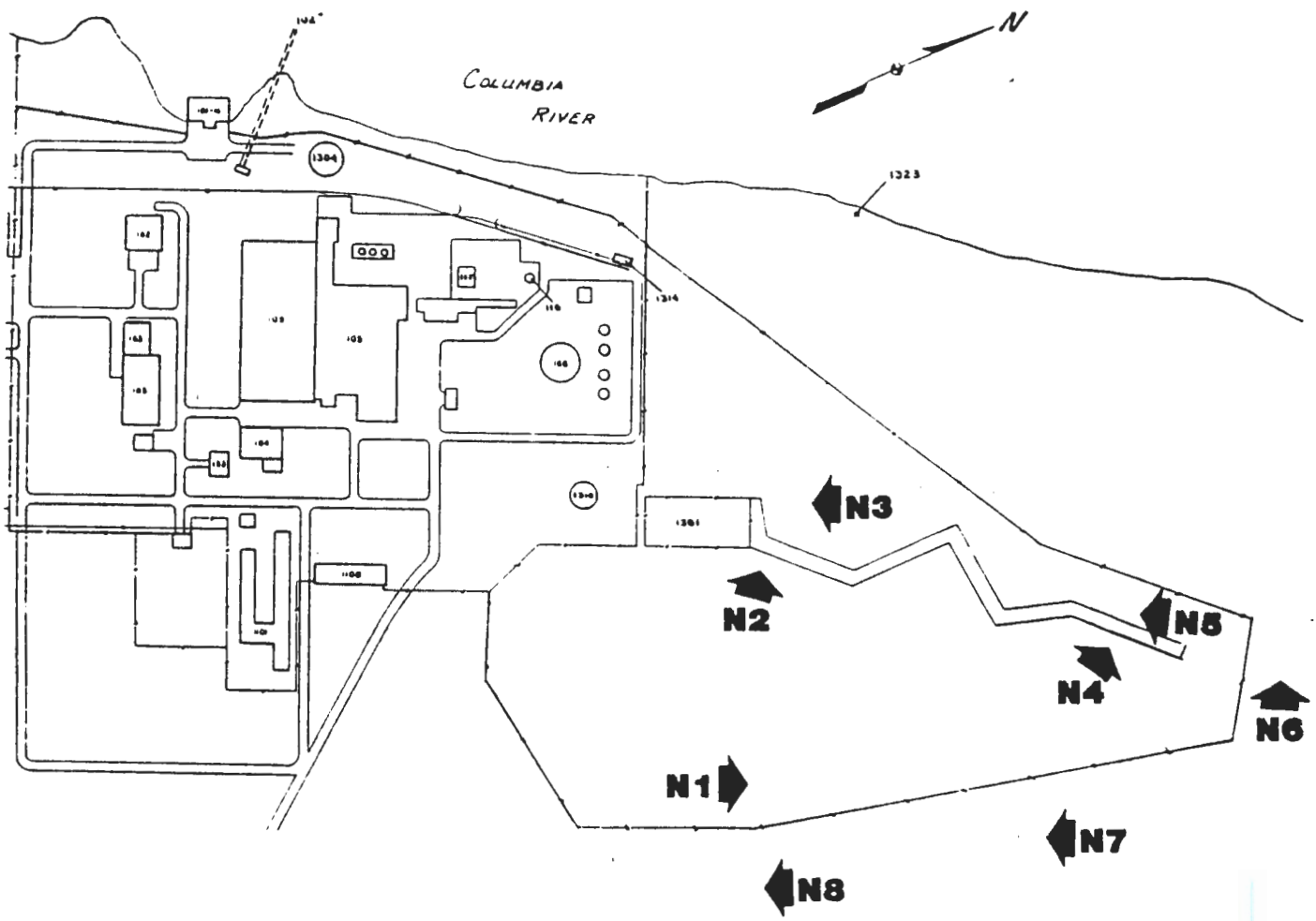


Figure 4.1. Soil and Vegetation Sampling Locations at 100-N Area.

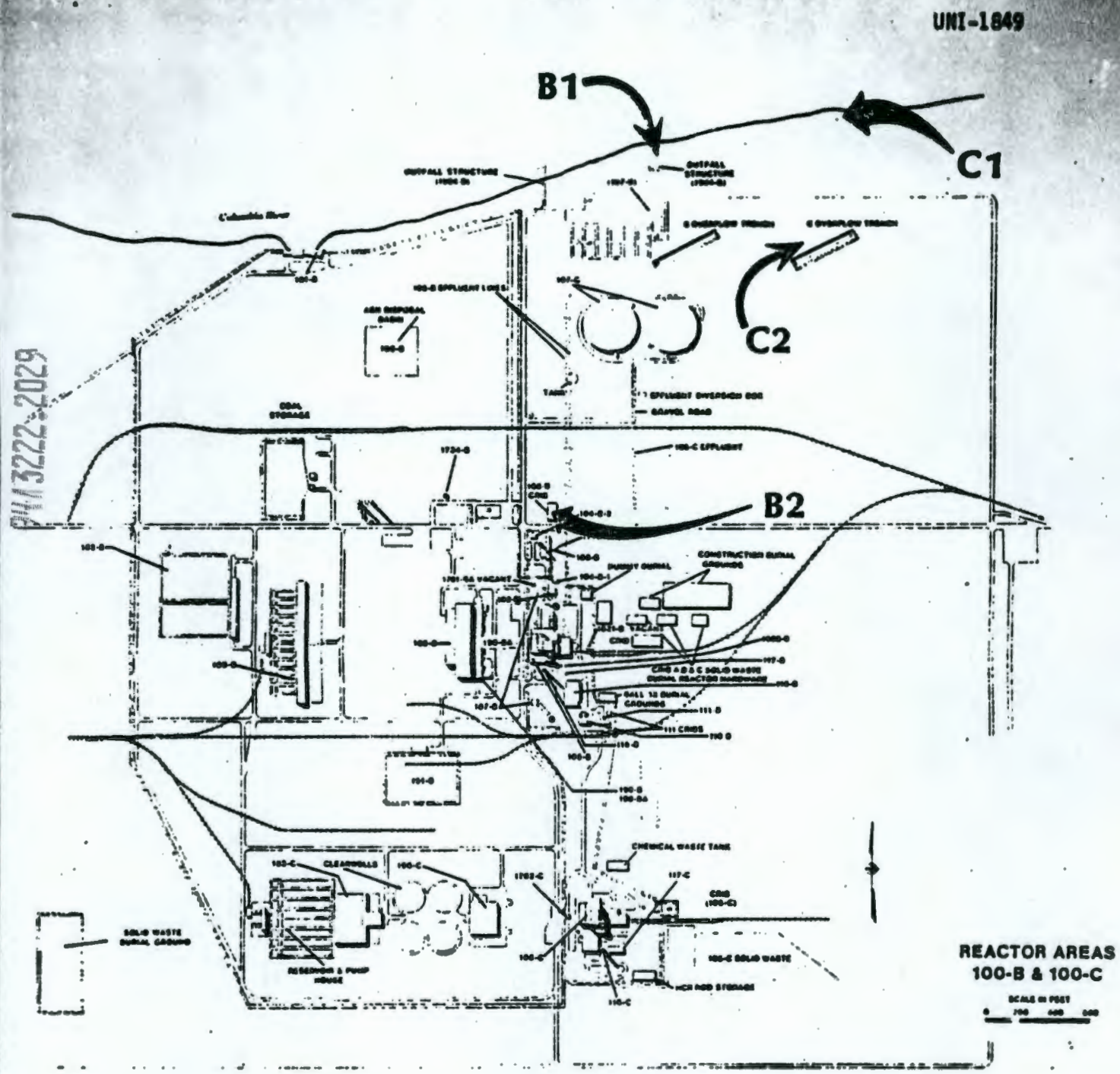


Figure 4.2. Soil and Vegetation Sampling Locations at 100-B/C Area.

