BNWL-B-278

ENVIRONMENTAL STATUS OF THE HANFORD RESERVATION FOR CY-1972

P. E. Bramson, J. P. Corley and W. L. Nees

Battelle
Pacific Northwest Laboratories
Richland, Washington 99352

SEPTEMBER 1973

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Occupational and Environmental Safety Department

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NOTICE

This document contains data obtained within the Hanford reservation for the use of the Atomic Energy Commission and its contractors. It does not provide the evaluation of exposure for the off-site population, which is documented separately.

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ENVIRONMENTAL STATUS OF THE HANFORD RESERVATION FOR 1972

I. INTRODUCTION

This report summarizes data collected during 1972 from locations within the Hanford plant boundaries (but generally outside areas under the control of individual contractors) for the environmental surveillance program, under the direction of the Environmental Evaluations staff. These environmental data are reported here for the information of the Richland Operations Office of the Atomic Energy Commission and its contractors.

The previous report in this series is BNWL-B-228, "Environmental Status of the Hanford Reservation for 1971." Graphs in this report show 14 months of data---the subject 12 months and the preceding two. Groundwater data are not included in this report but are presented most recently in BNWL-1737[1] and BNWL-1752.[2] Data from off-site sampling locations for 1972 are given in BNWL-1727.[3] Some data from off-site locations are included in this report for comparison with similar measurements made on-site.

The majority of radiochemical analyses presented in this report were performed by the U.S. Testing Company, Inc., on samples collected by Battelle-Northwest. The term "analytical limit," as used herein, is the concentration at which the laboratory can measure a radionuclide with a precision of ± 100 percent at the 90 percent confidence level. The detection limit for a specific radionuclide varies with sample type, sample size, counting time, and the amounts of interfering radionuclides present. The "analytical limits" represent upper bounds to these fluctuating detection limits.

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(1) K.L. Kipp, Radiological Status of the Groundwater Beneath the Hanford Project, January-June 1972, BNWL-1737, Battelle-Northwest Laboratories.

(2) K.L. Kipp, Radiological Status of the Groundwater Beneath the Hanford Project, July-December 1972, BNWL-1752, Battelle-Northwest Laboratories.

(3) P.E. Bramson and J.P. Corley, Environmental Surveillance at Hanford for CY-1972, BNWL-1727, with Addendum, BNWL-1727 ADD, Battelle-Northwest Laboratories, April, 1973.

II. SURVEILLANCE HIGHLIGHTS

Columbia River Water

The 100-KE Reactor was shut down in January, 1971, leaving 100-N Reactor as the only remaining plutonium-producing reactor, and no reactors using river water for once-through primary cooling. Some low-level radioactive wastes continued to be discharged to the ground and to the river during the year.

Measured concentrations of Sr-90 and total alpha activity in river water averaged, respectively, 5×10^{-10} and 5.4×10^{-10} μCi/ml at Vernita and 3.5×10^{-10} and 6.7×10^{-10} μCi/ml at Richland during the year. Tritium concentrations averaged 10^{-7} μCi/ml at Vernita and 10^{-7} μCi/ml at Richland.

The estimated annual GI tract dose for employees drinking 100-N water was 1.6 mrem, a decrease of about a factor of 2 from 1971. Radionuclide concentrations in drinking water at 100-H were measured during occupancy by non-AEC contractor personnel. GI tract dose was estimated at 3.2 mrem for 1972. Average concentrations of coliform bacteria in Columbia River water were slightly higher than 1971 averages but the increase was not attributed to Hanford operations. These and other water quality measurements---pH, turbidity and dissolved oxygen---indicated continued compliance with Washington State Water Quality Standards.

Swamps, Ditches, and Ponds

Radionuclide concentrations in samples collected from open waters on the Hanford project during 1972 were, in general, within their expected range of variation and were well below the plant working limit of 5×10^{-5} μCi/ml. The source of uranium alpha activity in excess of 10^{-7} μCi/ml in Honey Hill Pond was not identified.

Concentrations of radionuclides in gamebirds and mammals sampled on or near Hanford swamps and ponds were generally below levels recorded in 1971.

Results of radiological, chemical, and biological analyses of samples collected from 300-Area ponds and trenches were generally within the expected range. Coliform and enterococci concentrations in the

II. SURVEILLANCE HIGHLIGHTS (Continued)

Swamps, Ditches, and Ponds (Continued)

300 Area leach trench were somewhat higher than for 1971, and this was reflected in higher concentrations in the river shoreline seepage area.

Airborne Radioactivity

Concentrations of I-131 in the atmosphere, measured in charcoal samplers were below 2×10^{-14} μCi/ml. The maximum sample concentration measured during this reporting period was 10^{-14} μCi/ml, noted in May at the 300 Area.

