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WHC-EP-0145-3

Westinghouse Hanford Company Environmental Surveillance Annual Report--200/600 Areas

Calendar Year 1990

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Prepared for the U.S. Department of Energy
Office of Environmental Restoration
and Waste Management

Westinghouse
Hanford Company Richland, Washington

Hanford Operations and Engineering Contractor for the
U.S. Department of Energy under Contract DE-AC06-87RL10930

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SUBJECT: WESTINGHOUSE HANFORD COMPANY ENVIRONMENTAL SURVEILLANCE ANNUAL REPORT - 200/600 AREAS

The termination of the off-site analytical laboratory in June of 1990 has impacted the content of the Westinghouse Hanford Company Environmental Surveillance Annual Report -- 200/600 Areas for Calendar Year 1990. This report is normally reviewed and published by June 1 of the following calendar year.

Westinghouse Hanford Company (WHC) issues this report, consistent with Pacific Northwest Laboratory's schedule for the Hanford Site report. The report contains completed near-field data for groundwater monitoring, external radiation monitoring, pond and ditch monitoring, radiological surveys, and special projects and investigative surveillance. The remaining near-field data for ambient air, and soil and biota, which was delayed by the loss of the off-site laboratory, will be reported when the data is received, reviewed, and compiled.

At this time, WHC is issuing the report, with a limited distribution, on June 1, 1991, without the chapters relating to data that has been delayed. The completed report will be issued for full distribution when all chapters are complete.

If you have any questions concerning this matter, please contact J. W. Schmidt at 373-2116.

WHC-EP-0145-3

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Westinghouse Hanford Company Environmental Surveillance Annual Report--200/600 Areas

Calendar Year 1990

J. W. Schmidt
C. R. Huckfeldt
A. R. Johnson
S. M. McKinney

Date Published
June 1991

Prepared for the U.S. Department of Energy
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Westinghouse Hanford Company
P.O. Box 1970
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Prepared by:	J. W. Schmidt	5/29/91 Date
Reviewed by:	J. J. Dorian	5/29/91 Date
Approved by:	G. D. Carpenter	5/29/91 Date
Approved by:	R. D. Wojtasek	5/30/91 Date

WESTINGHOUSE HANFORD COMPANY ENVIRONMENTAL SURVEILLANCE ANNUAL REPORT--200/600 AREAS

Calendar Year 1990

J. W. Schmidt
C. R. Huckfeldt
A. R. Johnson
S. M. McKinney

ABSTRACT

This document presents the results of near-field environmental surveillance in 1990 of the Operations Area of the Hanford Site, in south central Washington State, as performed by Westinghouse Hanford Company. These activities are conducted in the 200 and 600 Areas to assess and control the impacts of operations on the workers and the local environment. Surveillance activities include sampling and analyses of ambient air, surface water, groundwater, sediments, soil, and biota. Also, external radiation measurements and radiological surveys are taken of waste disposal sites, radiological control areas, and roads.

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EXECUTIVE SUMMARY

Near-field environmental surveillance of the Operations Area of the Hanford Site, in south central Washington State, is performed by Westinghouse Hanford Company (Westinghouse Hanford) to assess and control the impacts of operations on the worker and the local environment. The results and conclusions of this program are presented in two reports; one covers the 100 Areas and other covers the 200 and 600 Areas. This report covers the 200 and 600 Areas.

Surveillance activities in the 200 and 600 Areas include sampling and analyses of ambient air, surface water, groundwater, sediments, soil, and biota at or adjacent to operating facilities and waste disposal sites. Also, external radiation measurements and radiological surveys are taken of waste disposal sites, perimeters, radiological control areas, and roads. The 1990 data are summarized below.

REGULATORY CONTROLS

Radiation exposure to workers and the offsite population are regulated by a tiered system of controls. The U.S. Department of Energy (DOE) has established the occupational exposure limit at 5,000 mrem/yr. The exposure limits for any member of the public were set by the DOE at 500 mrem/yr for occasional annual exposures and at 100 mrem/yr annually for exposures expect to last longer than 5 yr. An administrative action level of 25 mrem/yr to maximum individual member of the public has been identified by the DOE to ensure that these exposure limits are not exceeded.

Derived concentration guidelines (DCG) corresponding to the 100 mrem/yr effective dose equivalent standard are used in this report for comparison only. It should be noted that the DCGs are applicable at the point of actual exposure to members of the public off the Hanford Site and are, therefore, not applicable onsite. In keeping with Westinghouse Hanford's philosophy to keep exposures to workers and the public as low as reasonably achievable (ALARA), Westinghouse Hanford establishes ALARA requirements called administrative control values (ACV), which are used as guidance in maintaining releases below applicable regulatory standards.

AMBIENT AIR MONITORING

Not Yet Available.

GROUNDWATER MONITORING

The groundwater beneath five waste sites exceeded the DCGs on an annual average for 1990. Two sites were in use and three were inactive. None of the sites have projected offsite doses that exceed the DCGs.

- The 1990 annual average for tritium in the groundwater beneath the active 216-A-45 Crib was 1.8 times the DCG. This was down from an annual average of three times the DCG in 1988, but was consistent with the concentrations reported in 1989.

- The 1990 annual average for tritium in the groundwater beneath the active 216-A-37-1 was four times the DCG. This was up from the concentrations reported in 1989.

- The annual average for the concentration of ^{90}Sr beneath the inactive 216-B-5 Reverse Well was six times the DCGs in 1990, virtually unchanged from previous levels. The concentration of ^{239}Pu beneath the 216-B-5 Reverse Well was three times the DCGs in 1990.

- The annual average for total U exceeded the DCGs (using ^{235}U and ^{238}U as the limiting isotopes) in 1990 for the active 216-U-17 Crib and the inactive 216-U-1 and -2 cribs.

The groundwater beneath six sites exceeded the ACVs on an annual average.

- The ^{90}Sr concentration was greater than the ACV in the groundwater beneath the inactive 216-A-25 (Gable Mountain) Pond.

- The ^{137}Cs concentration in the groundwater exceeded the ACV beneath the inactive 216-B-5 Reverse Well.

- The U isotopes in the groundwater exceeded the ACV at the active 216-U-17 Crib and the inactive 216-T-33 and 216-U-1/2 Cribs.

- The ^{239}Pu concentration was greater than the ACV in the groundwat beneath the inactive 239-Z-9 Crib and the 216-B-5 Reverse Well.

SOIL AND BIOTA MONITORING

Not Yet Available.

EXTERNAL RADIATION MONITORING

Exposure rates from penetrating radiations, primarily gamma rays, were measured in the 200 Area environment. The environmental thermoluminescent dosimeters measured exposure rates from all external radiation sources: cosmic, naturally occurring radioactivity in air and soil, and fallout from nuclear weapons testing, as well as any contribution from 200 Area activities. In 1990, operations in the 200 Area did not contribute significantly to the external exposure rate [as measured by Pacific Northwest Laboratory (PNL)] in the general environment. Consequently, the exposure rate in the 200 Area environment was not significantly different from the exposure rate received offsite from natural sources of radiation. As expected, external radiation levels measured by the Westinghouse Hanford near-field environmental surveillance program were elevated at certain sites, radiological control areas, and facilities, reflecting the proximity to radioactive waste management activities.

POND AND DITCH MONITORING

While some increases in radioactivity were observed in the ponds and ditches in 1990, none of these levels exceeded the applicable standards. A surface waters associated with 200 Area operations were below the DCG for measured radionuclides. The analytical results of vegetation samples taken at the ponds and ditches revealed that physiological uptake of radionuclides was below the soil standards for the Table 5-4 posting of radiological control. Sediment samples demonstrated elevated levels of ^{137}Cs. However, all ponds and ditches that receive potentially contaminated water are within posted radiological control areas.

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APPENDIXES

LIST OF FIGURES

LIST OF TABLES

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METRIC CONVERSION CHART

To convert the English units of measure in this document into metric or the metric units of measure into English, use the conversion chart provided below.

METRIC CONVERSION CHART

INTO METRIC			OUT OF METRIC		
If You Know	Multiply by	To Get	If You Know	Multiply by	To Get
Length			Length		
inches	2.54	centimeters	millimeters	0.04	inches
feet	30	centimeters	centimeters	0.4	inches
yards	0.91	meters	meters	3.3	feet
miles	1.6	kilometers	kilometers	0.62	miles
Area			Area		
sq. inches	6.5	sq. centimeters	sq. centimeters	0.16	sq. inches
sq. feet	0.09	sq. meters	sq. meters	0.09	sq. feet
sq. yards	0.8	sq. meters	sq. kilometers	0.4	sq. miles
sq. miles	2.6	sq. kilometers	hectares	2.47	acres
acres	0.4	hectares			

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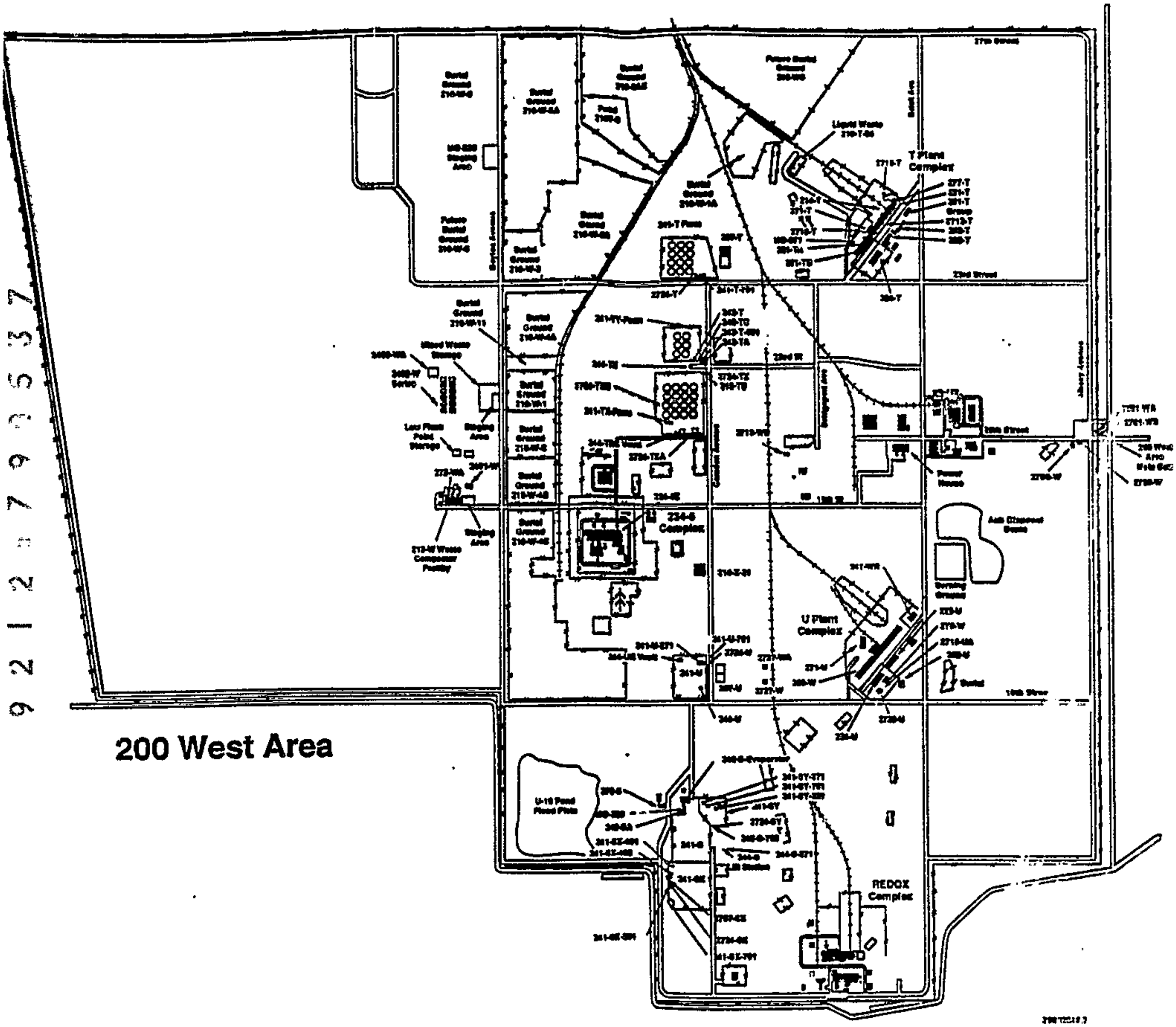

200 West Area

Figure 1-1. The Separations Area of the Hanford Site.

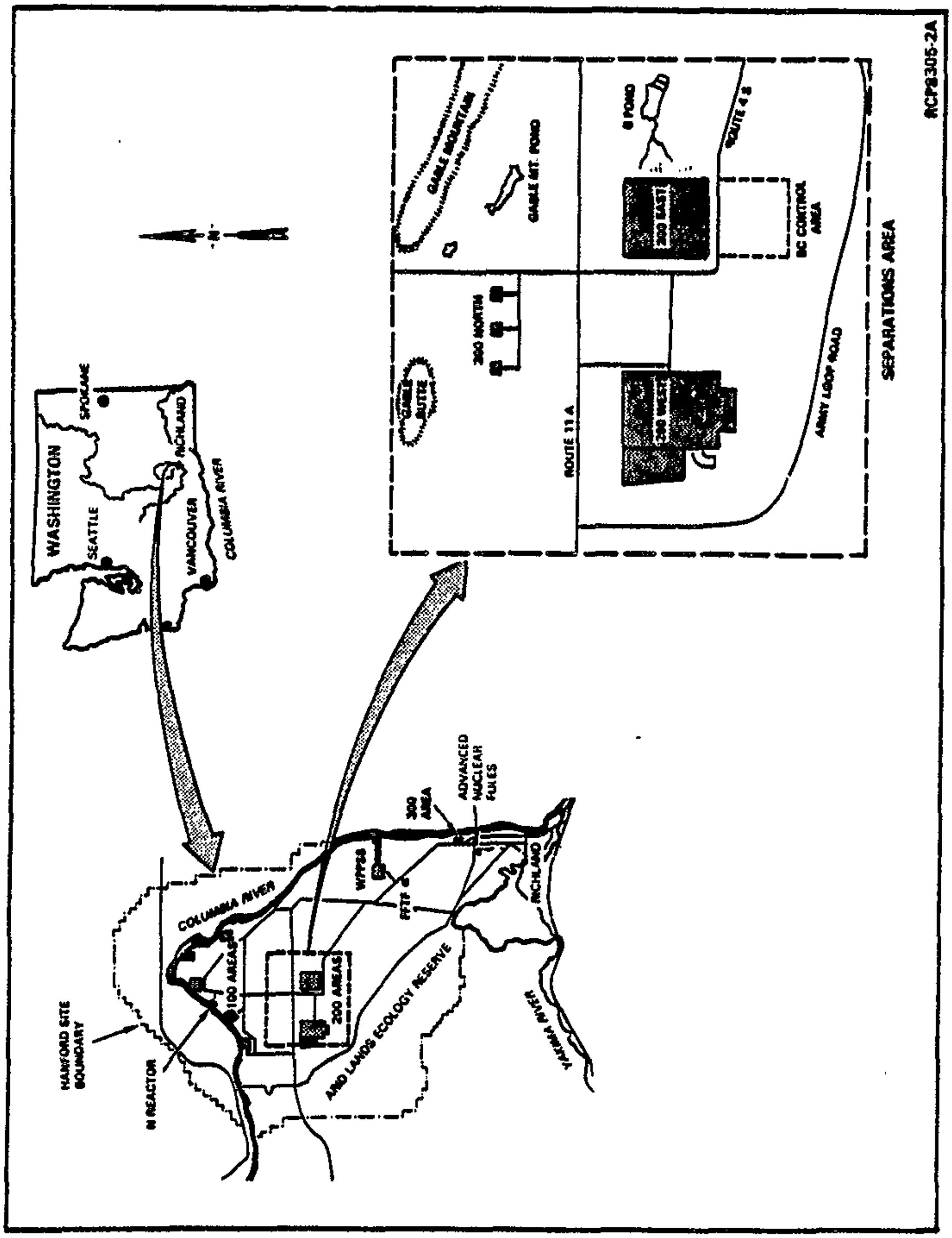

Figure 1-2. The 200 East Area.

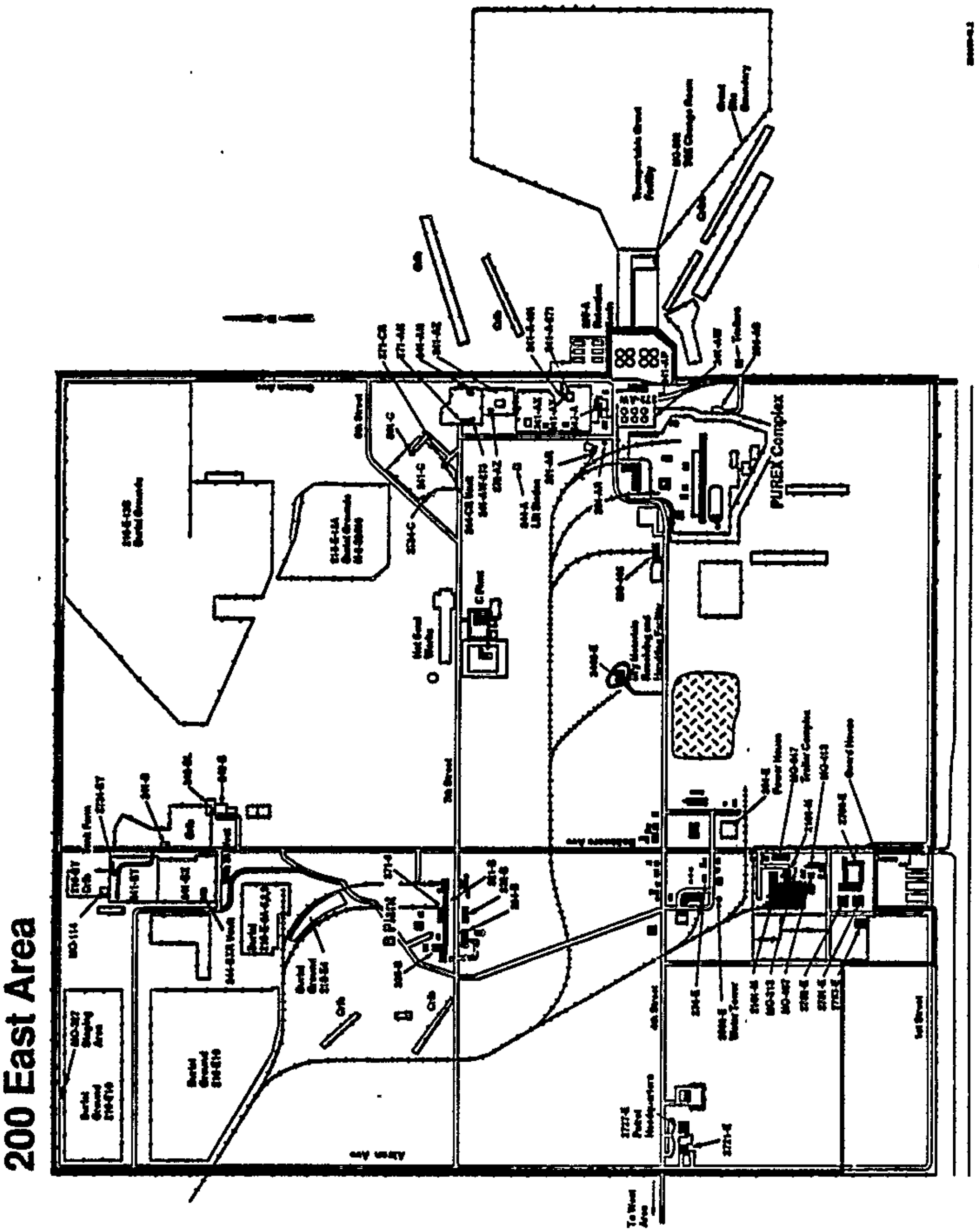

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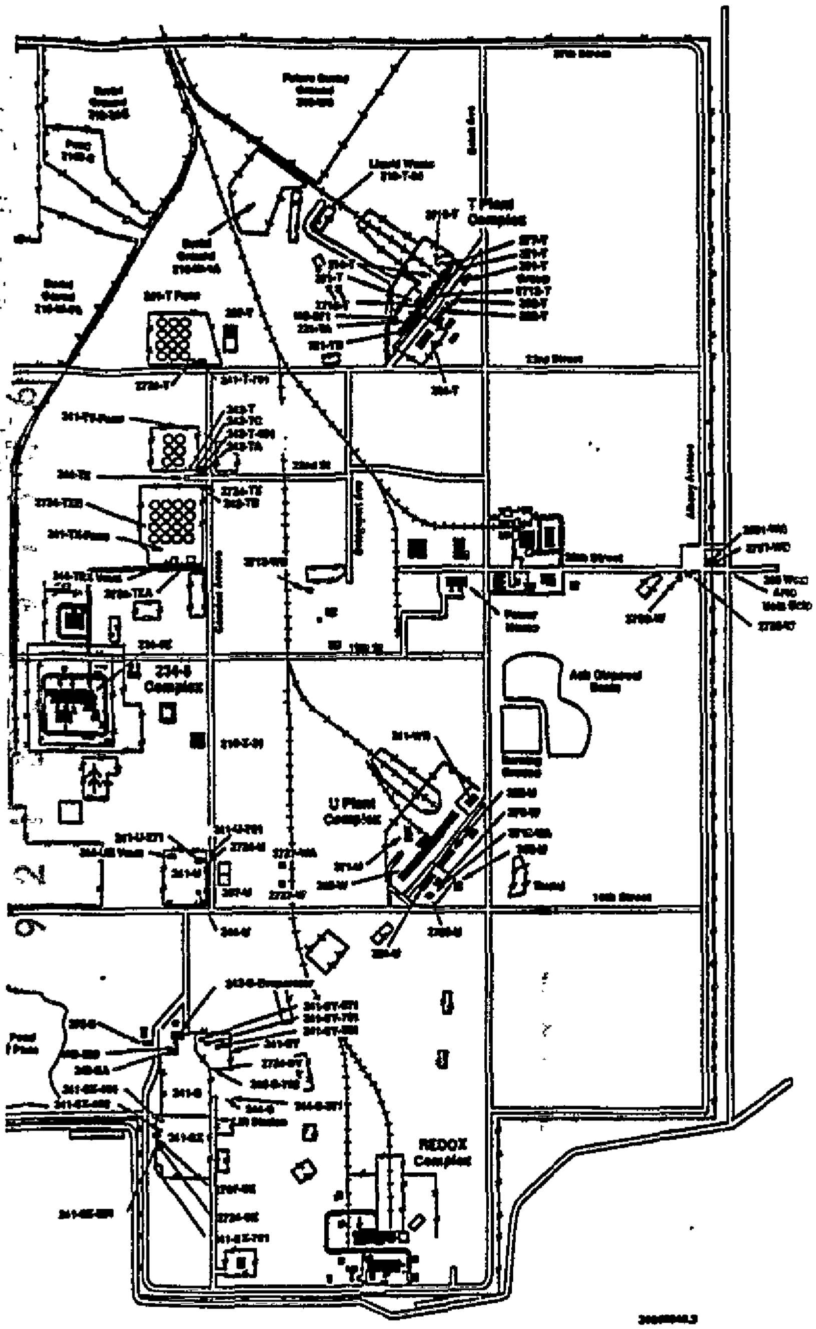
Figure 1-3. The 200 West Area.