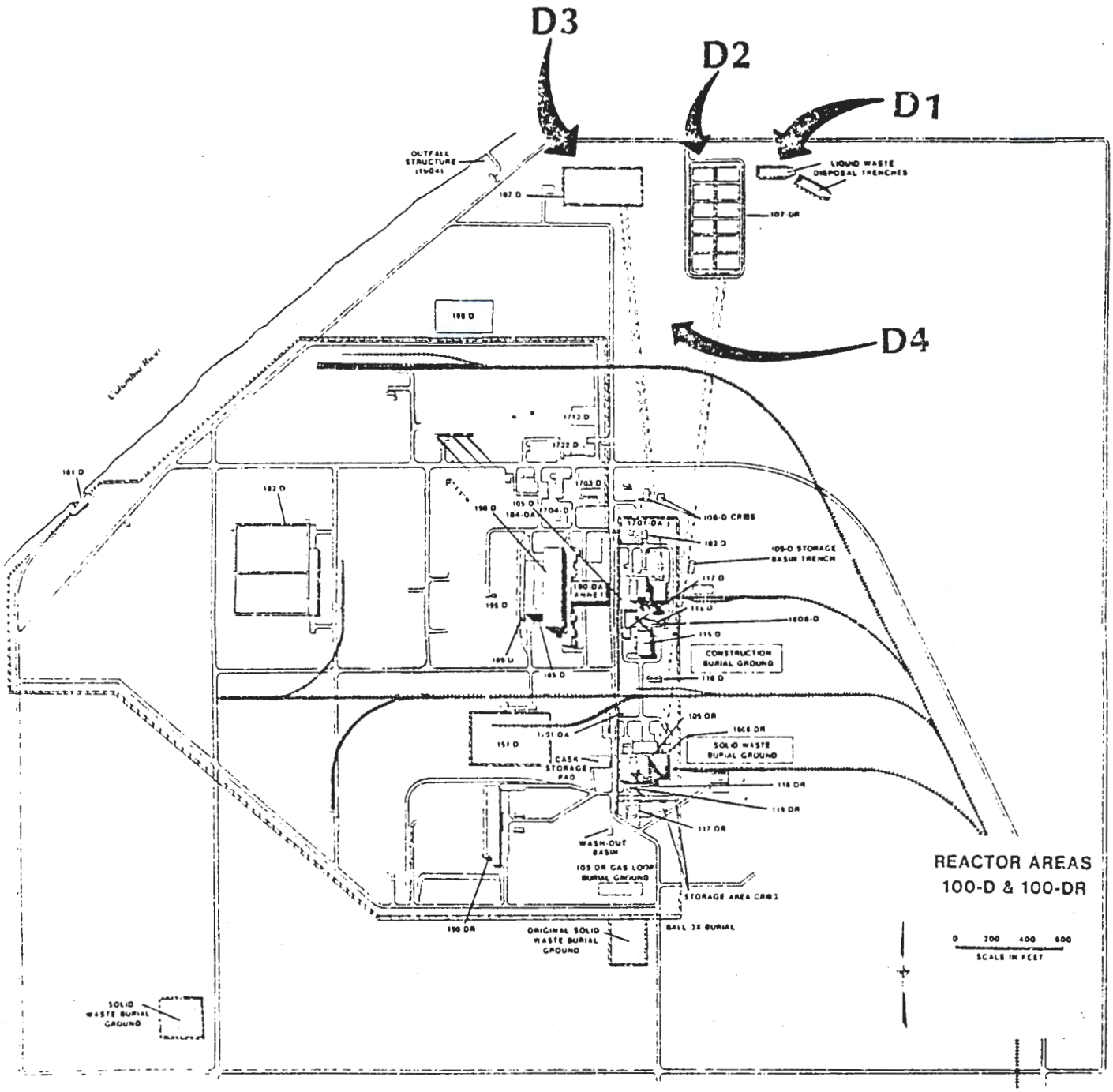


Figure 4.3. Soil and Vegetation Sampling Locations at 100-D/DR Area.

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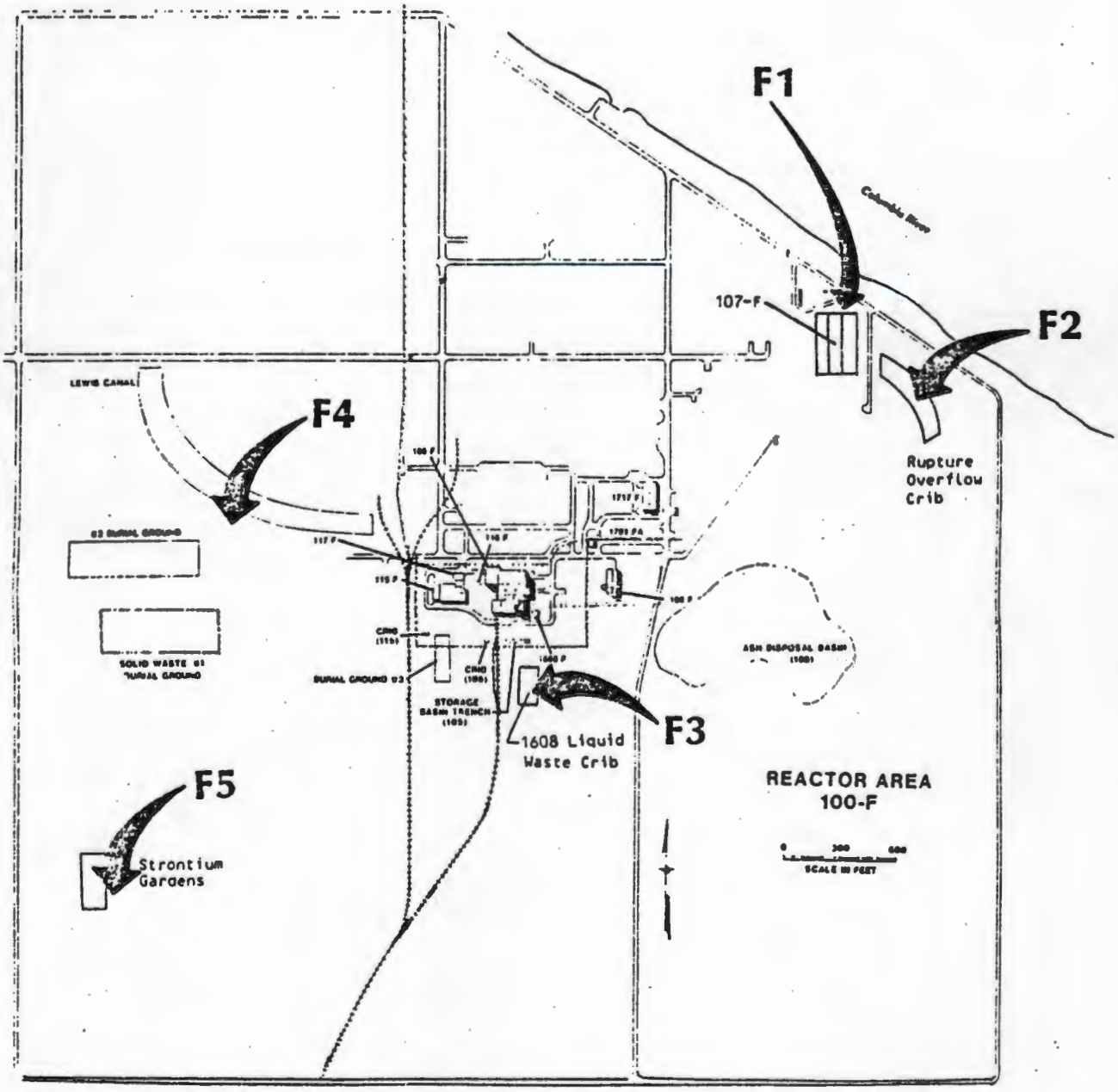


Figure 4.4. Soil and Vegetation Sampling Locations at 100-F Area.

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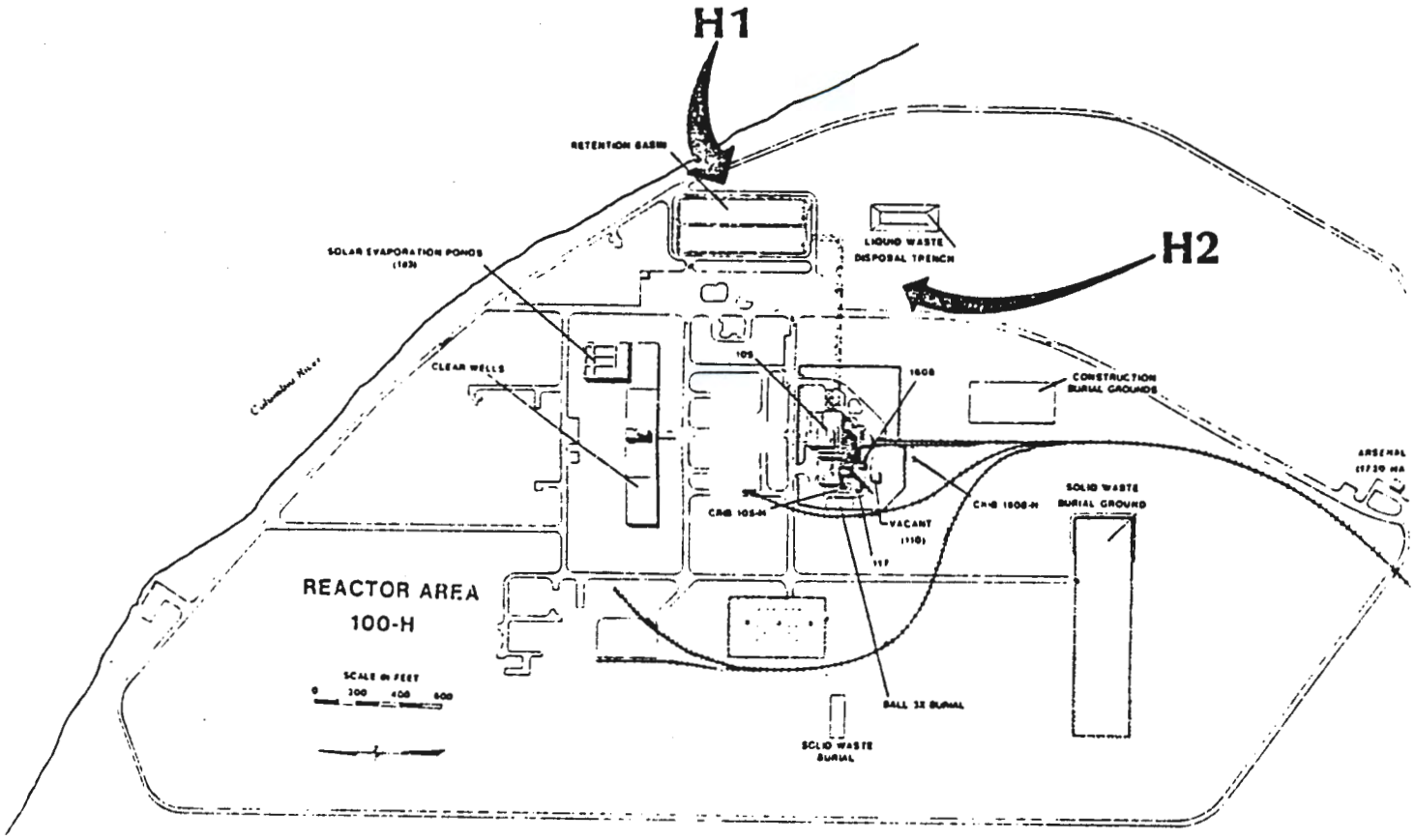


Figure 4.5. Soil and Vegetation Sampling Locations at 100-H Area.