At most locations, both on-site and off-site, the average total beta activity was similar to 1971 except that no pronounced summer peaking was observed. The maximum measured beta activity, 3×10^{-11} μCi/ml, occurred in October at a 200-East Area location. Annual average activity ranged from 10^{-13} to 2×10^{-13} μCi/ml and 2×10^{-13} to 3×10^{-13} μCi/ml in the 100 and 200 Areas, respectively. Off-site beta activity ranged from 10^{-13} to 3×10^{-13} μCi/ml and averaged about 2×10^{-13} μCi/ml.

Total alpha concentrations in air during 1972 averaged about 2×10^{-15} μCi/ml at most locations. Analyses of composite samples all showed less than 10^{-16} μCi/ml plutonium.

Soil and Vegetation

Plutonium concentrations in soil and vegetation at perimeter sampling locations were lower than in 1971, but probably typical of general levels for the arid western states. Relatively higher plutonium concentrations were detected at several sampling sites near the 200 Areas. Zirconium-Niobium-95 and Cesium-137 were present in on-site soil and vegetation samples from near the 200 Areas at higher concentrations than at perimeter sites. Concentrations of gamma-emitting radionuclides and Strontium-90 at perimeter sites are believed to be the result of regional fallout.

II. SURVEILLANCE HIGHLIGHTS (Continued)

Radiation Surveys

A few radioactive particles were found on Hanford roadways twice during the monthly road surveys. The most active was a particle reading 30,000 c/m. The annual railroad survey revealed one contaminated spot. The recovered soil read 7.5 rads/hr. Primary radionuclides were ^{90}Sr-Y and ^{144}Ce-Pr. Occurrences were attributed to waste hauling operations.

The only radioactivity found on the control plots in 1972 was fallout from a Chinese weapons test and a discarded luminous clock face, not of Hanford origin. Nothing was found that could be attributed to the Hanford operations.

The waste disposal sites audited were generally in good condition except for a piece of contaminated material found outside the 300 West disposal site.

There was a slight upturn in the external exposure rates at most locations this year. The maximum average exposure rate noted was 1.8 mR/day at 200-East Area. On the basis of exposure rate measurements off-site and at 100-N, the whole-body dose to WPPSS personnel from Hanford sources of external radiation at 100-N during 1972 was estimated to be 5 mrem.

III. COLUMBIA RIVER WATER

Columbia River water sampled upstream of the Hanford project at Vernita is analyzed for comparison with samples collected downstream of the project at Richland to determine overall plant effects on Columbia River water. These results are reported in the annual off-site environmental surveillance report.(3) In addition, sampling is done at intermediate locations to detect localized influences on plant drinking water or river water quality (see Section IV). Sampling locations for raw Columbia River water are shown in Map 1.

Fallout radionuclides H-3 and Sr-90, as well as total alpha activity, were measured in monthly composites of weekly grab samples at Vernita and in monthly composites of weekly integrated samples at Richland. The measured concentrations of Sr-90 and total alpha activity in river water averaged, respectively, 5.0×10^{-10} and 5.4×10^{-10} μCi/ml at Vernita, and 3.5×10^{-10} and 6.7×10^{-10} μCi/ml at Richland during the year. Measured tritium concentrations averaged 10^{-7} μCi/ml at Vernita and 10^{-7} at Richland. Averages were based on the actual sample results, which in many instances were less than the analytical limits.

Biological measurements of Columbia River water samples collected monthly from Vernita, 100-F, 300 Area, and North Richland appear in Table 1. From the Washington-Oregon border to Grand Coulee Dam, the Columbia is considered a Class A river, according to the Washington State Water Quality Standards,* which state that for Class A rivers total coliform organisms shall not exceed median values of 240 per 100 ml with less than 20% of the samples exceeding 1000 per 100 ml when associated with a fecal source. In addition to coliform, enterococci is measured to indicate contaminants of fecal origin. Normal seasonal peaking was observed during the summer months. Standards do not appear to have been exceeded during the year. Riverbank spring sampling indicates that the increase in the average coliform count between Vernita and North Richland (from 49 to 88) is not related to Hanford operations and was not of fecal origin.

*"Implementation and Enforcement Plan for Water Quality Standards, Surface Waters," State of Washington, Dept. of Ecology, January, 1973.

III. COLUMBIA RIVER WATER (Continued)

BOD and nitrate analysis was also performed on the weekly samples of river water from Vernita and Richland. Turbidity, pH, and dissolved oxygen measurements obtained at Vernita and 300-Area were generally in compliance with Washington State Water Quality Standards.

