PNL-3729
UC-41

Environmental Status of the Hanford Site for CY 1980

M. J. Sula
P. J. Blumer
R. L. Dirkes

August 1981

Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
by Battelle Memorial Institute

Battelle

PNL-3729

PACIFIC NORTHWEST LABORATORY
operated by
BATTELLE
for the
UNITED STATES DEPARTMENT OF ENERGY
Under Contract DE-AC06-76RLO 1830

Printed in the United States of America
Available from
National Technical Information Service
United States Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22151

Price: Printed Copy $________*; Microfiche $3.00

*Pages	NTIS Selling Price
001-025	$4.00
026-050	$4.50
051-075	$5.25
076-100	$6.00
101-125	$6.50
126-150	$7.25
151-175	$8.00
176-200	$9.00
201-225	$9.25
226-250	$9.50
251-275	$10.75
276-300	$11.00

PNL-3729
UC-41

ENVIRONMENTAL STATUS OF THE HANFORD SITE FOR CY-1980

M. J. Sula
P. J. Blumer
R. L. Dirkes

August 1981

Prepared for
the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
Richland, Washington 99352

ACKNOWLEDGMENTS

Acknowledgment is given to those who helped produce this report. Mary Ann McKinney edited and arranged for its publication and Gayle Niemeyer was the typist.

FOREWORD

Environmental surveillance at the Hanford Site involves numerous measurements of a variety of environmental media for potential contaminants. The results of these measurements are used for assessing the environmental impact of site operations, for demonstrating compliance with applicable regulations, and for verifying the adequacy of containment and effluent control systems applied to onsite facilities and operations.

The data generated by routine environmental surveillance measurements are reported annually in three separate reports. The first report, Environmental Surveillance at Hanford, summarizes all offsite environmental sampling data and any onsite data that pertain to the assessment of offsite radiation doses. The report discusses the significance of background levels, previous measurements, regulatory limits and provides an assessment of the impact of site operations on the environment in terms of radiation dose. The 1980 report was issued in April, 1981 (Sula and Blumer).

The second report, Radiological Status of the Ground Water Beneath the Hanford Site, summarizes and evaluates the concentrations and distribution of radioactive and other chemical constituents in the ground water beneath the Hanford Site and discusses their potential environmental impact. The 1980 report was issued in April, 1981 (Eddy and Wilbur).

The third report, Environmental Status of the Hanford Site, is provided here. This report specifically addresses surface environmental measurements made onsite. The primary purpose of this report is to present data concerning the radiological conditions in the immediate environs of the site's operating areas. The report also includes a summary of both radioactive and nonradioactive environmental discharges and related unusual occurrences for 1980 as reported for the various operating areas.

SUMMARY

Samples of air, surface water, soil, vegetation, and wildlife were collected and external penetrating radiation dose measurements were made in the vicinity of the major operating areas on the Hanford Site. The samples were analyzed for radioactive constituents including tritium, strontium-90, plutonium, and gamma-emitting radionuclides. In addition, site roads, railroad tracks, and burial grounds were surveyed periodically to detect any abnormal levels of radioactivity. Radioactive and nonradioactive waste discharges and environmentally related unusual occurrences reported for the major operating areas were summarized. Highlights of the data for 1980 are:

- Gross beta levels in airborne particulates increased towards the end of 1980 as a result of fallout from an atmospheric nuclear test by the People's Republic of China on October 16, 1980.
- Except for low concentrations of fallout radionuclides that were occasionally observed in airborne particulate samples during 1980, no artificially produced gamma-emitting radionuclides were identified. Airborne strontium-90, plutonium, and tritium concentrations at the onsite sampling stations were not significantly different from background measurements. Radioiodine was not identified in any air sample during 1980.
- Concentrations of ^{90}Sr and ^{137}Cs in B-Pond water were somewhat above expected normal levels when compared to past years' data. Strontium-90 concentrations rose from approximately 2 pCi/ℓ to a maximum of 40 pCi/ℓ during the summer. Concentrations returned to near normal levels (2.6 pCi/ℓ) by the year's end. Cesium-137 concentrations increased from approximately 10 pCi/ℓ to a maximum 110 pCi/ℓ during December. The increased radionuclide concentrations were well below the applicable Department of Energy (DOE) Concentration Guides and are not considered significant with respect to environmental impact.
- Analyses of tissue samples taken from several types of wildlife collected onsite continue to indicate that Hanford-produced radionuclides are accessible to wildlife in some areas.

- Several onsite soil and vegetation samples exhibited radionuclide concentrations above background levels. However, observed levels were similar to those reported in recent years.
- External penetrating dose measurements during 1980 showed that dose rates were above background levels at several onsite locations. Dose rates below the 100-K retention basin were almost five times background as a result of subsurface contamination. Dose rates at several locations in the 200 Area were up to two times background as a result of nearby waste management facilities. Dose rates at the 300 Pond dosimeter location north of the 300 Area increased to about three times background in May following the placement of a steam generator, which was removed from the Surry Nuclear Generating Station to a position near the dosimeter location.
- No instances of roadway contamination and only one instance of railroad contamination were found during 1980. The railroad contamination, which occurred between 100-N and 100-K Area, was attributed to the shipment of spent N-Reactor fuel to storage facilities at 100-K Area. Areas of contamination were either cleaned up or posted as radiation zones. Additional surveys have revealed no further contamination.
- There were no significant changes in the radiological status of burial grounds located outside of operating area perimeter fences.
- Discharges of radioactive and nonradioactive materials to the environment during 1980 generally were lower than previous years as a result of the temporary shutdown of several facilities.
- A total of twelve environment-related unusual occurrences were reported at Hanford during 1980.

CONTENTS

FIGURES

TABLES

ENVIRONMENTAL STATUS OF THE HANFORD SITE FOR CY-1980

INTRODUCTION

Department of Energy (DOE) operations on the Hanford Site began in 1943 and in the intervening years have involved a wide variety of nuclear and non-nuclear activities, the most notable of which has been the large-scale production and processing of radioactive materials for the national defense program. During the performance of these activities, materials have been released to the environment both in a routine and controlled manner and, occasionally, as a result of a process upset or other unplanned occurrence. Effluent and environmental monitoring programs are conducted to aid onsite waste management activities and to assess the impact of radioactive and nonradioactive discharges.

THE HANFORD SITE

The U.S. Department of Energy's Hanford Site is located in a rural region of southeastern Washington State and occupies an area of 1500 m^2 (560 square miles). The site, shown in Figure 1, lies about 320 km (200 miles) east of Portland, Oregon, 270 km (170 miles) southeast of Seattle, Washington, and 200 km (125 miles) southwest of Spokane, Washington. The Columbia River flows through the northern edge of the Hanford Site and forms part of its eastern boundary.

Established in 1943, the Hanford plant was originally designed, built, and operated to produce plutonium for nuclear weapons. At one time, nine production reactors were in operation, including eight with once-through cooling by treated river water. Between December 1964 and January 1971, all eight reactors with once-through cooling were deactivated. N-Reactor, the remaining production reactor in operation, has a closed primary cooling loop.

Facilities on the Hanford Site include the N-Production Reactor and the eight deactivated production reactors along the Columbia River in the "100 Areas." The reactor fuel-processing and waste-management facilities

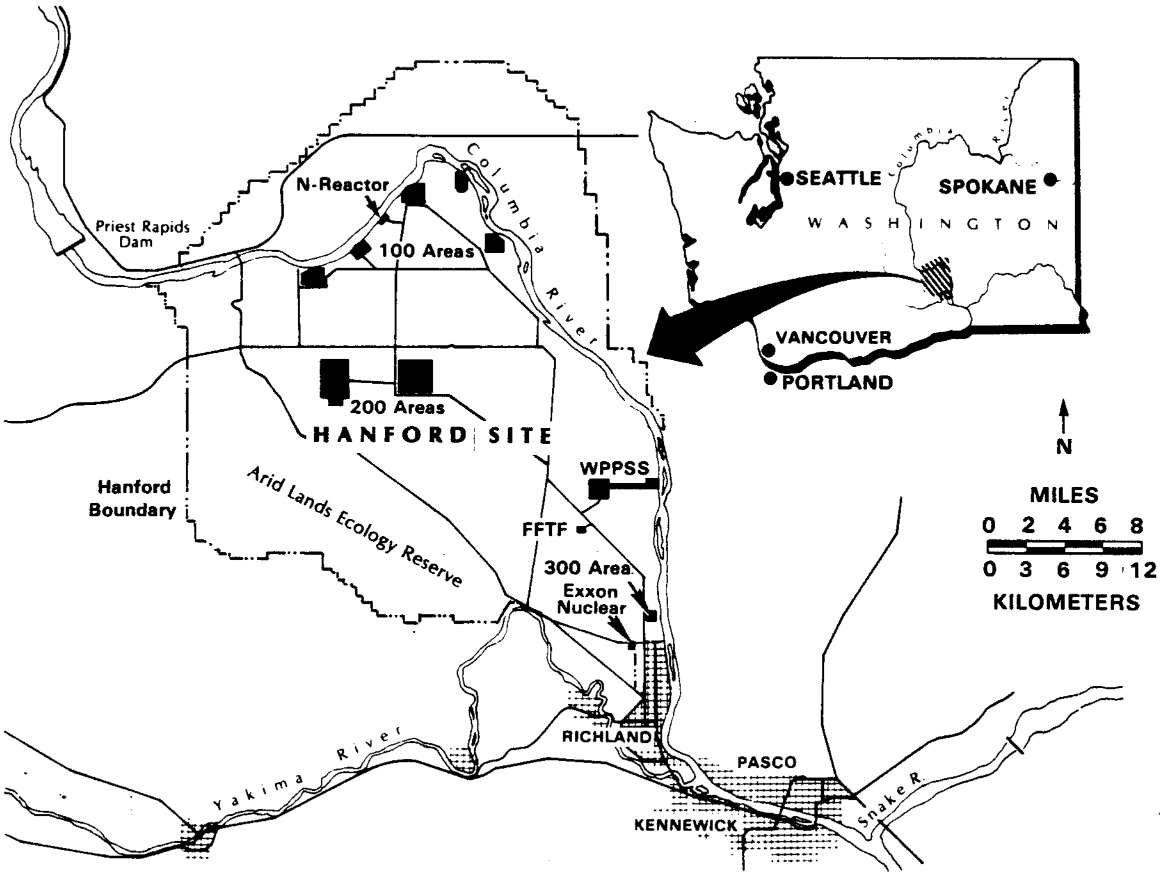

FIGURE 1. DOE's Hanford Site in Washington State

are on a plateau about 11.3 km (7 miles) from the river in the "200 Areas." The "300 Area," just north of the city of Richland, contains facilities for manufacturing reactor fuel and research and development laboratories. The Fast Flux Test Facility (FFTF) is located in the "400 Area" approximately 8.8 km (5.5 miles) northwest of the 300 Area.

Privately owned facilities located within the Hanford Site boundaries include the Washington Public Power Supply System generating station adjacent to N Reactor, the Washington Public Power Supply System power reactor site and office buildings (under construction), a hazardous-waste disposal site, and a radioactive-waste burial site. The Exxon fuel-fabrication facility is located immediately adjacent to the southern boundary of the Hanford Site.

Principal DOE contractors operating at Hanford are:

- Rockwell Hanford Operations (RHO)--responsible for fuel processing, waste management, and all site support services such as plant security, fire protection, central stores, electrical power distribution, etc.
- Battelle Memorial Institute--responsible for operating the Pacific Northwest Laboratory (PNL), including research in the physical, life, and environmental sciences; environmental surveillance; and development of advanced methods of nuclear waste management.
- UNC Nuclear Industries (UNC)--responsible for operating and fabricating fuel for N Reactor.
- Westinghouse Hanford Company--responsible for operating the Hanford Engineering Development Laboratory (HEDL), including advanced reactor developments, principally the Liquid Metal Fast Breeder Reactor Program and the Fast Flux Test Facility.

Highlights of operational activities at Hanford during 1980 are:

- N Reactor operation was limited to the period January through May due to a Hanford-wide labor dispute.
- Steam from N Reactor operations was used to drive turbine generators that produced up to 860 million watts of electrical power in the Washington Public Power Supply System's Hanford Generating Plant. Since its startup, N Reactor has supplied enough steam to produce nearly 50 billion kilowatt hours of electrical energy which was provided to the Bonneville Power Administration grid covering the Pacific Northwest.
- The Fast Flux Test Facility achieved initial criticality for a brief period on February 9 and achieved full power operation on December 21.
- A steam generator, removed from the Surry Nuclear Generating Station, was transported onto the site where it will undergo testing.
- Construction of double-walled underground storage tanks for high-level liquid wastes was completed.

* Solidification of high-level radioactive wastes, stored in the old single-walled tanks, was completed.

Work at Hanford during 1980 also included Hanford National Environmental Research Park (NERP) studies, and Arid Land Ecology (ALE) studies, as well as continued operation of a variety of research and laboratory facilities.

The desert plain on which Hanford is located has a sparse covering of vegetation primarily suited for grazing. The most broadly distributed type of vegetation on the site is the sagebrush/cheatgrass/bluegrass community. The mule deer is the most abundant big-game mammal on the site and the most abundant small-game animal is the cottontail rabbit. The raccoon is the most abundant furbearing animal. The osprey, golden eagle, and bald eagle are all occasional visitors to the relatively large areas of uninhabited land comprising the Hanford Site.

Hanford's climate is mild and dry; the area receives approximately 16 cm (6.3 in.) of precipitation annually. About 40% of the total precipitation occurs during November, December, and January, with only 10% falling in July, August, and September. The average maximum and minimum temperatures in July are 33°C (92°F) and 16°C (61°F). For January, the respective averages are 3°C (37°F) and -6°C (22°F). Approximately 45% of all precipitation from December through February is snow.

Mean monthly wind speeds range from about 14 km/hr (9 mph) in the summer to 10 km/hr (6 mph) in the winter. The prevailing regional winds are from the northwest with strong drainage and crosswinds causing complicated surface flow patterns. The region is a typical desert area with frequent strong inversions that occur at night and break during the day, causing unstable and turbulent conditions.

With the exception of Hanford site-related industries, the economy of the region is primarily agricultural. Major crops include alfalfa, wheat, corn, and potatoes. Several fruit orchards are located within a short distance of the Hanford Site. The Columbia River is used extensively for recreational purposes including fishing and waterfowl hunting.

The population center nearest to the Hanford Site is the Tri-Cities area (Richland, Pasco, and Kennewick), situated on the Columbia River downstream from the site with a combined population of approximately 90,000. Approximately 277,000 people live within an 80-km (50-mile) radius of the Hanford Site in the Yakima area, the Tri-Cities, several small communities, and the surrounding agricultural areas. Considerably more detail on site characteristics and activities is available in the Final Environmental Statement, Waste Management Operations at Hanford (ERDA 1975).

HANFORD ENVIRONMENTAL SURVEILLANCE PROGRAM

The Hanford Environmental Surveillance Program is conducted by the Pacific Northwest Laboratory (PNL), operated by the Battelle Memorial Institute under contract to DOE. The program provides for the measurement, interpretation, and evaluation of sampling data and other measurements for the purposes of assessing environmental impact, demonstrating compliance with pertinent regulations, and evaluating the adequacy of onsite waste management practices. The program is designed to evaluate all significant pathways of potential environmental impact, with emphasis on those which are most significant. Summaries of the data generated during the performance of Environmental Surveillance Activities are published annually in a set of three reports. These are:

- Environmental Surveillance at Hanford ("offsite" environmental surveillance report)
- Radiological Status of the Ground Water Beneath the Hanford Site
- Environmental Status of the Hanford Site ("onsite" environmental surveillance report)

This report is the last of the three reports to be issued for the year 1980. The Environmental Surveillance at Hanford for CY-1980 has previously been issued as PNL-3728 (Sula and Blumer 1981) and the Radiological Status of the Ground Water Beneath the Hanford Site has previously been issued as PNL-3768 (Eddy and Wilbur 1981).

The data provided in this report concern the radiological status of the environment in the immediate vicinity of the major operating areas. In general, the data were compared both to background measurements made during 1980 and to previous years' data. Sample analysis procedures are described in Appendix A and data analysis methods are provided in Appendix B.