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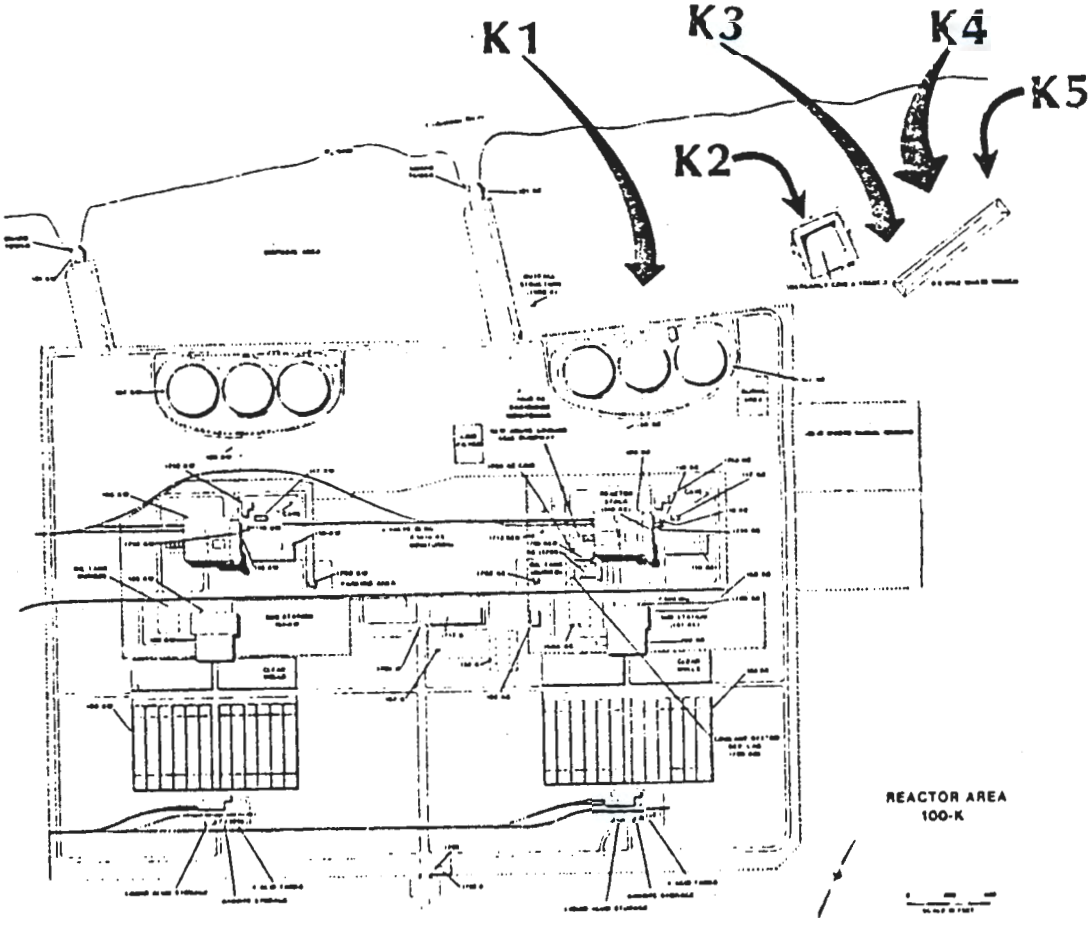


Figure 4.6. Soil and Vegetation Sampling Locations at 100-K Area.

Table 4.1. Radionuclide Concentrations Detected in Soil Samples Collected in the 100 Areas. Concentrations are in pCi/g (dry weight).

| SAMPLE | Mn-54 | Co-60 | Cs-137 | CePr-144 | Eu-152 | Eu-154 |
|---|---|---|---|---|---|---|
| S-N1 | ND | 2.9 | 0.73 | ND | ND | ND |
| S-N2 | 17 | 130 | 17 | 10 | ND | ND |
| S-N3 | 7.2 | 61 | 5.8 | 2.8 | ND | 0.70 |
| S-N4 | 0.97 | 5.6 | 3.6 | ND | ND | ND |
| S-N5 | 1.2 | 2.5 | 3.5 | ND | ND | ND |
| S-N6 | ND | 0.79 | 1.6 | ND | ND | ND |
| S-N7* | -- | -- | -- | -- | -- | -- |
| S-N8 | 0.16 | 1.8 | 0.44 | ND | ND | ND |
| S-B1 | ND | 0.72 | 0.92 | ND | 0.63 | ND |
| S-B2 | ND | 0.27 | 0.69 | ND | 0.28 | ND |
| S-C1 | ND | 0.62 | 2.1 | ND | 1.6 | ND |
| S-C2 | ND | 0.65 | 0.99 | ND | 2.3 | 0.65 |
| S-D1 | ND | 0.68 | 1.1 | ND | 0.97 | ND |
| S-D2 | ND | 0.30 | 0.25 | ND | 0.33 | ND |
| S-D3 | ND | 0.33 | 0.13 | ND | 0.44 | ND |
| S-D4 | ND | 0.13 | 0.11 | ND | ND | ND |
| S-F1 | ND | 0.32 | 0.25 | ND | ND | 0.58 |
| S-F2 | ND | 0.31 | 0.34 | ND | 0.52 | ND |
| S-F3 | ND | 0.50 | 1.1 | ND | 1.4 | ND |
| S-F4 | ND | 0.15 | 0.11 | ND | ND | ND |
| S-F5 | ND | 0.16 | 1.2 | ND | ND | ND |
| S-H1* | -- | -- | -- | -- | -- | -- |
| S-H2 | ND | 0.15 | 0.09 | ND | ND | ND |
| S-K1 | ND | 0.84 | 0.76 | ND | 1.7 | 0.74 |
| S-K2 | ND | 2.7 | 16 | ND | 3.6 | 1.6 |
| S-K3 | ND | 0.21 | 0.67 | ND | ND | ND |
| S-K4 | ND | 0.21 | ND | ND | ND | ND |
| S-K5 | ND | 0.21 | 0.35 | ND | ND | ND |

*Sample Lost

ND - Not Detected

In addition to the radionuclide concentrations listed above, the following concentrations were found: 2.8 pCi/g of Fe-59 and 0.29 pCi/g of Cs-134 in S-N4; 0.9 pCi/g of Cs-134 in S-N5; 11 pCi/g of Ru-103 in S-N8; and 0.27 pCi/g of Eu-155 in S-K1.

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## 5.0 TRENCH SEDIMENT SAMPLING

Trench sediment samples were collected once during 1981 at the locations indicated in Figure 5.1. Sediment samples were obtained by attaching a small jar to the end of a long pole and using this device as a scoop. Approximately 25 cc of sediment is collected. Sediment gathered by the scoop is transferred to a 200 mL jar and the scoop is then rinsed with the water in the trench.

Radionuclide concentrations detected in trench sediment samples are listed in Table 5.1. A comparison of the average concentrations of several radionculides found in trench sediment samples over the past several years is included in Table 5.2 and Figure 5.2.

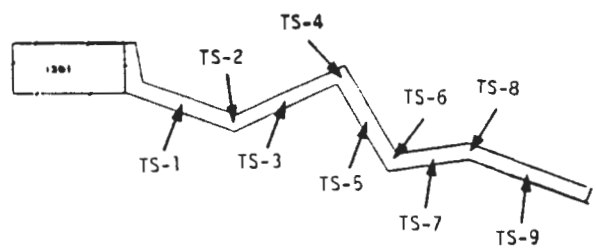


Figure 5.1. Trench Sediment Sampling Locations.