MAP 1

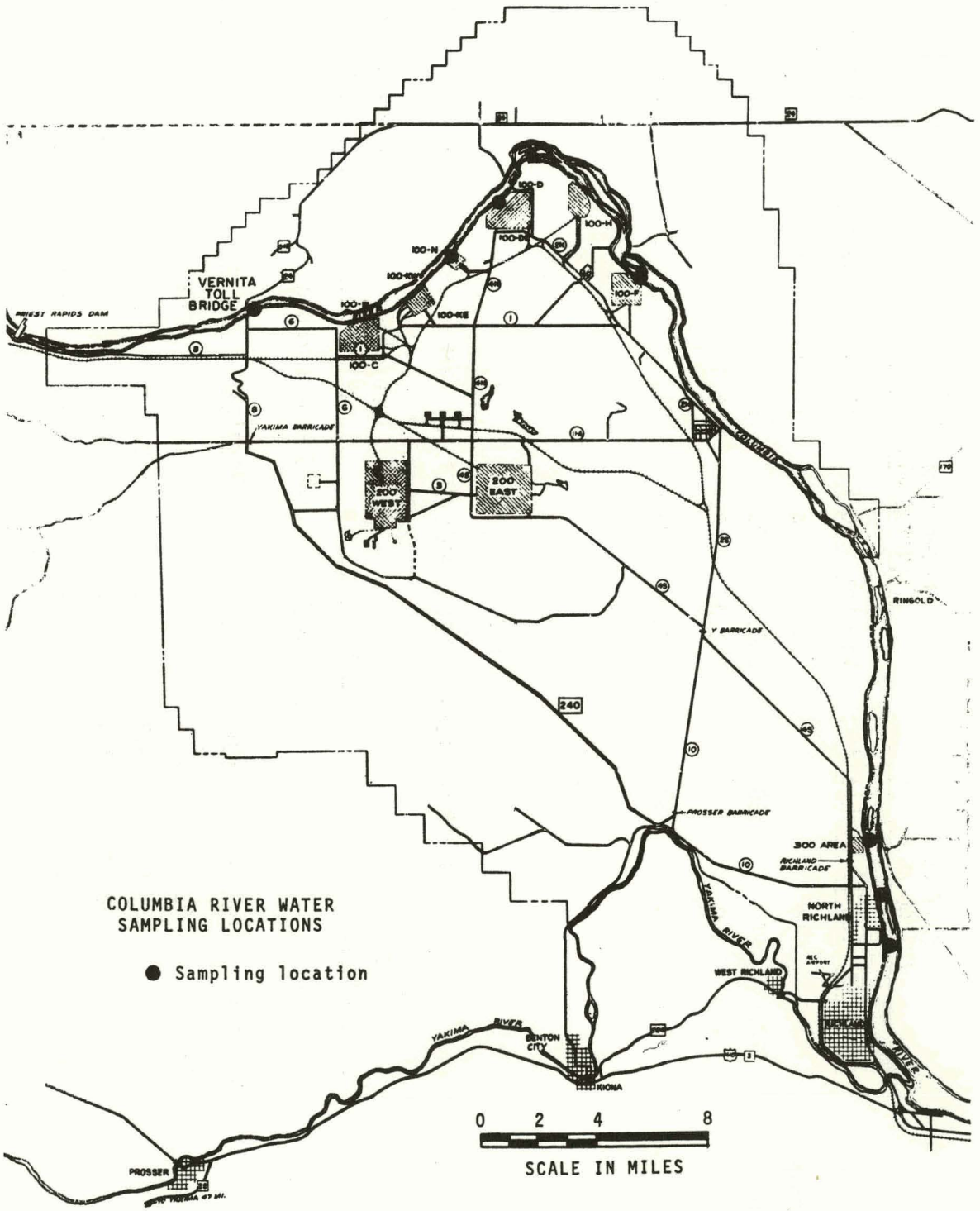
VERNITA TOLL BRIDGE
PRIEST RAPIDS DAM
100-D
100-H
100-N
100-K
100-F
100-KE
100-C
YAKIMA BARRICADE
200 WEST
200 EAST
RINGOLD
Y BARRICADE
240
PROSSER BARRICADE
300 AREA
RICHLAND BARRICADE
NORTH RICHLAND
WEST RICHLAND
YAKIMA RIVER
BENTON CITY
RIONA
PROSSER
COLUMBIA RIVER WATER SAMPLING LOCATIONS
● Sampling location
0 2 4 8
SCALE IN MILES

TABLE 1

COLUMBIA RIVER BIOLOGICAL ANALYSES FOR 1972

	Coliform (N/100 ml)			Enterococci (N/100 ml)			BOD (ppm)		
	Vernita	100-F	Richland	Vernita	100-F	Richland	Vernita	100-F	Richland
No. Samples	14	14	11	14	14	11	14	14	11
Maximum	210.	240.	460.	280.	88.	88.	4.1	4.0	4.2
Minimum	1.0	0.	2.0	1.0	0.	2.0	1.0	1.2	1.2
Average	49.	68.	88.	37.	24.	34.	2.6	2.5	2.9

TABLE 2

COLUMBIA RIVER CHEMICAL ANALYSES FOR 1972

	NO_3 (ppm)		pH		Turbidity (JTU)		Dissolved O_2 (ppm)	
Standard	45		6.5 to 8.5		5 + Background		8.0 min.	
	Vernita	Richland	Vernita	300 Area	Vernita	300 Area	Vernita	300 Area
No. Samples	51	52	47	224	48	219	34	181
Maximum	1.3	1.0	9.2	9.4	28.	30.	13.6	14.7
Minimum	*	0.14	7.4	7.2	0.6	0.05	4.0	8.1
Average	0.36	0.37	8.1	8.0	5.0	4.6	11.0	10.