The Columbia River is open for use by the public including boating, fishing, and hunting; and as such, environmental surveillance data pertaining to the river are contained in the "offsite" environmental surveillance report Environmental Surveillance at Hanford for CY-1980 (Sula and Blumer 1980).

AIR SAMPLING

Onsite air sampling provides a means for assessing the environmental impact of site operations, for demonstrating compliance with applicable regulations and for checking the effectiveness of containment and effluent control systems. Air sampling stations have been established at 23 onsite locations, primarily in the immediate vicinity of the four major operating areas as shown in Figure 2. Samples were collected and analyzed as described in Table 1.

Particulate airborne radionuclides are sampled by drawing air at a flow rate of 2.55 m^3/hr (1.5 ft^3/min) through a 5-cm (2-in.)-diameter high-efficiency particulate filter. Immediately downstream from the particulate filter is a cartridge of activated charcoal impregnated with potassium iodide for the collection of gaseous radioiodine. Atmospheric moisture, for tritiated water analysis, is collected at selected locations by passing a portion of the air through a cartridge of silica gel at a rate of 28.4 ℓ/hr (1 ft^3/hr).

The particulate filters are collected biweekly and analyzed for gross beta and alpha activity after a wait of seven days to allow the naturally occurring short-lived radon and thoron daughters to decay. Once a month the filters are grouped by geographical location and analyzed by gamma spectrometry. Each quarter the filters in each geographical group are dissolved and analyzed for ^{90}Sr and plutonium. Charcoal cartridges from a few of the sampling locations are collected and analyzed biweekly for ^{131}I. Charcoal cartridges from the remaining stations are changed monthly to ensure that fresh collection media exist at each location. These samples are analyzed only when ^{131}I is detected at one or more of the stations where analyses are routinely performed. The silica gel cartridges, located at three of the sampling stations, are collected and analyzed biweekly.

Results of onsite air sampling measurements made during 1980 are summarized in Tables 2-7. Comparison of the annual average onsite concentrations with that of background (distant offsite) locations does not reveal any significant differences. A review of the maximum observed concentrations

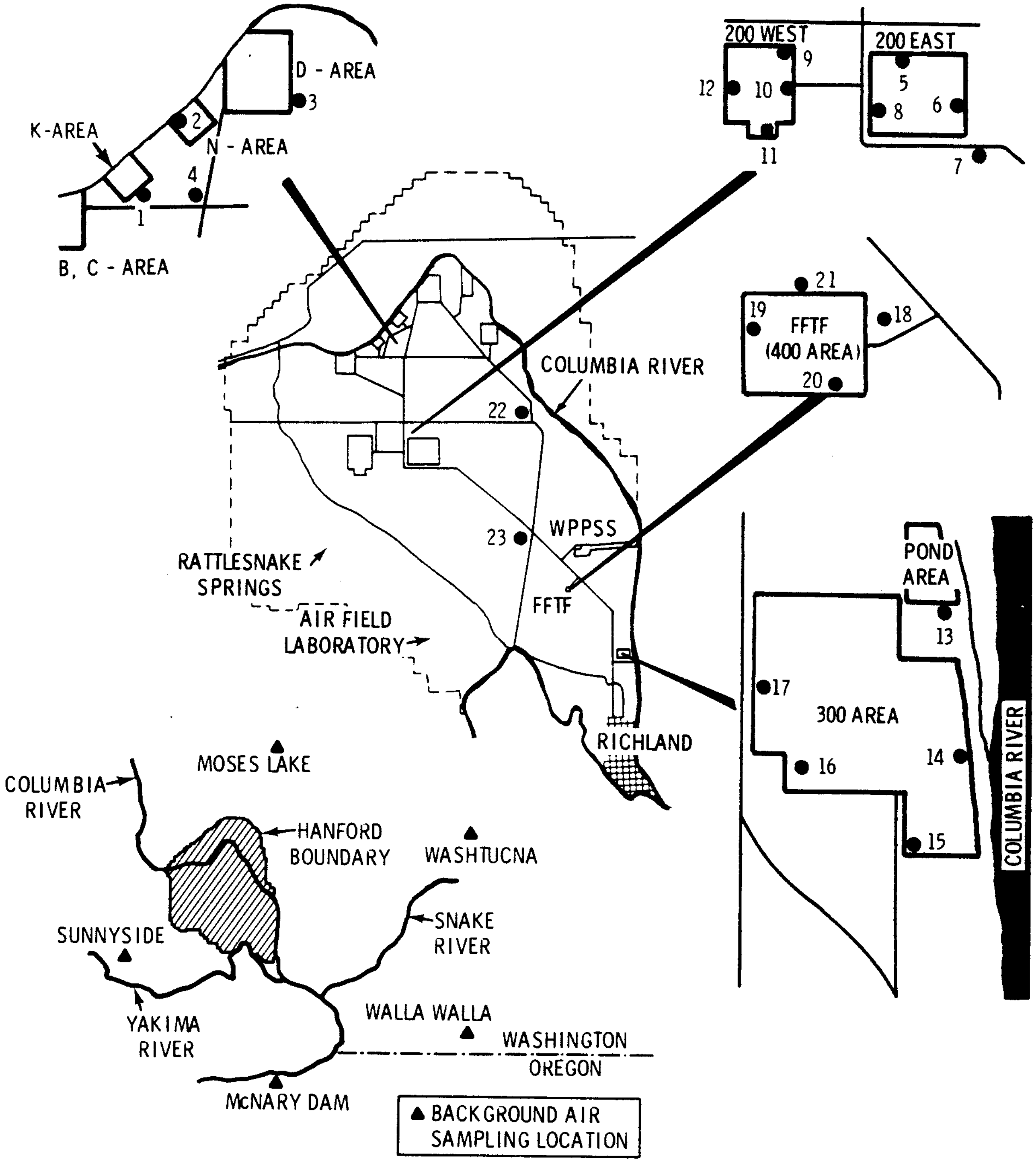

FIGURE 2. Onsite Environmental Air Sampling Location - 1980

TABLE 1. Onsite Air Sampling Schedule - 1980

Sample Location	Map Number	Particulate Filter: Filter Exchange Period	Particulate Filter: Analysis Frequency: Gross Beta	Gross Alpha	Gamma Scan	^{90}Sr	Pu	Charcoal Cartridge: Cartridge Exchange Period	Charcoal Cartridge: Analysis Frequency: ^{131}I	Silica Gel Cartridge: Cartridge Exchange Period	Silica Gel Cartridge: Analysis Frequency: ^{3}H (HTO)
100 Areas											
100-K	1	BW	BW					M	NRA		
100-N	2	BW	BW					M	NRA		
100-D	3	BW	BW					BW	BW	BW	BW
Fire Station	4	BW	BW					M	NRA		
Composite					M	Q	Q				
200 East Area											
200 ENC	5	BW	BW	BW				M	NRA		
200 EEC	6	BW	BW	BW				M	NRA		
200 ESE	7	BW	BW	BW				BW	BW	BW	BW
200 EWC	8	BW	BW					M	NRA		
Composite					M	Q	Q				
200 West Area											
200 WNE	9	BW	BW					M	NRA		
200 WEC	10	BW	BW	BW				M	NRA		
Redox	11	BW	BW	BW				M	NRA		
200 WWC	12	BW	BW					M	NRA		
Composite					M	Q	Q				
300 Area											
300 Pond	13	BW	BW					M	NRA		
3614-A Bldg.	14	BW	BW					M	NRA		
300 S. Gate	15	BW	BW	BW				M	NRA		
300 SW Gate	16	BW	BW					BW	BW		
3705 Bldg.	17	BW	BW					M	NRA		
Composite					M	Q	Q				
400 Area											
400 E	18	BW	BW	BW				BW	BW	BW	BW
400 W	19	BW	BW	BW				BW	BW		
400 S	20	BW	BW	BW				BW	BW		
400 N	21	BW	BW	BW				BW	BW		
Composite					M	Q	Q				
Inner East Sector											
Hanford	22	BW	BW					M	NRA		
Wye Barricade	23	BW	BW	BW				M	NRA		
Composite					M	Q	Q				

BW - Biweekly
M - Monthly
Q - Quarterly
NRA - Not Routinely Analyzed

TABLE 2. Airborne Radioactivity Concentrations During 1980 - 100 Areas

Radionuclide	Sampler Location	No. of Samples	Maximum	Minimum	Annual Average	Average 1980[a] Background
			Concentration, pCi/m^3			
^{3}H (HTO)	D-Area	23	2.8 ± 1.0[b]	0.09 ± 0.11	0.61 ± 1.2[b]	NS
^{90}Sr	Composite[c]	4	$3.0 \times 10^{-4} \pm 6.0 \times 10^{-5}$	$2.0 \times 10^{-4} \pm 5.0 \times 10^{-5}$	$2.3 \times 10^{-4} \pm 1.0 \times 10^{-4}$	$2.5 \times 10^{-4} \pm 4.4 \times 10^{-4}$
$^{95}ZrNb$	Composite[d]	12	0.01 ± 0.001	$-4.0 \times 10^{-3} \pm 2.0 \times 10^{-3}$	$3.8 \times 10^{-4} \pm 7.0 \times 10^{-3}$	$1 \times 10^{-3} \pm 2 \times 10^{-2}$
^{131}I	K-Area	26			NRA	
	N-Area	26			NRA	
	D-Area	24			0.002 ± 0.01	0.002 ± 0.01
	Fire Station	26			NRA	
^{137}Cs	Composite[d]	12			$-3.0 \times 10^{-4} \pm 2.0 \times 10^{-3}$	$2.4 \times 10^{-4} \pm 5.4 \times 10^{-3}$
$^{144}CePr$	Composite[d]	12			-0.004 ± 0.02	-0.005 ± 0.05
Total-Pu	Composite[c]	4	$3.0 \times 10^{-5} \pm 4.0 \times 10^{-6}$	$-5.0 \times 10^{-6} \pm 2.0 \times 10^{-6}$	$9.3 \times 10^{-6} \pm 3.0 \times 10^{-5}$	$3.1 \times 10^{-5} \pm 1.2 \times 10^{-4}$
Gross Beta	K-Area	26	0.12 ± 0.006	0.01 ± 0.004	0.04 ± 0.06	
	N-Area	26	0.08 ± 0.006	0.01 ± 0.004	0.04 ± 0.04	
	D-Area	25	0.09 ± 0.006	0.008 ± 0.004	0.04 ± 0.05	
	Fire Station	26	0.12 ± 0.006	0.008 ± 0.004	0.04 ± 0.05	
					0.04 ± 0.05	0.04 ± 0.07

(a) Except as noted, based on annual average of air samples collected from "Distant" stations during 1980. "Distant" stations include: Moses Lake, Wastucna, Walla Walla, McNary Dam, and Sunnyside.
(b) Individual results reflect the 2σ uncertainty level based on the variance of the mean as well as the counting errors.
(c) Quarterly composites of biweekly samples from four sampling locations.
(d) Monthly composites of biweekly samples from four sampling locations.
NRA Not Routinely Analyzed.
NS Tritium was not sampled at "Distant" stations. Average of Fir Road, Richland, and Benton City (perimeter) samples was 0.70 ± 1.5.

TABLE 3. Airborne Radioactivity Concentrations During 1980 - 200E Area

Radionuclide	Sample Location	No. of Samples	Maximum	Minimum	Annual Average	Average 1980[a] Background
			Concentration, pCi/m^3			
^{3}H (HTO)	200 ESE	26	2.8 ± 0.53	-0.08 ± 0.06	0.81 ± 1.4[b]	NS
^{90}Sr	Composite[c]	4	$8\times10^{-4} \pm 1\times10^{-4}$	$2\times10^{-4} \pm 7\times10^{-5}$	$5\times10^{-4} \pm 6\times10^{-4}$	$2.5\times10^{-4} \pm 4.4\times10^{-4}$
$^{95}ZrNb$	Composite[d]	12	0.01 ± 0.001	$-1\times10^{-3} \pm 1\times10^{-3}$	0.002 ± 0.008	0.001 ± 0.02
^{131}I	200 ENC	26			NRA	
	200 EEC	26			NRA	
	200 ESE	25			0.002 ± 0.010	
	200 EWC	26			NRA	
						0.002 ± 0.01
^{137}Cs	Composite[d]	12	0.01 ± 0.001	$-7\times10^{-6} \pm 1\times10^{-2}$	0.003 ± 0.007	0.00024 ± 0.0054
$^{144}CePr$	Composite[d]	12	0.02 ± 0.01	-0.02 ± 0.01	-0.003 ± 0.03	-0.005 ± 0.05
Pu-Total	Composite[c]	4	$4\times10^{-5} \pm 6\times10^{-6}$	$8\times10^{-6} \pm 4\times10^{-6}$	$2\times10^{-5} \pm 3\times10^{-5}$	$3.1\times10^{-5} \pm 1.2\times10^{-4}$
Gross Beta	200 ENC	26	0.15 ± 0.007	0.01 ± 0.004	0.05 ± 0.08	
	200 EWE	26	0.13 ± 0.006	0.01 ± 0.005	0.04 ± 0.05	
	200 ESE	26	0.15 ± 0.007	0.009 ± 0.004	0.04 ± 0.06	
	200 EEC	26	0.11 ± 0.006	0.006 ± 0.004	0.04 ± 0.05	
					0.04 ± 0.06	0.04 ± 0.07
Gross Alpha	200 ENC	25	0.002 ± 0.0006	0.0006 ± 0.0004	0.001 ± 0.001	
	200 EWC	26			NRA	
	200 ESE	25	0.002 ± 0.0005	0.0003 ± 0.0003	0.001 ± 0.001	
	200 EEC	26	0.003 ± 0.0009	0.0008 ± 0.0004	0.002 ± 0.001	
					0.001 ± 0.001	NS

(a) Except as noted, based on average of air samples collected from "Distant" stations during 1980. "Distant" stations include: Moses Lake, Washtucna, Walla Walla, McNary Dam, and Sunnyside.
(b) Individual results reflect the 2σ uncertainty level based on the variance of the mean as well as the counting errors.
(c) Quarterly composites of biweekly samples from four sampling locations.
(d) Monthly composites of biweekly samples from four sampling locations.
NRA Not Routinely Analyzed.
NS Tritium was not sampled at "Distant" stations. Average of Fir Road, Richland, and Benton City (perimeter) samples was 0.70 ± 1.5.

TABLE 4. Airborne Radioactivity Concentrations During 1980 - 200W Area

Radionuclide	Sample Location	No. of Samples	Maximum (Concentration, pCi/m^3)	Minimum (Concentration, pCi/m^3)	Annual Average (Concentration, pCi/m^3)	Average 1980[a] Background (Concentration, pCi/m^3)
^{90}Sr	Composite[c]	4	$5X10^{-4} \pm 6X10^{-5}$[b]	$2X10^{-4} \pm 9X10^{-5}$	$4X10^{-4} \pm 3X10^{-4}$[b]	$2.5X10^{-4} \pm 4.4X10^{-4}$
$^{95}ZrNb$	Composite[d]	4	0.01 ± 0.001	-0.003 ± 0.001	0.001 ± 0.008	0.001 ± 0.02
^{131}I	200 WEC	26			NRA	
	200 WNE	26			NRA	
	200 WWC	26			NRA	
	Redox	26			NRA	
^{137}Cs	Composite[d]	12	0.009 ± 0.001	-0.002 ± 0.001	0.001 ± 0.006	0.00024 ± 0.0034
$^{144}CePr$	Composite[d]	12	0.02 ± 0.01	-0.01 ± 0.02	-0.003 ± 0.02	-0.005 ± 0.05
Pu-Total	Composite[c]	4	$3X10^{-5} \pm 1X10^{-5}$	$7X10^{-6} \pm 8X10^{-6}$	$2X10^{-5} \pm 2X10^{-5}$	$3.1X10^{-5} \pm 1.2X10^{-4}$
Gross Beta	200 WEC	26	0.09 ± 0.006	0.02 ± 0.004	0.04 ± 0.04	
	200 WNE	25	0.11 ± 0.006	0.008 ± 0.004	0.04 ± 0.05	
	200 WWC	26	0.11 ± 0.006	0.01 ± 0.004	0.04 ± 0.05	
	Redox	25	0.10 ± 0.006	0.02 ± 0.005	0.04 ± 0.04	
					0.04 ± 0.05	0.04 ± 0.07
Gross Alpha	200 WEC	26	0.024 ± 0.005	0.0006 ± 0.0004	0.002 ± 0.009	
	200 WNE	25			NRA	
	200 WWC	26			NRA	
	Redox	25	0.002 ± 0.0006	0.0005 ± 0.0004	0.001 ± 0.001	
					0.002 ± 0.007	NS

(a) Except as noted, based on average of air samples collected from "Distant" stations during 1980. "Distant" stations include: Moses Lake, Washtucna, Walla Walla, McNary Dam, and Sunnyside.
(b) Individual results reflect the 2σ uncertainty level based on the variance of the mean as well as the counting errors.
(c) Quarterly composites of biweekly samples from four sampling locations.
(d) Monthly composites of biweekly samples from four sampling locations.
NRA Not Routinely Analyzed
NS Tritium was not sampled at "Distant" stations. Average of Fir Road, Richland, and Benton City (perimeter) samples was 0.70 ± 1.5.