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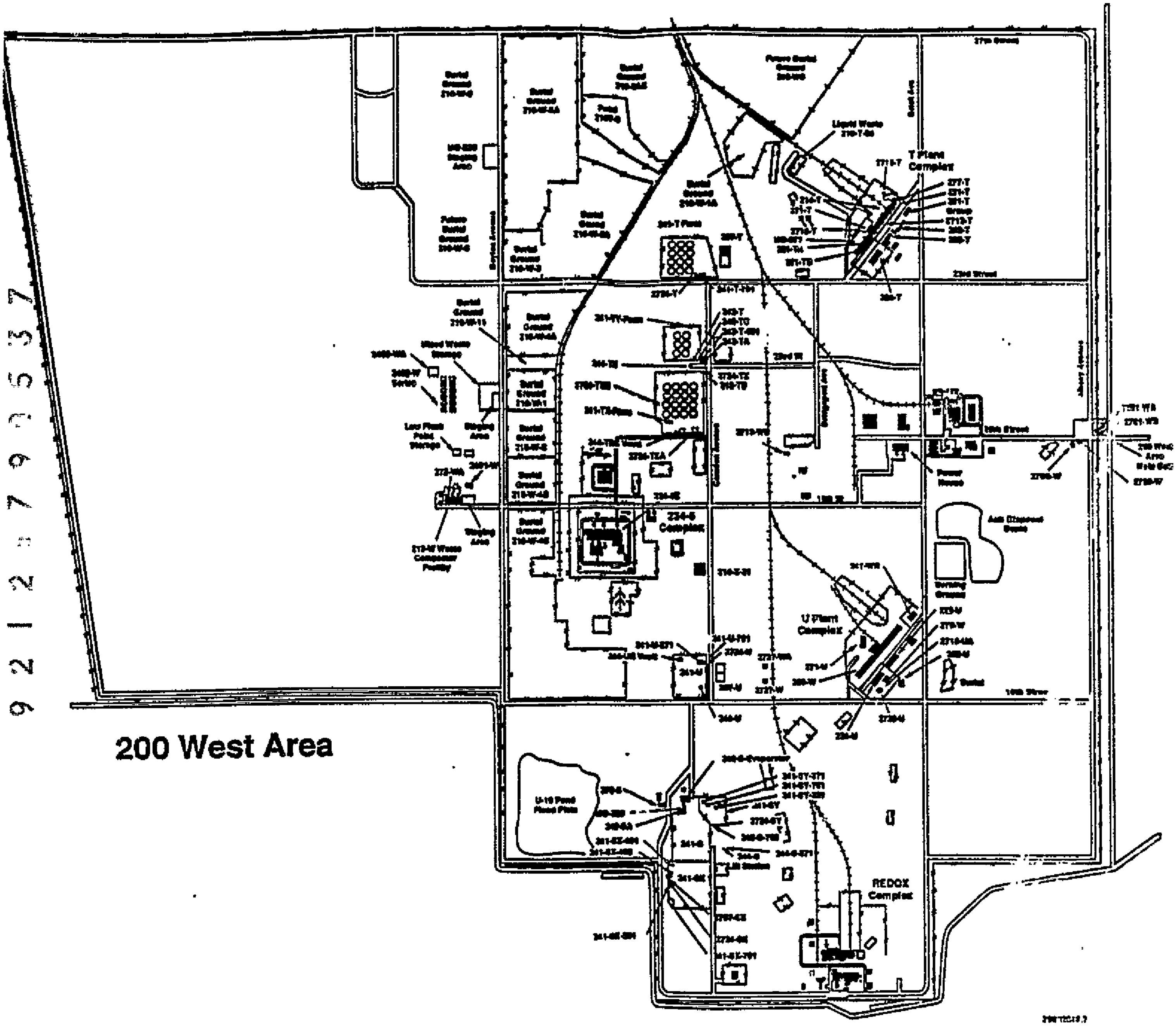
200 West Area
T Plant Complex
U Plant Complex
234-5 Complex
REDOX Complex

1.3 SURVEILLANCE ACTIVITIES

1.3.1 Chemical Processing Facilities

1.3.1.1 Plutonium/Uranium Extraction Plant. The Plutonium/Uranium Extraction (PUREX) Plant processes irradiated fuels from N Reactor to recover special materials (e.g., plutonium, neptunium, and U) and produces plutonium nitrate or plutonium oxide and uranyl nitrate. This process includes metal dissolution and solvent extraction. Supporting systems provide for the removal of nitric acid and organic compounds and the concentration and treatment of waste. The PUREX Plant was placed on standby in October, 1990.

1.3.1.2 Uranium Oxide Plant. The U Oxide (UO_3) Plant is used to produce UO_3 powder by calcining uranyl nitrate solutions from the PUREX Plant. The UO_3 powder is sealed in steel drums for shipment offsite. The UO_3 Plant was on standby during 1990, but will be used to complete processing of stored uranyl nitrate in 1991.

1.3.1.3 Plutonium Finishing Plant. The Plutonium Finishing Plant (PFP) is used to process and prepare plutonium products. At the PFP, the Plutonium Reclamation Facility (PRF) produces plutonium nitrate and the Plutonium Processing Facility converts plutonium nitrate to either plutonium oxide or metal. During 1990, PFP and the PRF were on standby.

1.3.1.4 T Plant. The T Plant was originally a fuel separation facility using the bismuth phosphate process. The facility is now used for decontamination and repair of equipment. This facility is currently active.

1.3.2 Waste Management Facilities

1.3.2.1 Tank Farms. Liquid waste from chemical processing operations containing high concentrations of radionuclides is stored on an interim basis in underground tanks. The Hanford Site tank farms contain 177 tanks (149 single-shell tanks (SST) and 28 double-shell tanks (DST)) with capacities ranging from 50,000 to 1,000,000 gal. Since 1967, new liquid waste has been stored in DSTs. The SSTs are no longer receiving waste and are planned for disposal.

The evaporators are facilities associated with the tank farms. These facilities are used to remove water from the liquid waste, thereby reducing the total volume of waste stored by the tank farms. During 1990, the 242-A Evaporator and the 242-S Evaporator were on standby.

1.3.2.2 B Plant/WESF. The scope of work for B Plant and the Waste Encapsulation and Storage Facility (WESF) is changing. No shipments of ^{137}Cs were made to customers in 1990 and the encapsulation processes for ^{90}Sr and ^{137}Cs at WESF were on standby. Upgrades are under way at B Plant to prepare for supporting the vitrification and grout projects.

1.3.2.3 Grout Facility. The Grout Facility combines low-level liquid waste with a cement mixture that is pumped into disposal vaults. The Grout Facility was inactive during 1990.

1.3.2.4 Cribs. Low-level liquid waste is discharged to the ground via structures called cribs. These subsurface systems allow the liquid component of the waste to percolate into the soil. The natural properties of the soil are used to remove radioactive material from the effluent water through filtration, ion exchange, and precipitation reactions. Of the 98 cribs in the 200/600 Areas, 13 were active in 1990.

1.3.2.5 Ponds. Ponds are used to manage the large quantities of water (i.e., cooling water and steam condensate) associated with chemical processing operations. These liquid effluents are normally uncontaminated. The ponds promote percolation of the liquid effluent into the soil column. Of the nine ponds in the 200/600 Areas, one remained active at the end of 1990.

1.3.2.6 Ditches. A ditch is an open, unlined excavation used for disposing of liquid effluents or transporting liquid effluents to ponds for disposal. Of the 16 ditches in the 200/600 Areas, 8 were active in 1990: A-29, T-4, B-3-3, S-10, U-14, 200 West and 200 East Power House ditch or pond, and B-63.

1.3.2.7 French Drains and Reverse Wells. These are pipes or rock-filled encasements inserted into the ground. These subsurface systems are used for managing potentially contaminated liquid waste by promoting percolation into the soil and using the natural filtration properties of soil to remove radioactive material from effluent water. These facilities terminate 200 or more feet above the groundwater. The 200 Areas have 20 French drains, none of which were active in 1990.

1.3.2.8 Solid Waste Disposal Sites. Contaminated solid waste is generated by various activities on the Hanford Site. This waste is buried in shallow trenches in the 200 Areas. The particular waste packaging procedures and burial practices used depend on the type of waste. Of the 33 solid waste disposal sites in the 200 Areas, 7 remained active in 1990.

1.3.3 Decontamination and Decommissioning

Westinghouse Hanford activities in the 200 Areas also involve decontamination and decommissioning of retired facilities, equipment, and waste disposal sites. These activities are aimed at preventing the release or spread of contamination and/or reducing the number of Radiological Control Areas. During 1990, approximately 20 acres of surface contamination were stabilized and reposted as underground radioactive material.

1.3.4 Analytical Laboratory

The 222-S Analytical Laboratory provides analytical support for Westinghouse Hanford activities in the 200/600 Areas. This laboratory handles radioactive samples taken in support of Chemical Processing and Waste Management facilities. The 222-S Analytical Laboratory was active in 1990.

2.0 AMBIENT AIR MONITORING

NOT YET COMPLETE

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3.0 GROUNDWATER MONITORING

3.1 INTRODUCTION

This section presents the status of the groundwater quality beneath the 200 Areas and associated waste sites in comparison with the Westinghouse Hanford ACV and the derived concentration guides (DCG). The ACVs for the separations area facilities and operations are contained in WHC-CM-7-5, *Environmental Compliance Manual* (WHC 1989) and listed in Table 3.1. This section also includes a brief description of Westinghouse Hanford's groundwater monitoring program, concentration summaries for active and inactive waste sites, and a summary of significant concentration trends that began in, or continued into, 1990. Comprehensive data from all monitored wells in the separations area will appear in a separate groundwater monitoring annual report to be issued by the Geosciences Group, Hydrology Section.

Westinghouse Hanford conducts the 200 Area groundwater monitoring program to determine the compliance status of 200 Area facilities and operations with Westinghouse Hanford's administrative controls pertaining to groundwater quality. The objectives of the program are as follows:

- Evaluate the quality of groundwater beneath the 200 Areas
- Determine the impact of waste disposal operations on the groundwater
- Assess the performance of disposal and storage sites in the 200 Areas
- Provide data for hydrologic analysis and model application.

3.2 MONITORING PROGRAM DESCRIPTION

The groundwater monitoring network for the 200 Areas consists of 166 wells. Of these, 86 wells in the unconfined aquifer and 9 wells in the confined aquifer were monitored during 1990. The groundwater monitoring well locations are shown in Appendix D, Figures D-1 through D-3.

The sampling of groundwater monitoring wells was halted in June 1990 when the DOE terminated U.S. Testing Company's contract. As a result, groundwater samples were not taken during the months of June through December.

Samples were collected for Westinghouse Hanford by Pacific Northwest Laboratory (PNL) and transported to U.S. Testing Company for analysis. Operational groundwater monitoring wells are sampled monthly, quarterly, or semiannually, depending on the well's operating history and/or the level of contamination and its rate of change. Most wells are equipped with dedicated submersible pumps; the remainder are sampled by bailing.

The analytical parameters in 1990 included total alpha, total beta, ^{60}Co, ^{90}Sr, ^{99}Tc, ^{129}I, ^{137}Cs, ^{106}Ru, ^{3}H, total U, and ^{238,239,240}Pu. Water samples from wells were selectively analyzed for these parameters based on effluent inventories and historical groundwater monitoring results. Sampling quality control is discussed in *Environmental Monitoring at Hanford for 1989* (PNL 1990).

Analytical results were reported by U.S. Testing Company to both the environmental assurance function and the Geosciences Group. The data are analyzed and reported annually.

Westinghouse Hanford has established ACVs pertaining to radionuclide concentrations in groundwater, which are specified in WHC-CM-7-5, Part N (Regulatory Compliance 1989) (WHC 1989). The intent of these ACVs is to ensure that at the end of institutional control and before migration to the site boundary, the groundwater concentration beneath the site dose not exceed the 0.04 DCG corresponding to 4 mrem/yr effective dose equivalent for radioactivity from current or future operations. It should be recognized that past accidents and practices may preclude meeting this standard for some isotopes. The ACVs serve as operating limits regulating discharges to liquid disposal sites and, as such, are more restrictive than the DCGs. Inactive liquid-waste disposal sites, i.e., those no longer receiving waste water, continue to be monitored to detect changes that could indicate a potential problem.

3.3 CONCENTRATION SUMMARY

The annual average concentration of radionuclides in groundwater beneath the 200 Area waste sites was compared to the ACV as well as the DCG. Note that the DCGs are applicable only at the point of actual exposure to members of the public (off the Hanford Site) and are not applicable onsite. Table 3-1 presents a comparison of the current WHC-CM-7-5 (WHC 1989) ACVs and the DCGs. Liquid-waste disposal sites that exceeded the ACVs or the DCGs are summarized below according to the contaminant involved.

3.3.1 Tritium

The groundwater beneath one active waste site and one inactive site exceeded the DCG for tritium ^{3}H in 1990. The active 216-A-45 Crib, which receives PUREX Plant effluents, was approximately 1.5 times the DCG. The elevated concentration of ^{3}H in the groundwater beneath this new crib is attributed to past practices in this area. Wells at inactive sites in the vicinity of this crib also showed ^{3}H concentrations in excess of the DCG. One well beneath the 216-A-37-1 Crib exceeded the DCG for 1990. The concentrations are expected to be below the DCG by the time the groundwater beneath these cribs reaches the Columbia River. A tritium plume map for the separations area can be found in a separate groundwater monitoring annual report for 1990 to be completed by the Geosciences Group, Hydrology Section.

Table 3-1. Administrative Control Values for Radioactive Groundwater.

Radionuclide	200 East	200 West	600 Area	DCG	Units
^{3}H	None	None	None	2,000,000	pCi/L
^{60}Co	5,000	5,000	5,000	5,000	pCi/L
^{90}Sr	74	480	40	1,000	pCi/L
^{99}Tc	4,000	4,000	4,000	100,000	pCi/L
^{106}Ru	6,000	6,000	240	6,000	pCi/L
^{129}I	20	20	20	500	pCi/L
^{137}Cs	210	1,200	120	3,000	pCi/L
^{234}U	20	20	20	500	pCi/L
$^{235,238}U$	24	24	24	600	pCi/L
Total U	60	60	60	-	pCi/L
^{238}Pu	2.0	3.6	1.6	40	pCi/L
$^{239,240}Pu$	1.2	1.2	1.2	30	pCi/L

3.3.2 Strontium-90

No active waste sites exceeded the ACV or DCG for ^{90}Sr.

Two inactive waste sites had elevated concentrations of ^{90}Sr in the groundwater. The groundwater beneath the inactive 216-B-5 Reverse Well had an annual average ^{90}Sr concentration of approximately 6 times the DCG and 80 times the ACV. The concentration has remained unchanged since 1985. The elevated ^{90}Sr concentration at this site was caused by the past direct discharge of contaminants to the water table. Except for 216-B-5, all reverse wells previously discharged into the vadose zone. This site, however, discharged directly into the water table from 1945 through 1947 (Law and Allen 1984). The high ^{90}Sr concentration results from residual contamination from that period of operation. Characterization has demonstrated that the radionuclides are sorbed on the sediments and that the contamination is localized (Smith 1980).

The groundwater beneath the stabilized 216-A-25 (Gable Mountain) Pond exceeded the ACV by three times during 1990 but did not exceed the DCG.

3.3.3 Technetium-99

None of the 15 wells analyzed for ^{99}Tc during 1990 exceeded the ACV or DCG.

3.3.4 Iodin -129

No waste sites exceeded the DCG or ACV for ^{129}I during 1990. Forty-eight wells were analyzed for ^{129}I in 1990. The concentration of ^{129}I in the groundwater has remained well below the ACV since 1989.

3.3.5 Cesium-137

The average annual concentration of ^{137}Cs at the inactive 216-B-5 Reverse Well was below the DCG, but was five times greater than the ACV. The concentration had been decreasing for the 5 yr before 1989, but remained constant during 1989 and 1990.

3.3.6 Plutonium

Two inactive waste sites, the 216-B-5 Reverse Well and the 216-Z-9 Crib, exceeded the ACV for ^{239}Pu in 1990 and the 216-B-5 Reverse Well exceeded the DCG by three times. This was first noted when more restrictive control limits were implemented internally by Westinghouse Hanford at the end of 1988. There has been no noticeable increase in the concentrations since the wells were first noted to exceed the ACV in 1988.

3.3.7 Uranium

The U concentration in the groundwater was expressed only as total U for 1990 and was not separated into the main isotopes as in previous years. The groundwater beneath one active site (216-U-17 Crib) exceeded the ACV and DCG. The concentrations of U in the groundwater have remained below the ACVs for the 216-B-62 and 216-S-25 Cribs since 1989.

The concentrations of U beneath the 216-U-17 Crib, which is scheduled to receive the UO_3 Plant process condensate effluent during future operations, was above the ACV and DCG for ^{235}U and ^{238}U as the limiting isotopes. The contamination is from other waste sites within the 200 West Area. The characterization of the plume was begun in 1989 with the drilling of three groundwater monitoring wells.

The groundwater beneath two inactive sites had concentrations of U isotopes that exceeded the ACV and one inactive site (216-U-1/2) exceeded the DCG for ^{235}U and ^{238}U as the limiting isotopes. The 216-U-1/2 and the 216-T-33 Cribs exceeded the ACV for total U in 1990.

3.3.8 Other Radionuclides

No other radionuclides were detected in excess of the ACVs or DCGs in any groundwater wells monitoring the Separations Area waste sites.

3.4 TRENDS

All groundwater data are analyzed to determine compliance with internal guidelines, and for trends to detect potential problems and demonstrate the effectiveness of waste site decommissioning.

Although concentration trends in the groundwater beneath the separations areas have been reported in the past years, no attempt has been made to determine trends using the limited data reported during 1990.

3.5 CONCLUSIONS

The groundwater beneath five waste sites exceeded the DCGs on an annual average for 1990. Two sites were in use and three were inactive. None of the sites have projected offsite doses that exceed the DOE limits.

- The 1990 annual average for tritium in the groundwater beneath the active 216-A-45 Crib was 1.8 times the DCG. This was down from an annual average of three times the DCG in 1988, but consistent with the concentrations reported in 1989.

- The annual average for tritium in the groundwater beneath the inactive 216-A-37-1 crib was four times the DCG.

- The annual average for the concentration of ^{90}Sr beneath the inactive 216-B-5 Reverse Well was six times the DCG in 1990, virtually unchanged from previous levels. The concentration for ^{239}Pu beneath the 216-B-5 Reverse Well was three times the DCG in 1990.

- The annual average for total U exceeded the DCGs (using ^{235}U and ^{238}U as the limiting isotopes) in 1990 for the active 216-U-17 crib.
- The annual average for total U exceeded the DCGs in 1990 for the inactive 216-W-1 and -2 cribs.

The groundwater beneath six sites exceeded the ACVs on an annual average.

- The ^{90}Sr concentration was greater than the ACV in the groundwater beneath the inactive 216-A-25 (Gable Mountain) Pond.
- The ^{137}Cs and ^{239}Pu concentrations in the groundwater exceeded the ACV beneath the inactive 216-B-5 Reverse Well.
- The U isotopes in the groundwater exceeded the ACV at the active 216-U-17 Crib.
- The U isotopes in the groundwater exceeded the ACV at the inactive 216-T-33 Crib.
- The U isotopes in the groundwater exceeded the ACV beneath the inactive 216-U-1 and -2 cribs.
- The ^{239}Pu concentration was greater than the ACV in the groundwater beneath the inactive 216-Z-9 crib and the 216-B-5 Reverse Well.

4.0 SOIL AND BIOTA MONITORING IN THE 200 AREAS

NOT YET COMPLETE

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5.0 EXTERNAL RADIATION MONITORING

5.1 INTRODUCTION

A network of thermoluminescent dosimeters (TLD) is positioned in and around the 200 Areas to monitor exposure rates from external radiation sources (primarily gamma rays). The TLD measurements are taken to determine baseline exposure rates in the 200 Area environment. From these baseline data, the contribution of Hanford Site activities can be discerned and the potential dose to employees caused by external exposure can be assessed. The dosimeters measure dose-equivalent rates, reported in terms of mrem/yr, at a specific location.

The environmental TLDs measure exposure rates from all types of external radiation sources. These include cosmic radiation, naturally occurring radioactivity in air and soil, and fallout from nuclear weapons testing, as well as any contribution from Hanford Site activities.