*Less than the analytical limit. See Appendix D.

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TABLE 3

CONCENTRATIONS OF RADIONUCLIDES IN COLUMBIA RIVER WATER FOR 1972

Units of 10^{-9} μCi/ml

Radionuclide	[a] Analytical Limit	C.G.	VERNITA					RICHLAND				
			No. of Samples	Max.	Min.	Avg.	Percent of C.G.	No. of Samples	Max.	Min.	Avg.	Percent of C.G.
Alpha	0.3	30	12	0.74	0.30	0.54	1.8	12	0.92	0.48	0.67	2.2
^{3}H	220.	3,000,000	12	1400.	*	110.	0.003	12	1300.	*	110.	0.003
^{32}P	6.0	20,000						11	*	*	*	<0.02
^{46}Sc	25.	40,000	5	*	*	*	<0.01	53	*	*	*	<0.01
^{51}Cr	20.	2,000,000	5	20.	*	*	<0.01	53	700.	*	94.	0.005
^{60}Co	15.	17,000	5	0.30	*	*	<0.01	53	42.	*	*	<0.02
^{65}Zn	2.0	100,000	5	2.0	*	*	<0.01	4	2.0	*	*	<0.01
^{90}Sr	0.5	300	12	2.8	*	0.50	0.17	13	0.55	0.12	0.35	0.12
^{131}I	1.0	300	5	5.2	*	1.2	0.67	26	6.4	*	*	<0.03
^{137}Cs-^{137m}Ba	3.0	20,000	8	*	*	*	<0.01	7	*	*	*	<0.01
^{239}Pu	0.01	1,700	4	0.03	*	0.008	0.0005	4	0.06	*	0.02	0.001

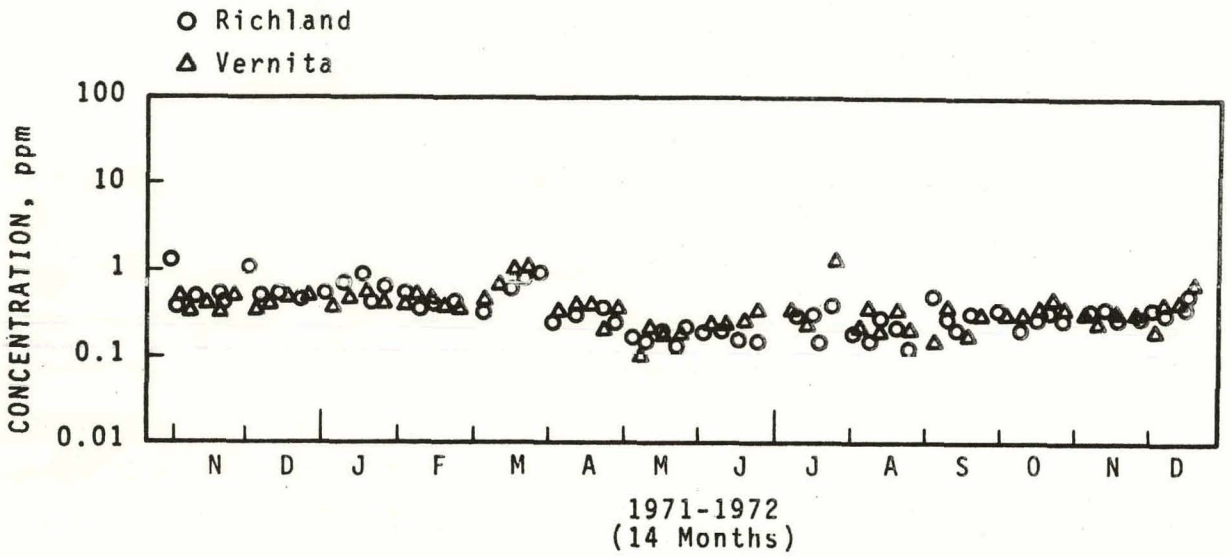
[a] See Appendix D.

*Less than the analytical limit shown (see Appendix D).

No entry indicates no specific analysis was made.