TABLE 5. Airborne Radioactivity Concentrations During 1980 - 300 Area

Radionuclide	Sample Location	No. of Samples	Concentration, pCi/m^3 Maximum	Minimum	Annual Average	1980 Average Background[a]
^{90}Sr	Composite[c]	4	$2 \times 10^{-4} \pm 6 \times 10^{-5}$[b]	$6 \times 10^{-5} \pm 4 \times 10^{-5}$	$1 \times 10^{-4} \pm 2 \times 10^{-4}$[b]	$2.5 \times 10^{-4} \pm 4.4 \times 10^{-4}$
$^{95}ZrNb$	Composite[d]	12	0.02 ± 0.001	-0.002 ± 0.001	0.0025 ± 0.016	0.001 ± 0.02
^{131}I	300 Pond	25			NRA	
	3614-A Bldg	26			NRA	
	300 S Gate	26			NRA	
	300 SW Gate	22			0.002 ± 0.02	0.002 ± 0.01
	3705 Bldg	18			NRA	
^{137}Cs	Composite[d]	12			$-4 \times 10^{-5} \pm 1 \times 10^{-3}$	$2.4 \times 10^{-4} \pm 5.4 \times 10^{-3}$
$^{144}CePr$	Composite[d]	12	0.01 ± 0.01	-0.01 ± 0.01	-0.004 ± 0.02	-0.005 ± 0.05
Pu-Total	Composite[c]	4	$3 \times 10^{-5} \pm 1 \times 10^{-5}$	$2 \times 10^{-6} \pm 3 \times 10^{-6}$	$1 \times 10^{-5} \pm 3 \times 10^{-5}$	$3.1 \times 10^{-5} \pm 1.2 \times 10^{-4}$
Gross Beta	300 Pond	25	0.14 ± 0.007	0.02 ± 0.004	0.04 ± 0.07	
	3614-A Bldg	26	0.13 ± 0.007	0.01 ± 0.004	0.04 ± 0.06	
	300 S Gate	26	0.17 ± 0.008	0.01 ± 0.004	0.04 ± 0.07	
	300 SW Gate	24	0.16 ± 0.007	0.01 ± 0.004	0.04 ± 0.06	
	3705 Bldg	18	0.17 ± 0.007	0.006 ± 0.004	0.05 ± 0.09	
					0.04 ± 0.07	0.04 ± 0.07
Gross Alpha	300 S Gate	26	$0.003 \pm 7 \times 10^{-4}$	$5 \times 10^{-4} \pm 4 \times 10^{-4}$	0.001 ± 0.001	NS

(a) Except as noted, based on average of air samples collected from "Distant" stations during 1980. "Distant" stations include: Moses Lake, Washtucna, Walla Walla, McNary Dam, and Sunnyside.
(b) Individual results reflect the 2σ uncertainty level based on the variance of the mean as well as the counting errors.
(c) Quarterly composites of biweekly samples from five sampling locations.
(d) Monthly composites of biweekly samples from five sampling locations.
NRA Not Routinely Analyzed.
NS Tritium was not sampled at "Distant" stations. Average of Fir Road, Richland, and Benton City (perimeter) samples was 0.70 ± 1.5.

TABLE 6. Airborne Radioactivity Concentrations During 1980 - 400 Area (FFTF)

Radionuclide	Sampler Location	No. of Samples	Concentration, pCi/m³ Maximum	Minimum	Annual Average	1980 Average[a] Background
^{3}H (HTO)	400E	23	2.3 ± 0.50[b]	-2.9 ± 1.1	0.61 ± 2.0[b]	
^{90}Sr	Composite[c]	4	$3X10^{-4} \pm 6X10^{-5}$	$5X10^{-5} \pm 7X10^{-5}$	$2X10^{-4} \pm 3X10^{-4}$	$2.5X10^{-4} \pm 4.4X10^{-4}$
$^{95}ZrNb$	Composite[d]	12	0.01 ± 0.001	-0.002 ± 0.001	0.001 ± 0.008	0.001 ± 0.02
^{131}I	400E	24			0.002 ± 0.009	
	400W	18			0.001 ± 0.009	
	400S	22			0.002 ± 0.009	
	400N	22			0.003 ± 0.010	
					0.002 ± 0.009	0.002 ± 0.01
^{137}Cs	Composite[d]	12	0.001 ± 0.001	-0.001 ± 0.001	$-1X10^{-4} \pm 3X10^{-3}$	$2.4X10^{-4} \pm 5.4X10^{-3}$
$^{144}CePr$	Composite[d]	12			-0.003 ± 0.04	-0.005 ± 0.05
Pu-Total	Composite[c]	4	$1X10^{-5} \pm 1X10^{-5}$	$-1X10^{-5} \pm 9X10^{-6}$	$1X10^{-6} \pm 2X10^{-5}$	$3.1X10^{-5} \pm 1.2X10^{-4}$
Gross Beta	400E	21	0.11 ± 0.006	0.007 ± 0.004	0.04 ± 0.05	
	400W	17	0.10 ± 0.006	0.02 ± 0.004	0.04 ± 0.04	
	400S	22	0.10 ± 0.006	0.01 ± 0.004	0.04 ± 0.05	
	400N	22	0.10 ± 0.006	0.005 ± 0.004	0.04 ± 0.05	
					0.04 ± 0.05	0.04 ± 0.07
Gross Alpha	400E	22	0.002 ± 0.0006	0.0003 ± 0.0003	0.001 ± 0.001	
	400W	17	0.003 ± 0.0008	0.0007 ± 0.0004	0.002 ± 0.002	
	400S	22	0.002 ± 0.0006	0.0005 ± 0.0004	0.001 ± 0.001	
	400N	22	0.002 ± 0.0006	0.0007 ± 0.0004	0.001 ± 0.001	
					0.001 ± 0.001	NS

(a) Except as noted, based on average of air samples collected from "Distant" stations during 1980. "Distant" stations include: Moses Lake, Washtucna, Walla Walla, McNary Dam, and Sunnyside.
(b) Individual results reflect the 2σ uncertainty level based on the variance of the mean as well as the counting errors.
(c) Quarterly composites of biweekly samples from four sampling locations.
(d) Monthly composites of biweekly samples from four sampling locations.
NRA Not Routinely Analyzed.
NS Tritium was not sampled at "Distant" stations. Average of Fir Road, Richland, and Benton City (perimeter) samples was 0.70 ± 1.5.

TABLE 7. Airborne Radioactivity Concentrations During 1980 - Inner East Sector

Radionuclide	Sampler Location	Number of Samples	Concentration, pCi/m³: Maximum	Minimum	Annual Average	1980 Average Background[a]
^{90}Sr	Composite[c]	4	$2 \times 10^{-4} \pm 1 \times 10^{-4}$[b]	$2 \times 10^{-4} \pm 1 \times 10^{-4}$	$2 \times 10^{-4} \pm 2 \times 10^{-4}$[b]	$2.5 \times 10^{-4} \pm 4.4 \times 10^{-4}$
$^{95}ZrNb$	Composite[d]	12	0.01 ± 0.002	-0.003 ± 0.003	0.001 ± 0.008	0.001 ± 0.02
^{131}I	Hanford	25			NRA	
	Wye Barricade	26			NRA	
^{137}Cs	Composite[d]	12	0.008 ± 0.002	-0.002 ± 0.003	0.001 ± 0.006	$2.4 \times 10^{-4} \pm 5.4 \times 10^{-3}$
$^{144}CePr$	Composite[d]	12			-0.005 ± 0.04	-0.005 ± 0.05
Pu-Total	Composite[c]	4	$5 \times 10^{-5} \pm 2 \times 10^{-5}$	$-1 \times 10^{-6} \pm 4 \times 10^{-6}$	$3 \times 10^{-5} \pm 5 \times 10^{-5}$	$3.1 \times 10^{-5} \pm 1.2 \times 10^{-4}$
Gross Beta	Hanford	25	0.13 ± 0.007	0.006 ± 0.004	0.04 ± 0.06	
	Wye Barricade	26	0.10 ± 0.006	0.02 ± 0.004	0.04 ± 0.04	
					0.04 ± 0.05	0.04 ± 0.07
Gross Alpha	Wye Barricade	25	0.002 ± 0.0006	$7 \times 10^{-4} \pm 4 \times 10^{-4}$	0.001 ± 0.001	NS

(a) Except as noted, based on average of air samples collected from "Distant" stations during 1980. "Distant" stations include: Moses Lake, Washtucna, Walla Walla, McNary Dam, and Sunnyside.
(b) Individual results reflect the 2σ uncertainty level based on the variance of the mean as well as the counting errors.
(c) Quarterly composites of biweekly samples from two sampling locations.
(d) Monthly composites of biweekly samples from two sampling locations.
NRA Not Routinely Analyzed.
NS Tritium was not sampled at "Distant" stations. Average of Fir Road, Richland, and Benton City (perimeter) samples was 0.70 ± 1.5.

for 1980 does not indicate any substantial differences either between operating areas or in comparison to previous years' data as reported in previous environmental status reports (Houston and Blumer 1980). All radionuclide concentrations were negligible in comparison to applicable radionuclide Concentration Guides for uncontrolled areas (USDOE 1981). Radioiodines were not identified in any air samples during 1980.

Figure 3 shows a comparison of gross beta trends at the operating areas with distant offsite locations for the past several years. There is a tendency for airborne particulate gross beta concentrations to be slightly

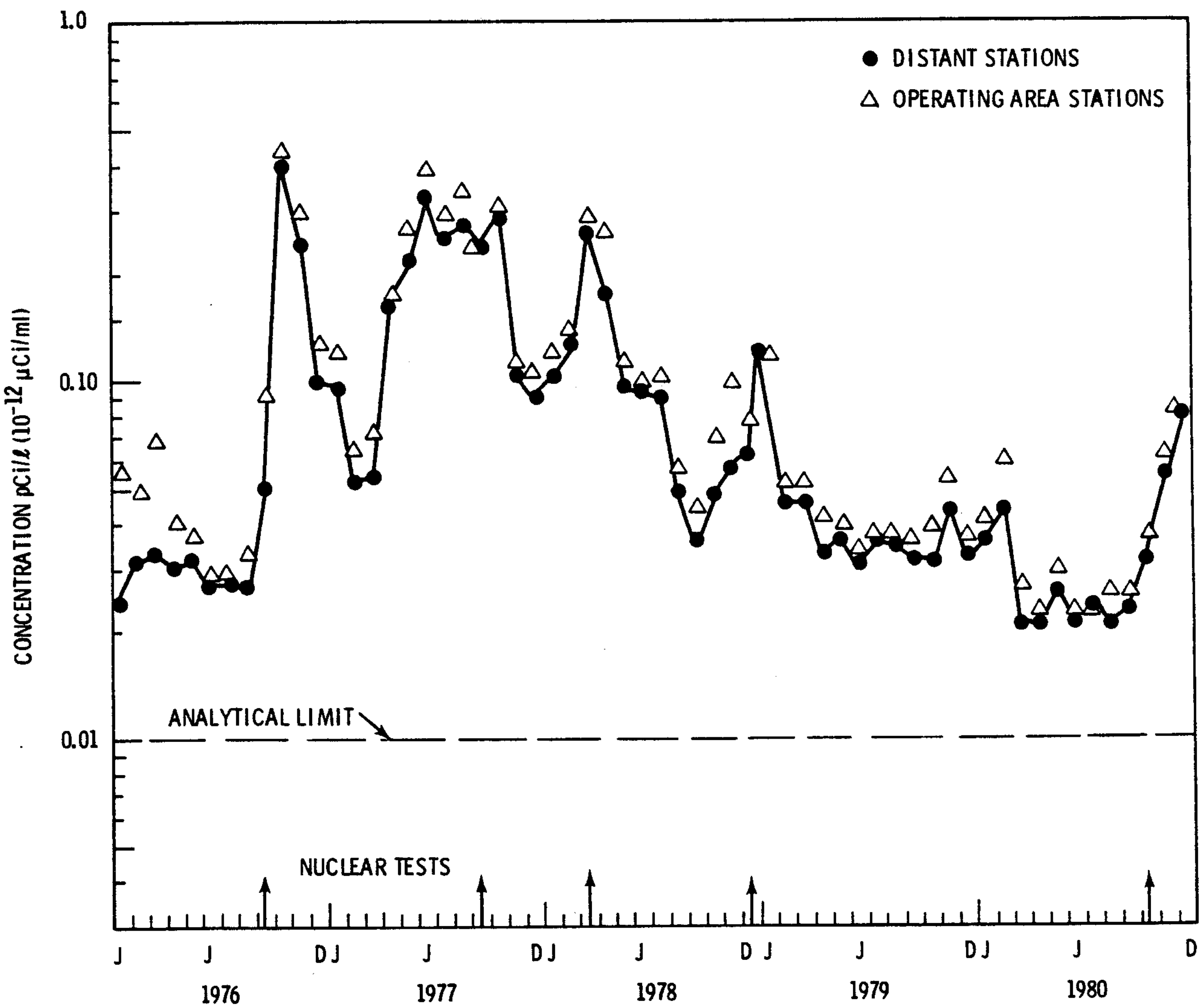

FIGURE 3. Monthly Average Gross Beta-Emitter Activity in the Atmosphere

higher near operating areas, although these differences are relatively small when compared to the changes in concentrations brought about by worldwide atmospheric nuclear weapons tests and changes in atmospheric conditions. Maximum gross beta concentrations were observed during late 1980 following an atmospheric nuclear detonation on October 16, 1980, by the People's Republic of China.