The TLDs consisting of three chips of CaF_2/Mg (Harshaw TLD-400) encased in an opaque capsule lined with 0.025 cm of Ta and 0.005 cm of Pb were replaced with TLDs consisting of four LiF (TLD-700) and one CaF_2:Dg (TLD-200) chips in a green Noryl plastic card. Each card is placed in a translucent, waterproof, plastic holder, and three cards are mounted about 3 ft above the ground at each location. The TLDs are placed at active and inactive surface-water disposal sites, and near facilities (tank farms, active cribs, and the facility fence lines). The TLDs are exchanged and read each calendar quarter. Each quarterly measurement is an average of the three cards exposed at the same location. The response of the chips has been calibrated by the PNL Radiation Calibration Laboratory; results are reported in terms of external exposure (mrem).

5.2 RESULTS

The TLD data are listed in Appendix F, Table F-1. Generally, all facility and surface-water sites showed an approximate 10 percent decrease in 1990. This overall decrease is believed to be a result of a decrease in operations and a restructuring of the external radiation monitoring program. The one site at the PUREX Plant-related facilities that has displayed an upward trend in the 1985 to 1989 time period showed a slight decrease in 1990. Trends for this site will continue to be monitored.

5.2.1 Surface-Water Sites

All TLDs at surface-water sites, except West Lake, are within radiologically controlled areas located at water-sampling sites (see Section 6.0). One surface-water site showed radiation above background level: the 216-B-3-3 Ditch. The highest exposure rate for surface-water sites in the Separations Area was at the 216-B-3-3 Ditch, with an exposure rate of 119 mrem/yr.

5.2.2 Facilities

The TLDs are located at several sites associated with the facility operations, including tank farms, active cribs, and the facility fence lines. These locations are shown in Appendix F, Figures F-1, F-2, and F-3. The only exposure rate significantly higher than the general Separations Area environment was at the 241-A Tank Farm complex. This facility, which receives high-level liquid waste from the PUREX Plant, had external radiation levels ranging from 110 to 1,195 mrem/yr. These elevated levels are localized and few in number (only four are significantly higher than the grid sites) and therefore have minimal environmental impact. All other TLD measurements of facilities were consistent with the levels seen in the general Separations Area environment.

5.2.3 External Radiation Trends

Site trending showed some decrease in exposure with the inception of the new TLDs used for monitoring and the restructuring of the external radiation monitoring program. This may also be an effect of the decreased operations in the 200 Areas. The sensitivity of the new TLD has required some monitoring locations to be changed. These combined effects will be monitored in the future to see what,if any, impact they have on the external dose rate measured.

5.3 CONCLUSIONS

In 1990, operations in the 200 Area did not contribute significantly to the external radiation exposure rate in the general environment. Consequently, the exposure rate in the general 200 Areas environment was not significantly different from the exposure rate received offsite from natural radiation sources. As expected, external radiation levels were elevated at certain sites, radiological control areas, and facilities, reflecting the proximity to radioactive waste management activities.

6.0 POND AND DITCH MONITORING

6.1 INTRODUCTION

Water, vegetation, and sediment samples were collected from the active ponds and ditches in 1990. Ponds and ditches in the 200 Areas receive potentially contaminated waste water from the chemical processing plants and other facilities. All water is continuously sampled at the point of discharge to ensure compliance with internal company standards and applicable DOE standards. As an additional operational check, the 200/600 Area Operational Environmental Surveillance Program collects water samples at the ponds and ditches. Sampling locations are shown in Appendix G, Figures G-1 and G-2. Sources of liquid effluents are listed in Table G-1.

Water samples of 1 L are collected on a weekly basis from the active ponds and ditches. The pH is determined each week, then the samples are composited and analyzed monthly for total alpha, total beta, gamma-emitting radionuclides, and ^{90}Sr. Each site has replicate samples taken for 1 mo (4 wk), on a rotating basis. Additionally, a 1-L sample is taken quarterly from each site for nitrate analysis. Samples of aquatic vegetation are collected from ponds and ditches yearly to determine root uptake of radionuclides from potentially contaminated sediments. Along with vegetation samples, sediment samples are collected to measure the accumulation of radionuclides. These samples consist of a composite of five plugs, each 900 cm^2 by 2.5 cm deep. Both the vegetation and sediments are analyzed for gamma-emitting radionuclides, ^{90}Sr, ^{239}Pu, and U.

6.2 RESULTS

6.2.1 Water

Results of water sampling at the ponds and ditches are summarized in Appendix G, Table G-2. A large percentage of the results are less than the analytical detection limit; only the maximum and minimum concentrations at each site are presented. The only elevated results were total alpha and total beta. The highest monthly total alpha result of 111 pCi/L was observed at the 216-T-4 Ditch. This is 370 percent of the DCG (using Pu-239 for comparison). The highest total beta concentration, 299 pCi/L, was found at the third overflow of the 216-B-3-3 Ditch and was only 30 percent of the DCG (using Sr-90 for comparison).

6.2.2 Nonradiological Parameters

Results of pH determinations are summarized in Appendix G, Table G-3 and nitrate determinations are summarized in Appendix G, Table G-4. The pH annual averages ranged from neutral to slightly basic. The highest annual average pH of 11.6 was found at West Powerhouse Pond, which receives discharge from the 200 West Area powerhouse. All of the nitrate results were less than the detection limit (approximately 1.2 ppm).

6.2.3 Vegetation

Aquatic vegetation samples are collected from ponds and ditches that have growing aquatic vegetation. Nine vegetation samples were collected from 11 ponds and 6 ditches in 1990. Each sample consisted of growing stems and leaves from the predominant plant species at each location. The vegetation was analyzed for gamma-emitting radionuclides, as well as ^{90}Sr, ^{239}Pu, and U with the results reported in Appendix G, Table G-5. The 216-A-29 Ditch will be sampled in greater detail in 1991 to characterize the ditch before stabilization.

6.2.4 Sediment

The results from sampling pond and ditch sediments are provided in Table G-6. The highest ^{137}Cs result was found at the 216-B-3-3 Ditch. The concentration measured in 1990 was 298 pCi/g, about 1 percent of Westinghouse Hanford's soil standard for posting. The highest Pu result was found at the 216-A-29 Ditch. The concentration measured in 1990 was 255 pCi/g, about 340 percent of Westinghouse Hanford's soil standard for posting. All ponds and ditches that receive potentially contaminated water are within posted radiological control areas.

6.3 CONCLUSIONS

While no significant increases in radioactivity were observed in surface water samples from ponds and ditches in 1990 (most samples were below the detection limits) two sample sites exceeded the applicable standards on 216-T-4 Ditch and 216-B-3-3 Ditch. All surface waters associated with Separations Area operations were below the DCG for all radionuclides. The analytical results of vegetation samples taken at the ponds and ditches revealed that, while some physiological uptake of radionuclides occurred, the amounts were relatively low. Sediment samples taken demonstrated elevated levels (above background) of mainly ^{137}Cs and Pu. However, all ponds and ditches that receive potentially contaminated water are within posted radiological control areas.

7.0 RADIOLOGICAL SURVEYS

7.1 INTRODUCTION

Radiological surveys are conducted to determine changes in the radiological status of the 200/600 Area environment. Trends in radiation levels or radiological contamination aid in assessing the adequacy of the underground radioactive material waste containment, indicate movement of radioactive material away from radiological control areas, or detect releases that might otherwise go undetected. The survey schedule is outlined in Appendix H, Table H-1.

7.2 ROADS

Road surveys are performed with the mobile surface contamination monitor (MSCM tractor) or a vehicle equipped with sodium iodide detectors mounted on the undercarriage. The detector height is adjustable. The average survey height is one foot above the pavement.

The vehicle is driven at approximately 5-7 mi/h. When activity is detected, the vehicle is stopped and a thorough survey is made with an Eberline Model BNW-1 portable survey instrument equipped with a P-11 probe. Appropriate management is notified when contamination is identified and corrective actions are initiated.

All frequently traveled blacktop and improved roads and parking lots in and perimeter roads around the 200 Areas are surveyed bimonthly to detect the presence of radioactive material. Roads less frequently traveled or with low contamination potential are surveyed either quarterly or semiannually. Other roads on the Hanford Site are surveyed by PNL. No new contamination was detected on the roads in 1990.

7.3 PONDS AND DITCHES

Open pond and ditch banks are routinely surveyed to identify contamination at these sites. The thin-window, pancake-type Geiger-Muller probe with the BNW-1 count-rate meter is the principal instrument used in these surveys. Special survey plots are designated around the perimeters of these sites. They are marked with metal posts and numbered. Several areas of contaminated soil and vegetation were identified at the 216-U-14 Active Ditch in 1990. Contamination levels from 600 c/min to 13 mrem/h were noted. This area is expected to be stabilized in 1991.

7.4 RADIOACTIVE SOLID-WASTE DISPOSAL SITES

The retired radioactive solid-waste disposal sites are surveyed semiannually to detect radiological changes, primarily via biological intrusion (indicative of loss of control), from year to year. These sites are located in the 600 Area (Appendix H, Figure H-1) and in the 200 Areas (see Figures 1-1 and 1-3).

Contaminated vegetation was identified at 218-E-12A, 218-E-12B, 218-E-1, and 218-E-2, 5, 5a, and 9 burial grounds in 1990. Clean-up activities have been initiated and schedules for the herbicide spray program have been improved.

The 218-C-9 burial ground stabilization was accomplished. This accounted for a 5-acre reduction in radiation area.

7.5 LOW-LEVEL LIQUID-WASTE DISPOSAL SITES

Low-level liquid-waste disposal sites, other than ponds and ditches, consist of cribs, french drains, reverse wells, trenches, and unplanned release sites. As with solid-waste disposal sites, liquid-waste sites are surveyed at least annually, and as often as quarterly, to detect changes in surface radiological conditions. The most significant results in 1990 are listed below.

7.5.1 216-A Sites

The 216-A-30 Crib was found to be 80 percent covered by growing vegetation. A considerable amount of this vegetation was contaminated. The vegetation was removed from this crib. Herbicide spray program schedules are being improved to keep this situation from reoccurring.

Contamination and standing water at the 216-A-40 basin is suspected to be a source of contaminated mud for swallow nests. This area is scheduled for clean up in 1991.

7.5.2 216-B Sites

Ant intrusion continues to be a problem at the 216-B-64 retention basin. The surface contamination zone, known as UN-216-E-36, has been expanded several times during 1990 to include identified contamination migration. This zone extension is now approximately 2 acres in size. Pesticides and stabilization methods are being investigated.

Approximately 12 acres of speck contamination north of 241-B Tank Farm was posted as having surface contamination and was given the site identification number of UN-216-E-44. The contamination levels are generally 400-800 c/min.

7.5.3 216-S Sites

Stabilization efforts were completed at 216-S-5, 216-S-6, S-172, and S-160 weirs during 1990. This accounts for about 2.5 acres.

Contamination at the 211-S Tank Storage Area continues to be a problem. The source of the speck contamination that migrates from this area has not yet been identified.

Roof vents at 233-S were painted to prevent the spread of alpha contamination. Smearable contamination of greater than 100,000 dis/min was identified on the vents during a routine building radiological survey.

7.5.4 216-T Sites

Stabilization efforts were completed at 216-T-18, 216-T-34, 216-T-35, and 216-T-26-28 cribs and the surrounding surface contamination zone in 1990. This accounts for approximately 6 acres.

7.5.5 216-U Sites

Approximately 1 acre of contamination at 216-U-11 overflow was cleaned and restabilized.

A contamination strip of approximately 1.5 acres was found on the south side of the 216-U-10 covered pond. Two feet of clean soil was added to stabilize this area.

7.5.6 216-Z Sites

No significant changes were noted at the Z Plant cribs.

7.5.7 Unplanned Release Sites

The area of contamination known as UN-216-W-7 (approx. 3.5 acres) was stabilized.

The most noteworthy contamination was found at the following unplanned release sites.

The zone at UN-216-W-33 that identifies contaminated vegetation over the underground pipeline from the 216-U-8 Crib to 224-U has been extended to include newly found contaminated vegetation. This area is now approximately 3 acres.

Spotty contamination (to a maximum of 700 mrem/h) was found on the East-West transfer line (UN-216-E-41). Some clean-up work has been accomplished to remove the high-level contaminates. The remainder is scheduled for clean up in 1991. The transfer line is posted as having surface contamination from end to end and equals approximately 17 acres.

UN-216-E-17 has been redefined to include the contamination identified to the north to 12th Street and to the west to include 216-B-57 Crib. This area is scheduled for stabilization in 1991. This area is now approximately 11.5 acres.

An area of contamination south of the 244-A Lift Station was given the site identification number of UN-216-E-43. This area was found to have speck contamination and contaminated rabbit droppings. The maximum contamination level was 900 mrem/h. This area is approximately 2 acres and is scheduled to be cleaned in 1991.

Approximately 2 acres of contamination east of 241-U Tank Farm was given the site identification number of UN-216-W-35. Maximum contamination in this area is 800 c/min.

The area of contamination surrounding the 216-T-30 Catch Tank was given the site identification number of 216-W-36. The total surface contamination is approximately 1 acre.

7.6 TANK FARM PERIMETERS

Tank farm perimeters and associated facilities are surveyed semiannually to detect any migration of contamination. Tank farms and related facilities are considered to be sources of environmental contamination. Recontamination of the same fence lines from year to year appears to be associated with blowing of known contamination in relation to contamination patterns that conform to the prevailing wind direction.

The fence lines of the 241-B Farm and the 241-BX and -BY Farms continue to be a problem. Evidence of speck contamination up to 10 mrem/h has been noted.

In the 200 West Area the east fence line of SX Farm has a zone extension to the blacktop road. A sizable surface contamination area (UN-216-W-24) is adjacent to this fenceline. Speck contamination with levels up to 14 mrem/h has also been identified in this 6-acre area.

The north fence line of 241-U has a 0.5-acre zone extension with contamination levels from 300 c/min to 15,000 c/min.

The north and east fence-line contamination of 241-T Farm is adjacent to the migrating contamination of UN-216-W-31.

The clean-up schedule for these areas around the tank farms has yet to be determined. The interior of the tank farms are planned for clean up before the fence lines to prevent recontamination.

7.7 BC CRIBS AND CONTROLLED AREA

The BC Cribs and trenches (Appendix H, Figure H-2) are a series of liquid-waste disposal sites that were active in the mid-1950's. In 1958, it was discovered that animals had burrowed into one trench and transported radioactivity over a large area. In 1979, special survey plots were established throughout the controlled area to monitor for migration of the contamination. Data accumulated during the 10-yr period indicates that no significant migration of contamination away from the areas has occurred. The cribs and trenches (approximately 50 acres) were surface stabilized in 1982 and are surveyed semiannually with the MSCM tractor.

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8.0 SPECIAL PROJECTS AND INVESTIGATIVE SURVEILLANCE

8.1 INTRODUCTION

Because the grid system of near-field environmental monitoring in the 200 Areas was eliminated in 1989, special projects and investigative surveillance have assumed a greater role in Westinghouse Hanford's operational and effluent monitoring program.

Special projects in 1990 included radionuclide analyses of soil near Z Plant, analyses of cottontail rabbits from 244-A Lift Station to try to determine contamination sources, review of the vegetation control program, and testing of engineered biological barriers with captive mammals to determine the effect of burrowing and water penetration on simulated waste sites.

Special investigative surveillances were conducted in the operations areas in 1990 to clarify conditions indicated by routine samples or survey results, or to determine the need for a full-scale site characterization. They are often performed to help explain questions that result from analyses of routine samples; however, they are also the result of concerns about radiological or potentially hazardous waste as they affect or are affected by employee safety, biotic intrusion, maintenance of containment systems, or potential contamination migration. For example, special surveillances or samples may be collected from the following:

- A broader area when analytical results from one of the routine samples show elevated radionuclide content
- An area where scheduled construction activities in the vicinity of a waste site make it desirable to demonstrate the radiological condition on the area
- A site where biotic intrusion, such as animal burrows or deep-rooted vegetation has created the potential for the spread of contaminants
- Sites where the integrity of the waste maintenance systems is questioned.

These are examples, but not an all-inclusive list, of instances when special surveillances or samples are needed to ensure operational compliance with guidelines and regulations.

8.2 SAMPLE TYPES

Types of special samples in the past have included air, water, snow, sediments, soil, vegetation, animal excrement, and whole animals such as spiders, ants, termites, birds, mice, coyotes, and bobcats. In 1990 special samples included soil, vegetation (tumbleweeds and mulberry), termites, gold fish, a gopher snake, pigeons (including feces), swallows (including fecal and nesting material), house mice (including nest material and feces), and cottontail rabbits.

8.3 INVESTIGATIVE METHODS

8.3.1 Vegetation Control

The effectiveness of the Vegetation Control Program on radioactive waste sites was determined by detection of contamination during routine radiological surveys of the waste sites. In addition, visual inspections of the waste sites were conducted to observe vegetative cover.

8.3.2 Animal Capture and Collection

The Washington Department of Wildlife granted Westinghouse Hanford a scientific collection permit (Permit No. 179) in 1990 to allow collection and salvage of selected animals for contamination analyses and engineered-barrier testing. Collection methods varied from live traps to snap (kill) traps to salvage of dead animals for laboratory analyses.

8.3.3 Laboratory Analyses

Field preparation of samples was done as outlined in routine-sample-collection procedure manuals. Methods for exceptions of unusual samples (e.g., bobcat) not covered in a procedure manual were specified by the environmental protection field work coordinator. Samples that had radioactivity levels above background, as determined by field survey instruments, were sent to Westinghouse Hanford onsite analytical laboratories; those at or below background levels were sent to the U.S. Testing Laboratory in Richland, Washington until that contract was terminated in May, 1990. A new contract to provide analytical services was still pending at the end of 1990, and samples were archived awaiting the new contract. Contaminated samples were sent to the Westinghouse Hanford laboratory at 222-S in 200 West.

Samples were washed to remove external contamination before analyses. Vegetation samples occasionally included the entire plant, including roots if required. Animal samples of larger specimens were washed, then divided into portions to separate skin and fur or feathers, gastro-intestinal organs, and muscle and bone. Small animals were dissolved in acid and analyzed for radionuclides.

8.4 INVESTIGATION RESULTS

8.4.1 Vegetation Control

Vegetation control was again noticeably less effective in 1990 for the reasons reported in the 1989 annual report (Schmidt 1990). Improved vegetation control because of new equipment and pesticide changes will probably not be noticed until 1991.

8.4.2 Animal Collection and Salvage

Animals captured or salvaged in 1990 included 24 specimens from 11 species. These include the following:

- Two termite colonies
- One goldfish
- One gopher snake
- Two cliff swallows
- One house mouse
- Two Townsend's ground squirrels
- Four northern pocket gophers
- Three deer mice
- Four Great Basin pocket mice
- One bushy-tailed wood rat
- Four Nuttall's cottontails.

Results are reported in Appendix I for those species analyzed for radionuclide contamination.

8.4.3 Biotic Radioactive Contamination

Ten instances of tumbleweed (*Salsola kali*) contamination were documented in the 200 Areas in 1990, and two mulberry trees growing near B Pond had low-level radionuclide contamination. Contaminated termites were collected on two occasions at BC Cribs. No contaminated domestic pigeons were captured in 1990. Contaminated swallow nests were found at most facilities near the PUREX Plant. A likely source is thought to be the inactive 216-A-40 Crib. Contaminated mice were captured near Z Plant, C Tank Farm, and 202-S. Contaminated cottontail rabbits were captured at the 244-A Lift Station and contaminated rabbit fecal material was found near C Tank Farm and T Plant. Results of radionuclide analyses are reported in Appendix I.

The total number and kinds of biota found to be contaminated with radioactivity were not unusual with the exception of the slight increase in contaminated vegetation, which has been observed over the past three years.

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APPENDIX A

QUALITY ASSURANCE

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APPENDIX A

QUALITY ASSURANCE

Quality Assurance (QA) may be defined as the actions necessary to ensure the accuracy of a program. Westinghouse Hanford Company's (Westinghouse Hanford) environmental surveillance QA program consists of procedures and guides to demonstrate that environmental monitoring techniques and analyses are performed within established limits of acceptance. A sound QA program for environmental monitoring is essential in maintaining credibility.

Written operating procedures are an integral part of the Westinghouse Hanford environmental surveillance QA program. Procedures for field operations are provided in an internal Westinghouse Hanford manual. Emergency response and other special procedures may be documented separately. This appendix briefly describes the essential components of the Westinghouse Hanford environmental surveillance QA program.

DOCUMENTATION

Record keeping is a vital part of any environmental monitoring program. Maintenance of environmental data is not only important from a QA standpoint, but also from a regulatory standpoint, and for trend analysis and optimizing environmental monitoring procedures. For these reasons, each phase of the Westinghouse Hanford Operational Environmental Surveillance Program is documented. This documentation includes sampling logs, annual reports, and unusual-occurrence reports.

SAMPLE REPLICATION

Replicate sampling and subsequent analysis are the primary means of assessing sample variability. Duplicate samples of air, water, soil, sediment, and vegetation are collected as part of the routine Environmental Surveillance Program.

DATA ANALYSIS

Environmental data are reviewed to determine compliance with applicable federal and company guides. The 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 hard-copy printouts.

TRAINING

To ensure quality and consistency in sample collection and handling, all personnel performing such work receive formal training. All Westinghouse

Hanford Health Physics Technologists (HPT) are required to complete a certification program through the Westinghouse Hanford Health Physics Department. In addition, those HPTs assigned to environmental programs receive special classroom orientation and on-the-job training by experienced personnel. Environmental Assurance personnel receive training in such courses as "Radiation in the Environment," taught through the Tri-Cities University Center, courses taught at the Harvard School of Public Health, and various short courses.

SAMPLE FREQUENCY

The frequency of sample collection varies according to the importance of the measurement. Media sampled more frequently are critical in determining immediate releases to, or impacts on, the environment. A brief description of the sampling program is presented below.

1. Ambient air sample filters and water samples from active ponds and ditches are collected weekly.

2. Radiological surveys of 200 East and 200 West Area roads are performed on a quarterly or bimonthly basis, as stated in Section 7.0.