Table 5.1. Radionuclide Concentrations Detected in 1301-N Trench Sediment Samples*. Concentrations are in pCi/g (dry weight).

| Sample Location | Mn-54 | Co-60 | Sr-90 | Cs-137 | CePr-144 | Pu-238 | Pu-239/240 |
|---|---|---|---|---|---|---|---|
| TS-1 | $1.3\times10^{6}$ | $6.6\times10^{6}$ | $1.7\times10^{5}$ | $1.9\times10^{5}$ | $2.7\times10^{6}$ | $5.5\times10^{3}$ | $2.6\times10^{4}$ |
| TS-2 | $1.1\times10^{6}$ | $6.3\times10^{6}$ | $7.7\times10^{5}$ | $1.9\times10^{5}$ | $1.1\times10^{6}$ | $1.5\times10^{3}$ | $9.2\times10^{3}$ |
| TS-3 | $1.7\times10^{6}$ | $1.9\times10^{7}$ | $1.1\times10^{5}$ | $5.3\times10^{5}$ | ND | $6.2\times10^{3}$ | $2.5\times10^{4}$ |
| TS-4 | $9.8\times10^{5}$ | $6.0\times10^{6}$ | $3.6\times10^{4}$ | $3.3\times10^{5}$ | $1.2\times10^{6}$ | $1.8\times10^{3}$ | $1.2\times10^{4}$ |
| TS-5 | $3.9\times10^{5}$ | $4.4\times10^{6}$ | $2.1\times10^{4}$ | $4.9\times10^{5}$ | $4.4\times10^{5}$ | $7.8\times10^{2}$ | $5.5\times10^{3}$ |
| TS-6 | $1.3\times10^{6}$ | $1.7\times10^{7}$ | $9.6\times10^{4}$ | $5.7\times10^{5}$ | $7.7\times10^{5}$ | $4.9\times10^{3}$ | $2.5\times10^{4}$ |
| TS-7 | $9.0\times10^{5}$ | $8.9\times10^{6}$ | $1.1\times10^{5}$ | $5.3\times10^{5}$ | $8.4\times10^{5}$ | $6.3\times10^{3}$ | $3.0\times10^{4}$ |
| TS-8 | $7.5\times10^{5}$ | $5.4\times10^{6}$ | $2.5\times10^{4}$ | $4.4\times10^{5}$ | $7.9\times10^{5}$ | $1.2\times10^{3}$ | $6.6\times10^{3}$ |
| TS-9 | $9.9\times10^{5}$ | $8.3\times10^{6}$ | $4.5\times10^{4}$ | $7.8\times10^{5}$ | $1.1\times10^{5}$ | $4.0\times10^{3}$ | $2.0\times10^{4}$ |
| Avg. | $1.0\times10^{6}$ | $9.1\times10^{6}$ | $1.5\times10^{5}$ | $4.5\times10^{5}$ | $9.9\times10^{5}$ | $3.6\times10^{3}$ | $1.8\times10^{4}$ |

*In addition to the radionuclides listed above, sample TS-1 contained $1.4 \times 10^{5}$ pCi/g of Nb-95 and $7.5\times10^{5}$ pCi/g of Ru-106 and sample TS-2 contained $9.0 \times 10^{4}$ pCi/g of Nb-95.

ND = Not Detected

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Table 5.2. Comparison of Average Concentrations (pCi/g - dry wt.) of Selected Radionuclides in 1301-N Trench Sediment Samples Since 1975.

| Year | Co-60 | Cs-137 | Sr-90 | Pu-239/240 |
|---|---|---|---|---|
| 1975 | $5.2 \times 10^6$ | $1.1 \times 10^6$ | $2.4 \times 10^3$ | $9.8 \times 10^2$ |
| 1976 | $2.0 \times 10^6$ | $1.8 \times 10^5$ | $2.7 \times 10^4$ | $3.7 \times 10^3$ |
| 1977 | $7.1 \times 10^5$ | $7.9 \times 10^4$ | $2.1 \times 10^4$ | $4.6 \times 10^3$ |
| 1978 | $5.2 \times 10^6$ | $2.2 \times 10^5$ | $2.5 \times 10^4$ | $5.2 \times 10^3$ |
| 1979 | $2.6 \times 10^7$ | $8.1 \times 10^5$ | $4.2 \times 10^4$ | $6.2 \times 10^3$ |
| 1980 | $6.4 \times 10^6$ | $2.8 \times 10^5$ | $1.1 \times 10^5$ | $4.0 \times 10^4$ |
| 1981 | $9.1 \times 10^6$ | $4.5 \times 10^5$ | $1.5 \times 10^5$ | $1.8 \times 10^4$ |

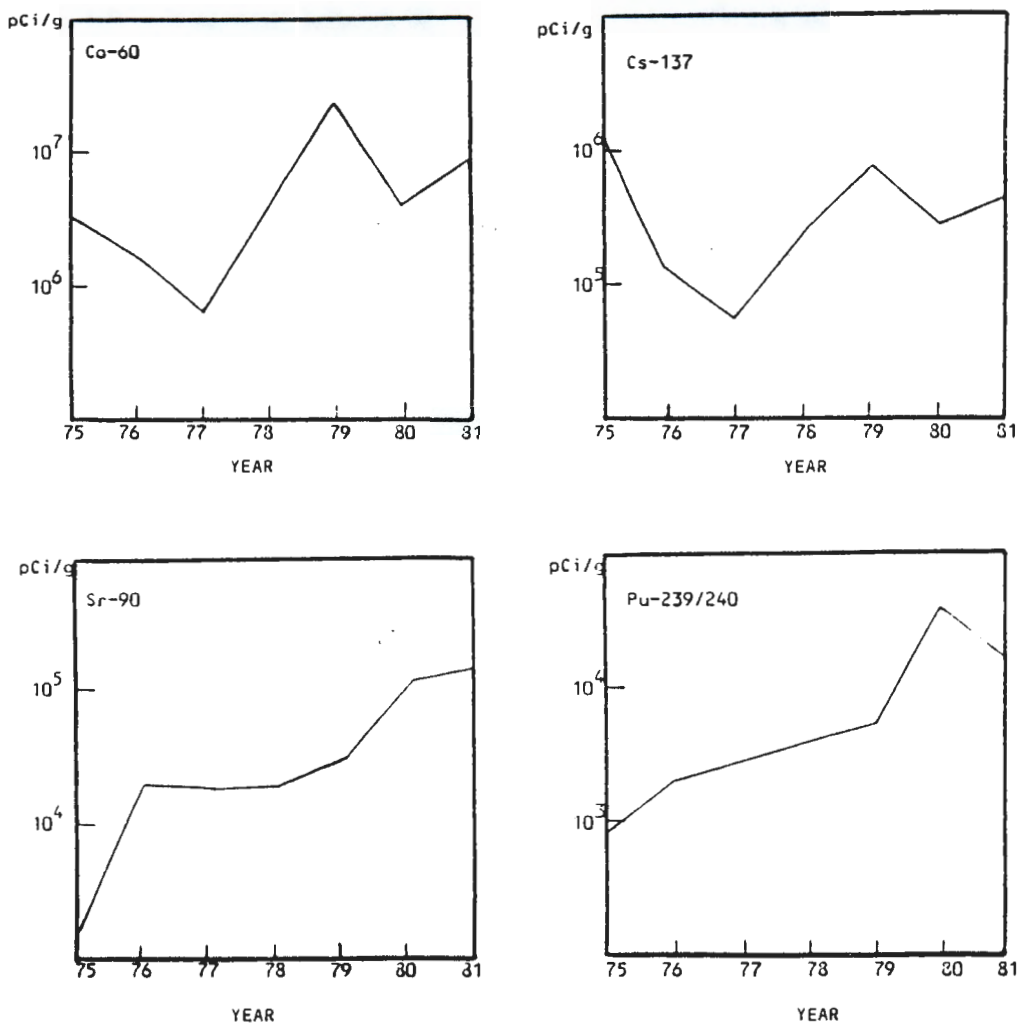


Figure 5.2. Average Concentrations (pCi/g - dry wt.) of Selected Radionuclides in 1301-N Trench Sediment Samples since 1975.

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## 6.0 VEGETATION SAMPLING

Radionuclides can concentrate in plants by surface deposition, root uptake, and translocation from other parts of the plant. Since herbivorous animals in the 100 Areas may utilize potentially contaminated vegetation as a food source, it is important to analyze vegetation samples to assess the potential for biotransport of radionuclides upward through higher trophic levels.

Four vegetation samples were collected along the 1301-N Riverbank Springs in 1981. All vegetation samples in this area consisted of the lush riparian plants common along the shoreline. Each sample was taken from an area where a visible spring was entering the river in an attempt to maximize the potential for detecting radionuclides in the vegetation along the riverbank springs. Sample SV-1 was collected approximately 100 feet upstream of the 1323-N sample building and sample SV-4 was collected about 200 feet downstream of 1323-N. The other samples were collected between these two sample locations. Concentrations of radionuclides detected in the 1301-N Riverbank springs vegetation samples are presented in Table 6.1.

Other vegetation samples were collected once during 1981 in all of the 100 Areas at the same locations as the soil samples (refer to Figures 4.1 - 4.6). Vegetation sampling locations were selected to maximize the potential for detecting radionuclides in the vegetation from either airborne deposition or root uptake of underground radioactive liquid. Vegetation samples consisted of the growing parts of the plants (except cheatgrass) that were dominant at a particular location. Whenever possible, perennial shrubs were collected in order to compare as closely as possible to the PNL Environmental Surveillance Program. Concentrations of radionuclides detected in the vegetation samples are listed in Table 6.2.