FIGURE 1

NITRATE CONCENTRATIONS IN COLUMBIA RIVER WATER

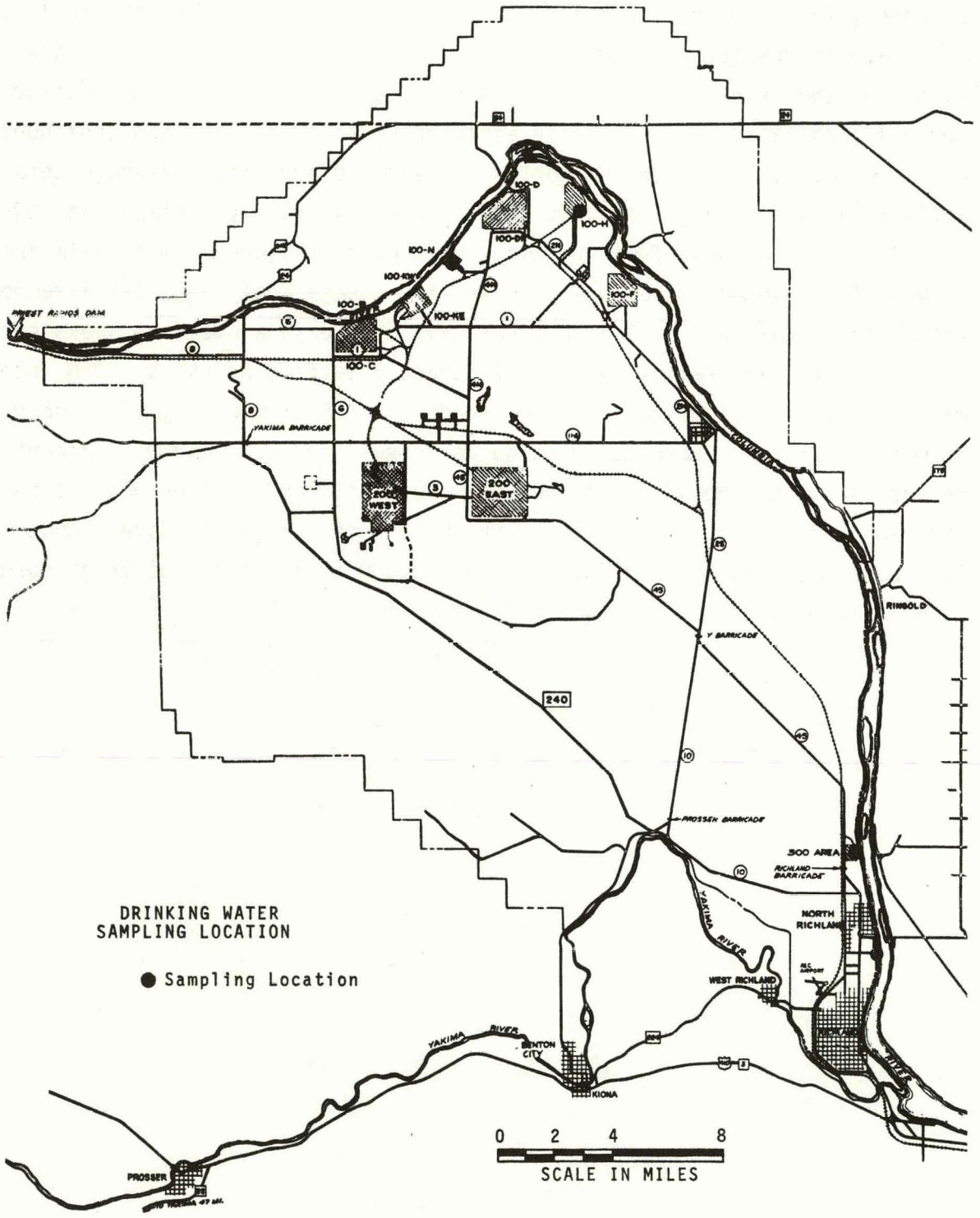


IV. DRINKING WATER

Drinking water was sampled at the four locations shown in Map 2. In December, 1971, several buildings in the 100-H Area were made available to a private contractor for use in a manufacturing venture. A monthly grab sample of the drinking water supply was initiated in December to monitor potential radiation dose to those employed at this site and was continued until December, 1972 when the contractor vacated the area. Average beta activity in 100-H water was .006 cpm/ml compared with .003 cpm/ml at 100-N.

The GI tract dose from drinking 100-N water (Figure 2) was estimated from monthly isotopic and more frequent total beta analyses. The assumed water intake rate was 0.93 liters per day, five days a week, 50 weeks per year, as reported previously. The GI tract dose from drinking 100-N water was about 1.6 mrem during 1972, compared with 2.8 mrem during 1971 and 9.5 mrem during 1970. These GI tract doses represented 0.2, and 0.6 percent, respectively, of the 1500 mrem per year dose standard for non-occupationally exposed individuals, or 0.02 and 0.06 percent of the yearly dose standard for occupationally exposed individuals (15,000 mrem/year). GI tract dose from drinking 100-H water was about 3.2 mrem during 1972.

MAP 2


DRINKING WATER
SAMPLING LOCATION
● Sampling Location
200 WEST
200 EAST
100-D
100-H
100-N
100-K
100-F
100-B
100-C
100-KE
YAKIMA BARRICADE
Y BARRICADE
PROSSER BARRICADE
RICHLAND BARRICADE
300 AREA
RINGOLD
240
NORTH RICHLAND
WEST RICHLAND
YAKIMA RIVER
BENTON CITY
KIONA
PROSSER
0 2 4 8
SCALE IN MILES

V. SWAMPS, DITCHES, AND PONDS

Open waters, primarily for disposal of cooling water, were sampled routinely at the locations shown in Map 3. Grab samples were collected monthly except that an integrated sample was collected weekly from the 300 Area Process Pond inlet. The sampling is not conducted for inventory purposes but rather serves as a surveillance of the radioactive contamination level in these waters. Total alpha and total beta concentrations were well below 5×10^{-5} μCi/ml, the limit for open waters (AEC Manual, RL Supplement 0510).