3. The thermoluminescent dosimeters (TLD) at facilities, ponds, and ditches are exchanged quarterly.

4. Radiological surveys of waste sites are performed quarterly, semiannually, or annually depending on the operating status, condition, and history of the site.

5. The soil, vegetation, and fecal samples are collected annually. Mud and vegetation samples from active ponds and ditches are also collected annually.

ANALYTICAL PROCEDURES

Four laboratories provided analytical support to the Westinghouse Hanford Environmental Surveillance Program; these are the United States Testing Company (UST), International Technology Analytical Services-Richland Laboratory (ITAS-RL), the Radiation Standards and Engineering Laboratory at Pacific Northwest Laboratory (PNL), and the Westinghouse Hanford 222-S Analytical Laboratory. The environmental samples are analyzed in accordance with prescribed procedures and quality control guides. The analytical procedures necessary to implement the environmental monitoring program are briefly described below and are listed according to the respective laboratory.

United States Testing Company and International Technology Analytical Services

The UST provided analytical support for the 200/600 Area Environmental Surveillance Program until May, 1990 when USTs contract was terminated.

Samples were held in archive until the procurement of ITAS-RL's services in February, 1991. Both laboratories performed the following functions for the Environmental Surveillance Program.

Much of the Environmental Surveillance Program involves measuring radionuclide concentrations at or near background levels. These environmental measurements require a very low detection limit and are typically performed at UST and ITAS-RL. These analytical laboratories routinely perform analyses on soil, vegetation, animal feces, and air samples. Analyses are performed according to procedures and quality control guides described by the Environmental Measurements Laboratory (1972), the U.S. Atomic Energy Commission (1974), and the National Council on Radiation Protection and Measurements (1976).

1. Air Samples

   a. Gamma Energy Analysis - Gamma-emitting radionuclides are measured by direct counting of the air sample filter with a hyperpure germanium detector. The gamma spectra are analyzed using a Nuclear Data 7700 software system.

   b. Strontium - Airborne ^{89}Sr and ^{90}Sr are determined by leaching the composited air sample filters with nitric acid and initially precipitating them as a nitrate. The sample is purified by Fe and Ba scavenging. The final precipitate, strontium carbonate, is then counted for total beta (needed to set the ^{89}Sr value) with a low-background beta proportional counter. Both ^{89}Sr and ^{90}Sr are calculated from the resulting count data using a computer.

   c. Plutonium - The various Pu isotopes are leached from the air sample filter with nitric acid and passed through an ion-exchange resin. Further decontamination from Pb, Bi, and other transuranics by washing with nitric and hydrochloric acids is done. The Pu is then eluted from the resin and electrodeposited on a stainless steel disk where it is counted using a surface barrier alpha spectrometer and data collected on a Nuclear Data system.

   d. Uranium - The U is leached from the air sample filter and extracted as tetrapropyl ammonium uranyltrinitrate followed by back extraction into water. Following treatment with Na and LiF, the aqueous sample is analyzed with a fluorometer to determine the mass U.

2. Groundwater Samples

   a. Total Alpha and Beta Activity - The total activity caused by alpha- and beta-emitting radionuclides is measured by directly counting the dried residue with a gas flow proportional counter.

   b. Strontium-90 - The strontium is removed from the water sample by precipitating it as a nitrate using nitric acid. The sample is purified by repeated scavenging with barium chromate and precipitating with barium carbonate. The strontium carbonate is then counted with a low-background gas flow proportional counter.

   c. Gamma Energy Analysis - Gamma-emitting radionuclides are analyzed by directly counting the water sample with a Ge(Li) detector equipped with a multichannel pulse-height analyzer.

   d. Tritium - Water samples are analyzed for Tr with a liquid scintillation spectrometer.

   e. Total Uranium - The water samples are analyzed for U by first treating them with sodium and lithium fluoride then analyzing them with a fluorometer.

3. Soil Samples

   a. Gamma Energy Analysis - Gamma-emitting radionuclides in soil are measured using a Marinelli beaker and counting with a Ge(Li) detector equipped with a multichannel pulse-height analyzer.

   b. Strontium-90 - The ^{90}Sr is removed from the soil sample by leaching the dried sample with nitric acid. The Sr in solution is converted to an oxalate followed by precipitation as strontium carbonate. The carbonate is deposited on a planchet and counted in the same manner as the ^{90}Sr water samples.

   c. Technetium-99 - The ^{99}Tc is isolated from other elements using hydroxide carbonate coprecipitation leaving it in solution as the pertechnethe ion (TcO_4^-). Further purification is achieved by an anion exchange column path, followed by liquid scintillation spectrometry.

4. Vegetation Samples

   a. Gamma Energy Analysis - Gamma-emitting radionuclides in vegetation are measured by direct counting of the sample with a Ge(Li) detector equipped with a multichannel pulse height analyzer.

   b. Strontium-90 - The ^{90}Sr is removed from the vegetation sample by leaching the dried sample with nitric acid. The Sr in solution is converted to an oxalate followed by precipitation as strontium carbonate. The carbonate is deposited on a planchet and counted in the same manner as the ^{90}Sr water samples

c. Technetium-99 - The ^{99}Tc is isolated from other elements using hydroxide carbonate coprecipitation leaving it in solution as the pertechnethe ion (TcO_4^-). Further purification is achieved by an anion exchange column path, followed by liquid scintillation spectrometry.

Westinghouse Hanford 222-S Analytical Laboratory

The Westinghouse Hanford 222-S Laboratory also provides analytical support to the 200/600 Area Environmental Surveillance Program. This laboratory is the one normally used for samples containing higher than normal environmental levels of radioactivity. Analytical procedures and quality control guides are described by the Environmental Measurements Laboratory (1972), the American Society for Testing and Materials (1976), the American Public Health Association (1980), and the U.S. Environmental Protection Agency (1979). A brief description of the routine analyses performed by the 222-S Laboratory is presented below.

1. Pond and Ditch Water

a. Total Alpha and Beta - An aliquot of the pond or ditch water is added to a stainless steel dish and evaporated to dryness. The total alpha and beta activities are measured by direct counting with a gas flow proportional counter.

b. Gamma Energy Analysis - The liquid sample is sealed inside a geometrically approved container. The gamma-emitting radionuclides are measured by direct counting with a Ge(Li) detector equipped with a multichannel analyzer.

c. Strontium-90 - The ^{90}Sr is removed from the aqueous sample by precipitating the ^{90}Sr out with barium carbonate. The strontium carbonate is purified by redissolving with nitric acid, precipitating as a nitrate, and finally precipitating again as a carbonate. The ^{90}Sr activity is determined by beta counting with a gas flow proportional counter.

d. Plutonium - Actinides are removed from the aqueous sample by precipitation with iron. The precipitate is redissolved in hydrochloric acid and the Pu separated from the other actinides by ion exchange. The Pu is electrodeposited on a planchet and counted using alpha spectrometry.

2. Pond and Ditch Mud and Sediment

a. Gamma Energy Analysis - The gamma-emitting radionuclides are measured by direct counting of the dried sediment sample using a Ge(Li) detector equipped with a multichannel analyzer.

b. Soil leach - Sr, Pu, Am, and other radionuclides are leached from the soil sample using a mixture of hydrochloric and nitric acids. The leachate is then analyzed for specific radionuclides as is done with the liquid samples.

3. Pond and ditch vegetation

a. Gamma energy analysis - The liquid sample is sealed inside a geometrically approved container. The gamma-emitting radionuclides are measured by direct counting with a Ge(Li) detector equipped with a multichannel analyzer.

b. Vegetation leach - The vegetation samples are dry ashed in a furnace and then leached with a mixture of hydrochloric and nitric acids. The leachate is analyzed for specific radionuclides as is done with the liquid samples.

Pacific Northwest Laboratory Radiation Standards and Engineering

External Radiation (Thermoluminescent Dosimeters) - External radiation levels are measured using TLDs. Three TLDs at each sampling location monitor facilities, water sampling sites, and active tank farms and cribs associated with the PUREX Plant operation. The TLDs consist of four LiF (TLD-700) and one CaF_2:Dy (TLD-200) chip in a green Noryl plastic card.

The TLDs are calibrated, packaged, and read by the PNL Radiation Calibration Laboratory, Radiation Standards and Engineering Department. All TLD work is performed in accordance with the procedures and specific guides from the American National Standards Institute and PNL.

APPENDIX B

GLOSSARY

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APPENDIX B

GLOSSARY

List of Acronyms

ACV	administrative control value
ALARA	as low as reasonably achievable
DCG	derived concentration guideline
DOE	U.S. Department of Energy
DST	double-shell tank
DWS	drinking water standard
EPA	U.S. Environmental Protection Agency
HPT	Health Physics Technologist
ITAS-RL	International Technology Analytical Services-Richland Laboratory
ICRP	International Commission on Radiological Protection
MSCM tractor	mobile surface contamination monitor
OEC	Operations and Engineering Contractor
PFP	Plutonium Finishing Plant
PNL	Battelle's Pacific Northwest Laboratories
PRF	Plutonium Reclamation Facility
PUREX	Plutonium Uranium Reduction Extraction (Plant)
QA	quality assurance
SST	single-shell tank
TLD	thermoluminescent dosimeter
UO_3	Uranium Oxide (Plant)
UST	U.S. Testing Company, Inc.
WESF	Waste Encapsulation and Storage Facility
Westinghouse Hanford	Westinghouse Hanford Company

Definitions

Aquifer - A subsurface formation consisting of sufficient saturated permeable material to yield significant quantities of water.

Confined Aquifer - A subsurface water-bearing region having defined and relatively impermeable upper and lower boundaries.

Unconfined Aquifer - An aquifer that has a water table or surface at atmospheric pressure.

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 radioactive materials
- Contaminated animals themselves that have ingested radioactive materials directly or ingested other contaminated animals or plants
- Physical displacement of radioactive materials 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.

Burial Ground - An area specifically designated for the subsurface disposal and/or storage of solid, dry radioactive waste.

Chemical Processing - Chemical treatment of material to selectively separate desired components. At the Hanford Site, plutonium, U, 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 - The collection and analysis of samples of air, water, soil, foodstuffs, biota, and other media from DOE sites and their environs and the measurement of external radiation for purposes of demonstrating compliance with applicable standards, assessing radiation exposures to members of the public, and assessing effects, if any, on the local environment.

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.

Operations - In this report this term loosely refers to Westinghouse Hanford activities including chemical processing, waste management, and decommissioning.

Percolation - Downward movement of water through the interstices of unsaturated rock or soil because of gravity or hydrostatic pressure.

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.

Radiological Posting - Barriers in the form of signs and chains to prevent access into a radiological control area.

Release From Radiological Posting - Removal of signs and chains when access to an area no longer needs to be restricted for radiological protection purposes.

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

Separations Area - The primary area in the Hanford Site where chemical processing and most waste management activities are performed. It includes the 200 Areas and nearby 600 Area sites. Westinghouse Hanford is landlord of the Separations Area.

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

Surface Stabilization - A remedial action program on waste disposal sites that includes the addition of at least 4 ft of clean soil followed by revegetation. It is designed to cover surface contamination and inhibit biological transport.

Tank Farm - An area of large underground tanks designed to store up to 1 Mgal each of high-level liquid waste.

Underground Radioactive Material - A radiological posting status where subsurface radioactivity is present, but where surface contamination is not in excess of the Soil Standards.

Unplanned Release Site - An area that was contaminated by an unplanned release of radioactive contamination from a nearby source, making it a radiological control area.

Vadose Zone - The unsaturated region of soil or the zone of aeration between the ground surface and the water table.

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.

Waste Management - The activity involved with storing, disposing, shipping, handling, and monitoring all radioactive waste.

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

Wind Rose - A diagram illustrating the distribution of wind directions at a given location during a specific time. It illustrates the direction the wind blows from.

APPENDIX C

AMBIENT AIR MONITORING FIGURES AND TABLES

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APPENDIX C

AMBIENT AIR MONITORING FIGURES AND TABLES

No air sampling data are available at this time. The locations of the air sampling stations on the Hanford Site are shown in Figures C-1, C-2, and C-3.

Figure C-1. The 200 East Area Showing Air Sampler Locations.

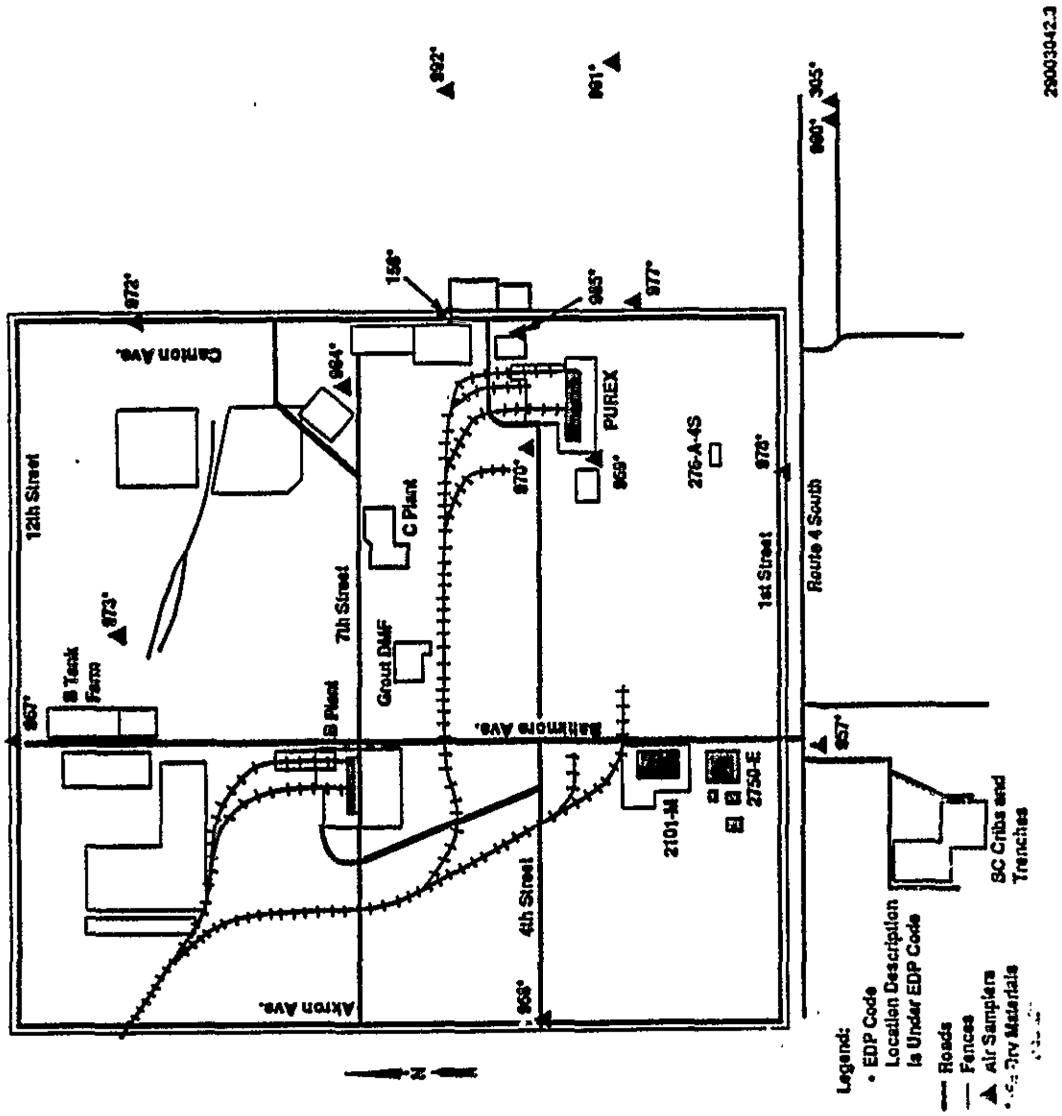


Figure C-2. The 200 West Area Showing Air Sampler Locations.

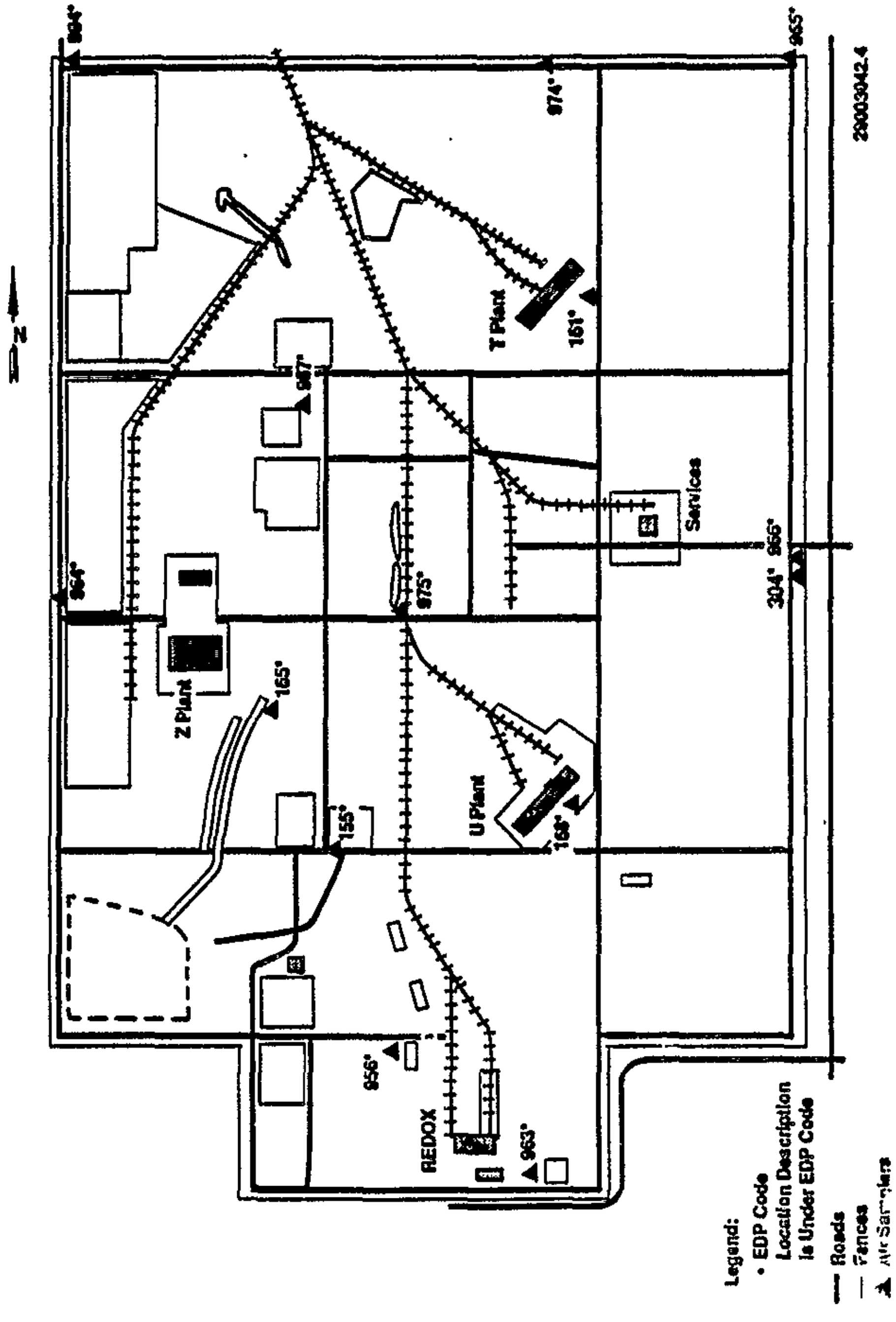
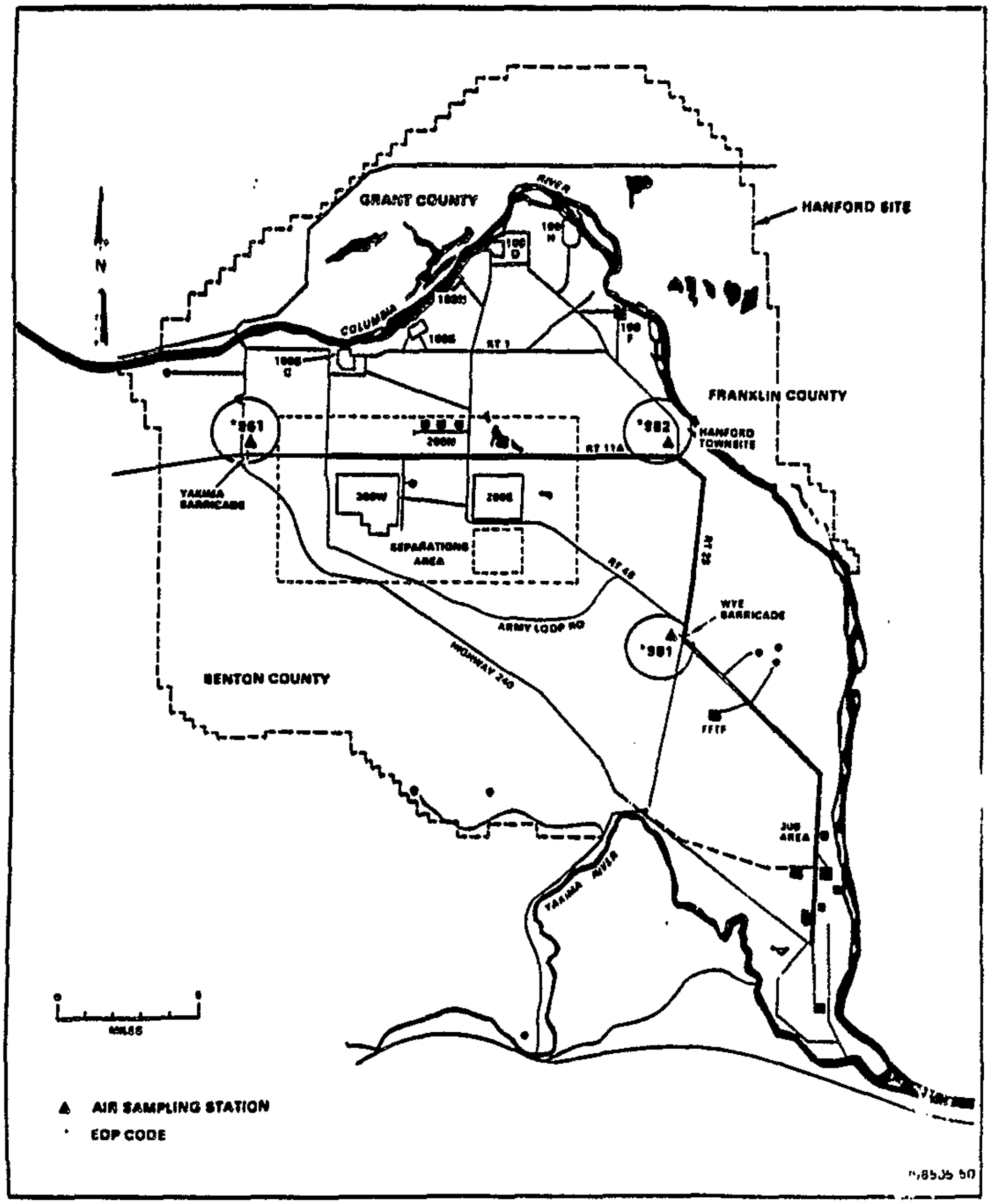


Figure C-3. Locations of Additional Air Sampling Stations.