PONDS

Four ponds, located outside of operating area exclusion fences (Figure 4) were sampled routinely for radioactivity. Two of the ponds, Gable Pond and B-Pond near the 200 East Area, were built in the mid-1950's for disposal of process cooling water and chemical wastes usually containing low levels of radioactive contamination. The FFTF Pond, built in 1978, is a sewage disposal and treatment lagoon and does not receive any radioactive wastes. The

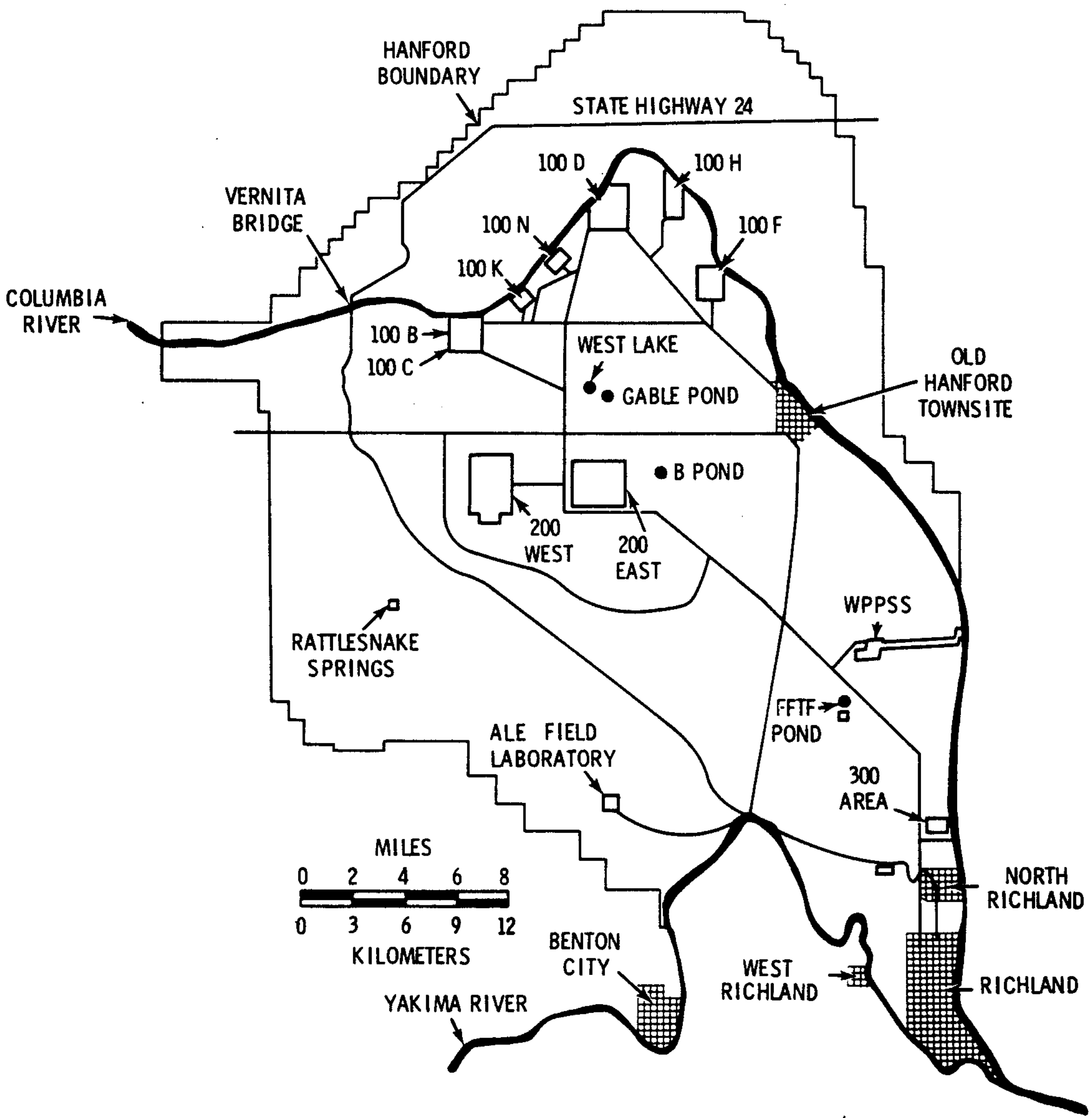

FIGURE 4. Onsite Ponds Sampled During 1980

fourth pond, West Lake, is a natural lake and does not receive liquid wastes from site facilities. The ponds are accessible to migrating waterfowl as well as other animals. Thus, a potential pathway exists for removal and dispersal of contaminants that may be present in the pond water.

Grab samples of water from each pond are collected quarterly and analyzed for gross alpha, gross beta, gamma emitters, and ^{90}Sr, with the exception that FFTF Pond water is analyzed for ^{22}Na instead of ^{90}Sr. Results of 1980 samples are shown in Table 8.

Increased ^{90}Sr and ^{137}Cs concentrations were observed in B-Pond water during 1980. Figure 5 shows the ^{90}Sr and ^{137}Cs concentrations in B-Pond water from 1978 through early 1981. The figure shows that the ^{90}Sr peaked (40 pCi/ℓ) during the summer of 1980 and returned to near normal levels (2.6 pCi/ℓ) at the end of the year. The figure also shows an increasing trend in ^{137}Cs concentrations during late 1980. As a result of these observations, the sampling frequency at B-Pond has been increased from quarterly to monthly and results are being carefully monitored. The increased radionuclide concentrations have been well below applicable Concentration Guides and are not considered to pose any special environmental problems.

The highest gross alpha and gross beta concentrations were observed in West Lake. West Lake is a natural pond and receives no waste water from Site operations. The ^{90}Sr and ^{137}Cs concentrations in West Lake are lower than the other ponds sampled, and analyses of water from West Lake for gamma-emitting radionuclides have not shown unusual concentrations of other fission and activation products. West Lake receives recharge from a deep confined aquifer and there is very little exchange of water between the pond and the shallow, contaminated Hanford aquifer (Gephart et. al. 1976). Therefore, it is possible that the observed radioactivity is due to the naturally occurring radionuclides in the pond recharge which have been concentrated by evaporation. It is also possible that radioactive materials have, in the past, been disposed of in the pond.

TABLE 8. Radionuclide Concentrations in Onsite Ponds During 1980

Location	Date	Concentration pCi/ℓ[a] ^{51}Cr[b]	^{65}Zn	^{90}Sr[c]	^{137}Cs[d]	^{22}Na	Total Alpha Activity	Total Beta Activity
West Lake	2/12	35 ± 66	-2.6 ± 13	0.09 ± 1.4	23 ± 7.5	NA	.23 ± 1.8	13 5.4
	5/6	29 ± 45	2.4 ± 11	2.0 ± 0.27	0.84 ± 5.4	↓	211 ± 14.3	368 45
	8/12	31 ± 26	14 ± 6.3	6.4 ± 0.45	10 ± 3.3	↓	141 ± 8.1	797 30
	11/18	39 ± 110	7.0 ± 16	3.1 ± 0.27	0.83 ± 7.2	↓	104 ± 9.9	502 53
Gable Pond	2/12	52 ± 130	2.7 ± 27	0.41 ± 0.18	110 ± 16	↓	.49 ± .41	24 56
	5/6	4.2 ± 9.8	0.04 ± 2.5	0.60 ± 0.17	61 ± 5.3	↓	.56 ± .28	63 6.5
	8/12	8.9 ± 6.4	-0.04 ± 1.3	0.52 ± 0.14	47 ± 1.1	↓	.85 ± .33	188 8.8
	11/18	4.0 ± 7.0	-0.18 ± 1.5	0.37 ± 0.14	23 ± 1.0	↓	.37 ± .37	23 5.6
B Pond	2/12	-7.9 ± 20	-0.01 ± 4.4	1.7 ± 0.45	12 ± 2.5	↓	.09 ± .32	99 7.3
	5/6	-1.4 ± 7.9	-0.22 ± 1.7	6.6 ± 0.17	7.5 ± 0.98	↓	.93 ± .33	23 5.8
	8/12	7.5 ± 6.2	1.1 ± 1.5	40 ± 1.6	32 ± 1.1	↓	.93 ± .37	81 7.1
	9/23	-3.5 ± 5.7	-0.21 ± 1.3	19 ± 2.0	7.0 ± 0.79	↓	1.3 ± .38	36 5.7
	11/18	5.6 ± 6.2	0.88 ± 1.5	2.6 ± 0.14	30 ± 1.1	↓	.37 ± .41	37 5.8
	12/17	-0.09 ± 19	0.23 ± 4.1	2.6 ± 0.27	107 ± 9.4	↓	.28 ± .29	111 7.3
FFTF Pond	5/6	-0.32 ± 15	1.2 ± 3.7	NA	1.2 ± 1.9	1.4 ± 4.8	.49 ± .41	45 6.1
	8/12	-2.2 ± 12	2.8 ± 3.0	↓	0.38 ± 1.6	.52 ± 4.7	.56 ± .29	21 4.6
	11/18	13 ± 14	2.7 ± 3.0	↓	-0.14 ± 1.6	-.66 ± 4.7	.09 ± .35	19 3.7

(a) Individual results show the 2σ counting error. No entry indicates the sample was not analyzed for the particular constituent.

(b) Chromium-51, ^{65}Zn, and ^{137}Cs, based on analysis by gamma-spectrometry. No other artificially produced radionuclides were detected.

(c) Concentration Guide for uncontrolled areas is 300 pCi/ℓ (DOE 5480.1, Chapter XI).

(d) Concentration Guide for uncontrolled areas is 20,000 pCi/ℓ (DOE 5480.1, Chapter XI).

NA Radionuclide not analyzed.

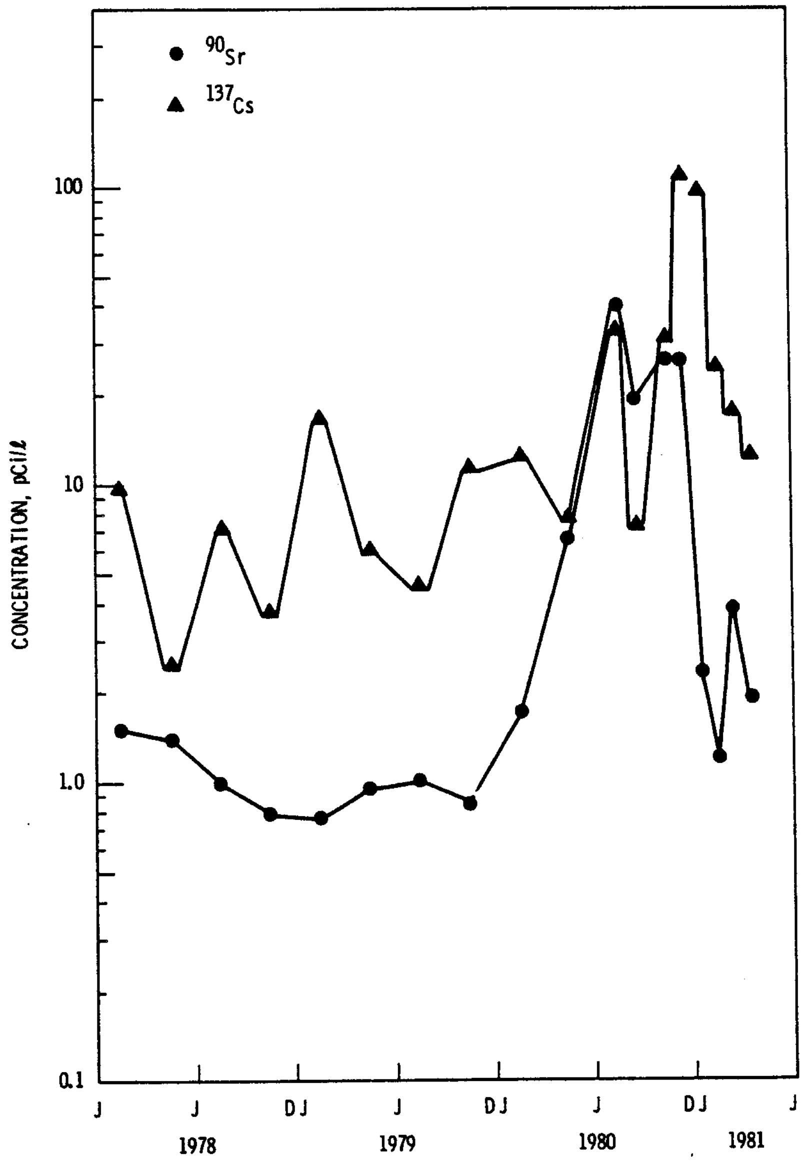

FIGURE 5. Strontium-90 and Cesium-137 Concentrations in B-Pond

WILDLIFE

The Hanford Site provides refuge for migratory and resident waterfowl, upland game birds, and a variety of mammals. These animals have access to contaminated onsite ponds (see previous section) and vegetation growing in and near the ponds. The ingestion of contaminated water or vegetation from the pond areas, or from any other contaminated area provides a mechanism for transfer of radionuclides away from the designated waste management areas. Additionally, for game animals, the ingestion of radioactive contamination represents a potential public exposure pathway.

Wildlife sampling provides an indication of the availability of contamination in the vicinity of the operating areas. Sampling was performed in and near operating areas to maximize the probability of collecting an animal with detectable levels of Hanford-produced radionuclides. The sampling program, therefore, provides an indication of radionuclide availability and, for game animals that may migrate offsite, an estimate of the potential maximum dose that could be received by a member of the public through ingestion of game.

Onsite wildlife sampled during 1980 include waterfowl (ducks, geese), upland game birds (quail, pheasant), deer, and rabbits. Results of samples collected during 1980 (except for rabbits) have also been discussed in the 1980 Hanford Environmental Surveillance Report (Sula and Blumer 1981).

DEER

Only deer that had been accidentally killed were collected for analysis. Ten deer were collected during 1980 (nine following collisions with vehicles on Site roads and one following an unsuccessful experimental capture) from the locations shown in Figure 6 (D-1 through D-6). Results of tissue-sample analyses are shown in Table 9.

Except for two samples, ^{90}Sr levels in deer bone were near minimum detectable concentration levels. The highest ^{90}Sr concentrations were measured in two deer (a doe and fawn) which had been grazing together. The observed ^{90}Sr concentrations in the two deer were similar to maximum concentrations reported in previous years.

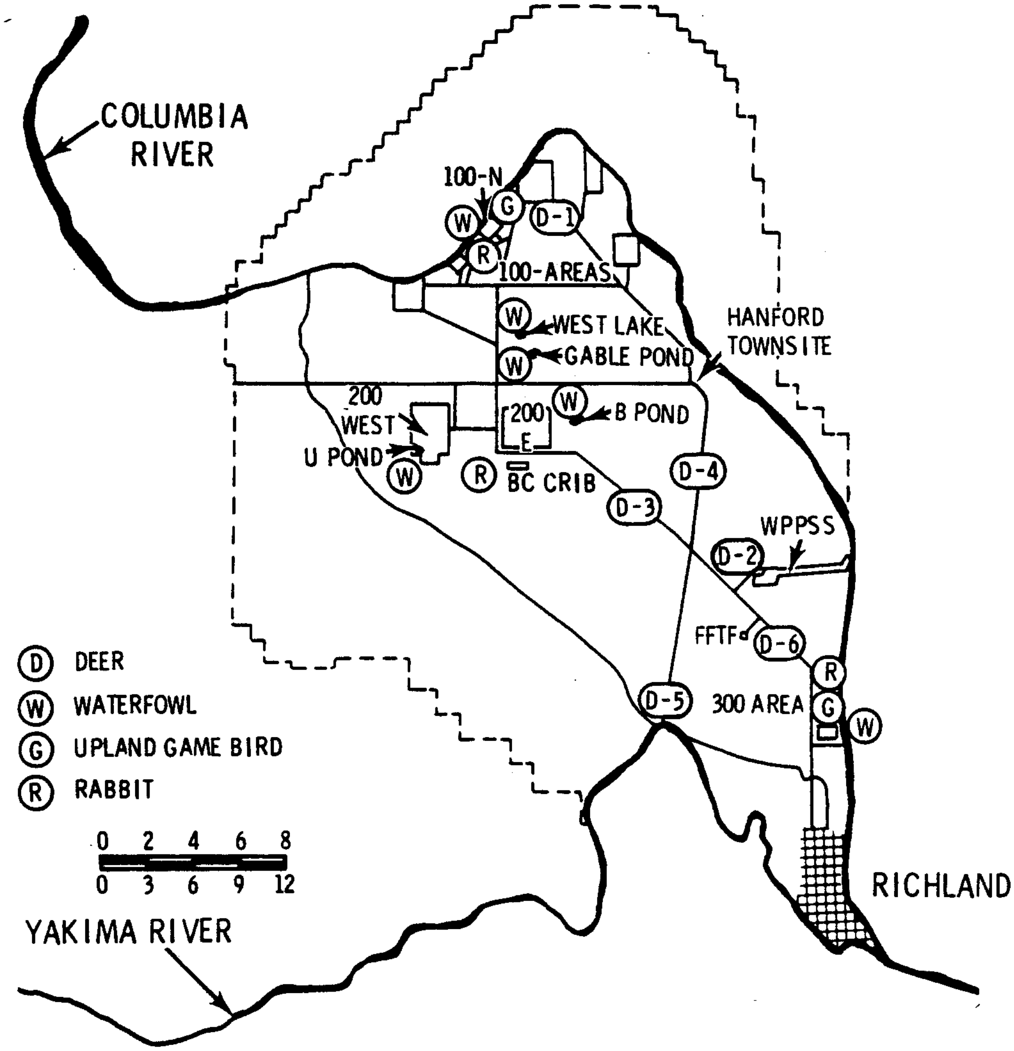

FIGURE 6. Onsite Wildlife Collection Locations During 1980

Cesium-137 concentrations were near the minimum detectable concentration levels and within the concentration range reported in recent previous years.

Because of problems encountered during the analysis of deer livers for plutonium, the analytical laboratory reported results for only five of the ten samples. Two of the five samples exhibited ^{239}Pu concentrations somewhat above the range observed in previous year's samples and one sample exhibited an apparently high ^{238}Pu concentration. Deer liver samples at Hanford have not previously been analyzed for ^{238}Pu.