300 Area Process Pond samples received both radionuclide and chemical analyses. Biological measurements were also obtained on samples from the 300 Area Sanitary Waste Leach Trench and its associated river shoreline seepage area.

A. 200 Area Waste Waters

The waste waters sampled in the 200 Areas are primarily cooling water from chemical processes and waste tanks. Monthly grab samples were collected from 222-S Swamp (216-S-19), T-Swamp (216-T-4), U-Swamp (216-U-10), Redox Swamp (216-S-16), Gable Swamp (216-A-25), B-Swamp (216-B-3), Chemical Sewer Emergency Ditch (216-B-63) and 231-Z Ditch (216-Z-11). Honey Hill Pond was added to the routine sampling in June, 1972 after a special sample revealed alpha concentrations in excess of 10^{-7} pCi/ℓ. Analysis results are presented in Figures 2, 3, 4, and 5, as well as Table 4. Alpha and beta activity in all swamps was within normal range of fluctuation. Due to ice, no samples could be obtained during November and December.

Swamp and pond samples received a quarterly gamma-emitter analysis (Table 4). From time to time the fallout radionuclides typically found in Columbia River water were also detected in samples collected from the swamps at concentrations similar to those found in Columbia River water. This is expected, since the Columbia River is the major source of process and cooling waters for the 200 Areas.

The source of the alpha activity in Honey Hill Pond has not been identified. There was no apparent surface water flow between Honey

V. SWAMPS, DITCHES, AND PONDS (Continued)

A. 200 Area Waste Waters (Continued)

Hill Pond and Gable Swamp. Furthermore, Gable Swamp alpha activity is an order of magnitude less than Honey Hill. Sampling of groundwater and soil surfaces in the vicinity of Honey Hill Pond revealed no unusual alpha concentrations. Radioanalysis indicated that uranium was the source of the alpha activity detected in Honey Hill Pond.

B. 100-F Leach Trench

The 100-F Leach Trench receives waste water runoff from the 100-F Biology animal pens.

Sr-90 and alpha analysis of monthly grab samples collected from 100-F Leach Trench are presented in Figure 5. Average Sr-90 and alpha concentrations were 8.1×10^{-7} and 3.3×10^{-11} μCi/ml, respectively, for 100-F Leach Trench.

C. 300 Area Waste Waters

300 Area process pond receives manufacturing process and cooling water from fuel fabrication processes as well as cooling water and small amounts of laboratory waste waters from the laboratory operations.

Total beta, uranium, nitrate ion, and hexavalent chromium concentrations measured in weekly cumulative samples, collected near the inlet of the 300 Area processing pond, are presented in Figure 6. The concentration of uranium is based on a measurement of total alpha. Monthly average fluoride ion measurement results appear in Table 5. The average fluoride ion concentration for 1972 was 2.1 ppm, the same as for 1971.

300 Area Leach Trench receives sewer waste waters from the laboratory office and manufacturing facilities in the 300 Area. Samples were collected monthly from the 300 Area Leach Trench and from the river shoreline seepage area. Analyses for coliform, enterococci (fecal bacteria), and BOD (biochemical oxygen demand) are summarized in Table 6.

331 Pond receives waste waters from the 331 Building laboratories and effluent liquor from the animal pen septic tanks. Monthly grab

V. SWAMPS, DITCHES, AND PONDS (Continued)

C. 300 Area Waste Waters (Continued)

samples were collected from 331 Pond. Analysis results for alpha and beta are presented in Figure 7. Table 4 presents the results of quarterly gamma scans of 331 Pond water. Gamma-emitter concentrations were less than the analytical detection limit except for a sample in July which contained 4.4×10^{-7} μCi/ml ^{51}Cr.