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APPENDIX D

GROUNDWATER MONITORING FIGURES AND TABLES

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APPENDIX D

GROUNDWATER MONITORING FIGURES AND TABLES

No groundwater monitoring data are available at this time. The locations of groundwater monitoring wells on the Hanford Site are presented in Figure D-1, D-2, and D-3.

Figure D-1. Groundwater Monitoring Well Locations in the 200 East Area.

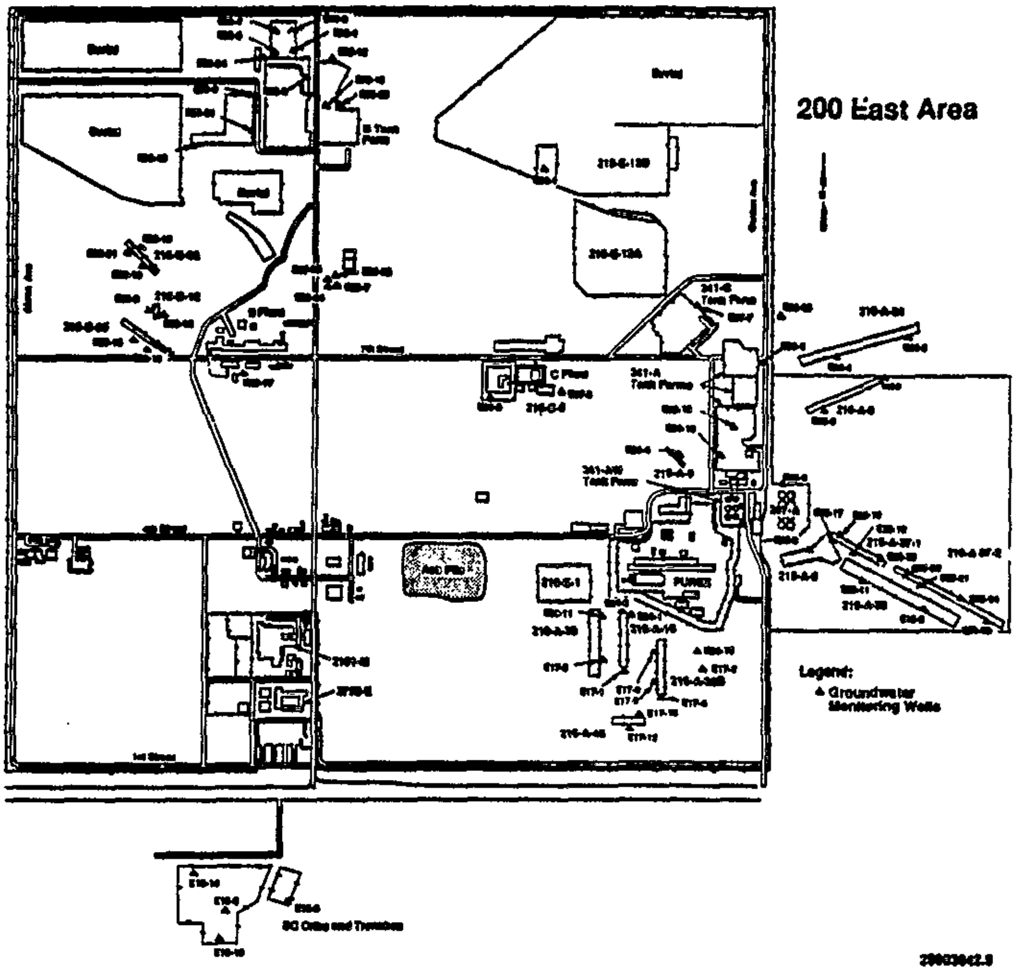


Figure D-2. Groundwater Monitoring Well Locations in the 200 West Area.

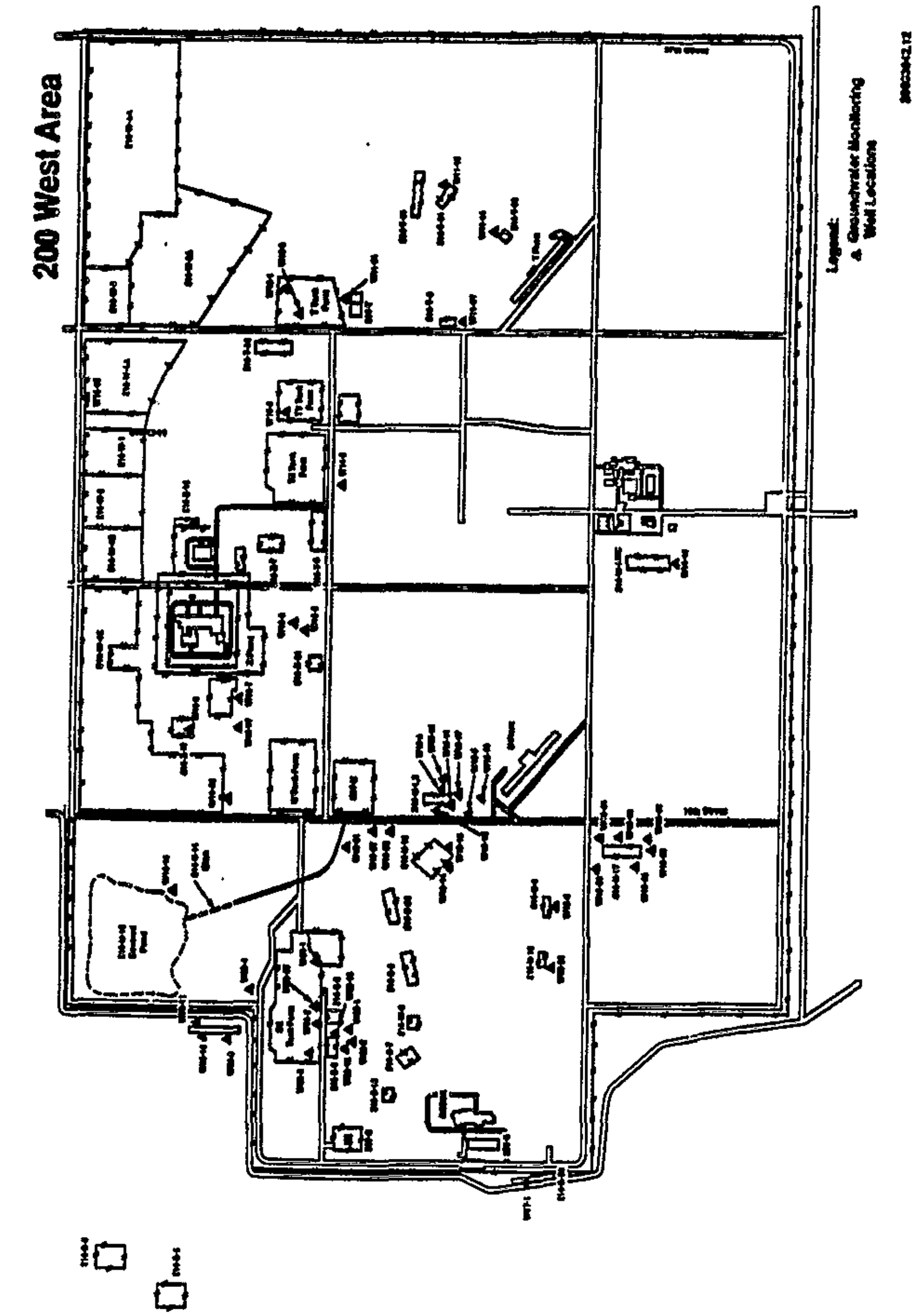
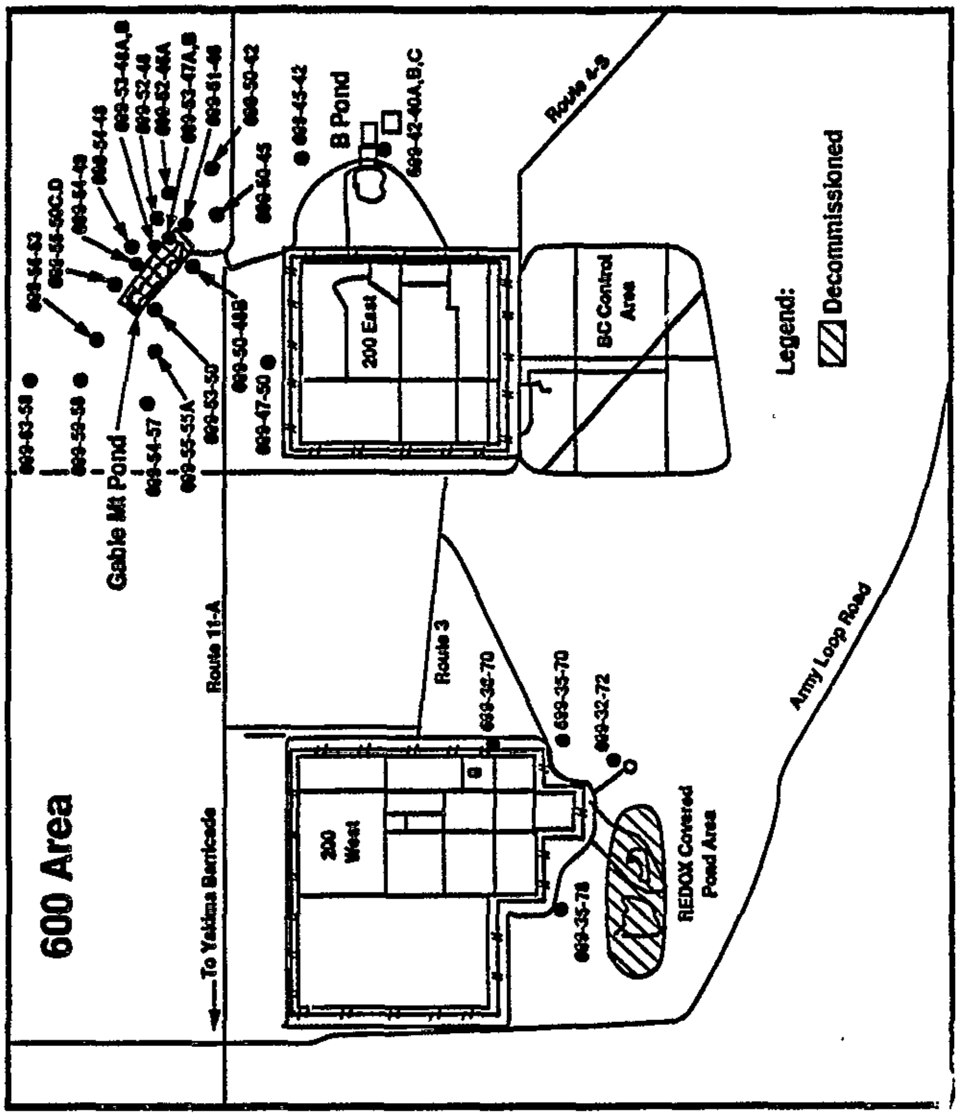


Figure D-3. Groundwater Monitoring Well Locations in the Separations Area.



APPENDIX E

SOIL AND BIOTA MONITORING FIGURES AND TABLES

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APPENDIX E

SOIL AND BIOTA MONITORING FIGURES AND TABLES

No soil and biota monitoring data are available. The soil and vegetation sampling locations for 1990 are shown in Figures E-1, E-2, and E-3.

Figure E-1. 1990 Soil and Vegetation Sampling Locations in the 200 East Area.

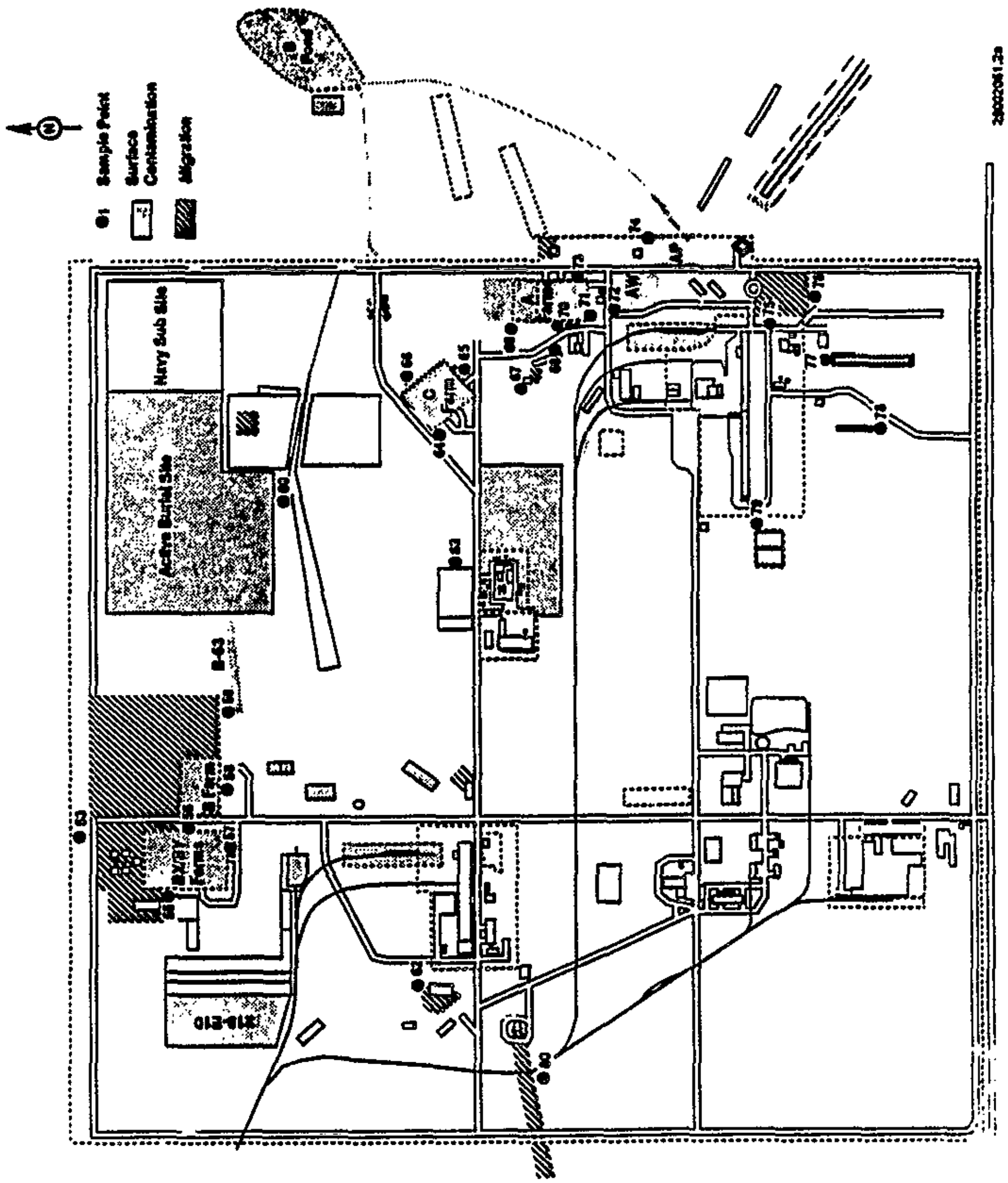

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Figure E-2. 1990 Soil and Vegetation Sampling Locations in the 200 West Area.

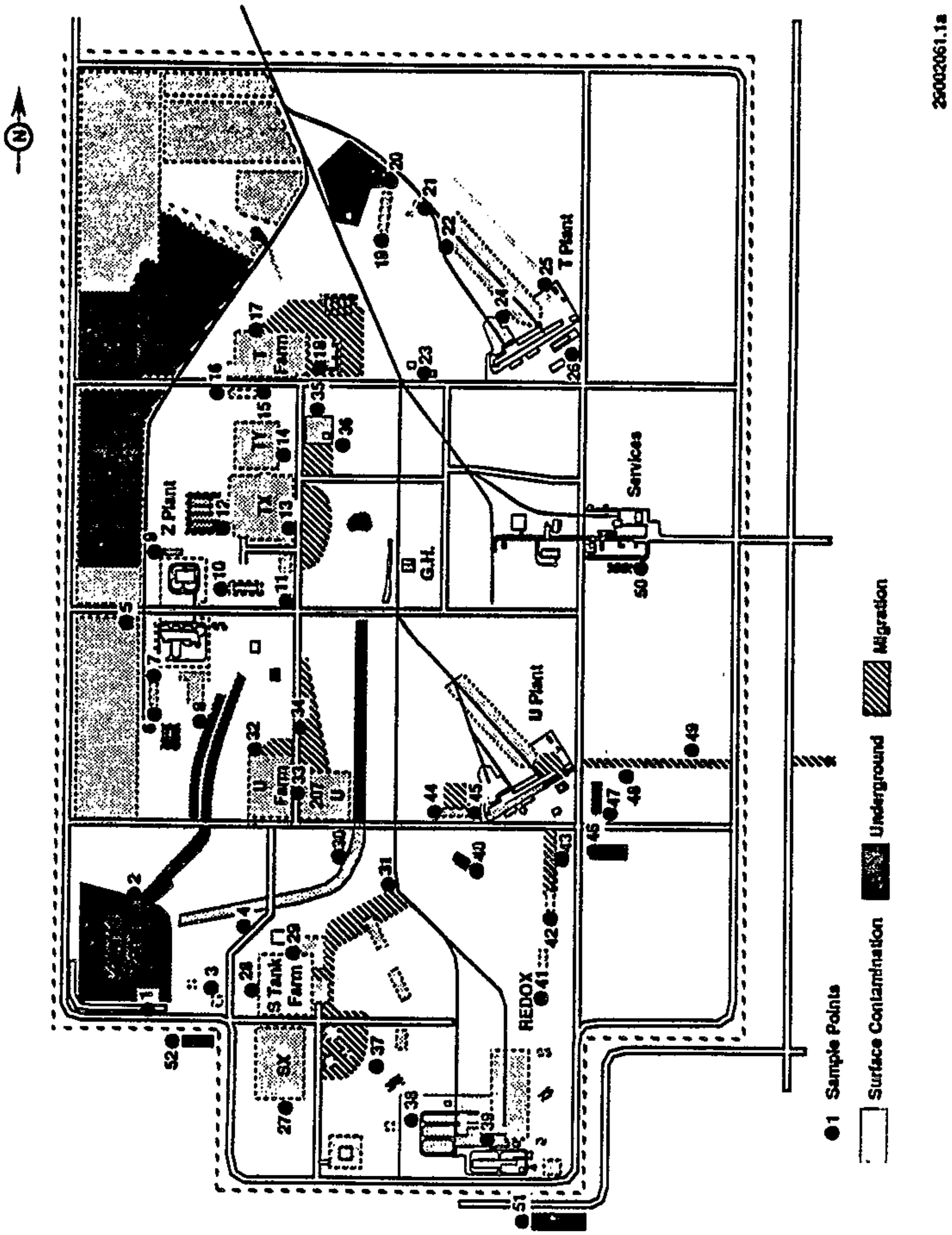
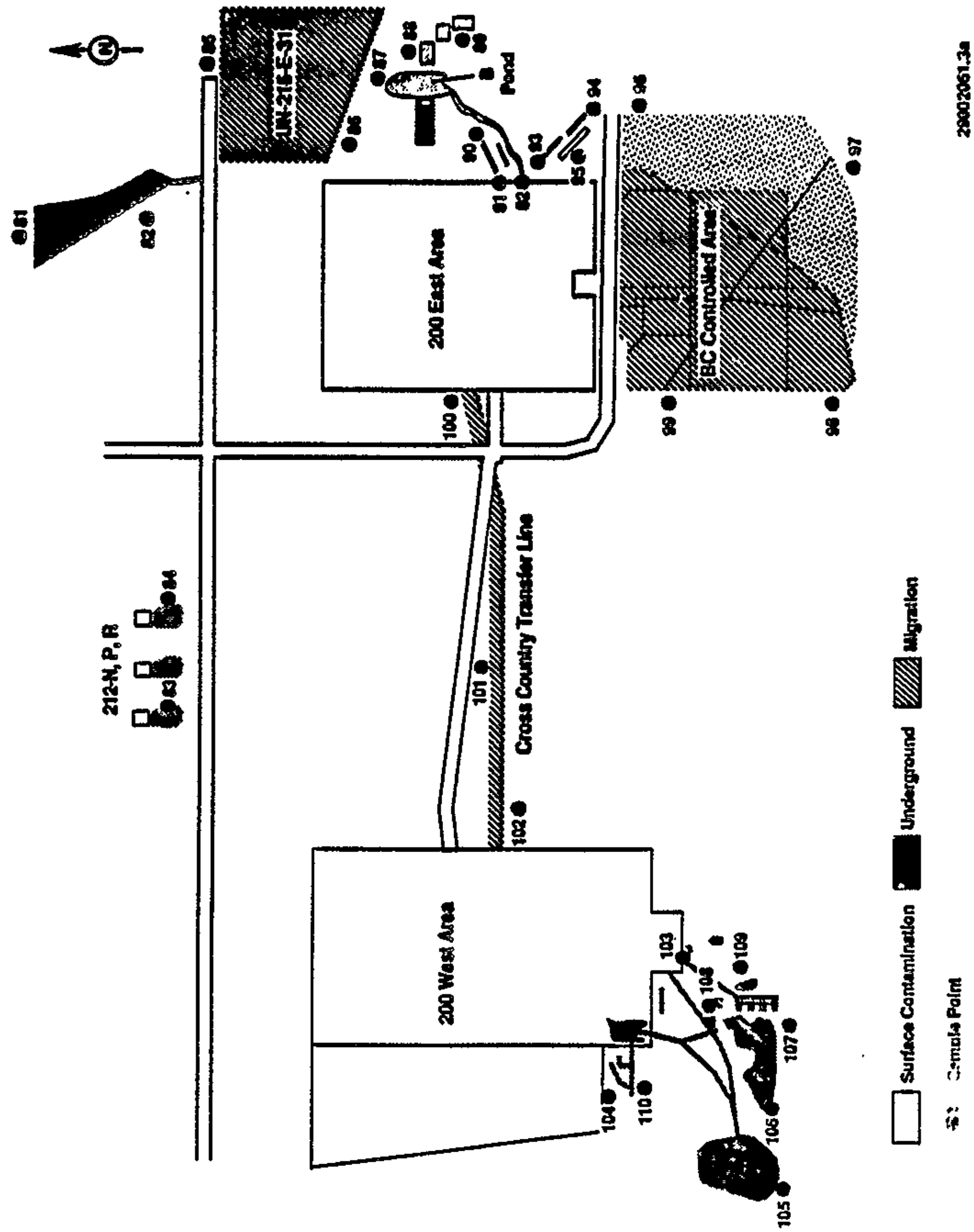


Figure E-3. 1990 Soil and Vegetation Sampling Locations in the 600 Area.