Table 6.1. Concentration of Radionuclides Detected in 1301-N Riverbank Springs Vegetation Samples. Concentrations are in pCi/g (dry wt.).

| Sample | Co-60 | Sb-125 |
|---|---|---|
| SV-1 | 3.6 | 0.19 |
| SV-2 | 1.7 | Not Detected |
| SV-3 | 3.3 | 0.24 |
| SV-4 | 4.6 | 0.31 |
| Avg. | 3.3 | 0.25 |

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Table 6.2. Concentrations of Radionuclides Detected in 100 Area Vegetation Samples. Concentrations are in pCi/g (dry weight).

| SAMPLE | Mn-54 | Co-60 | Nb-95 | Cs-137 | CePr-144 | Eu-154 |
|---|---|---|---|---|---|---|
| V-N1A | 1.0 | 6.1 | 4.9 | 0.52 | 1.3 | ND |
| V-N1P | 0.85 | 3.9 | 3.8 | 0.29 | 1.4 | ND |
| V-N2A | 3.2 | 20 | 4.5 | 3.7 | 4.2 | ND |
| V-N2P | 2.8 | 13 | ND | 1.2 | 4.0 | ND |
| V-N3 | 4.6 | 5.1 | ND | 2.0 | ND | ND |
| V-N4 | 2.8 | 14 | 3.1 | 3.6 | 1.4 | ND |
| V-N5 | 2.3 | 21 | 2.6 | 0.96 | 1.9 | ND |
| V-N6 | 1.6 | 21 | 4.3 | 1.2 | ND | ND |
| V-N7 | 0.72 | 7.0 | 2.9 | 0.58 | 1.3 | ND |
| V-N8A | 4.7 | 71 | 4.4 | 0.87 | ND | ND |
| V-N8P | 0.19 | 1.2 | 1.5 | 0.18 | 0.95 | ND |
| V-B1 | ND | 0.15 | ND | ND | ND | ND |
| V-B2 | ND | 14 | ND | ND | ND | ND |
| V-C1 | ND | 0.13 | ND | 0.36 | ND | ND |
| V-C2 | ND | 0.21 | ND | ND | ND | 0.25 |
| V-D1 | ND | 0.12 | ND | 0.20 | ND | ND |
| V-D2 | ND | ND | ND | 0.11 | ND | 0.10 |
| V-D3 | ND | 3.4 | ND | 0.18 | ND | 0.46 |
| V-D4 | ND | 0.20 | ND | ND | ND | ND |
| V-F1 | ND | 0.53 | ND | 0.14 | ND | 0.56 |
| V-F2 | ND | 1.7 | ND | 2.6 | ND | 0.37 |
| V-F3 | ND | | ND | 7.7 | ND | 0.44 |
| V-F4 | ND | 0.59 | ND | 0.08 | ND | 0.32 |
| V-F5 | ND | 0.85 | ND | 0.29 | ND | ND |
| V-H1 | ND | 1.2 | ND | 0.19 | ND | 0.58 |
| V-H2 | ND | 0.15 | ND | 0.11 | ND | ND |
| V-K1 | ND | 5.1 | ND | ND | ND | ND |
| V-K2 | ND | 0.50 | ND | 0.11 | ND | ND |
| V-K3 | ND | 0.15 | ND | ND | ND | ND |
| V-K4 | ND | 0.19 | ND | ND | ND | ND |
| V-K5 | ND | 0.11 | ND | 0.09 | ND | ND |

ND = Not Detected

**In addition to the radionuclide concentrations listed above, the following concentrations were found: 2.2 pCi/g of Zr-95 in V-N5; 2.8 pCi/g of Sb-124 in V-N6; 3.9 pCi/g of Zr-95 and 8.0 pCi/g of Sb-124 in V-N8A; 0.33 pCi/g of Eu-152 in V-F3; and 0.05 pCi/g of Sb-125 in V-H1.

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## 7.0 DIRECT RADIATION MEASUREMENT

### 7.1 1301-N Grid Survey

A grid network of radiation survey locations is established adjacent to the 1301-N crib and trench (Figure 7.1). Surveys were taken at intersecting points of the grid shown in the figure below. A direct reading count rate integrating instrument (an Eberline HP-210 probe with an Eberline Scaler) was used to measure activity. Data collected is presented in Table 7.1.

Measurements were made at a height of one metre. To obtain a count rate per minute, counts were made for two minutes and averaged. Direct radiation surveys of the 1301-N grid are performed annually. This survey was performed on August 31, 1981. At this time, N Reactor was operating at a power level of 3680 MWt and the crib flow rate was 2360 gpm. There was no internal decontamination of reactor piping during 1981, so there were no decontamination wastes in the 1310-N or 1314-N waste tanks.

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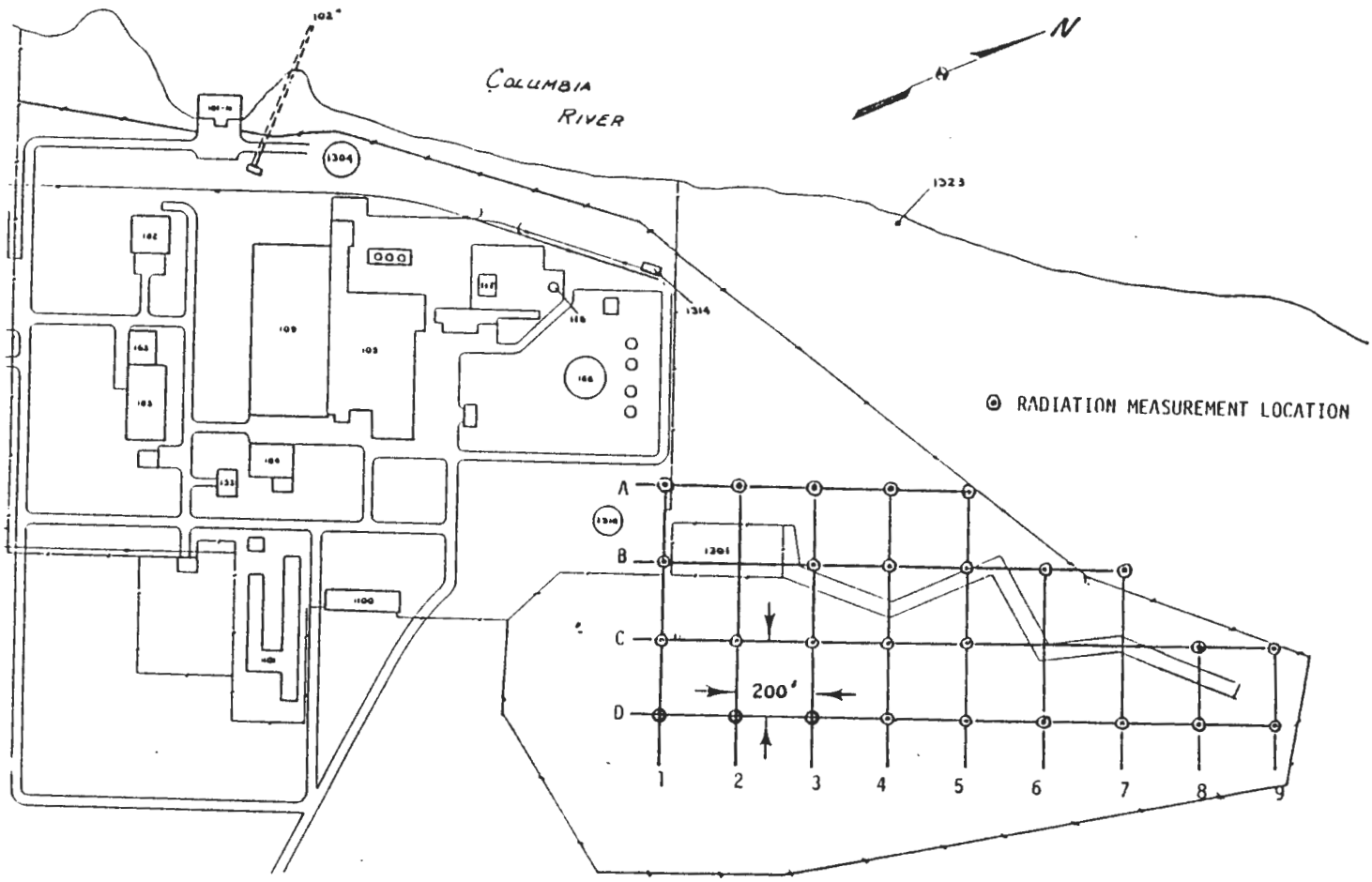


Figure 7.1. Grid Used for Radiation Survey Around the 1301-N Facility.

Table 7.1. Data from 1301-N Grid Survey in Counts per Minute.*

| Grid Point | CPM |
|---|---|
| A1 | 710 |
| A2 | 600 |
| A3 | 450 |
| A4 | 340 |
| A5 | 230 |
| B1 | 9,900 |
| B3 | 1,500 |
| B4 | 360 |
| B5 | 1,400 |
| B6 | 270 |
| B7 | 150 |
| C1 | 2,200 |
| C2 | 370 |
| C3 | 480 |
| C4 | 420 |
| C5 | 340 |
| C8 | 280 |
| C9 | 190 |
| D1 | 300 |
| D2 | 240 |
| D3 | 200 |
| D4 | 180 |
| D5 | 360 |
| D6 | 200 |
| D7 | 270 |
| D8 | 290 |
| D9 | 330 |

*Based on 1980 data, every 100 counts per minute detected on the integrating instrument is roughly equal to a dose rate of 45 μR/hr.

## 7.2 Environmental Dosimeters

External radiation dose information is collected at 100-N Area using $CaF_2$:Mn (TLD-400) thermoluminescent dosimeters. The dosimeters used are delivered and picked up monthly by PNL where they are read, calibrated, and annealed.