TABLE 9. Radionuclide Concentrations in Hanford Deer - 1980

Location	Map Location	Date	Muscle ^{60}Co	Muscle ^{65}Zn	Muscle ^{137}Cs	Bone ^{90}Sr	Liver ^{238}Pu	Liver $^{239-240}Pu$
			Concentration pCi/g (10^{-6} μCi/g) wet weight					
100-D	D-1	6/5	0.02 ± 0.03	0.01 ± 0.03	0.005 ± 0.02	0.38 ± 0.15	-0.004 ± 0.002	0.002 ± 0.003
WPPSS	D-2	6/9	0.008 ± 0.02	-0.02 ± 0.03	-0.006 ± 0.01	0.92 ± 0.19	-0.004 ± 0.003	0.002 ± 0.004
		10/23	0.009 ± 0.009	0.03 ± 0.01	0.03 ± 0.006	0.16 ± 0.10	0.005 ± 0.004	0.07 ± 0.01
Rt 4S Mi 9	D-3	10/17	-0.003 ± 0.02	-0.01 ± 0.03	-0.003 ± 0.01	0.03 ± 0.23	0.16 ± 0.009	0.07 ± 0.006
		12/18	0.007 ± 0.02	-0.009 ± 0.03	-0.007 ± 0.01	0.48 ± 0.11		
Rt 2S Mi 5	D-4	10/21	0.04 ± 0.02	0.009 ± 0.02	0.02 ± 0.01			
Prosser Barricade	D-5	10/24	0.008 ± 0.01	0.03 ± 0.02	0.01 ± 0.008	0.0 ± 0.09		
Rt 4S Mi 19	D-6	10/30	0.00005 ± 0.01	0.03 ± 0.02	0.01 ± 0.008	2.1 ± 0.21	-0.00004 ± 0.003	0.02 ± 0.005
		10/30	0.006 ± 0.01	0.04 ± 0.02	0.01 ± 0.008	20 ± 0.12		
		12/3	0.02 ± 0.02	0.01 ± 0.04	0.005 ± 0.02	0.24 ± 0.11		

Note: Results include the two-sigma counting error.
No entry indicates the analysis was not successfully performed.

WATERFOWL

Ducks and geese were collected in the vicinity of the 100-N Area and at White Bluffs along the Columbia River. Ducks were also collected from each of four onsite ponds shown in Figure 6. A sample of muscle tissue taken from each bird was analyzed for gamma-emitting radionuclides. Results of these analyses are shown in Table 10. Samples taken from ducks and geese collected along the Columbia River showed low concentrations of ^{137}Cs attributable to worldwide fallout. However, samples from ducks collected at waste-water ponds near the 200 Areas showed an accumulation of ^{137}Cs in their tissues. The maximum concentration observed in a duck (210 pCi ^{137}Cs/g, wet weight at Gable Pond) was similar to that observed in other ducks collected from the waste-water ponds in recent years.

UPLAND GAME BIRDS

Upland game bird samples including pheasant and quail were collected on the Hanford Site during 1980. Two pheasants were collected near the old production-reactor sites and three quail samples (three bird composites) were collected, one each, from the 100, 200, and 300 Areas (see Figure 6). Samples of muscle tissue were analyzed for gamma-emitting radionuclides. Results of these analyses are shown in Table 10. Cesium-137 and naturally occurring ^{40}K were the only radionuclides observed in the samples. None of the ^{137}Cs concentrations exceeded levels that would be expected from worldwide fallout.

RABBITS

Rabbits were collected in the vicinity of operating areas, as shown in Figure 6. Analyses of rabbit samples included ^{90}Sr in bone and gamma-emitters (^{137}Cs) in muscle. Results are shown in Table 11. Cesium-137 was detected in only one of the five samples. The positive ^{137}Cs identification was near the minimum detectable concentration level and was generally lower than that observed in other rabbit samples during the past several years.

Strontium-90 was detected in all samples. The highest ^{90}Sr concentration (21 pCi/g) was observed in the rabbit collected from the 100-N Area.

TABLE 10. Radionuclide Concentrations in Game Birds - 1980

Location	Species	No. of Samples	Concentration, pCi/g, Wet Weight[b] Maximum[c]	Minimum[c]	Average
100 Areas	Pheasant	2			0.009 ± 0.08
100 Areas	Quail	1			0.003 ± 0.03
100-N Area (River)	Duck	3			0.02 ± 0.06
100-N Area (River)	Goose	2			0.008 ± 0.07
200 Areas	Quail	1			0.13 ± 0.02
U-Pond	Duck	1			52 ± 1.1
B-Pond	Duck	2	110 ± 2.0	0.03 ± 0.03	55 ± 157
West Lake	Duck	2	47 ± 0.37	0.007 ± 0.11	24 ± 66
Gable Pond	Duck	1			210 ± 5.3
300 Area	Quail	1			-0.007 ± 0.09
300 Area (River)	Duck	4	0.23 ± 0.04	0.02 ± 0.03	0.10 ± 0.20

(a) Based on gamma-spectrum analysis of 450 gram (1 lb) muscle samples. No other artificially produced radionuclides were identified in any of the samples.

(b) Individual results show the 2σ counting error. Averages show the 2σ confidence interval about the average based on the variance of the means as well as the counting error.

(c) Maximum and minimum values were not included when there was no positive identification of ^{137}Cs in any of the samples or if only one sample was collected.

TABLE 11. Radionuclide Concentrations in Rabbits - 1980

Vicinity of Sample	Date	Concentration, pCi/g (wet weight) ^{90}Sr (bone)	^{137}Cs (muscle)
100-N	1/29	21 ± 0.61	0.006 ± 0.16
200-Area (BC Crib)	7/7	2.7 ± 0.52	0.05 ± 0.03
300-Area	3/19	0.5 ± 0.25	-0.007 ± 0.08
	7/7	1.1 ± 0.61	-0.01 ± 0.02
	10/30	0.38 ± 0.15	0.0007 ± 0.12

Because only one other rabbit sample has been collected at 100-N Area during recent years (72 pCi/g ^{90}Sr in bone, 1979) little can be said regarding trends; however, ^{90}Sr levels in the 100-N Area rabbits collected in 1979 and 1980 represent the highest concentrations observed throughout the site for those two years. Evaluation of the current accessibility of ^{90}Sr at 100-N Area, based on available data, would be difficult because of the many variables contributing to the observed concentrations. Samples collected in 1979 and 1980 would appear to indicate that the availability of ^{90}Sr at 100-N Area is greater than at other operating areas.

SOIL AND VEGETATION

Soil and vegetation samples are collected annually for the purposes of establishing background concentrations of naturally occurring and fallout radioactivity and to assess any buildup of radioactivity from site operations. Samples were collected from seven onsite locations during 1980 as shown by map locations 1-7 in Figure 7. Each sample consisted of a composite of five "plugs" of soil collected within a 100 m^2 area designated as the sampling location. Each "plug" of soil was 2.5 cm deep and 10 cm in diameter.

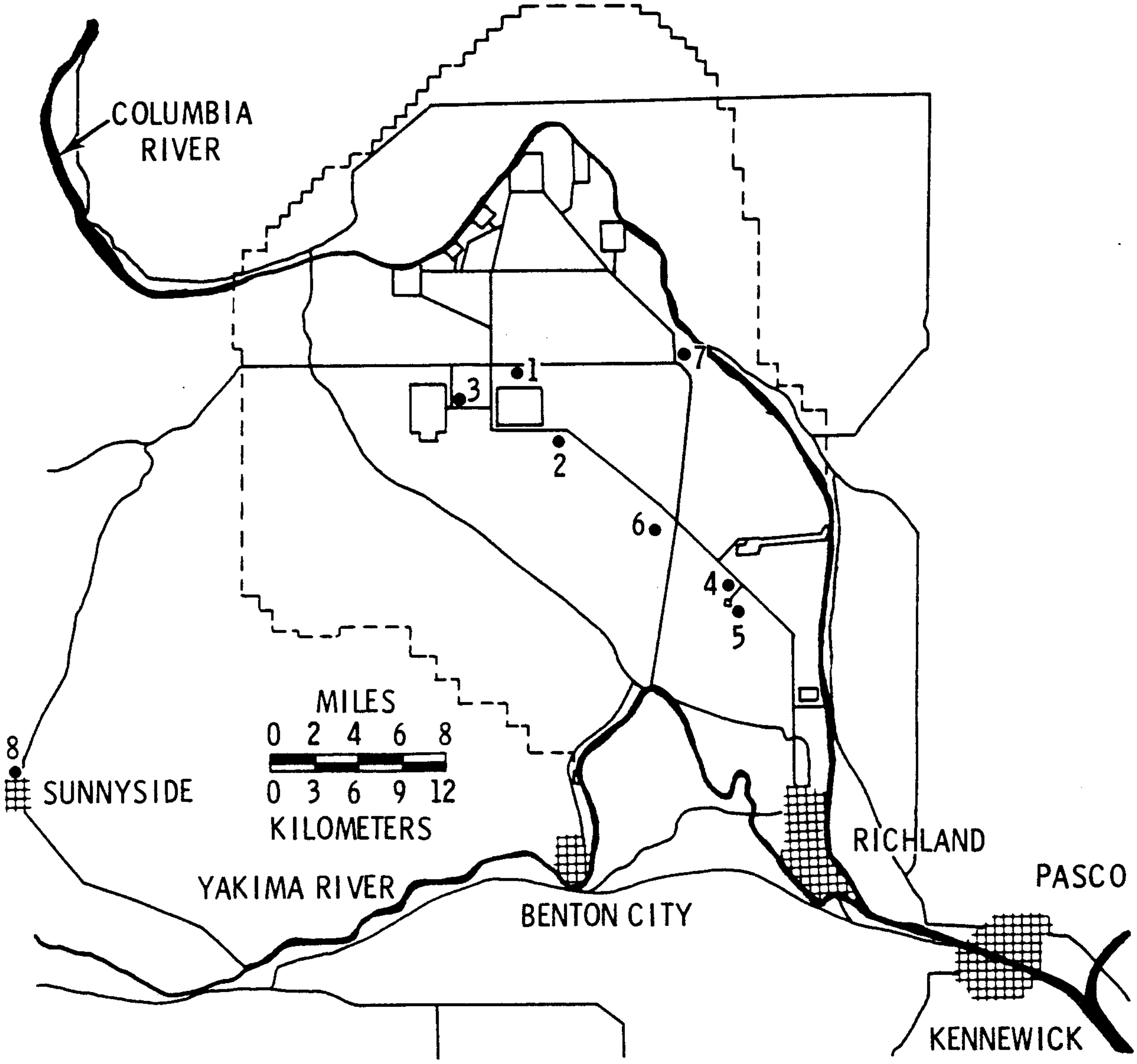

FIGURE 7. Onsite Soil and Vegetation Sampling Locations - 1980

Samples of perennial shrubs (rabbitbrush, sagebrush, and bitterbrush) were collected in the immediate vicinity of each soil sample location. Because no one type of perennial vegetation was abundant at every one of the sampling locations, each sample consisted of a mixture of the species present at the sample location in proportion to its relative abundance. Both the soil and vegetation samples were analyzed for gamma-emitting radionuclides, ^{90}Sr, plutonium, and uranium.

Tables 12 and 13 show the results of the soil and vegetation samples for 1980. For comparison, the tables include the results of samples collected during 1977-1980 at an offsite location (map number 8, Figure 7) representative of background concentrations.*

Soil radionuclide concentrations were, in general, similar to previous years with ^{90}Sr, ^{137}Cs, and plutonium continuing to be observed at concentrations above background in several of the samples. With the exception of locations near the FFTF facility (map number 4 and 5), ^{90}Sr and ^{137}Cs concentrations appeared elevated in all onsite samples. A range fire in 1970 that destroyed the cover vegetation in the FFTF area and exposed the surface soil to wind erosion may account for the lower concentrations observed in this area.

Plutonium concentrations in the onsite soil samples were similar to levels observed at the offsite locations except for the sample collected east of the 200 West Area (Location #3). Plutonium concentrations at this location have historically exceeded background levels (samples have been collected annually since 1975) and currently observed concentrations are not significantly different from those noted previously.

Results of plutonium analyses of vegetation samples were not reported by the analytical laboratory for several of the samples because of the inadvertent contamination of the samples during the analysis process. Results that were reported (Table 13) showed concentrations to be similar to that observed in previous years at the respective sampling locations. Only

---

* Soil and vegetation sample results for 1980 at offsite locations are reported by Sula and Blumer (1981).

TABLE 12. Radionuclide Concentrations in Onsite Soil Samples - 1980

Sample Location	Map Location	Concentration pCi/g, dry weight[a] ^{58}Co	^{60}Co	^{90}Sr	$^{95}ZrNb$	^{134}Cs	^{137}Cs	^{144}Ce	^{238}Pu	$^{239-240}Pu$	U-Total
200 ENC	1	0.05 ± 0.03	-0.0005 ± 0.02	0.70 ± 0.06	0.07 ± 0.05	0.03 ± 0.03	28 ± 0.44	0.43 ± 0.13	0.002 ± 0.0006	0.03 ± 0.002	0.27 ± 0.10
200 East Hill	2	0.006 ± 0.02	0.03 ± 0.02	0.29 ± 0.02	-0.01 ± 0.03	0.003 ± 0.02	1.2 ± 0.9	0.34 ± 0.11			0.29 ± 0.10
East of 200 West Area	3	-0.009 ± 0.02	0.007 ± 0.02	0.83 ± 0.01	0.01 ± 0.04	0.009 ± 0.02	4.8 ± 0.18	0.34 ± 0.12	0.01 ± 0.002	0.63 ± 0.02	0.62 ± 0.22
NE of FFTF	4	0.008 ± 0.02	0.03 ± 0.03	0.04 ± 0.01	0.01 ± 0.04	-0.01 ± 0.02	0.22 ± 0.04	0.28 ± 0.11	0.0003 ± 0.0009	0.004 ± 0.002	0.22 ± 0.08
SE of FFTF	5	0.03 ± 0.03	0.01 ± 0.02	0.09 ± 0.007	0.02 ± 0.04	0.04 ± 0.02	0.40 ± 0.05	0.40 ± 0.11	0.002 ± 0.001	0.007 ± 0.002	0.23 ± 0.08
Wye Barricade	6	0.01 ± 0.03	0.005 ± 0.03	0.23 ± 0.007	0.06 ± 0.05	0.02 ± 0.03	1.1 ± 0.10	0.28 ± 0.13	0.0009 ± 0.0009	0.01 ± 0.002	0.26 ± 0.09
Hanford Townsite	7	0.007 ± 0.03	0.007 ± 0.03	0.23 ± 0.007	-0.04 ± 0.05	-0.007 ± 0.02	1.7 ± 0.12	0.31 ± 0.15	0.006 ± 0.001	0.04 ± 0.003	0.28 ± 0.10
Offsite Location[b] (Sunnyside)	8	-0.01 ± 0.05	0.004 ± 0.35	0.12 ± 0.24	0.02 ± 0.07	0.03 ± 0.04	0.52 ± 0.53	0.36 ± 0.23	0.0008 ± 0.002	0.013 ± 0.02	0.37 ± 0.24

(a) Results include the ±2σ counting error. No entry indicates that the sample was not successfully analyzed.
(b) Offsite concentrations were based on 1977-1980 results from the Sunnyside sampling location. Errors shown are at the two-sigma level and include the variability of the observed means as well as the counting error

TABLE 13. Radionuclide Concentrations in Onsite Vegetation Samples - 1980

Sample Location	Map Location	Concentrations pCi/g, dry weight[a] ^{60}Co	^{90}Sr	$^{95}ZrNb$	^{137}Cs	^{144}Ce	^{238}Pu	$^{239-240}Pu$	U-Total
200 ENC	1	0.02 ± 0.17	0.07 ± 0.01	-0.09 ± 0.27	0.57 ± 0.23	0.29 ± 0.79			0.01 ± 0.01
200 East Hill	2	-0.05 ± 0.11	0.05 ± 0.01	0.07 ± 0.20	0.08 ± 0.12	-0.02 ± 0.54	0.007 ± 0.003	0.06 ± 0.008	0.005 ± 0.01
East of 200 West Area	3	0.17 ± 0.20	0.05 ± 0.01	-0.03 ± 0.26	-0.01 ± 0.15	-0.12 ± 0.84			0.004 ± 0.01
NE of FFTF	4	-0.01 ± 0.12	0.03 ± 0.01	0.0006 ± 0.20	0.11 ± 0.13	0.43 ± 0.60			0.01 ± 0.01
SE of FFTF	5	-0.02 ± 0.23	0.19 ± 0.05	0.11 ± 0.39	0.06 ± 0.23	-0.33 ± 1.2			0.01 ± 0.01
Wye Barricade	6	0.02 ± 0.16	0.03 ± 0.01	-0.009 ± 0.25	0.02 ± 0.15	0.21 ± 0.80	0.002 ± 0.0008	0.002 ± 0.0007	0.02 ± 0.01
Hanford Townsite	7	0.05 ± 0.12	0.12 ± 0.01	0.003 ± 0.18	0.32 ± 0.15	-0.01 ± 0.57			0.04 ± 0.20
Offsite Location[b] (Sunnyside)	8	0.03 ± 0.25	0.08 ± 0.10	0.13 ± 0.45	0.12 ± 0.19	0.38 ± 1.5	0.0027 ± 0.01	0.0023 ± 0.004	0.015 ± 0.02

(a) Results include the ±2σ counting error. No entry indicates that the analysis was not successfully performed.