APPENDIX F

EXTERNAL RADIATION MONITORING FIGURES AND TABLES

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Table F-1. Thermoluminescent Dosimeter Results (1990).

TLD Number	Location	Max (a) mrem/year	Min (a) mrem/year	Total mrem/year
0201	274-W	88	38	73
0202	218-W-2A	124	100	108
0203	221-T East	124	104	109
0204	241-TX Tank Farm East	160	136	147
0205	216-Z-20	116	88	102
0206	216-U-14	136	92	117
0207	216-U-10	108	88	97
0208	241-U East	208	52	135
0209	221-U Southeast	116	92	105
0210	E-122 Baseline Site	164	100	125
0211	216-U-12 South	116	100	106
0212	216-U-12 North	116	96	102
0213	216-S-19	108	92	97
0214	200-East South	108	92	96
0215	200-East Southeast	108	92	96
0216	E-67 Baseline Site	112	88	101
0217	216-A-37-1 East	116	100	107
0218	216-A-37-1 North	124	96	103
0219	Grout Facility	116	100	107
0220	North of Grout Vaults	120	92	103
0221	Grout Facility	116	88	95
0222	216-A-29	104	88	98
0223	216-A-8 South	120	100	106

Table F-1. Thermoluminescent Dosimeter Results (1990).

TLD Number	Location	Max (a) mrem/year	Min (a) mrem/year	Total mrem/year
0224	216-A-8 East	132	100	121
0225	216-B-3-3	152	92	119
0226	Gable Mt. Pond East	112	88	98
0227	Gable Mt. Pond North	104	80	88
0228	West Lake	128	92	106
0229	218-E-10 East	132	104	121
0230	241-BX Tank Farm South	192	108	138
0231	218-E-12	116	100	105
0232	216-B-12 East	120	100	108
0233	221-B West	128	104	116
0234	221-B Northeast	140	96	114
0235	221-B Southwest	112	96	102
0236	221-B SSW	112	100	107
0237	216-B-55-1	128	92	115
0238	216-B-55-2	116	92	103
0239	216-B-62-1	112	92	98
0240	216-B-62-2	112	96	98
0241	216-B-63	128	96	106
0242	216-A-10-1	112	92	99
0243	216-A-10-2	120	96	107
0244	216-A-36-1	112	92	100
0245	216-A-36-B-2	120	88	100
0246	202-A-1	112	96	100
0247	202-A Southeast	108	96	104
0248	202-A Parking Lot	280	96	144

Table F-1. Thermoluminescent Dosimeter Results (1990).

TLD Number	Location	Max (a) mrem/year	Min (a) mrem/year	Total mrem/year
0249	ATF#1	332	136	216
0250	ATF#2	160	116	132
0251	ATF#3	144	108	122
0252	ATF#4	140	100	113
0253	ATF#5	124	104	110
0254	ATF#6	128	96	116
0255	ATF#7	2,300	112	1,100
0256	ATF#8	2,000	384	1,200
0258	ATF#10	1,900	384	908
0259	ATF#11	576	132	236
0260	ATF#12	140	124	129
0261	ATF#13	156	92	112
0262	East Corner 241-AP Tank Farm	136	96	117

(a) Quarterly dose normalized to annual dose rate.

Figure F-1. Thermoluminescent Dosimeter Locations in the 200 East Area.

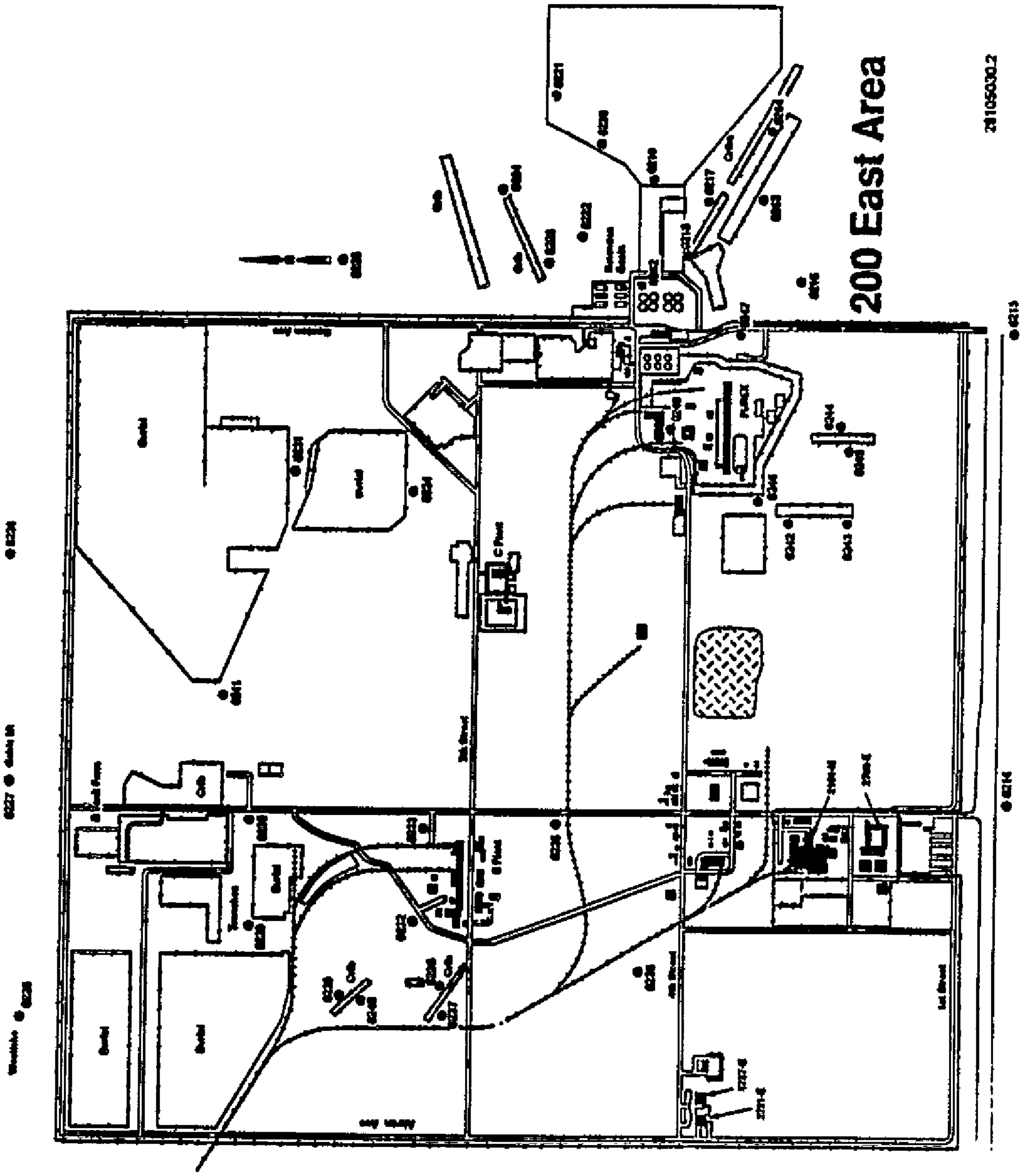

Figure F-2. Thermoluminescent Dosimeter Locations in the 200 West Area.

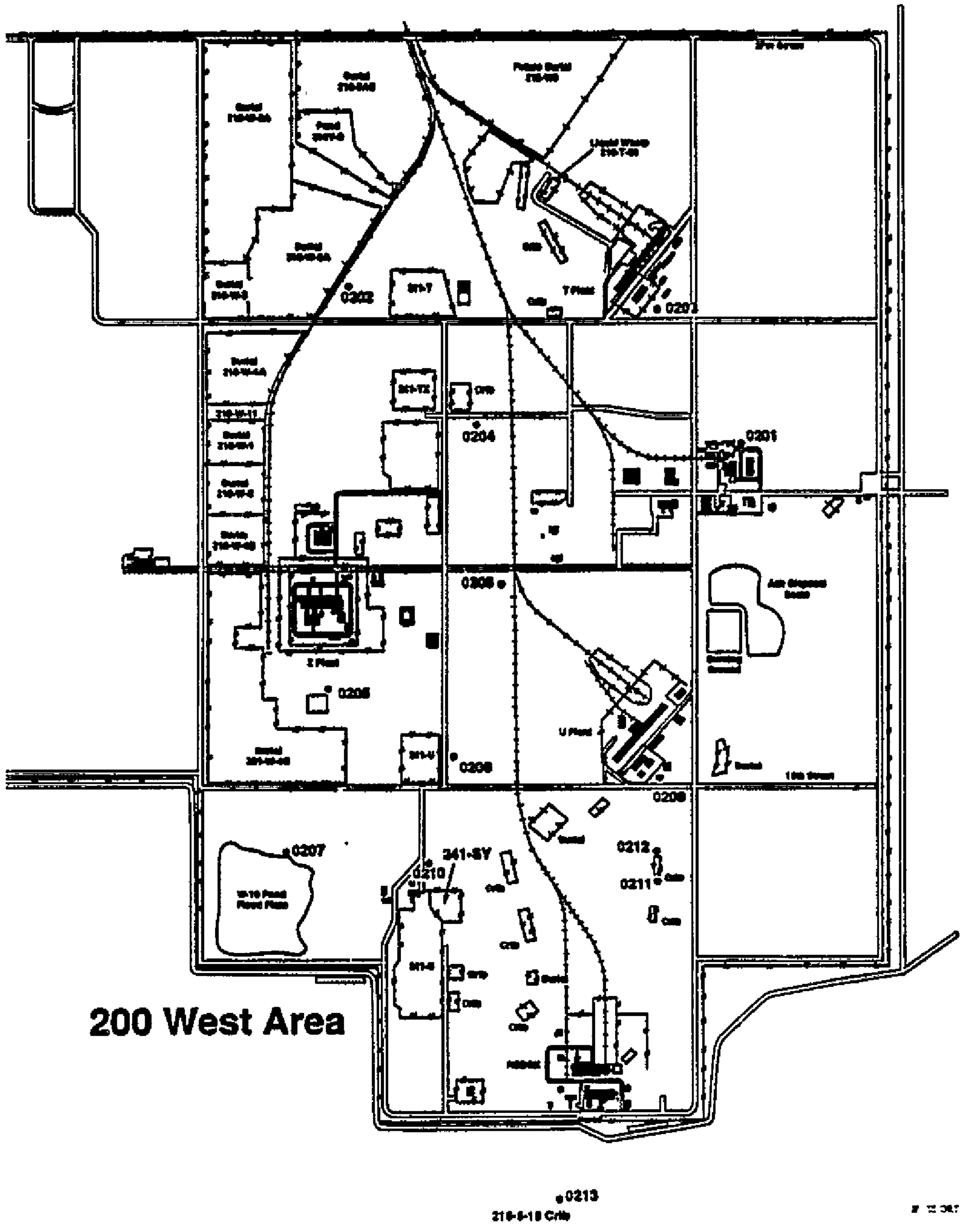

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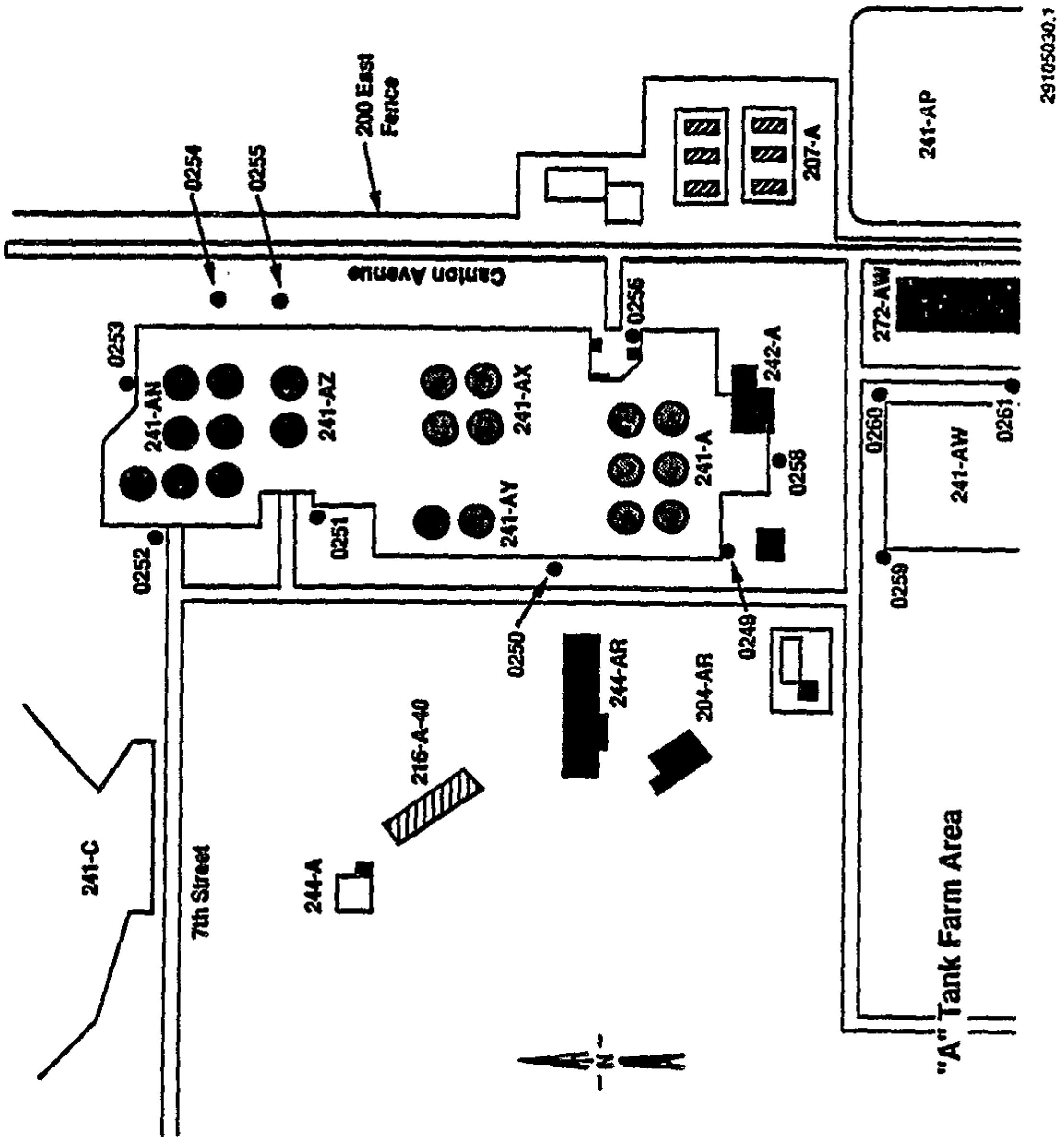
Figure F-3. Thermoluminescent Dosimeter Locations in the 241-A Tank Farm Complex.



APPENDIX G

POND AND DITCH MONITORING FIGURES AND TABLES

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Table G-1. Sample Location and Number Ponds and Ditches (1990).

Sample Location	Sample Number
216-T-4 Ditch	RM 03
216-B-63 Ditch	RM 18
216-A-29 Ditch	RM 20
216-B-3-3 Ditch	RM 21
216-B-3 Pond East	RM 22
216-B-3 Pond South	RM 23
216-B-3 Pond Overflow	RM 26
West Powerhouse Pond	RM 27
216-S-10 Ditch	RM 28
216-B-3 3rd Overflow	RM 29
216-Z-21 Basin	RM 30
West Lake	RM 53

Table G-2. Radiological Parameters in Water (1990).

Sample Location	Sample Number	Total Alpha pCi/L		Total Beta pCi/L		^{137}Cs pCi/L		^{90}Sr pCi/L	
		MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN
216-T-4 Ditch	RM 03	111	<DL	202	<DL	<DL	<DL	<DL	<DL
216-B-63 Ditch	RM 18	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL
216-A-29 Ditch	RM 20	<DL	<DL	104	<DL	<DL	<DL	<DL	<DL
216-B-3-3 Ditch	RM 21	<DL	<DL	299	<DL	<DL	<DL	<DL	<DL
216-B-3 Pond East	RM 22	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL
216-B-3 Pond South	RM 23	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL
216-B-3 Pond Overflow	RM 26	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL
West Powerhouse Pond	RM 27	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL
216-S-10 Ditch	RM 28	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL
216-B-3 3rd Overflow	RM 29	53	<DL	<DL	<DL	<DL	<DL	<DL	<DL
216-Z-21 Basin	RM 30	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL
West Lake	RM 53	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL
Detection Limit		40		100		200		100	
DCG		30[a]		1,000[b]		3,000		1,000	

NOTE: <DL = less than detection limit.
[a]Using ^{239}Pu DCG for comparison.
[b]Using ^{90}Sr DCG for comparison.

Table G-3. pH Results for Ponds and Ditches (1990).

Sample Location	Sample Number	Maximum pH	Minimum pH	Average pH
216-T-4 Ditch	RM 03	9.06	6.78	7.76
216-B-63 Ditch	RM 18	9.18	7.53	7.94
216-A-29 Ditch	RM 20	9.01	7.41	7.72
216-B-3-3 Ditch	RM 21	9.29	7.51	7.99
216-B-3 Pond East	RM 22	9.61	7.73	8.52
216-B-3 Pond South	RM 23	9.44	7.08	8.37
216-B-3 Pond Overflow	RM 26	9.63	7.75	8.66
West Powerhouse Pond	RM 27	11.60	7.25	9.16
216-S-10 Ditch	RM 28	9.21	7.56	8.15
216-B-3 3rd Overflow	RM 29	9.53	7.66	8.67
216-Z-21 Basin	RM 30	9.87	7.17	8.39
West Lake	RM 53	10.64	7.78	9.25

NOTE: pH maximum and minimum are from weekly samples.

Table G-4. Nitrate Results for Ponds and Ditches (1990).

Sample Location	Sample Number	Maximum NO_3 ppm	Minimum NO_3 ppm	Average NO_3 ppm
216-T-4 Ditch	RM 03	<DL	<DL	<DL
216-B-63 Ditch	RM 18	<DL	<DL	<DL
216-A-29 Ditch	RM 20	<DL	<DL	<DL
216-B-3-3 Ditch	RM 21	<DL	<DL	<DL
216-B-3 Pond East	RM 22	<DL	<DL	<DL
216-B-3 Pond South	RM 23	<DL	<DL	<DL
216-B-3 Pond Overflow	RM 26	<DL	<DL	<DL
West Powerhouse Pond	RM 27	<DL	<DL	<DL
216-S-10 Ditch	RM 28	<DL	<DL	<DL
216-B-3 3rd Overflow	RM 29	<DL	<DL	<DL
216-Z-21 Basin	RM 30	<DL	<DL	<DL
West Lake	RM 53	<DL	<DL	<DL

<DL = less than detection limit (1.2 ppm).

Table G-5. Radionuclide Concentrations in Vegetation Samples From Ponds and Ditches (1990).

Sample Location	Sample Number	Pu pCi/g	U g/g	^{137}Cs pCi/g	^{90}Sr pCi/g
216-T-4 Ditch	RM 03	<DL	1.39 E-8	<DL	3.5 E0
216-B-63 Ditch	RM 18	NS	NS	NS	NS
216-A-29 Ditch	RM 20	NS	NS	NS	NS
216-B-3-3 Ditch	RM 21	<DL	5.96 E-8	<DL	7.5 E-1
216-B-3 Pond East	RM 22	<DL	3.76 E-8	<DL	7.3 E-1
216-B-3 Pond South	RM 23	<DL	2.50 E-8	<DL	1.8 E0
216-B-3 Pond Overflow	RM 26	<DL	2.08 E-8	<DL	9.0 E-1
West Powerhouse Pond	RM 27	<DL	8.61 E-9	<DL	1.7 E0
216-S-10 Ditch	RM 28	<DL	1.81 E-8	<DL	1.3 E0
216-B-3 3rd Overflow	RM 29	<DL	1.31 E-8	<DL	8.1 E0
216-Z-21 Basin	RM 30	NS	NS	NS	NS
West Lake	RM 53	<DL	8.58 E-8	<DL	7.1 E-1

NS: No sample taken (216-A-29 will be sampled in depth in 1991).
<DL: Less Than the Detection Limit.