MAP 3

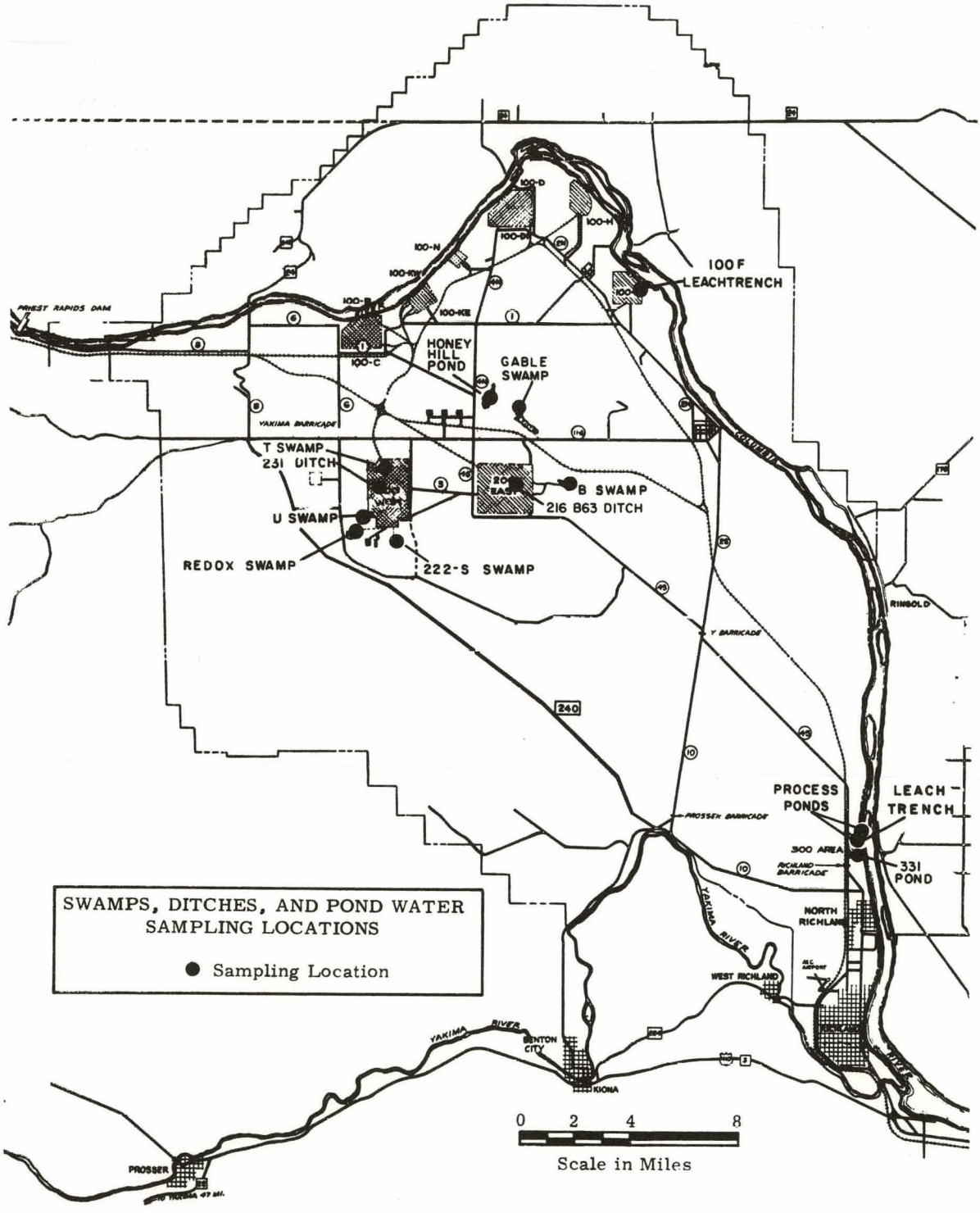

100 F
LEACHTRENCH
HONEY
HILL
POND
GABLE
SWAMP
T SWAMP
231 DITCH
B SWAMP
216 B63 DITCH
U SWAMP
REDOX SWAMP
222-S SWAMP
PROCESS
PONDS
LEACH
TRENCH
300 AREA
331
POND
NORTH
RICHLAND
WEST RICHLAND
RICHLAND
YAKIMA
RIVER
BENTON
CITY
KIONA
PROSSER
RINGOLD
240
SWAMPS, DITCHES, AND POND WATER
SAMPLING LOCATIONS
● Sampling Location
0 2 4 8
Scale in Miles