(b) Offsite concentrations were based on 1977-1980 results from Sunnyside sampling location. Errors shown are at the two-sigma level based on the variability of the observed means as well as counting error

^{137}Cs at the 200 ENC location (map number 1) appeared elevated in comparison to the observed background concentrations. However, the 200 ENC location has historically shown elevated ^{137}Cs and ^{90}Sr concentrations.

EXTERNAL RADIATION MEASUREMENTS

Onsite external radiation measurements were made for each operating area and for the Inner East Sector at the locations shown in Figure 8. The measurements were made using thermoluminescent dosimeters (TLDs). The dosimeters consist of CaF_2:Mn chips encased in an opaque plastic capsule with appropriate filtration to flatten their response to low-energy radiations (Fix and Miller 1978). The dosimeters integrate the dose received during the duration of their four-week field cycle. The number of measurements obtained during a year is often below the scheduled number because of loss of the dosimeters to high winds, vandalism, etc.

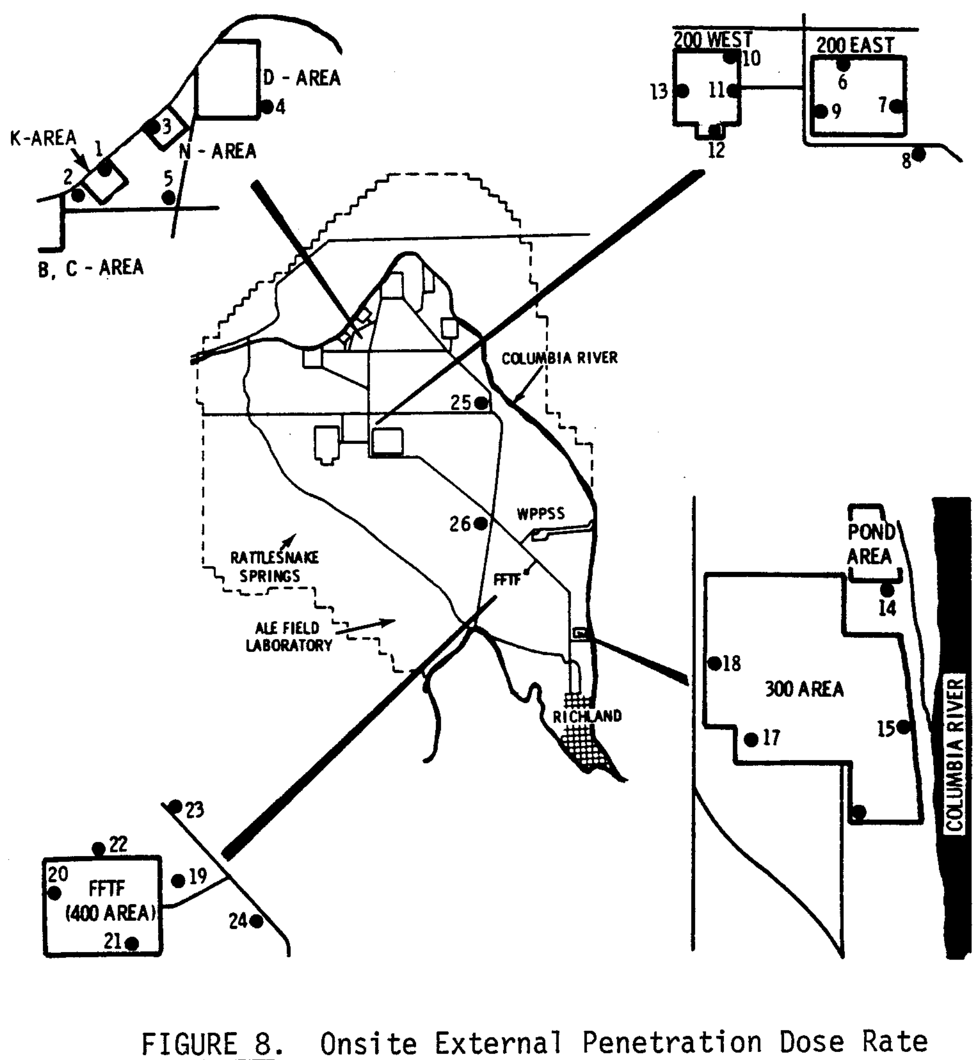

FIGURE 8. Onsite External Penetration Dose Rate Measurement Locations - 1980

The results of measurements taken onsite during 1980 are given in Table 14. All readings are expressed in units of mrem/yr to provide compatability with offsite external dose measurements reported in the Annual Environmental Surveillance Report (Sula and Blumer 1981, Table 14). For comparison, the 1980 average background dose rate, based on measurements recorded at dosimeter locations some distance from the site boundary was 69 ± 17 mrem/yr (Sula and Blumer 1981).

TABLE 14. Onsite External Penetrating Dose Measurements - 1980

Location		Map Location	No. of Measurements	Dose Rate, mrem/y Maximum	Minimum	Average
Operating Areas						
100 Area	100 K	1	10	77	62	68 ± 9
	Below 100-K Retention Basin	2	9	405	329	377 ± 49
	100 N	3	11	106	69	86 ± 21
	100 D	4	10	88	69	75 ± 11
	100 Area Fire Station	5	11	77	69	72 ± 6
200 East Area	200 ENC	6	10	164	139	151 ± 16
	200 EEC	7	10	95	80	87 ± 10
	200 ESE	8	10	84	69	77 ± 10
	200 EWC	9	11	77	66	72 ± 6
200 West Area	200 WNE	10	11	77	66	71 ± 8
	200 WEC	11	10	73	66	70 ± 6
	Redox	12	11	88	77	80 ± 7
	200 WWC	13	10	110	95	100 ± 11
300 Area	300 Pond	14	10	212	73	145 ± 119
	3614-A Bldg.	15	10	84	69	72 ± 9
	300 South Gate	16	11	80	66	71 ± 9
	300 SW Gate	17	11	88	66	73 ± 13
	3705 Bldg.	18	10	88	62	72 ± 14
400 Area	400 E	19	11	80	69	72 ± 8
	400 W	20	10	69	55	64 ± 9
	400 S	21	11	73	37	64 ± 19
	400 N	22	11	73	40	66 ± 19
	FFTF North	23	9	80	69	74 ± 8
	FFTF Southeast	24	9	77	69	71 ± 6
Inner East Sector	Hanford	25	9	77	58	70 ± 12
	Wye Barricade	26	9	77	66	71 ± 8

Except for the "Below 100-K Retention Basin" location, the 100 Area dosimeters appear to show no effect of their location (direction and distance) with respect to N Reactor. The "Below 100-K Retention Basin" location is directly above a known subsurface contamination deposit and does not represent radiation doses attributable to operating facilities.

The 200 Area dosimeters show dose rates above background, as expected, with the higher readings primarily due to direct radiation from nearby waste management facilities.

The 300 Area readings, normally near background, were consistent with past measurements, except for the "300 Pond location." The monthly dose rate measurements at the "300 Pond' location increased sharply during May 1980 in response to the temporary storage of a steam generator near the dosimeter location as shown in Figure 9. Dose rates in this area will remain above background until the steam generator is moved into an examination facility (currently under construction) in the 300 Area, sometime in 1981.

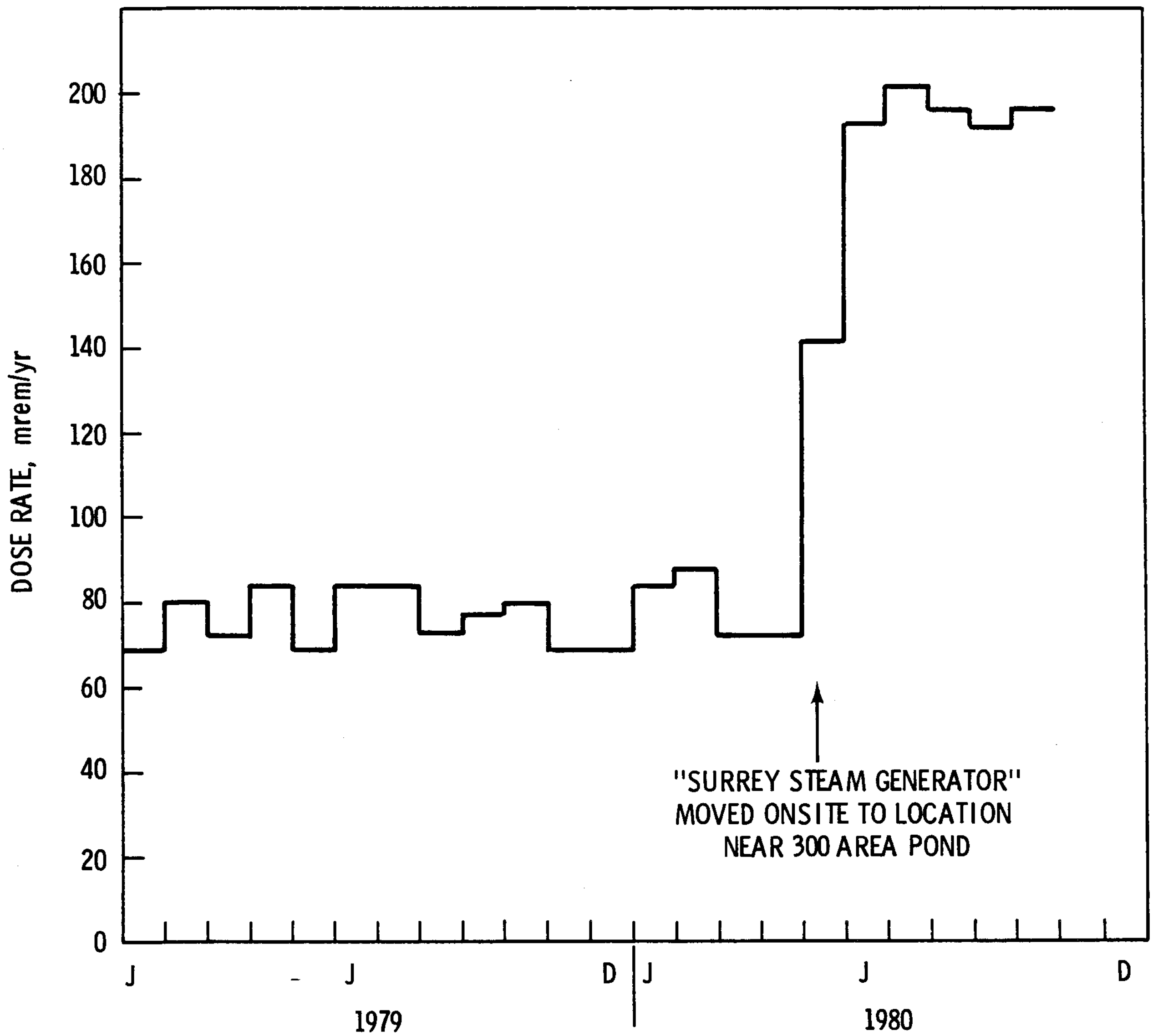

FIGURE 9. External Dose Measurements at the 300-Area Pond Location

RADIATION SURVEYS

Onsite environmental surveillance activities include periodic radiation surveys of site roads, railroads, and waste disposal sites outside of operating areas. In addition, an aerial survey is performed on an annual basis. Survey routes and frequencies for 1980 are provided in the surveillance program's Master Schedule (Blumer, Houston, and Eddy 1979).

ROAD SURVEYS

Roads on the Hanford Site were surveyed using a scintillation detector mounted on the right front end of a truck and positioned about 0.3 m above the road surface. The monitor has been described by Phillip and Sheen (1965). Roads surveyed during 1980 are shown in Figure 10. The surveys were conducted either monthly or quarterly, depending on their use and contamination potential. No instances of roadway contamination were observed during 1980.

RAILROAD SURVEYS

Site railroad tracks, shown in Figure 10, were surveyed on either a quarterly or annual frequency, depending on use and potential for contamination. The survey was performed using the road-monitor scintillation detector attached to a railroad maintenance car.

One instance of railroad track contamination requiring corrective action occurred during 1980. The incident involved spots of contamination in several places between 100-N and 100-K Area, probably caused by spillage from a "well car" used to transport spent N-Reactor fuel to storage facilities at 100-K Area. The incident was reported as an Unusual Occurrence (UNC, UO-80-28).

WASTE DISPOSAL SITES

Active, inactive, and retired waste-disposal sites outside of operating area perimeter fences are routinely surveyed for radioactivity and inspected for general physical condition. The survey schedule for 1980 is provided

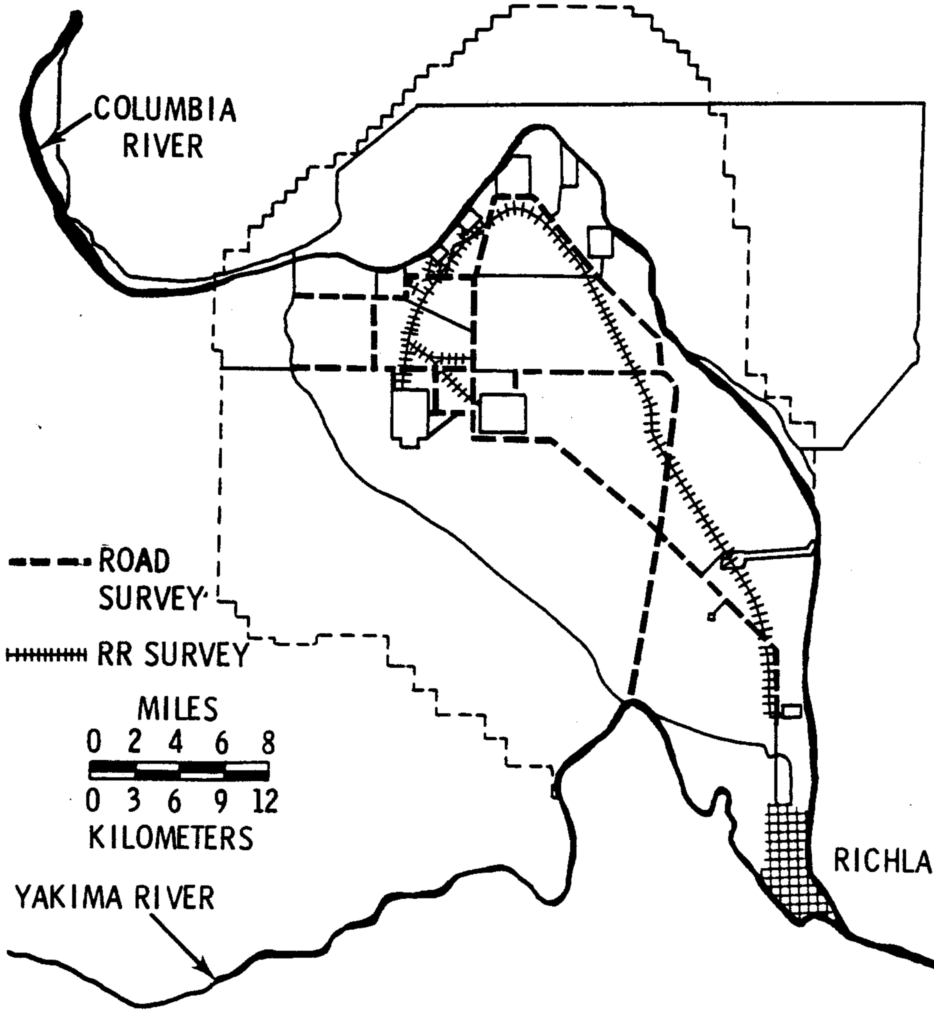

FIGURE 10. Road and Railroad Survey Routes - 1980

in the environmental surveillance program's Master Schedule (Blumer, Houston, and Eddy 1979). Most sites are surveyed semiannually. Changes in conditions at the sites noted during the surveys are reported to the responsible operating contractors. During 1980, no significant changes in burial ground status were observed.