Table G-6. Radionuclide Concentrations in Sediment Samples From Ponds and Ditches (1990).

Sample Location	Sample Number	Pu pCi/g	U g/g	^{137}Cs pCi/g	^{90}Sr pCi/g	CePr 144 pCi/g
216-T-4 Ditch	RM 03	<DL	1.03 E-7	3.5 E0	7.1 E-1	NR
216-B-63 Ditch	RM 18	1.3 E1	6.6 E-6	8.1 E1	42.2 E0	NR
216-A-29 Ditch	RM 20	2.6 E2	2.2 E-9	6.9 E0	9.5 E-1	9.0 E1
216-B-3-3 Ditch	RM 21	2.5 E1	1.2 E-6	298.0 E0	3.7 E0	NR
216-B-3 Pond East	RM 22	<DL	6.1 E-7	7.1 E0	1.6 E0	NR
216-B-3 Pond South	RM 23	5.1 E0	8.9 E-7	12.5 E0	1.2 E0	NR
216-B-3 Pond Overflow	RM 26	5.5 E-1	5.3 E-7	12.1 E0	1.2 E0	NR
West Powerhouse Pond	RM 27	<DL	1.4 E-6	<DL	2.9 E-1	NR
216-S-10 Ditch	RM 28	1.7 E0	2.1 E-6	5.0 E0	5.9 E-1	NR
216-B-3 3rd Overflow	RM 29	3.3 E1	3.5 E-6	1.1 E2	2.5 E0	6.3 E1
216-Z-21 Basin	RM 30	1.7 E0	1.4 E-6	1.2 E0	8.7 E-1	NR
West Lake	RM 53	9.8 E-1	4.0 E-6	1.4 E0	1.0 E0	NR

NR: No Analytical Results Recorded
<DL: Less Than the Detection Limit.

Figure G-1. The 200 East Area Pond and Ditch Sample Sites.

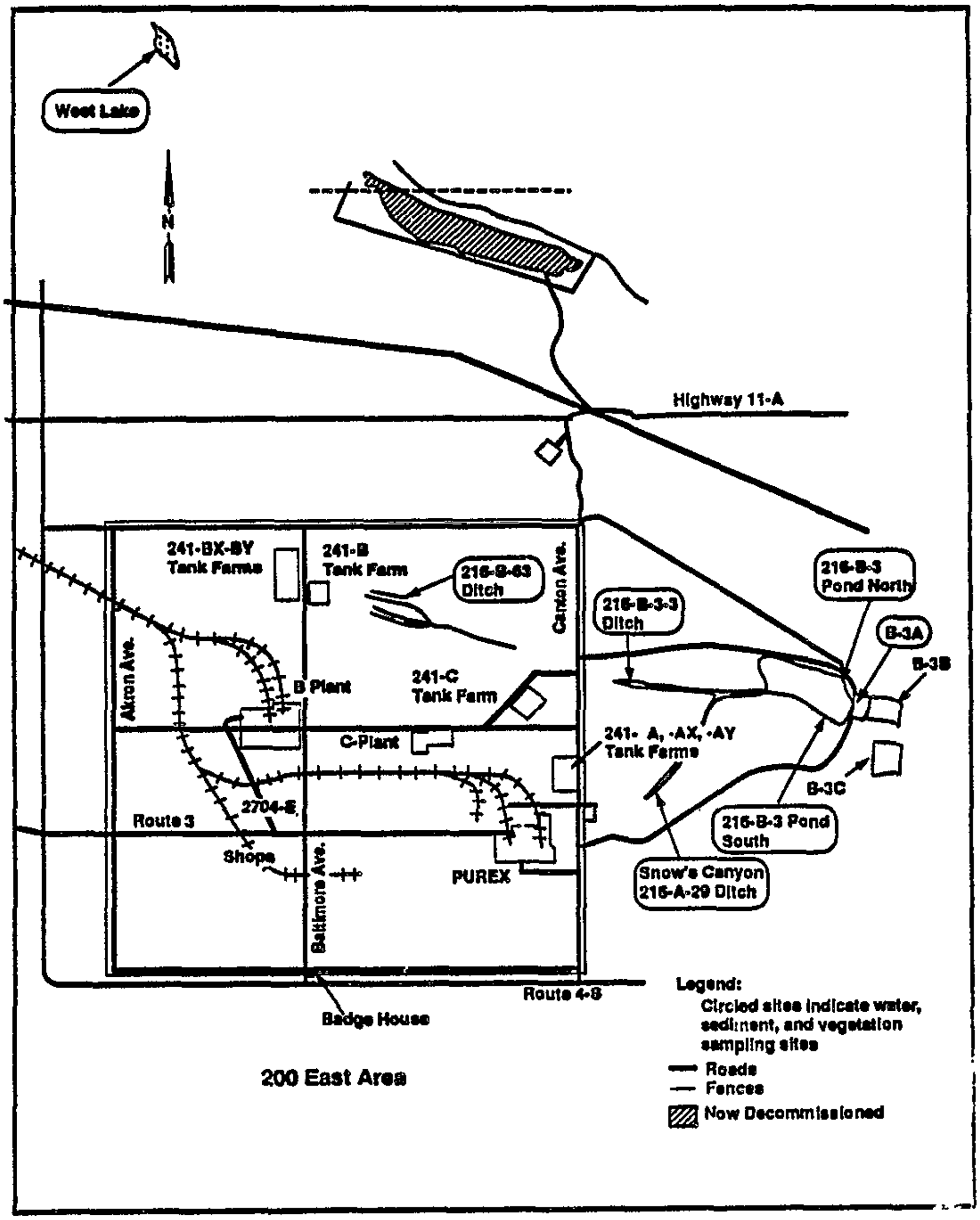

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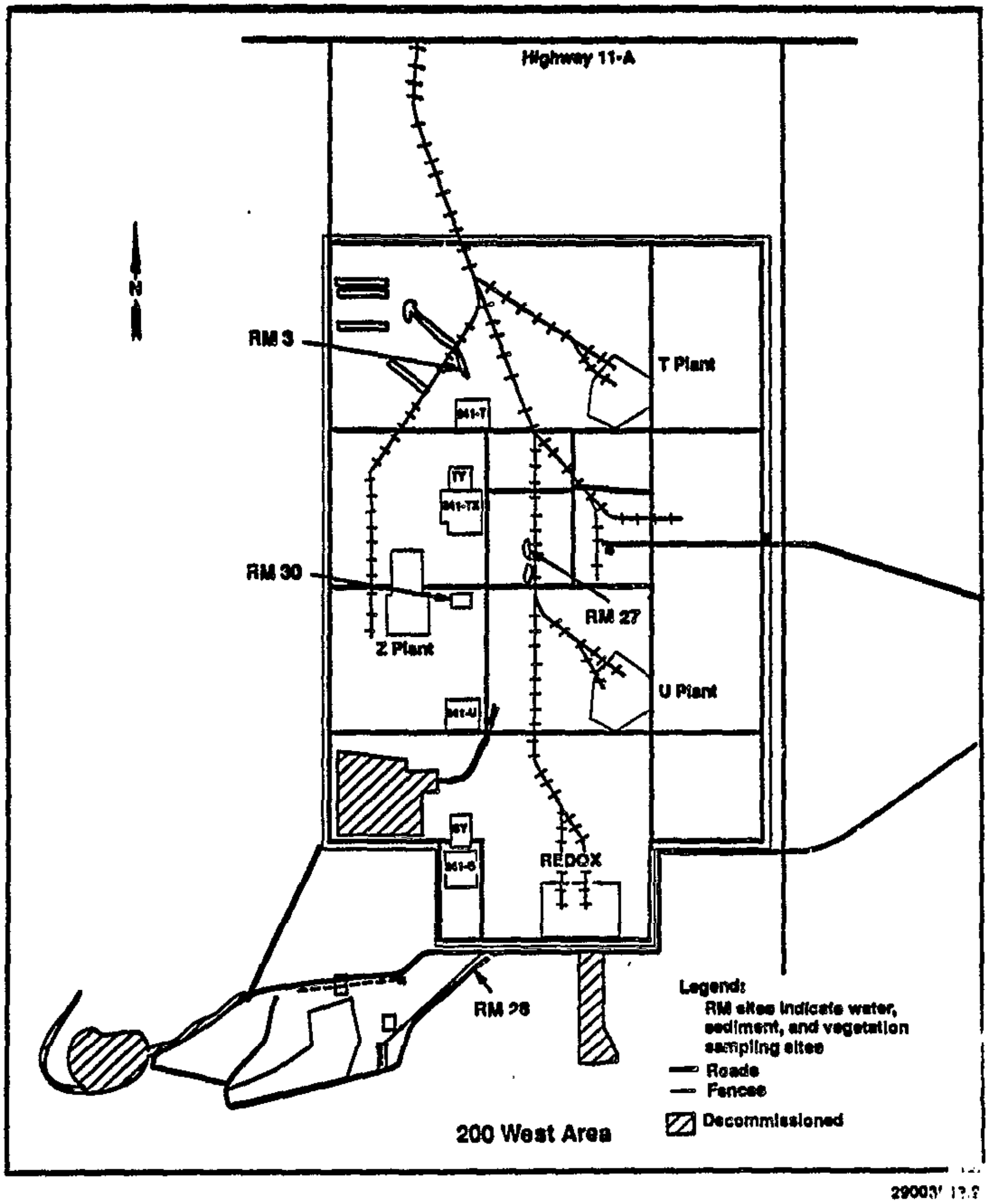
Figure G-2. The 200 West Area Pond and Ditch Sample Sites.



APPENDIX H

RADIOLOGICAL SURVEYS FIGURES AND TABLES

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Table H-1. The 1990 Radiological Survey Schedule.

ANNUAL:

All cribs, trenches and French Drains not surveyed elsewhere
618 Burial Grounds
Outside perimeters of all East and West Area burial grounds
216-B-3-3 Ditch survey plots
West Lake Shoreline survey plots
216-T-4 Ditch Shoreline survey plots
Snow's Canyon Ditch Bank survey plots
Underground pipeline from 216-B-3 Ditch
Tank farm perimeters and any inactive diversion boxes not inside tank farms
216-U-14 Ditch (active section)
216-B-3 Pond survey plots
216-B-63 Ditch survey plots
218-W-7 Burial Vault
218-W-8 Burial Vault
218-W-9 Burial Vault
All retention basin perimeters
All unplanned release sites
Cross-country transfer line

MISCELLANEOUS BUILDING ROUTINES

(Roofs, outdoor areas, and RR cuts)
PUREX
B Plant
REDOX
T Plant
Z Plant
East tank farms (inside tank farm surveys)
West tank farms (inside tank farm surveys)

QUARTERLY:

Water samples from sites for nitrate
Road survey outside 200 East Area
Road survey outside 200 West Area
Road survey Route 4-S from 200 West Gate to 200E Hill
216-A-37-1 Crib
216-A-37-2 Crib
TLD Exchange
216-U-12 Crib
216-B-55 Crib
216-B-62Crib
216-A-10 Crib
216-A-30 Crib
216-A-36-B Crib
216-S-26 Crib
216-W-LWC Crib
216-A-45 Crib
216-U-17 Crib

SEMIANNUAL:

All stabilized sites in 200/600 Areas (45 surveys)
BC controlled area roads and firebreaks
BC crib ground plot survey
Vent station perimeters

Figure H-1. Radiological Survey Locations in the 600 Area Burial Grounds.

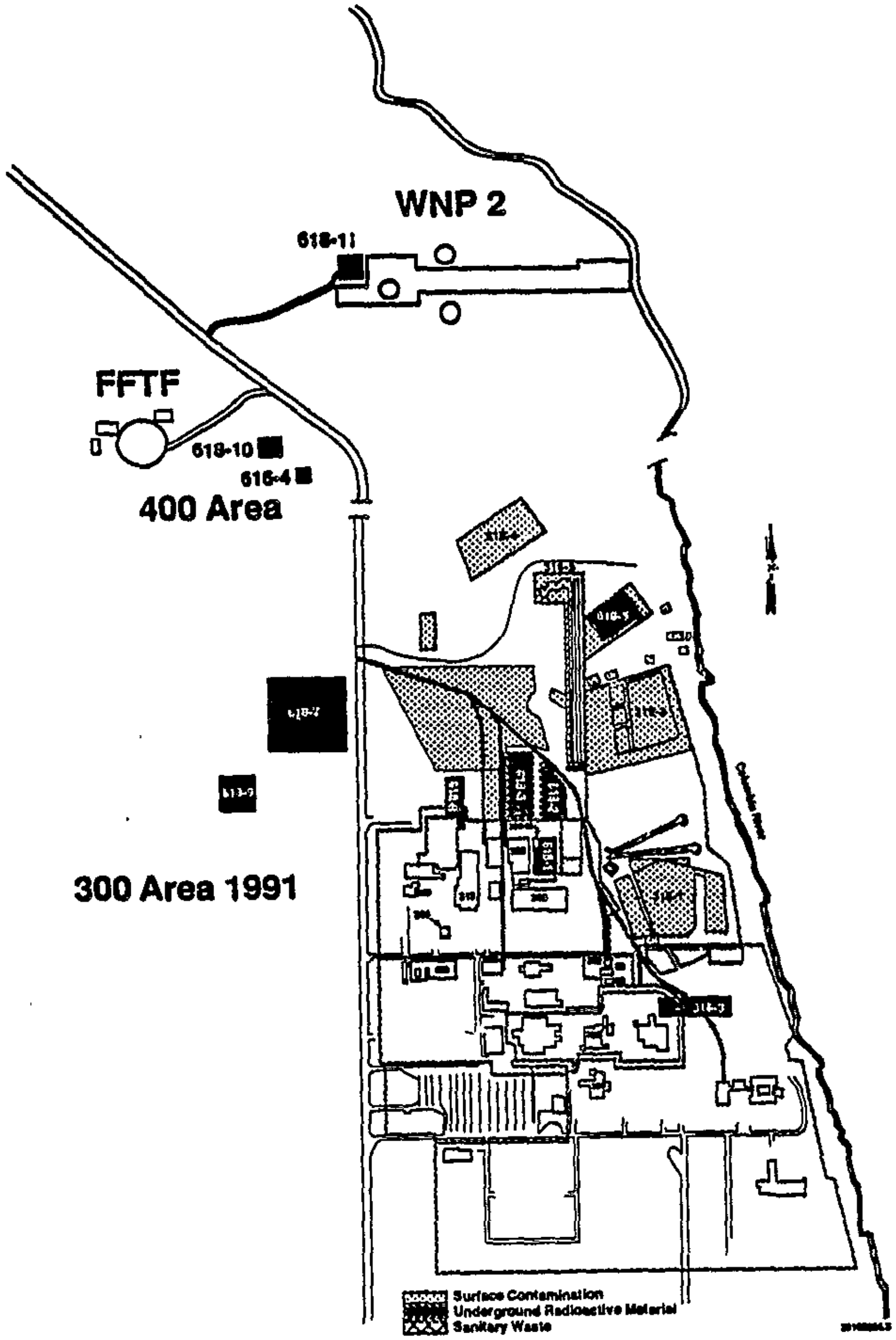
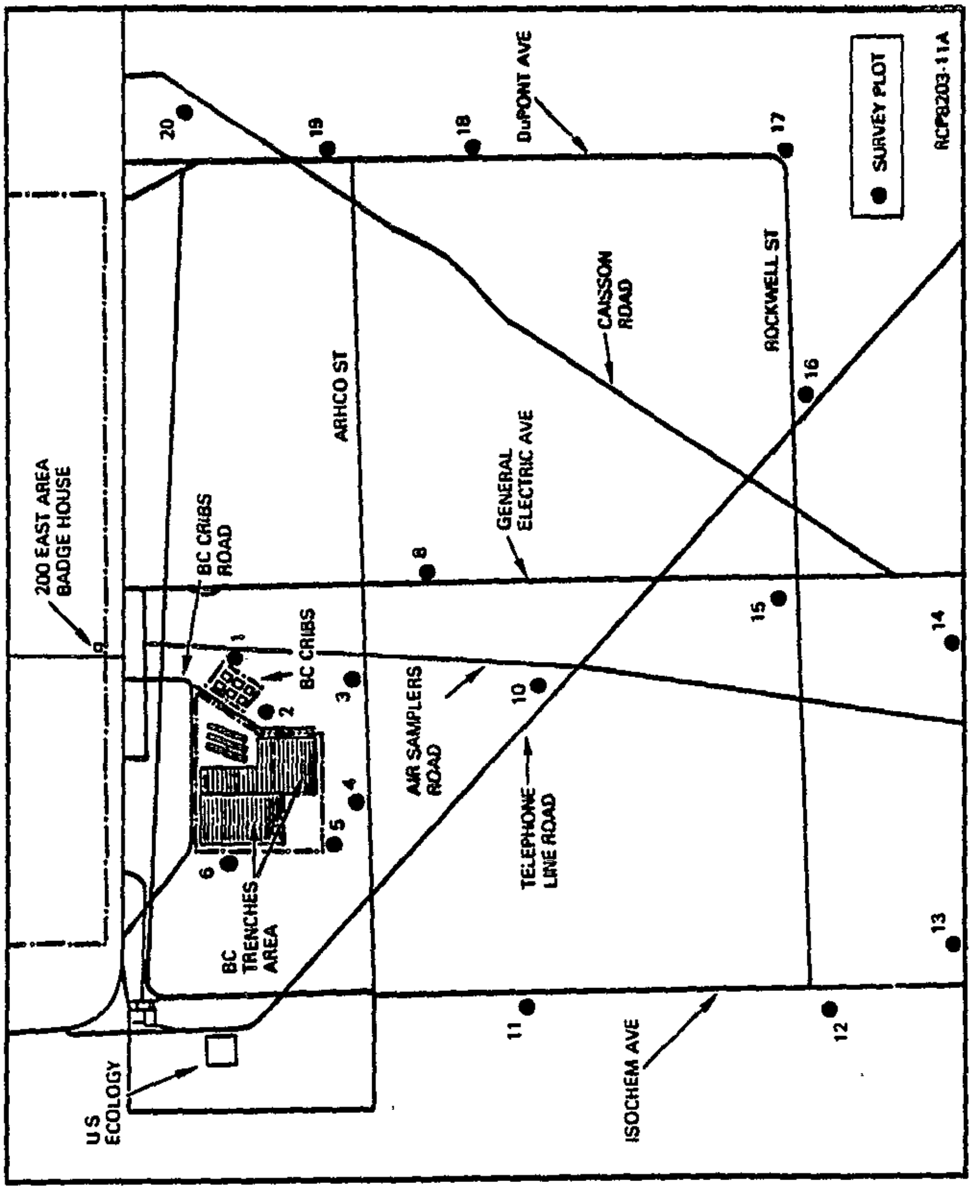


Figure H-2. Radiological Survey Locations in the BC Cribs Controlled Area.



APPENDIX I

SPECIAL SAMPLING FIGURES AND TABLES

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Table I-1. Special Sample Results (1990).

Sample Type, Count, and Location	^{137}Cs	Pu	Sr	U
Rabbit (400 c/min) Wash 244-AR Lift Station	<6.7 E-5 µCi/L	<5.0 E0 pCi/L	1.3 E-4 µCi/L	2.9 E-6 g/L
Rabbit (400 c/min) Feces 244-AR Lift Station	<5.8 E0 pCi/g	<4.0 E-1 pCi/g	47.6 E0 pCi/g	8.9 E-7 g/L
Rabbit (400 c/min) Urine 244-AR Lift Station	<2.2 E-3 µCi/L	<4.17 E-4 µCi/L	3.3 E-3 µCi/L	4.5 E-5 g/L
Rabbit (400 c/min) Muscle 244-AR Lift Station	<2.0 E-1 pCi/g	<1.0 E-1 pCi/g	4.0 E-1 pCi/g	2.4 E-9 µCi/L
Rabbit (400 c/min) Bone 244-AR Lift Station	<7.0 E-1 pCi/g	<1.0 E-1 pCi/g	6.7 E1 pCi/g	7.6 E-8 g/L
Rabbit (400 c/min) Intestine 244-AR Lift Station	<3.0 E-1 pCi/g	<1.0 E-1 pCi/g	2.6 E0 pCi/g	1.33 E-7 g/g
Rabbit (200 c/min) Wash 244-AR Lift Station	<6.9 E-5 µCi/L	<5.0 E-6 µCi/L	3.5 E-4 µCi/L	2.8 E-6 g/sample
Rabbit (200 c/min) Skin 244-AR Lift Station	<3.0 E-1 pCi/g	Lost in Process	1.2 E0 pCi/g	6.6 E-9 g/g

Table I-1. Special Sample Results (1990).

Sample Type, Count, and Location	^{137}Cs	Pu	Sr	U
Rabbit (200 c/min) Intestine 244-AR Lift Station	<2.0 E-1 pCi/g	<3.0 E-2 pCi/g	5.0 E-1 pCi/g	8.9 E-8 g/g
Rabbit (200 c/min) Bone 244-AR Lift Station	<1.7 E0 pCi/g	1.0 E0 pCi/g	2.4 E1 pCi/g	8.0 E-9 g/g
Rabbit (200 c/min) Muscle 244-AR Lift Station	<4.0 E-1 pCi/g	<6.0 E-2 pCi/g	<7.0 E-2 pCi/g	2.9 E-9 g/g
Rabbit (300 c/min) Wash 244-AR Lift Station	<6.7 E-5 μCi/L	Lost in Process	3.8 E-5 μCi/L	4.4 E-7 g/sample
Rabbit (300 c/min) Skin 244-AR Lift Station	<4.0 E-1 pCi/g	<6.0 E-2 pCi/g	1.2 E1 pCi/g	1.3 E-8 g/g
Rabbit (300 c/min) Intestine 244-AR Lift Station	<3.0 E-1 pCi/g	<5.0 E-2 pCi/g	5.9 E0 pCi/g	1.8 E-7 g/g
Rabbit (300 c/min) Bone 244-AR Lift Station	<1.6 E0 pCi/g	<2.0 E-1 pCi/g	5.3 E1 pCi/g	9.3 E-9 g/g
Rabbit (300 c/min) Muscle 244-AR Lift Station	<3.0 E-1 pCi/g	<5.0 E-2 pCi/g	3.0 E-2 pCi/g	1.9 E-9 g/g

Table I-1. Special Sample Results (1990).