Locations of the environmental dosimeters at 100-N Area are depicted in Figure 7.2. This drawing also shows the area of river shoreline that was surveyed in the annual shoreline survey.

The data collected from the 100-N Area environmental dosimeters are presented in Table 7.2. Included is the average dose rate, continuous occupancy dose, and the dose to workers. The dose to workers is defined as the dose to a person that spends 40 hours per week and 52 weeks per year at the site of a specific environmental dosimeter.

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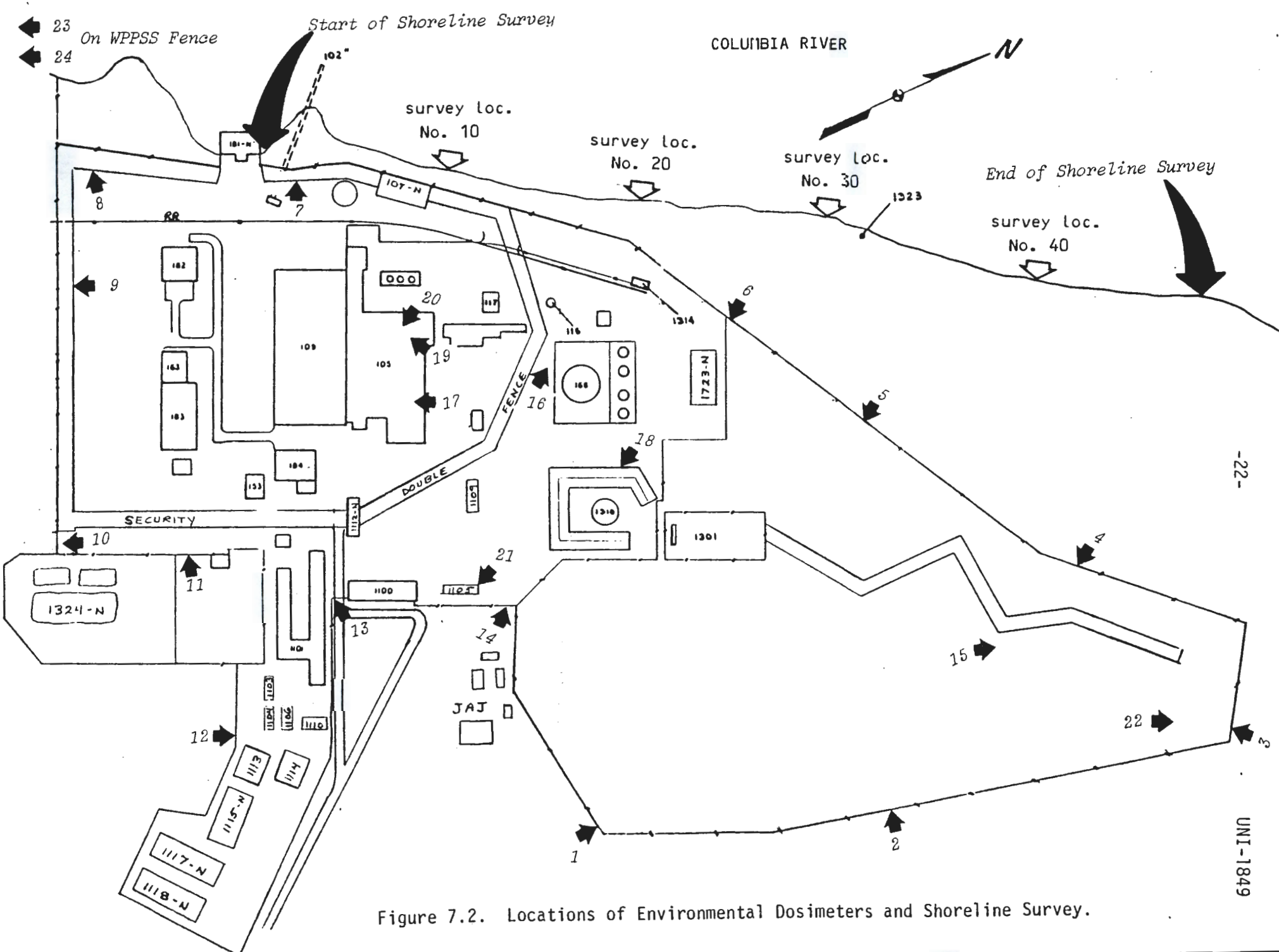


Figure 7.2. Locations of Environmental Dosimeters and Shoreline Survey.

| TLD LOCATIONS AND DATES | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aug, 1980 | .056 | .157 | .135 | .480 | .140 | .704 | .326 | .009 | .007 | .008 | .010 | .011 | .027 | .090 | 3.126 | .036 | .005 | .119 | .005 | .008 | .095 | .471 | .005 | .005 |
| Sep | .049 | .147 | .132 | .440 | .130 | .654 | .287 | .008 | .006 | .007 | .009 | .010 | .025 | .086 | 2.822 | .036 | .005 | .115 | .006 | .007 | .089 | * | .006 | .005 |
| Oct | .044 | .113 | .094 | .355 | .109 | .603 | .267 | .008 | .006 | .008 | .009 | .009 | .023 | .073 | 2.185 | .027 | .005 | .098 | .005 | .005 | .083 | .343 | .005 | .005 |
| Nov | .032 | .076 | .056 | .229 | .074 | .251 | .614 | .007 | .006 | .007 | .007 | .008 | .019 | .065 | 1.365 | .026 | .005 | .091 | .004 | .004 | .077 | .197 | .005 | .004 |
| Dec | .030 | .064 | .056 | .199 | .067 | .668 | .232 | .008 | .007 | .007 | .008 | .008 | .020 | .063 | 1.246 | .033 | .004 | .089 | .006 | .005 | .077 | .188 | .006 | .004 |
| Jan, 1981 | .033 | .072 | .055 | .212 | .070 | .681 | .258 | .008 | .006 | .008 | .008 | .009 | .021 | .064 | 1.231 | .036 | .006 | .094 | .006 | .006 | .071 | .186 | .006 | .005 |
| Feb | .031 | .073 | .068 | .228 | .077 | .067 | * | .007 | .004 | .006 | .008 | .008 | .020 | .068 | 1.288 | .040 | .005 | .090 | .005 | .006 | .075 | .221 | .005 | .004 |
| Mar | .028 | .049 | .040 | .139 | .060 | .062 | .139 | .008 | .006 | .007 | .009 | .008 | .021 | .062 | .690 | .041 | .006 | .096 | .006 | .008 | .079 | .107 | .006 | .004 |
| Apr | .029 | .042 | .031 | .108 | .053 | .065 | .154 | .007 | .006 | .008 | .009 | .009 | .025 | .067 | .553 | .077 | .006 | .078 | .005 | .012 | .076 | .069 | .018 | .004 |
| May | .021 | .031 | .024 | .083 | .040 | .053 | .168 | .007 | .006 | .008 | .007 | .007 | .018 | .054 | .426 | .060 | .005 | .078 | .006 | .007 | .067 | .063 | .006 | .005 |
| Jun | .028 | .056 | .038 | .145 | .064 | .070 | .181 | .008 | .007 | .008 | .008 | .008 | .022 | .057 | .785 | .078 | .005 | .096 | .005 | .006 | .073 | .125 | .007 | .006 |
| Jul | .026 | .055 | .043 | .152 | .061 | .064 | .147 | .007 | .006 | .006 | .015 | .007 | .021 | .062 | .919 | .082 | .007 | .077 | .008 | .009 | .069 | .132 | .005 | .004 |
| Aug | .033 | .059 | .041 | .147 | .054 | .062 | .150 | .008 | .007 | .009 | .010 | .011 | .024 | .064 | .767 | .072 | .006 | .089 | .006 | .005 | .075 | .118 | .007 | .005 |
| Average Dose Rate (mRad/hr) | .034 | .076 | .062 | .22 | .077 | .31 | .24 | .008 | .006 | .015 | .009 | .009 | .022 | .067 | 1.3 | .049 | .005 | .093 | .006 | .007 | .077 | .19 | .007 | .005 |
| Continuous Occupancy Dose, mRad/yr | 300 | 670 | 540 | 2,000 | 670 | 2,700 | 2,100 | 67 | 52 | .130 | 79 | 79 | 190 | 590 | 12,000 | 430 | 47 | 810 | 52 | 61 | 670 | 1,600 | 61 | 47 |
| Dose to Workers mRad/yr | 71 | 160 | 130 | 470 | 160 | 640 | 510 | 17 | 12 | 31 | 19 | 19 | 46 | 140 | 2,800 | 100 | 10 | 190 | 12 | 15 | 160 | 390 | 15 | 10 |

*TLD Lost

## 7.3 Shoreline Survey

An Eberline HP-210 probe with an Eberline Scaler was used to conduct a Columbia River shoreline radiation survey which began just downstream of the 181-N building and ended approximately 1000 feet downstream from the 1323-N sample shed. The measurements were made approximately every 50 feet along the high water mark of shoreline and were taken one metre above ground. Data collected during the shoreline survey is presented in Table 7.3.

The shoreline survey is performed annually. This survey was conducted on August 31, 1981. At that time the reactor was operating at a power level of 3680 MWt. There were no internal decontamination wastes in the 1310-N or 1314-N waste tanks at the time of the survey and the crib flow rate was 2360 gpm.