AERIAL SURVEY

The perimeter of the Site is surveyed annually using a scintillation detector mounted in an airplane that is flown 500 ft above the ground at an indicated air speed of 120-130 mph. There was no indication of any radioactivity above background in 1980.

ENVIRONMENTAL RELEASES

Each operating contractor at Hanford is responsible for the control, disposal, monitoring, and reporting of wastes at their facilities. This section summarizes the disposal of wastes at Hanford during 1980, routine and unplanned, as reported by the applicable operating contractors. The section is divided into two parts: "Environmental Discharges" and "Environmentally Related Unusual Occurrences."

Information included under "Environmental Discharges" was obtained from the following sources:

Battelle-Northwest Laboratories - Radioactive discharges to the environment for 1980 are contained in the DOE Effluent Information System. Additional information, on nonradioactive effluents, was provided in an internal report.

Rockwell Hanford Operations - Radioactive and nonradioactivd discharges were reported in Radioactivity in Gaseous Waste Discharged from the Separation Facilities During 1980, RHO-CD-80-35-4Q, (Aldrich and Sliger 1981(b)); Radioactive Liquid Wastes Discharged to Ground in the 200 Areas During 1980, RHO-CD-80-34-4Q, (Aldrich and Sliger 1981(a)); Summary of Radioactive Solid Waste Burials in the 200 Areas During 1980, RHO-LD-80-24-4Q, (Anderson and Poremba 1981), and Effluent Controls Group Annual Report, CY-1980, RHO-CD-81-75, (RHO Effluent Controls Group 1981).

UNC Nuclear Industries - Radioactive and nonradioactive discharges from all operations at Hanford were reported in UNC Nuclear Industries Reactor and Fuels Production Facilities 1980 Effluent Release Report, UNI-1701, (Greager 1981).

Westinghouse Hanford Company - Radioactive discharges to the environment during 1980 are contained in the DOE Effluent Information System. Additional information, concerning nonradioactive discharges, were provided in an internal report.

The "Environmentally Related Unusual Occurrence" portion of this section is a compilation of unusual occurrences at Hanford during 1980 involving the release or the potential release of pollutants to the environment. The reporting of such occurrences is required by DOE in DOE 5484.1, Environmental Safety and Health Protection Information Reporting Requirements (1981). The unusual occurrence reports, of which only brief summaries are provided here, are maintained in the public reading room of the Hanford Science Center, located in the Federal Building, Richland, Washington.

ENVIRONMENTAL DISCHARGES

Environmental discharges are divided into three categories: airborne discharges, liquid effluents, and solid wastes.

Airborne Discharges - Radioactive and nonradioactive pollutants discharged to the atmosphere during 1980 are summarized in Tables 15 and 16. The tables are subdivided according to the major operation areas and include all releases reported by contractors in each of the areas. Radioactive materials discharged to the atmosphere consisted of fission and activation products normally associated with the uranium fuel cycle. Nonradioactive airborne releases consisted primarily of fossil-fueled steam plant emissions, oxides of nitrogen from various fuel-processing operations, and organic liquids disposed by evaporation. The 400 Area (FFTF) reported that there were no airborne discharges during 1980.

Liquid Discharges - Liquid wastes generated at Hanford are placed in storage facilities, converted to solids, or discharged either to ground disposal facilities (cribs, trenches, ponds, etc.) or to the Columbia River.

Radioactive and nonradioactive liquid wastes, discharged to the ground during 1980 are shown in Tables 17 and 18 respectively. The quantities shown are totals for all ground disposal facilities within the listed operating areas.

TABLE 15. Radioactive Airborne Discharges From DOE Facilities at Hanford During 1980

Radionuclide	Half-Life	Effluent (Ci) 100 Area	200 Area	300 Area
^{3}H	12.3 yr	14	---	---
^{24}Na	15.0 hr	0.36	---	---
^{41}Ar	1.8 hr	23,000	---	---
^{51}Cr	27.8 d	0.081	---	---
^{54}Mn	303 d	0.020	---	---
^{56}Mn	2.6 hr	3.4	---	---
^{59}Fe	46.0 d	0.037	---	---
^{58}Co	71.0 d	0.011	---	---
^{60}Co	5.3 yr	0.030	---	1.7×10^{-5}(a)
^{65}Zn	245 d	0.012	---	---
^{76}As	26.4 hr	0.38	---	---
^{85m}Kr	4.4 hr	150	---	---
^{87}Kr	76.0 min	500	---	---
$^{88}KrRb$	2.8 hr	370	---	---
^{89}Sr	52.7 d	0.033	---	---
^{90}Sr	27.7 yr	0.0023	0.23(b)	4.5×10^{-5}(c)
^{91}Sr	9.7 hr	1.7	---	---
^{95}Zr	65.5 d	0.0054	---	---
^{95}Nb	35.0 d	0.0057	---	---
$^{97}ZrNb$	17.0 hr	0.041	---	---
$^{99m}MoTc$	66.7 hr	0.53	---	---
^{103}Ru	39.5 d	0.012	---	---
^{106}Ru	368 d	0.025	---	---
^{122}Sb	2.8 d	0.022	---	---
^{124}Sb	60.4 d	0.0067	---	---
^{132}Te	77.7 hr	0.013	---	---
^{129}I	1.7×10^{7} yr	5.1×10^{-9}	---	---
^{131}I	8.1 d	0.21	---	6.7×10^{-4}
^{132}I	2.3 hr	9.5	---	---
^{133}I	20.3 hr	1.4	---	---
^{135}I	6.7 hr	7.1	---	---
^{135}Xe	9.1 hr	480	---	---
^{134}Cs	2.1 yr	0.0033	---	---
^{137}Cs	30.0 yr	0.0055	---	---
^{138}Cs	32.2 min	1,900	---	---
^{140}Ba	12.8 d	0.17	---	---
^{140}La	40.2 hr	0.31	---	---
^{141}Ce	32.5 d	0.0094	---	---
$^{144}CePr$	284 d	0.046	---	---
^{147}Nd	11.1 d	0.077	---	---
^{153}Sm	46.8 hr	0.023	---	---
^{154}Eu	16.0 yr	0.0021	---	---
^{155}Eu	1.8 yr	0.013	---	---
^{187}W	23.9 hr	0.13	---	---
Th nat	1.4×10^{10}	---	---	2.3×10^{-7}
U-nat	4.4×10^{9}	---	---	4.9×10^{-5}
^{239}Np	2.3 d	0.16	---	---
^{238}Pu	86.4 yr	2.5×10^{-6}	---	---
^{239}Pu	2.44×10^{4} yr	1.5×10^{-5}	0.0012(d)	2.7×10^{-5}(e)

(a) Reported as mixed activation products.

(b) Reported as total beta activity composed principally of ^{90}Sr.
(c) Reported as mixed fission products and unidentified beta-gamma activity.

(d) Reported as total alpha activity composed principally of ^{239}Pu.
(e) Reported as ^{239}Pu and unidentified alpha activity.

NOTE: --- Radionuclide not reported in effluent.

TABLE 16. Nonradioactive Airborne Discharges from DOE Facilities at Hanford During 1980

Constituent	Quantity Discharged, kg		
	100 Area	200 Area	300 Area
Particulates	3.3×10^4	4.7×10^6	1.8×10^4
Nitrogen Dioxides	1.2×10^5	5.0×10^5	1.8×10^5 (a)
Sulfur Dioxides	3.7×10^5	8.0×10^5	2.3×10^5
Carbon Monoxide	6.0×10^3	6.6×10^4	
Hydrocarbons	4.5×10^3	3.3×10^4	
Aldehydes	1.6×10^3		
Perchlorethylene			1.7×10^4 (b)
1,1,1-Trichoroethane			5.5×10^2 (b)

(a) Includes discharges reported by UNC and HEDL.
(b) Reported as quantity placed in an evaporation lugger.

TABLE 17. Radioactivity in Liquids Discharged to Ground Disposal Facilities at Hanford During 1980

Radionuclide	Total Undecayed Activity, Ci[a] 100 Areas	200 Area	300 Area
^{3}H	88	82	
^{32}P	15		
^{51}Cr	550		
^{54}Mn	81		
^{59}Fe	740		
^{58}Co	65		
^{60}Co	1,200	<0.0016	
^{65}Zn	16		
^{89}Sr	320		
^{90}Sr	160	6.4	
$^{95}ZrNb$	1,400		
$^{99m}MoTc$	690		
^{103}Ru	270		
^{106}Ru	320	<0.0073	
^{124}Sb	49		
^{131}I	230		
^{133}Xe	260		
^{134}Cs	55	0.25	
^{137}Cs	360	25	
$^{140}BaLa$	3,500		
^{141}Ce	380		
$^{144}CePr$	1,000	0.21	
^{154}Eu		.056	
^{155}Eu	28	.058	
Unidentified beta		76	0.02
Short-Lived radionuclide[b]	19,000		
^{234}U			0.09
^{235}U			0.004
^{238}U		<0.77[c]	0.088
^{241}Am		<0.057[d]	
^{238}Pu	0.35		
$^{239/240}Pu$	1.4		
Pu Total		24.0 grams	

(a) Activities based on influent measurements corrected to time of discharge. No adjustment was made for decay following discharge.
(b) Short lived radionuclides T1/2 <48h.
(c) Reported as <.225 X 10^{4} Kg.
(d) Reported as <.180 X 10^{-2} gram.

TABLE 18. Nonradioactive Liquid Discharges to the Ground at Hanford During 1980

Constituent	Quantity Discharged, kg (except as noted) 100 Area	200 Area	300 Area
Polyacrylamide	6.6×10^{2} (a)		
Sulfuric acid	5.5×10^{5} (a)		
Sodium hydroxide	3.0×10^{5} (a)		
Aluminum sulfate	2.0×10^{5} (b)		
Water treatment backwash		6.5×10^{3} m^3	
Zn			45
Hg			0.091
NO_3^-			1.8×10^{3}
Pb			2.3
Cd			0.91
Cu			20
F			120

(a) Reported as quantity consumed. Discharged to waste disposal pond (163-N/183-N facility).
(b) Reported as quantity consumed. The aluminum is sent to a waste disposal pond (163-N/183-N facility) and the sulfates are either discharged to the river or to the waste disposal pond.

Radioactive liquids discharged to the Columbia River during 1980 are listed in Table 19. The reported discharges are for liquid effluent systems in the 100-Areas, including seepage from the 100-N Area ground disposal facility. Not included in Table 19 are radionuclides (primarily tritium) discharged to the ground at the 200 Areas that have entered the river via the unconfined aquifer underlying the Hanford Site (Eddy and Wilbur 1981). The magnitude of this source has not been quantified; however, to date there have been no observable increases in river water radionuclide concentrations attributable to this source.

TABLE 19. Radioactive Liquid Discharges to the Columbia River from DOE Facilities at Hanford During 1980

Radionuclide	Half-Life	Discharge, Ci
^{3}H (HTO)	12.3 hr	88
^{32}P	14.3 d	0.27
^{51}Cr	27.8 d	0.20
^{54}Mn	303 d	0.13
^{56}Mn	2.6 hr	4.2
^{59}Fe	46.0 d	0.18
^{58}Co	71.0 d	0.033
^{60}Co	5.3 yr	0.76
^{89}Sr	52.7 d	0.94
^{90}Sr	27.7 yr	1.8
^{95}Zr	65.5 d	0.071
^{95}Nb	35.0 d	0.11
$^{99m}MoTc$	66.7 hr	0.39
^{103}Ru	39.5 d	0.59
^{106}Ru	368 d	0.65
^{124}Sb	60.4 d	0.10
^{125}Sb	2.7 yr	0.16
^{129}I	1.7×10^{7} yr	6.2×10^{-6}
^{131}I	8.1 d	2.1
^{133}I	20.3 hr	0.36
^{133}Xe	5.3 d	3.2
^{137}Cs	30.0 yr	0.040
^{140}Ba	12.8 d	0.33
^{140}La	40.2 hr	0.55
^{141}Ce	32.5 d	0.036
^{147}Nd	11.1 d	0.028
^{238}Pu	86.4 yr	3.5×10^{-4}
^{239}Pu	2.44×10^{4}yr	2.0×10^{-4}

Nonradioactive liquid effluents discharged to the Columbia River are monitored in compliance with discharge permits issued under the National Pollution Discharge Elimination System (NPDES). Monitoring required by the permits includes flow, temperature, pH, suspended and settleable solids, and oil and grease as appropriate for each specific discharge point. Of the seven NPDES discharge locations, permit limits were exceeded at only one location during 1980. The violation involved intermitant temperature excursions and was reported as Unusual Occurrence UNC UO-80-36, a brief summary of which is provided in the following part of this section. Chemical pollutants reported discharged to the river during 1980 included aluminum sulfate, hydrazine, and morpholine (Greager 1981).

Solid Wastes - Solid wastes are buried in trenches and landfills in or near the 200 Areas. Radioactive material in solid wastes include fission and activation products, uranium, and transuranics (primarily plutonium). Solid wastes containing ^{233}U or transuranics are packaged and buried separately from the nontransuranic wastes to make retrieval at a future date possible. Table 20 lists the quantities of radionuclides contained in solid waste burials during 1980 (Anderson and Poremba 1981). Also included are the quantities of general wastes, asbestos, waste chemicals and powerhouse wastes buried during 1980.

ENVIRONMENTAL RELATED UNUSUAL OCCURRENCES

Several unplanned releases of contaminants occurred during 1980 as a result of accidents or other unusual occurrences (equipment or instrumentation malfunctions, operator errors, or design inadequacies). The impact of the releases on the environment were negligible and, for the most part, confined to the immediate vicinity of the release. Formal occurrence reports were issued by the responsible contractor for each occurrence. A brief discussion of each occurrence is provided in the following summaries. The complete report may be found in the public reading room of the Hanford Science Center in Richland, Washington.

TABLE 20. Solid Wastes Buried at Hanford During 1980

Waste	Quantity
Radioactive	
Uranium	6.2×10^6 g
Plutonium	8.1×10^4 g
Other transuranics	6.7×10^3 g
Strontium-90	2.0×10^4 Ci
Ruthenium-106	1.7×10^4 Ci
Cesium-137	2.2×10^4 Ci
Other fission and activation products	3.8×10^5 Ci
General waste	6400 m^3
Asbestos	166 m^3
Waste chemicals	17 m^3
Flyash and boiler clinker waste	6500 metric tons

Airborne Effluents - Two accidental releases of contamination to the atmosphere occurred during 1980:

- PNL Occurrence Report No. 80-PNL 5, 5/15/80

  The plutonium concentrations in the 321-Z Building E-4 exhaust stream exceeded applicable release guides. The integrity of the HEPA filtration system was good. The source of the contamination was believed to have been from ductwork downstream of the filters.

- RHO Occurrence Report No. 80-70, 7/24/80

  Beta-gamma alarm levels on the 242-A Vessel vent stack were exceeded. It was determined that Table I release levels were not violated; however, the 3.9×10^{-9} μCi/cc concentration exceeded the normal levels. The cause of the release was a dried liquid seal-loop which allowed contamination to enter the exhaust system downstream of the High Efficiency Particulate Adsorber

(HEPA) filters. The loop seal was filled and a weekly seal level check was initiated to prevent a recurrence.