Sample Type, Count, and Location	^{137}Cs	Pu	Sr	U
Rabbit (250 c/min) Wash 244-AR Lift Station	<6.7 E-5 µCi/L	<5.0 E-6 µCi/L	6.5 E-4 µCi/L	1.4 E-6 µCi/L
Rabbit (250 c/min) Skin 244-AR Lift Station	<3.0 E-1 pCi/g	<5.0 E-2 pCi/g	3.5 E0 pCi/g	7.15 E-9 g/g
Rabbit (250 c/min) Intestine 244-AR Lift Station	<3.0 E-1 pCi/g	<5.0 E-2 pCi/g	8.9 E0 pCi/g	9.8 E-8 g/g
Rabbit (250 c/min) Bone 244-AR Lift Station	<1.6 E0 pCi/g	Lost in Process	3.2 E1 pCi/g	3.2 E-9 g/g
Rabbit (250 c/min) Muscle 244-AR Lift Station	<4.0 E-1 pCi/g	<6.0 E-2 pCi/g	<1.1 E1 pCi/g	1.1 E-9 g/g
Rabbit (40,000 c/min) Feces 244-AR Lift Station	1.3 E1 pCi/g	Lost in Process	Lost in Process	4.1 E-7 g/g
Soil UN-216-E-31	3.0 E2 pCi/g	1.5 E1 pCi/g	<3.0 E-1 pCi/g	3.2 E0 pCi/g
Vegetation UN-216-E-31	3.86 E0 pCi/g	<3.0 E-1 pCi/g	2.6 E3 pCi/g	Not Analyzed
Soil East of 241-U	6.3 E1 pCi/g	3.3 E0 pCi/g	2.9 E3 pCi/g	2.6 E-7 g/g
Vegetation UN-216-E-1	3.7 E-1 pCi/g	<3.0 E-1 pCi/g	1.8 E0 pCi/g	Not Analyzed
Vegetation 218-E-12B	1.1 E0 pCi/g	<3.0 E-1 pCi/g	1.9 E3 pCi/g	6.3 E-8 g/g

Table I-1. Special Sample Results (1990).

Sample Type, Count, and Location	^{137}Cs	Pu	Sr	U
Soil & Termites (20,000 c/min) BC Cribs	1.2 E2 pCi/g	Not Analyzed	8.6 E2 pCi/g	Not Analyzed
Mouse Feces (50,000 c/min) West of Z-Plant	9.2 E1 pCi/g ^{137}CS; 2.8 E1 pCi/g ^{60}Co	2.8 E1 pCi/g ^{238}Pu	4.5 E1 pCi/g	Not Analyzed
Mouse (200 c/min) 202-S	6.1 E1 pCi/g	<3.0 E-1 pCi/g	3.9 E1 pCi/g	Not Analyzed
Fish 261-B-3A	<8.0 E-1 pCi/g	<1.0 E-1 pCi/g	5.0 E-1 pCi/g	5.6 E-4 g/L
Vegetation 216-Z-9 Crib	<3.0 E-1 pCi/g	<3.0 E-1 pCi/g	Not Analyzed	5.1 E-8 g/g
Soil (1,000 c/min) 202-S Rail Road Cut	1.0 E1 pCi/g	Not Analyzed	Not Analyzed	Not Analyzed
Soil (80,000 c/min) Rail Road Bed Near 272-W	1.6 E3 pCi/g	Not Analyzed	Not Analyzed	Not Analyzed
Mouse (1.5 rad) 241-C Tank Farm	3.5 E5 pCi/g	Not Analyzed	Not Analyzed	Not Analyzed
Soil (1,000 c/min) 271-U Door 9	3.0 E2 pCi/g	Not Analyzed	1.7 E2 pCi/g	Not Analyzed
Swallow Nest PUREX	1.9 E1 pCi/g	<3.0 E-1 pCi/g	5.9 E2 pCi/g	2.3 E-4 g/g
Swallow Nest PUREX	5.8 E0 pCi/g	<3.0 E-1 pCi/g	4.3 E1 pCi/g	1.2 E-5 g/g
Bird and Egg PUREX	<3.0 E-5 pCi/g	Lost in Process	9.6 E0 pCi/g	Lost in Process
Swallow Nest (500 c/min) B-Plant	<6.0 E-1 pCi/g	3.0 E-1 pCi/g	4.7 E0 pCi/g	8.1 E-7 g/g

Table I-1. Special Sample Results (1990).

Sample Type, Count, and Location	^{137}Cs		Pu	Sr	U
Soil 271-U Door 9	8.0 E1 pCi/g ^{137}Cs	6.7 E0 pCi/g ^{60}Co	2.1 E0 pCi/g	3.6 E2 pCi/g	2.43 E-5 g/g
Soil (30,000 c/min) 216-A-40 Basin	1.8 E2 pCi/g		<3.0 E-1 pCi/g	2.6 E3 pCi/g	Not Analyzed
Termites (20,000 c/min) BC Cribs	Not Analyzed		Not Analyzed	5.8 E3 pCi/g	Not Analyzed
Swallow Nest (2,000 c/min) PUREX	6.7 E1 pCi/g ^{137}Cs	1.7 E0 pCi/g ^{60}Co	<3.0 E-1 pCi/g	7.6 E2 pCi/g	2.9 E-7 g/g
Swallow Eggs (50 c/min) PUREX	<9.3 E0 pCi/g		<1.0 E0 pCi/g	3.4 E1 pCi/g	Lost in Process
Swallow Nest (1,500 c/min) PUREX	1.6 E1 pCi/g		<3.0 E-1 pCi/g	2.0 E2 pCi/g	1.1 E-6 g/g
Swallow (<DET) PUREX	<1.4 E1 pCi/g		1.2 E0 pCi/g	<4.3 E0 pCi/g	7.6 E-8 g/g
Soil (60 mrad) Rail Road Tracks Suzie Jct.	9.4 E-4 µCi/sample		Not Analyzed	Not Analyzed	Not Analyzed
Soil (35 mrad) Rail Road Tracks Ethyl Jct.	<7.8 E0 pCi/g ^{137}Cs	2.5 E-3 pCi/g ^{212}Pb	Lost in Process	1.7 E2 pCi/g	Not Analyzed
Vegetation (1,000 c/min) 207-U Basin	1.8 E3 pCi/g		5.0 E-1 pCi/g	3.9 E0 pCi/g	2.6 E-7 g/g
Soil & Vegetation (1,000 c/min) 207-U Basin	5.0 E2 pCi/g		5.0 E-1 pCi/g	3.3 E0 pCi/g	9.0 E-7 g/g

Table I-1. Special Sample Results (1990).

Sample Type, Count, and Location	^{137}Cs	Pu	Sr	U
Swallow Nest (700 c/min) 271-AB Stairwell	1.8 E1 pCi/g	<3.0 E-1 pCi/g	1.5 E2 pCi/g	Not Analyzed
Soil 216-T-31 Crib	3.5 E-3 pCi/g Am 241 1.7 E-2 pCi/g Am 243 2.5 E1 pCi/g ^{60}Co 4.8 E-3 pCi/g ^{137}Cs	2,971 E0 pCi ^{238}Pu 4.5 E2 pCi ^{239}Pu	1.9 E3 pCi/g	Not Analyzed
Soil (<DET) 202-S North Side	2.3 E1 pCi/g	8.8 E0 pCi/g	1.1 E1 pCi/g	Not Analyzed
Soil (<DET) 233-SA North Side	2.2 E0 pCi/g	2.8 E0 pCi/g	2.6 E0 pCi/g	Not Analyzed
Bird Nest (<DET) 233-S	5.3 E0 pCi/g	1.7 E0 pCi/g	2.0 E1 pCi/g	Not Analyzed
Bird Feces (<DET) 233-S	<6.9 E0 pCi/g	9.5 E0 pCi/g	Lost in Process	Not Analyzed
Vegetation Pipeline South of 216-B-43-50	5.3 E2 pCi/g	Not Analyzed	5.3 E3 pCi/g	Not Analyzed
Vegetation Pipeline North of 216-B-43-50	3.3 E1 pCi/g	Not Analyzed	2.5 E3 pCi/g	Not Analyzed
Smear 233-S Ventilation Before Painting	8.9 E-4 pCi Am 241 <2.3 E1 pCi ^{137}Cs	1.0 E3 pCi ^{238}Pu 1.9 E-4 pCi ^{239}Pu	Not Analyzed	Not Analyzed

Table I-1. Special Sample Results (1990).

Sample Type, Count, and Location	^{137}Cs	Pu	Sr	U
Smear 233-S Ventilation Before Painting	9.2 E2 pCi Am 241 <2.2 E1 pCi ^{137}Cs	1.1 E2 pCi	Not Analyzed	Not Analyzed
Smear 233-S Ventilation Before Painting	<2.3 E1 pCi	1.3 E1 pCi	Not Analyzed	Not Analyzed
Soil East of 216-B43-50	3.3 E1 pCi/g	1.2 E0 pCi/g	3.3 E0 pCi/g	4.5 E-7 g/g
Rabbit Feces (7,000 c/min) S.E. of 241-C Tank Farm	2.4 E1 pCi/g	Lost in Process	3.8 E3 pCi/g	9.6 E-8 g/g
Snake (200 c/min) 221-B	8.3 E2 pCi/g	Lost in Process	2.4 E1 pCi/g	Lost in Process
Soil (7,000 c/min) UN-216-E-36	1.8 E2 pCi/g	<3.0 E-1 pCi/g	8.8 E1 pCi/g	4.1 E-7 g/g
Soil (40 mrad) UN-216-E-36	4.3 E3 pCi/g	<3.0 E-1 pCi/g	6.1 E3 pCi/g	1.2 E-6 pCi/g
Vegetation (2,000 c/min) UN-216-E-36	1.0 E2 pCi/g	<3.0 E-1 pCi/g	3.5 E3 pCi/g	2.0 E-6 g/g
Mulberry Tree (<DET) West of B Pond	3.4 E0 pCi/g	<3.0 E-1 pCi/g	2.1 E2 pCi/g	3.5 E-7 g/g
Mulberry Tree (<DET) East of B Pond	1.8 E0 pCi/g	<3.0 E-1 pCi/g	5.4 E1 pCi/g	2.3 E0 pCi/g
Vegetation (<DET) 291-U	6.4 E1 pCi/g	<3.0 E-1 pCi/g	8.9 E2 pCi/g	6.1 E-8 g/g
Mouse Feces (20,000 c/min) 202-S	7.9 E4 pCi/g	Lost in Process	4.2 E4 pCi/g	3.0 E-5 g/g

Table I-1. Special Sample Results (1990).

Sample Type, Count, and Location	^{137}Cs	Pu		Sr	U
Soil (250 c/min) North of 241-B Tank Farm	1.1 E2 pCi/g	8.0 E-1 pCi/g ^{238}Pu	6.0 E-1 pCi/g ^{239}Pu	8.7 E0 pCi/g	3.4 E-7 g/g
Soil (250 c/min) North of 241-B Tank Farm	1.2 E1 pCi/g	<3.0 E-1 pCi/g		Not Analyzed	3.5 E-7 g/g
Vegetation Fragments (200 c/min) North of 241-B Tank Farm	1.1 E1 pCi/g	<3.0 E-1 pCi/g		5.1 E1 pCi/g	5.1 E-8 g/g
Soil (200 c/min) North of 241-B Tank Farm	9.3 E1 pCi/g	<3.0 E-1 pCi/g		1.4 E0 pCi/g	4.9 E-7 g/g
Vegetation (500 c/min) UN-216-E-33	7.0 E-1 pCi/g	<4.0 E-1 pCi/g		1.1 E2 pCi/g	1.1 E-7 g/g
Rabbit Feces (2,500 c/min) 221-T Door 19	1.6 E2 pCi/g	<1.3 E0 pCi/g		5.8 E4 pCi/g	3.8 E-7 g/g
Soil (10,000 c/min) 216-A-24 Crib	2.8 E1 pCi/g	2.1 E2 pCi/g		6.7 E1 pCi/g	6.9 E-3 g/g

<DET - Less than the detection limit

Table I-2. Special Soil Samples 234-5 Z-plant (1990).

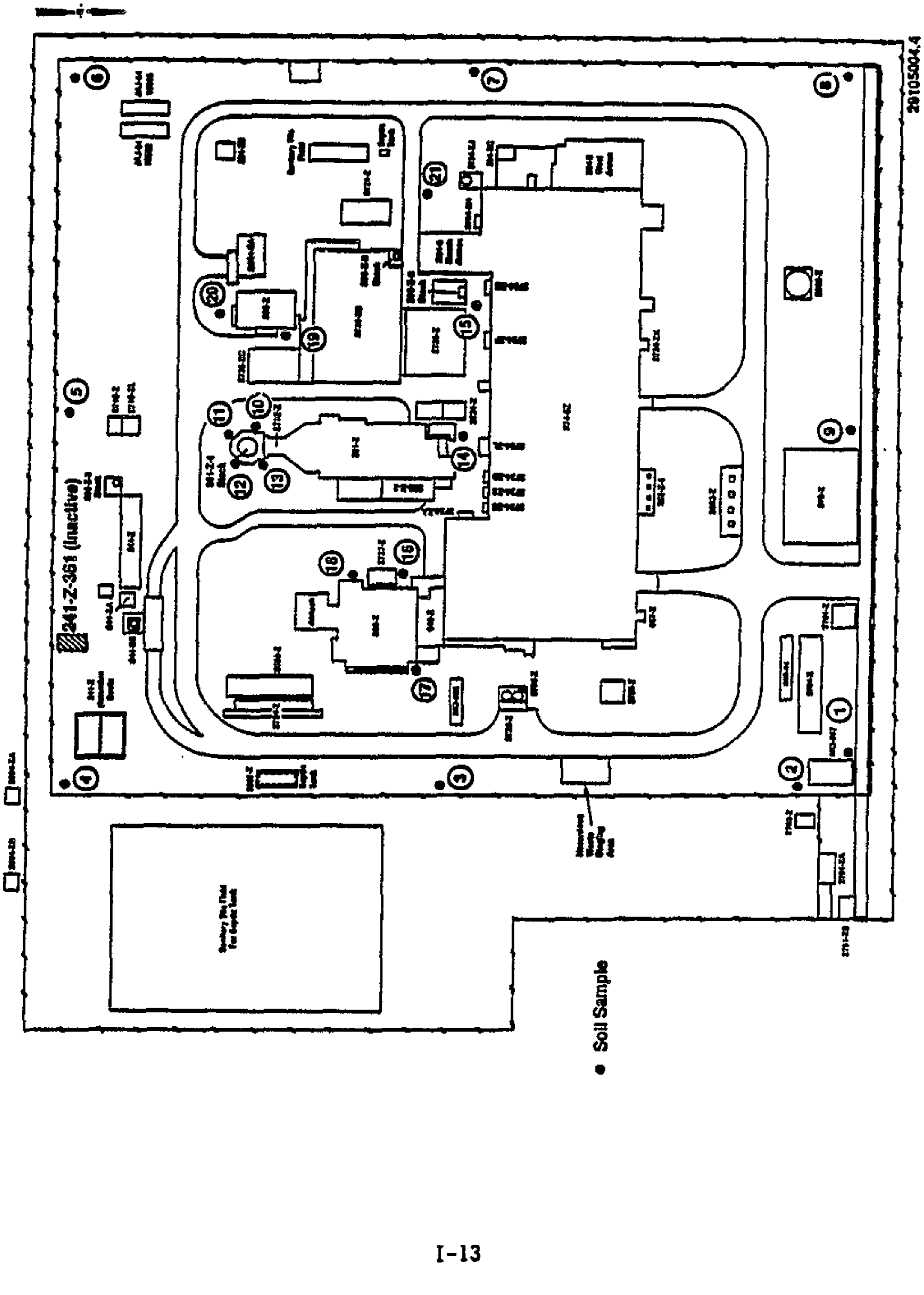
Sample Type	Cs-137 pCi/g	Pu pCi/g
Soil #1 (<DET) Z-Plant Area	0.4	<0.3
Soil #2 (<DET) Z-Plant Area	<0.3	0.8
Soil #3 (<DET) Z-Plant Area	<0.2	<0.3
Soil #4 (<DET) Z-Plant Area	1.6	2.9
Soil #5 (<DET) Z-Plant Area	0.5	1.5
Soil #6 (<DET) Z-Plant Area	<0.3	<0.3
Soil #7 (<DET) Z-Plant Area	0.5	<0.3
Soil #8 (<DET) Z-Plant Area	0.4	<0.3
Soil #9 (<DET) Z-Plant Area	0.5	<0.3
Soil #10 (<DET) Z-Plant Area	<0.3	0.9
Soil #11 (<DET) Z-Plant Area	0.6	3.9
Soil #12 (<DET) Z-Plant Area	0.4	1.8
Soil #13 (<DET) Z-Plant Area	<0.3	0.7

Table I-2. Special Soil Samples 234-5 Z-plant (1990).

Sample Type	Cs-137 pCi/g	Pu pCi/g
Soil #14 (<DET) Z-Plant Area	<0.3	1.2
Soil #15 (<DET) Z-Plant Area	<0.3	0.4
Soil #16 (<DET) Z-Plant Area	<0.3	1.4
Soil #17 (<DET) Z-Plant Area	0.4	0.8
Soil #18 (<DET) Z-Plant Area	<0.3	1.4
Soil #19 (<DET) Z-Plant Area	0.4	0.7
Soil #20 (<DET) Z-Plant Area	<0.2	0.7
Soil #21 (<DET) Z-Plant Area	<0.5	1.4
Soil #22 (<DET) Z-Plant Area	<0.3	<0.3

<DET - Less than the detection limit

Figure I-1. Z Plant Special Soil Sample.



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APPENDIX J

CONCENTRATION GUIDELINES

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APPENDIX J

CONCENTRATION GUIDELINES

Table J-1. Airborne Derived Concentration Guidelines.

Radionuclide	DCG (pCi/m3)
^{90}Sr	9
^{137}Cs	400
^{106}Ru	30
^{239}Pu	0.02

Table J-2. Groundwater Administrative Control Valve Versus Derived Concentration Guidelines for Water (pCi/L).

Radionuclide	200 East	200 West	600 Area	DCG
^{3}H	None	None	None	200,000
^{60}Co	5,000	5,000	5,000	5,000
^{90}Sr	74	480	40	1,000
^{99}Tc	4,000	4,000	4,000	100,000
^{106}Ru	6,000	6,000	240	6,000
^{129}I	20	20	20	500
^{137}Cs	210	1,200	120	3,000
^{234}U	20	20	20	500
^{235}U, ^{238}	24	24	24	600
^{238}Pu	2.0	3.6	1.6	40
^{239}Pu, ^{240}	1.2	1.2	1.2	30

Table J-3. Surface Soil Concentration Guides for Posting.

Radionuclide	Guide (pCi/g)
Co-58	10,000
Co-60	5,000
Sr-90	600
I-129	4,000
Cs-134	10,000
Cs-137	20,000
Ce-144	1,900
Eu-152	3,000
Eu-154	3,000
Eu-155	20,000
Pu-238	75
Pu-239	75
Pu-240	75
U-234	100
U-235	15
U-238	50

Table J-4. Surface Soil Concentration Guides for Release.

Radionuclide	Guide (pCi/g)
Co-58	10
Co-60	1
Sr-90	13
I-129	50
Cs-134	2
Cs-137	3
Ce-144	75
Eu-152	3
Eu-154	3
Eu-155	100
Pu-238	75
Pu-239	75
Pu-240	75
U-234	100
U-235	15
U-238	50

APPENDIX K

DATA SUMMARIES

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APPENDIX K

DATA SUMMARIES

Measuring any physical quantity has some degree of inherent uncertainty. This uncertainty results from the combination of all possible inaccuracies in the measurements process, including such factors as the reading of the result, the calibration of the measuring device, and numerical rounding errors. In this report, individual radioactive measurements are accompanied by a plus or minus (+/-) value, which is the uncertainty term known as a two-sigma counting error. The two-sigma counting error gives information on what the measurement might be if the same sample were counted again under identical conditions. The two-sigma counting error implies that approximately 95 percent of the time, a recount of the same sample would give a value within plus or minus the two-sigma counting error at the value reported. Values in the tables that are less than the two-sigma counting error indicate that the reported result might have come from a sample with no radioactivity. Such values are considered as below the detection limits of the measuring instrument. Also note that each radioactive measurement must have the random background radioactivity of the measuring instrument subtracted; therefore, negative results are possible, especially when the sample has very little radioactivity.

Reported averages are also accompanied by two standard errors of the mean. If the data fluctuates randomly, then the standard error is a measure of the uncertainty in the estimated average of the data because of this randomness. If trends of periodic fluctuations are present, the standard error is primarily a measure of the variability in the trends and fluctuations about the average of the data, rather than a measure of the uncertainty of the estimated average because of random fluctuations in the data.

The average, $\overline{X}$, was computed as:

$$\overline{X} = \frac{1}{n} \sum_{i=1}^{n} X_i$$

where X_i is the ith measurement and n is the number of measurements.

The standard error of X was computed as

$$SE = \sqrt{(S^2/n)}$$

where S^2, the variance of the n measurements, was computed as

$$S^2_M = \frac{1}{n-1}\sum_{i=1}^{n}(X_i-\bar{X})^2$$

This estimator, S^2_M, includes the variance among the samples and the counting variance. The estimated S^2_M may occasionally be less than the average counting variance.

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