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Table 7.3 Radiation Data from the 100-N Area Shoreline Survey.

| Location | CPM* | Location | CPM* |
|---|---|---|---|
| 1 | 70 | 26 | 100 |
| 2 | 90 | 27 | 110 |
| 3 | 100 | 28 | 110 |
| 4 | 115 | 29 | 85 |
| 5 | 140 | 30 | 80 |
| 6 | 90 | 31 | 75 |
| 7 | 85 | 32 | 90 |
| 8 | 75 | 33 | 120 |
| 9 | 80 | 34 | 105 |
| 10 | 85 | 35 | 105 |
| 11 | 80 | 36 | 105 |
| 12 | 65 | 37 | 70 |
| 13 | 95 | 38 | 80 |
| 14 | 110 | 39 | 120 |
| 15 | 105 | 40 | 80 |
| 16 | 115 | 41 | 90 |
| 17 | 100 | 42 | 75 |
| 18 | 100 | 43 | 120 |
| 19 | 100 | 44 | 80 |
| 20 | 110 | 45 | 85 |
| 21 | 110 | 46 | 110 |
| 22 | 120 | 47 | 95 |
| 23 | 100 | 48 | 135 |
| 24 | 90 | 49 | 120 |
| 25 | 105 | 50 | 100 |

* CPM = counts per minute

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## 8.0 SPECIAL ENVIRONMENTAL SAMPLES

As part of the Environmental Surveillance Program for the 100 Areas, the results of special environmental samples or studies of the 100 Area environs is included in the annual surveillance report. These special samples are listed in the following subsections.

### 8.1 Radioanalysis of Rabbits Collected Around the 1301-N Facility

Several cottontail rabbits (*Sylvilagus nuttallii*) were collected around the 1301-N Facility on May 15, 1981. The rabbits were collected and radioanalyzed as part of an investigation of the possible biotransport of radionuclides from the 1301-N Facility. Rabbit fecal pellets collected around the 1301-N crib and trench were also analyzed for radionuclide concentrations.

Five rabbits were collected within the security fence surrounding the crib and trench, which is in a radiation zone, while four rabbits were collected around the large rock piles outside of the fence (see Figure 8.1). The fence is not a barrier to rabbit movement, however, the rabbits collected outside the fence were farther from the 1301-N Facility than the rabbits collected inside the fence.

Radioanalysis of rabbit muscle, bone, and liver tissue samples indicated the rabbits closest to the 1301-N Facility contained much higher radionuclide concentrations than rabbits collected farther from the crib and trench. The higher concentrations are attributed to the use of the crib and trench as a drinking water source for those rabbits residing close to the 1301-N Facility. As can be seen in the results of subsection 8.3, vegetation growing in or very close to the trench may also have contributed to the high radionuclide concentrations found in the rabbits.

Rabbits collected inside the radiation zone contained significant concentrations of radionuclides, however, tissue samples from rabbits collected outside the 1301-N security fence contained radionuclide concentrations at or near background levels. This finding reinforces the observations by other investigators (Rickard, et al, 1974) that cottontail rabbits do not have a very wide home range.

Although cottontails are eaten by humans, their limited movement insures that the rabbits residing in the 100 Areas will be insignificant from an offsite human dose standpoint. Since hunting is not allowed on the Hanford site, these rabbits would also be an insignificant contributer to the onsite human dose, however, they may provide a significant dose to rabbit predators. At 100-N Area, the major cottontail predators would include raptors, snakes, and coyotes. Cottontails are also prey for badgers, skunks, mink, raccoons, and bobcats on the Hanford Site.

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Radionuclide concentrations detected in rabbit tissue samples and rabbit fecal pellets are included in Table 8.1.1 and 8.1.2, respectively.

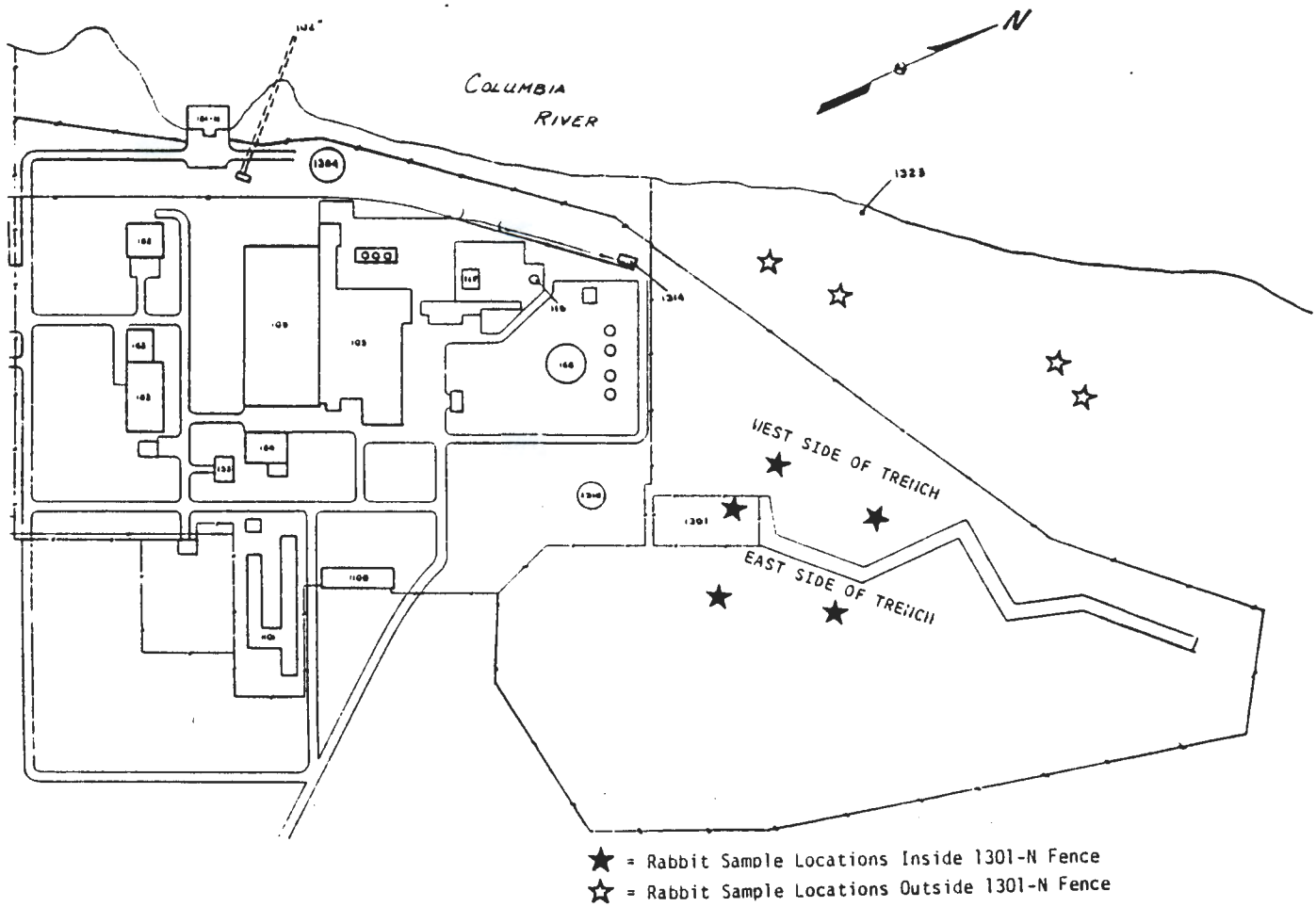


Figure 8.1. Locations where Rabbits and Rabbit Pellets were Collected Around the 1301-N Facility.

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Table 8.1.1. Radionuclides Detected in Rabbits Collected Around the 1301-N Facility. Concentrations in pCi/g (wet weight).