Liquid Effluents - Seven occurrences involving liquid wastes occurred during 1980:

- UNC Occurrence Report No. 80-06, 2/19/80

  Approximately one-curie of beta-gamma contamination was released to the ground at 100-N Area from a leak in a primary-coolant-line drain valve. The valve was repaired. No contamination was observed during a followup survey along the N-Area river shoreline. Contaminated soil was removed to the 200 Area for disposal.

- RHO Occurrence Report No. 80-30, 3/7/80

  Approximately 200 gallons of fuel oil were inadvertently spilled on the ground while a storage tank was being filled. The cause was a faulty gauge which indicated less fuel in the tank than there actually was. Fifteen cubic yards of fuel-soaked earth were removed to the 200 Area for disposal.

- RHO Occurrence Report No. 80-41, 3/25/80

  A leaking flange connection on a condensate catch tank resulted in the contamination of soil around the connection. The flange was repaired and the contaminated soil was removed and taken to the 200 Area waste burial ground.

- RHO Occurrence Report No. 80-80, 7/23/80

  Approximately two gallons of radioactive liquid were spilled on the ground during the transfer of a contaminated pump. The area involved was within an established radiation zone. All the contaminated soil was removed, bagged, and taken to the 200 Area waste burial ground.

- UNC Occurrence Report No. 80-35, 10/3/80 and 10/22/80

  Approximately 5800 gallons of neutralized acid was inadvertently discharged into a potentially leaky solar-evaporation basin. The basin was not authorized for use. Ground-water monitoring in the vicinity of the basin was immediately increased, and as of yet, there has been no indication of leakage.

- UNC Occurrence Report No. 80-36, 10/21-30/80

  A total of 32 temperature violations of the Hanford NPDES Permit at N Reactor occurred between October 21 and 30. The elevated temperatures were attributed to the discharge of condensate from the medium pressure steam system. N Reactor was not in operation at the time. Dilution of the steam condensate with water from the cold filtered water storage tank lowered the temperature to within limits. No significant impact was observed and no detectable increases in river temperature were seen downstream of N Reactor at Richland.

- RHO Occurrence Report No. 80-101, 12/8/80

  The 242-Z Annex was flooded when a fire-system water line froze and then broke resulting in the spread of contamination outside the annex. The contaminated soil was removed and antifreeze was added to the fire water system to prevent a recurrence.

Solid Wastes - Three occurrences during 1980 involved contaminated solid wastes:

- UNC Occurrence Report No. 80-03, 1/25/80

  Several small specks of radioactive material were found in the vicinity of the 100-N entrance gate. The specks were most likely transported by foot traffic from the 100-N fuel storage basin. Followup surveys of the area after removal of the original specks have not revealed any additional contamination.

- PNL Occurrence Report No. 80-PNL 4, 5/29/80

  Low-level beta-gamma contamination was discovered, unexpectedly, during the removal of an earthen berm near the 305-B facility. All of the contaminated material was removed and taken to the 200 Area for burial.

- UNC Occurrence Report No. 80-28, 8/18-25/80

Contamination was discovered on a section of track just outside the 100-K Area during a routine survey. Followup surveys revealed several additional small specks along the tracks inside the K Area and near the WPPSS gate inside N-Area. The source of the specks was believed to have been contamination jarred loose from a well car used for transporting radioactive liquids. Areas of contamination were either cleaned up or posted as radiation zones. Additional surveys have shown no further contamination.

REFERENCES

Aldrich, R. C., and G. J. Sliger. 1981(a). Radioactive Liquid Wastes Discharged to Ground in the 200 Areas During 1980. RHO-CD-80-34-4Q, Rockwell Hanford Operations, Richland, Washington.

Aldrich, R. C., and G. J. Sliger. 1981(b). Radioactivity in Gaseous Waste Discharged from the Separations Facilities During 1980. RHO-CD-80-35-4Q, Rockwell Hanford Operations, Richland, Washington.

Anderson, J. D., and B. E. Poremba. 1981. Summary of Radioactive Solid Waste Burials in the 200 Areas During 1980. RHO-LD-80-24-4Q, Rockwell Hanford Operations, Richland, Washington.

Blumer, P. J., J. R. Houston, and P. A. Eddy. 1979. Master Schedule for CY-1980 Hanford Environmental Surveillance Routine Programs. PNL-3222, Pacific Northwest Laboratory, Richland, Washington.

Eddy, P. A., and J. S. Wilbur. 1981. Environmental Monitoring Report on the Status of Ground Water Beneath the Hanford Site January-December 1980. PNL-3768, Pacific Northwest Laboratory, Richland, Washington.

Fix, J. J., and M. L. Miller. 1978. The Hanford Environmental CaF_2:Mn Thermoluminescent Dosimeter. PNL-2389, Pacific Northwest Laboratory, Richland, Washington.

Gephart, R. E., et al. 1976. Geohydrologic Study of the West Lake Basin. ARH-CD-775, Atlantic Richfield Hanford Company, Richland, Washington.

Greager, E. M. 1981. UNC Nuclear Industries Reactor and Fuels Production Facilities 1980 Effluent Release Report. UNI-1701, UNC Nuclear Industries, Inc., Richland, Washington.

Houston, J. R., and P. J. Blumer. 1980. Environmental Status of the Hanford Site for 1979. PNL-3284, Pacific Northwest Laboratory, Richland, Washington.

Philipp, L. D., and E. M. Sheen. 1965. Aerial and Ground Gamma Survey Monitors. BNWL-62, Pacific Northwest Laboratory, Richland, Washington.

Rockwell Hanford Operations Effluent Control Group. 1981. Effluent Controls Group Annual Report CY-1980. RHO-CD-81-75, Rockwell Hanford Operations, Richland, Washington.

Sula, M. J., and P. J. Blumer. 1981. Environmental Surveillance at Hanford for CY-1980. PNL-3728, Pacific Northwest Laboratory, Richland, Washington.

USDOE. 1981. "Requirements for Radiation Protection." In DOE 5480.1. Chapter XI, U.S. Department of Energy, Washington, D.C.

USDOE. 1981. Environmental Protection, Safety, and Health Protection Information Reporting Requirements. DOE 5484.1, U.S. Department of Energy, Washington, D.C.

U.S. Energy Research and Development Administration (USERDA). 1975. Final Environmental Statement, Waste Management Operations, Hanford Reservation. ERDA-1538, U.S. Department of Energy, Washington, D.C.

APPENDIX A

ANALYTICAL PROCEDURES

APPENDIX A

ANALYTICAL PROCEDURES

AIR SAMPLES

All routine envirnomental surveillance samples are analyzed according to detailed, written analytical procedures which are described in general terms below. Minimum detectable concentrations for the various media/analysis combination are shown in Table A.1.

Alpha-, Beta-, and Gamma-Emitting Radionuclides are measured by a direct count of the asbestos paper filter; alpha on a low background gas flow proportional counter, beta on a gas flow proportional counter, and gamma on a 23-cm x 23-cm (9-in. x 9-in.) NaI (Tl) well detector with a multichannel gamma-ray spectrometer.

Strontium-89, 90 are collected on filter paper and determined by leaching the filters with nitric acid, precipitating with fuming nitric acid, scavenging with barium chromate, precipitating as a carbonate, transferring to a stainless steel planchet, and counting with a gas flow proportional counter.

Plutonium is leached from the filter paper with fuming nitric acid and passed through an anion exchange resin. The resin column is eluted with 0.4 N HNO_3 - 0.01 N HF and the plutonium in the eluate is electrodeposited on a stainless steel disk, exposed to nuclear track film, and then counted.

Tritium in air as HTO is determined by collecting the water vapor with silica gel. The water vapor is removed by heat and vacuum and collected in a freeze trap. The tritium content of the water vapor is determined with a liquid scintillation spectrometer.

Iodine-131 is collected on activated charcoal which is then counted in the well of a 23-cm x 23-cm (9-in. x 9-in.) NaI (Tl) well detector.

WATER SAMPLES

Beta-Emitting Radionuclides are measured by a direct count of dried residue.

Uranium and Plutonium (Total Alpha) are extracted into ether from strong nitric acid. The ether phase is evaporated off and the residue plated on a stainless steel planchet and counted with a low-background gas-flow proportional counter.

Gamma-Emitting Radionuclides are determined by a direct count of 500 ml of sample in the well of a 23-cm x 23-cm (9-in. x 9-in.) NaI (Tl) well detector with a multichannel gamma-ray spectrometer.

Strontium-90 in large-volume water samples is precipitated with fuming nitric acid, scavenged with barium chromate, precipitated as a carbonate, transferred to a stainless steel planchet, and beta-counted with a low-level beta proportional counter. After a 15-day period the yttrium-90 daughter is separated and counted with a low-level beta proportional counter.

Tritium is measured in distilled water samples with a liquid scintillation spectrometer.

Filter-Resin Samples are analyzed for gamma-emitting radionuclides using a GeLi detector with a multichannel gamma-ray spectrometer. Aliquots of the samples are analyzed by neutron activation analysis for ^{129}I and by chemical separation and alpha spectrometric means for plutonium.

VEGETATION

Uranium, Plutonium, Strontium, and Gamma-Emitting Radionuclides are determined using the procedures described for air samples.

SOIL

Gamma-Emitting Radionuclides are analyzed by placing approximately 500 grams of sample into a marinelli beaker and counting on a lithium-drifted germanium detector, with a multichannel pulse height analyzer.

Plutonium and Strontium-90 are measured when the soil is dried, mixed thoroughly, leached with a mixture of nitric and hydrochloric acids, and then passed through an ion exchange resin in 8 N nitric acid.

The nitric acid retains strontium and other metal ions. This phase is precipitated with fuming nitric acid, scavenged with barium chromate, precipitated as a carbonate, and transferred to a stainless steel planchet. The ^{90}Sr sample is counted with a low-background beta proportional counter.

The plutonium is eluted from the resin column with 0.4 N HNO_3 - 0.01 N HF and electrodeposited on a stainless steel disk for alpha spectrometric analyses.

TABLE A.1. Minimum Detectable Concentrations (MDC)[(a)]

Radionuclide	Air: Minimum Sample Size (m^3)	Air: MDC (pCi/m^3)	Water: Minimum Sample Size (liters)	Water: MDC (pCi/ℓ)	Water (Resin Sampler): Minimum Sample Size (liters)	Water (Resin Sampler): MDC (pCi/ℓ)	Foodstuff & Wildlife: Minimum Sample Size (kg)	Foodstuff & Wildlife: MDC (pCi/kg)	Soil & Vegetation: Minimum Sample Size (kg)	Soil & Vegetation: MDC (pCi/kg)
^{3}H	5 mℓ (condensate)	300 pCi/ℓ (condensate)	1	500			0.02	3500		
^{89}Sr	1500	0.06	10	0.6			0.5	5		
^{90}Sr	1500	0.006	10	0.06			0.5	2	0.5	5
^{99}Tc			1	20						
^{106}Ru			1	5						
^{129}I					1000	0.0001				
^{131}I	1500	0.01	1	4	1000	0.1	4ℓ (milk)	0.5 (pCi/ℓ)		
^{226}Ra			10	0.06						
^{228}Ra			10	0.06						
U-nat			0.01	0.5					0.5	10
^{238}Pu			10	0.01					0.5	0.6
$^{239,240}Pu$			10	0.01					0.5	0.6
Pu-total	1500	0.0001								
Gamma-Emitters	1500	0.1[(b)]	5	8[(b)]	1000	0.1[(b)]	0.5	5[(b)]	0.5	20 Soil, 30 Veg.
Gross Alpha	800	0.001	1	5						
Gross Beta	800	0.01	1	10						

(a) Contractually established MDCs based on the minimum sample size shown. Lower MDCs are usually obtained in actual practice.

(b) Based on ^{137}Cs minimum detectable concentration. When present individually, other gamma emitting radionuclides will have a MDC commensurate with its photon yield and energy as related to ^{137}Cs.

APPENDIX B

DATA ANALYSIS

APPENDIX B

DATA ANALYSIS

Most data summary tables in this report show maximum, minimum and average concentration values for various radionuclide-media-location combinations. The words maximum and minimum refer to the largest and smallest concentrations found in a single sample during the year. Average values are usually accompanied by a plus or minus (±) value. This value indicates the 95% confidence range for the primary value (i.e., two times the total standard deviation of the sample distribution), and is derived by taking the square root of the mean square error (MSE). The MSE is calculated by adding the variability between the observed individual sample results (Eq. 2) to the mean sample variability contributed by measurement or counting errors as shown in Equation 4. The relative magnitude of the MSE is indicative of the precision of the combined sample mean. When an average is shown for groups of locations, this value has also been computed from the individual results; and the plus or minus value accompanying it is also twice the square root of its MSE. Where individual samples are reported (e.g., maximum and minimum concentrations) no estimates of sample variability can be made, so only the individual 2σ counting error estimates are provided.

The means, variances, standard deviations and error mean square estimates shown in this report were calculated using the following equations.

$$\bar{x} = \frac{1}{n} \sum_{i-1}^{n} x_i \qquad (1)$$

where x = arithmetic average, or mean
n = number of samples analyzed
X_i = individual sample results

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

where: σ^2 = variance
n = number of samples analyzed
x_i = individual sample results
x = arithmetic mean

$$\sigma = \sqrt{\sigma^2} \qquad (3)$$

where: σ = standard deviation
σ^2 = variance

$$MSE = \frac{\sum_{i=1}^{n} \sigma^2_{i(CE)} + \sigma^2_{(samples)}}{n} \qquad (4)$$

where:

MSE = mean square error

$\sigma^2_{i(CE)}$ = variance of individual counting error estimates

$\sigma^2_{(samples)}$ = variance between individual results

n = number of samples taken

$$TSD_x = \quad MSE \qquad (5)$$

where
TSD_x = Total standard deviation of a mean (x)

MSE = Mean square error.

For many sample analyses, it is possible to obtain net values that are lower than the detection limit of the system. This is particularly true when an instrument or chemical background must be subtracted. It is not uncommon for individual measurements to result in negative numbers because of statistical fluctuations. In fact, an approximately equal number of net positive and negative results is expected when many measurements of a true zero sample are taken. Although negative values do not represent a physical reality, they must be included along with the other values when computing the correct average for the population. For this reason the primary values given in this report are the actual values obtained from individual measurements.

Environmental data have been found to be better described by a Gaussian distribution function of the logarithms of the data than by the data itself (Speer and Waite 1975). Therefore, log-normal probability plots have been freely used throughout the report as analytical tools and graphic presentation of the data. Log-normal probability plotting produces a straight line plot if the data are log-normally distributed and result from a single source such as worldwide fallout. If the data describe two connecting straight lines or if data points at high cumulative probability fall significantly above a single straight line, more than one source may be contributing to the observed values.

Speer, D. R., and D. A. Waite. 1975. Statistical Distributions as Applied to Environmental Surveillance Data. BNWL-SA-5482, Pacific Northwest Laboratory, Richlans, Washington.

DISTRIBUTION

No. of Copies	
OFFSITE	
1	A. A. Churm DOE Patent Division 2900 South Cass Avenue Argonne, IL 60439
27	DOE Technical Information Center
ONSITE	
12	DOE Richland Operations Office
	R. E. Austin D. R. Elle (6) O. J. Elgert L. F. Perkins H. E. Ransom J. L. Rhoades M. W. Tiernan
7	Rockwell Hanford Operations
	G. F. Boothe G. L. Hanson P. G. Lorenzini T. J. McLaughlin D. L. Uhl R. E. Wheeler RHO Files
1	Hanford Environmental Health Foundation
	R. D. Gilmore
4	UNC Nuclear Industries, Inc.
	P. A. Carlson J. J. Dorian E. M. Greager UNI Files

No. of Copies	
3	Westinghouse Hanford Co.
	G. D. Carpenter R. B. Hall J. M. McCarthy
67	Pacific Northwest Laboratory
	G. E. Backman P. J. Blumer P. E. Bramson (2) C. S. Cline J. P. Corley R. L. Dirkes P. A. Eddy J. R. Eliason J. J. Fuquay J. J. Jech H. V. Larson W. D. McCormack K. R. Price M. R. Quarders (6) L. L. Rader (2) C. R. Richey W. H. Rickard G. A. Sehmel J. M. Selby J. K. Soldat D. J. Sommer M. J. Sula (32) C. M. Unruh D. G. Watson Technical Information (5) Publishing Coordination RO (2)