| Inside 1301-N Security Fence | Tissue | Mn-54 | Co-60 | Zn-65 | Cs-134 | Cs-137 | Sr-90 | Pu-238 | Pu-239/240 |
|---|---|---|---|---|---|---|---|---|---|
| #1 | Muscle | ND | 0.2 | ND | 0.55 | 8.9 | NA | NA | NA |
| | Bone | ND | ND | 0.46 | ND | 3.2 | 73 | ND | ND |
| #2 | Muscle | 6.1 | 13 | 6.2 | 320 | 3,700 | NA | NA | NA |
| | Bone | 46 | 13 | 13 | 98 | 1,100 | 6,000 | ND | 0.14 |
| | Liver | 210 | 120 | ND | 160 | 2,300 | 5.2 | 0.07 | 0.35 |
| #3 | Muscle | 4.2 | 2.2 | 2.1 | 270 | 3,400 | NA | NA | NA |
| | Bone | 21 | 5.2 | ND | 77 | 1,200 | 1,300 | 0.01 | 0.06 |
| | Liver | 330 | 60 | ND | 190 | 3,400 | 5.6 | 0.005 | 0.02 |
| #4 | Muscle | 1.5 | 9.0 | 0.53 | 9.1 | 120 | NA | NA | NA |
| | Bone | 1.4 | 0.57 | ND | 3.0 | 51 | 200 | ND | 0.15 |
| | Liver | 11 | 12 | 8.7 | 9.9 | 160 | 13 | 0.13 | 0.08 |
| #5 | Muscle | 2.2 | 3.4 | 0.42 | 9.4 | 140 | NA | NA | NA |
| | Bone | 2.5 | 1.7 | ND | 3.1 | 43 | 180 | 0.07 | 0.04 |
| | Liver | 26 | 22 | ND | 7.8 | 130 | 1.4 | 0.03 | 0.05 |
| Average | Muscle | 2.8 | 5.6 | 1.9 | 120 | 1,500 | NA | NA | NA |
| | Bone | 14 | 4.1 | 2.7 | 36 | 480 | 1,600 | 0.02 | 0.08 |
| | Liver | 140 | 54 | 2.2 | 92 | 1,500 | 6.3 | 0.06 | 0.13 |
| **Rock Pile Outside Fence** | | | | | | | | | |
| #1 | Muscle | ND | 0.36 | ND | ND | 0.07 | NA | NA | NA |
| | Bone | ND | 0.29 | 0.73 | ND | 0.51 | 11 | ND | ND |
| | Liver | ND | 0.36 | ND | ND | 0.25 | ND | ND | 0.005 |
| #2 | Muscle | ND | 0.06 | ND | ND | 0.02 | NA | NA | NA |
| | Bone | 1.2 | 0.44 | ND | 1.9 | 0.16 | 1.4 | ND | ND |
| | Liver | ND | 0.22 | ND | 2.7 | 0.13 | ND | ND | ND |
| #3 | Muscle | ND | 0.07 | ND | ND | ND | NA | NA | NA |
| | Bone | ND | 0.22 | 0.16 | ND | ND | 49 | * | * |
| | Liver | ND | 0.13 | ND | 0.33 | 0.15 | ND | * | * |
| #4 | Muscle | 2.4 | ** | 0.59 | ND | 9.5 | NA | NA | NA |
| | Bone | ND | 0.72 | ND | ND | 0.19 | 1.5 | ND | ND |
| | Liver | ND | 0.18 | ND | ND | 0.17 | ND | ND | 0.02 |
| Average | Muscle | 0.60 | 0.16 | 0.15 | ND | 2.4 | NA | NA | NA |
| | Bone | 0.30 | 0.42 | 0.22 | 0.48 | 0.26 | 16 | ND | ND |
| | Liver | ND | 0.22 | ND | 0.76 | 0.18 | ND | ND | 0.008 |

ND - Not Detected
NA - Not Analyzed
* - Sample Lost
** - Cross contamination suspected.

Table 8.1.2. Radionuclides Detected in Rabbit Feces Collected Around the 1301-N Facility. Concentrations in pCi/g (dry weight).

| | Mn-54 | Co-60 | Cs-134 | Cs-137 | Ce-144 |
|---|---|---|---|---|---|
| East of trench | 1300 | 340 | 63 | 740 | Not detected |
| West of trench | 650 | 870 | 19 | 270 | 120 |

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## 8.2 Drill Core Samples Obtained During Drilling of the Diesel Oil Detection Wells at 100-N Area

During FY 1981, eleven new groundwater monitoring wells (N-16 through N-26) were installed at 100-N Area as part of the Diesel Oil Leakage Control Project. The wells were strategically located to monitor the groundwater near underground diesel oil storage tanks and pipelines, as well as the spent fuel storage basin and underground radioactive drain pipelines. The wells are pictured in Figure 3.1.

Drill core samples were obtained from each well during the drilling operations. Samples were obtained at five foot intervals, beginning at the minus five foot level and extending to the well bottom. Samples were checked for gross activity (with a NaI scintillation detector, Eberline Model Spa 3, and the Eberline Mini-Scaler, Model MS-2), with those samples showing higher than background activities analyzed for gamma-emitting radionuclides.

The results of radioanalyses of the drill core samples are presented in Table 8.2. The higher concentrations detected in well N-25 are attributed to a surface spill from the Emergency Dump Tank in 1974. The incident was reported under UO 74-5 and resulted in an estimated 200 mCi of activity being discharged to ground.

Table 8.2. Radionuclides Detected in Drill Core Samples From the Diesel Oil Detection Wells*. Concentrations are in pCi/g (dry weight).

| Well No. | Depth (ft) | Mn-54 | Co-60 | Cs-137 | Ce-144 |
|---|---|---|---|---|---|
| N-17 | 65 | ND | 0.41 | ND | ND |
| N-17 | 70 | ND | 0.65 | ND | ND |
| N-18 | 65 | ND | 0.61 | ND | ND |
| N-19 | 60 | ND | 2.64 | ND | ND |
| N-25 | 15 | 4.7 | 77 | 3.4 | 2.7 |

ND = Not Detected

*In addition, the following samples were analyzed and no evidence of man-made radionuclides was found: 60' from well N-18;, 55' from well N-20; 50' from well N-22; 75' from well N-23; 5', 15', and 55' from well N-24; 5', 10', 25', and 35' from well N-25; and 35', 55', and 65' from well N-26.

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## 8.3 Vegetation Sampling from Plants Growing in the 1301-N Facility

Lush vegetation is growing along the length of the trench and in several areas in the crib. This vegetation may be used as a food source by animals residing near the 1301-N Facility. Since these plants utilize the radioactive effluent water discharged to the crib, the plants may contribute to the biotransport of radionuclides (see subsection 8.1). Vegetation was sampled along the locations identified in Figure 8.3 to determine the potential for biotransport. Concentrations of radionuclides detected in the vegetation samples are reported in Table 8.3.

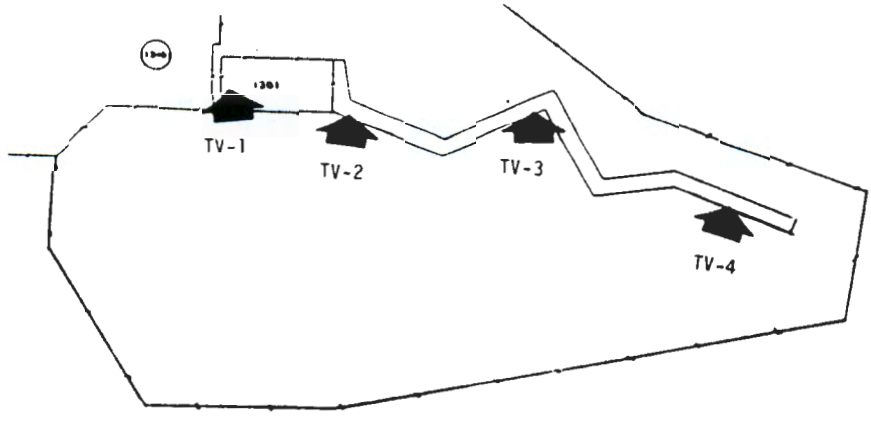


Figure 8.3. Locations Where Vegetation Samples Were Collected from the 1301-N Facility

Table 8.3. Concentrations of Radionuclides Detected in Vegetation Growing in the 1301-N Facility. Concentrations are in pCi/g (dry weight).

| Sample | Mn-54 | Co-60 | Zn-65 | Nb-95 | Ru-106 | Cs-134 | Cs-137 | CePr-144 |
|---|---|---|---|---|---|---|---|---|
| TV-1 | 780 | 1100 | 17 | 18 | 44 | 280 | 840 | 120 |
| TV-2 | 50 | 180 | ND | ND | 8 | 2 | 48 | 35 |
| TV-3 | ND | 770 | 22 | ND | ND | 410 | 480 | 28 |
| TV-4 | 780 | 510 | 14 | ND | ND | 140 | 1600 | 28 |
| Avg. | 540 | 640 | 18 | -- | -- | 210 | 740 | 53 |

ND = Not Detected

9113222.2049

## 9.0 REFERENCES

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9413222.2050

# APPENDIX A

## SPECIES COMPOSITION OF VEGETATION SAMPLES

Legend:

CHNA = Chrysothamnus nauseosus (Gray Rabbitbrush)
BETE = Bromus tectorum (Cheatgrass)
SAKA = Salsola kali (Tumbleweed)
ACMI = Achillea millefolium (Yarrow)
TRDU = Tragopogon dubius (Yellow Salsify)
CHDO = Chaenactis douglasii (False Yarrow)
SIAL = Sisymbrium altissimum (Tumble Mustard)

100-N Area:

V-N1P - CHNA
V-N1A - ACMI, TRDU
V-N2P - CHNA
V-N2A - BRTE, SIAL
V-N3 - CHNA
V-N4 - BRTE, ACMI
V-N5 - CHDO
V-N6 - BRTE
V-N7 - BRTE, ACMI, TRDU
V-N8P - CHNA
V-N8A - BRTE, SAKA, ACMI

100-K Area:

V-K1 - BRTE, ACMI
V-K2 - CHNA
V-K3 - BRTE, ACMI, TRDU
V-K4 - SAKA, SIAL
V-K5 - BRTE, ACMI, TRDU

100-F Area:

V-F1 - CHNA
V-F2 - CHNA
V-F3 - CHNA
V-F4 - CHNA
V-F5 - BRTE

100-D Area:

V-D1 - ACMI, BRTE, TRDU
V-D2 - CHNA
V-D3 - CHNA
V-D4 - SAKA

100-B/C Area:

V-B1 - ACMI
V-B2 - SAKA
V-C1 - CHNA
V-C2 - CHNA

100-H Area:

V-H1 - CHNA
V-H2 - Unknown grasses

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