FIGURE 2

RADIOACTIVITY OF WASTE WATER SAMPLES 200-EAST AREA

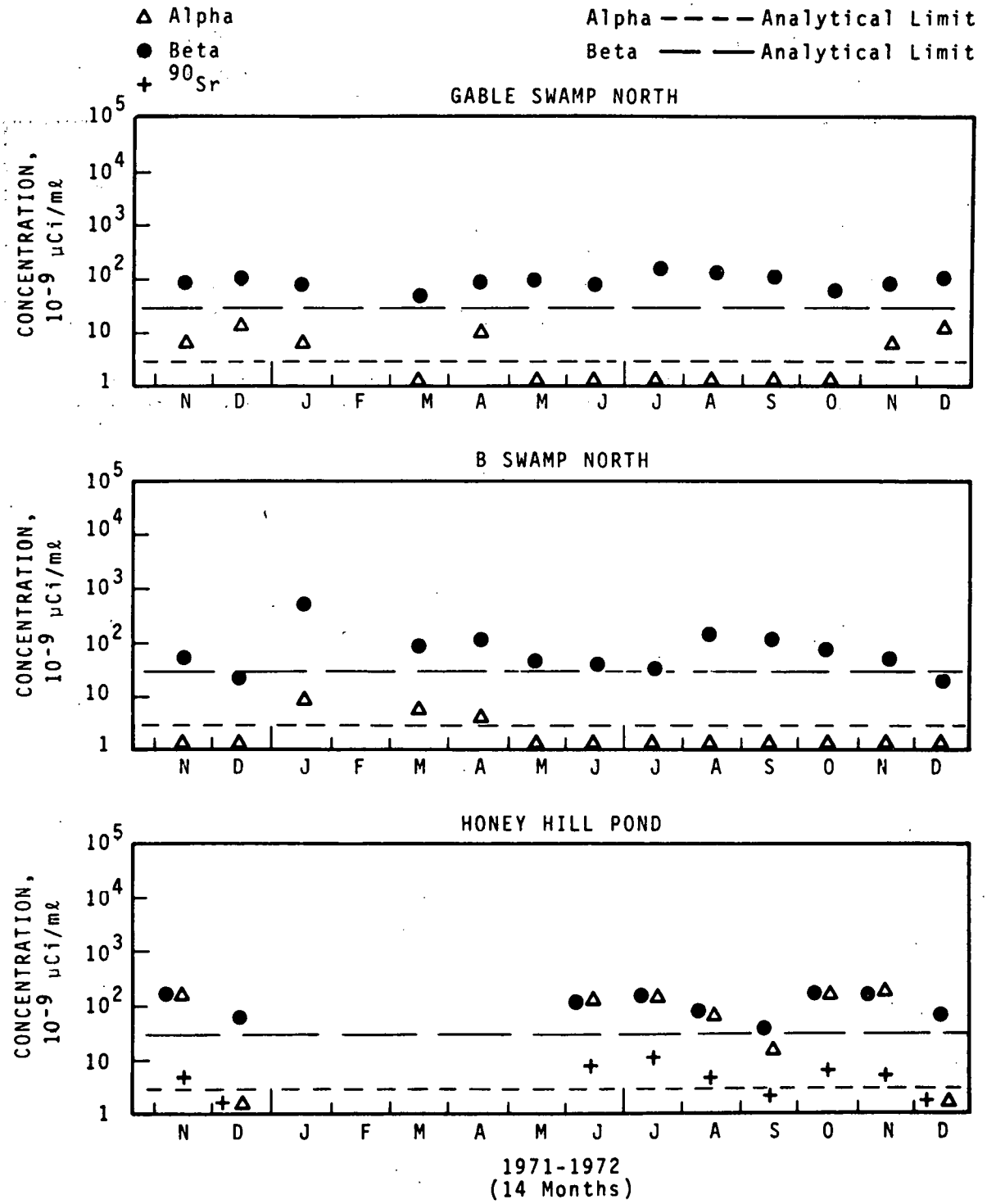


FIGURE 3

RADIOACTIVITY OF WASTE WATER SAMPLES
200 EAST AREA

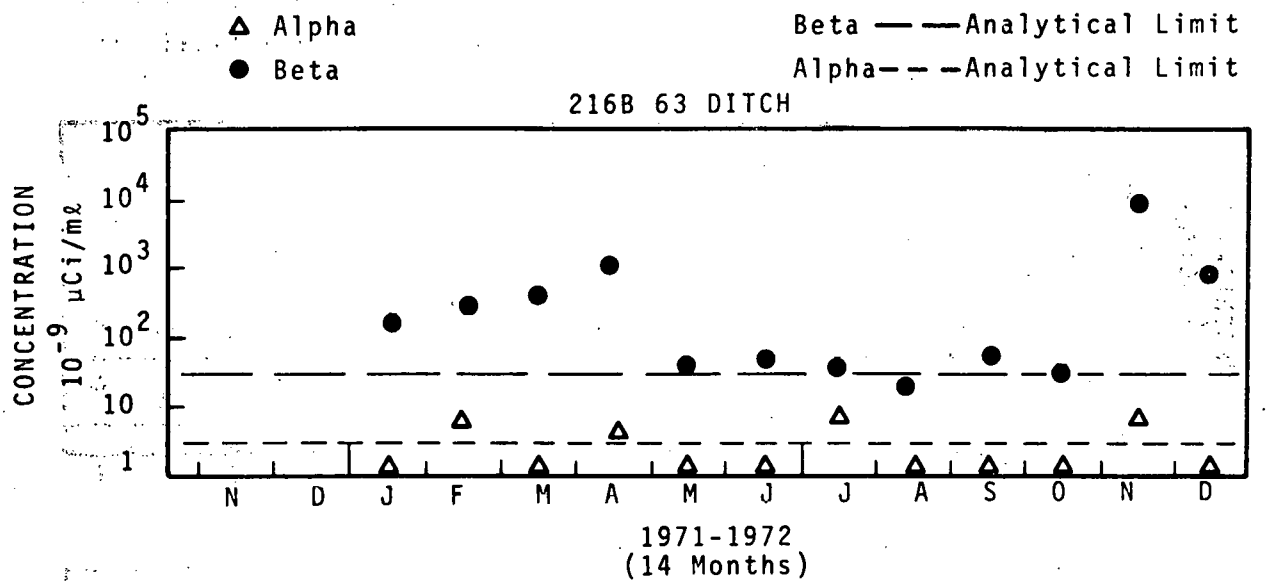


FIGURE 4
RADIOACTIVITY OF WASTE WATER SAMPLES
200-WEST AREA

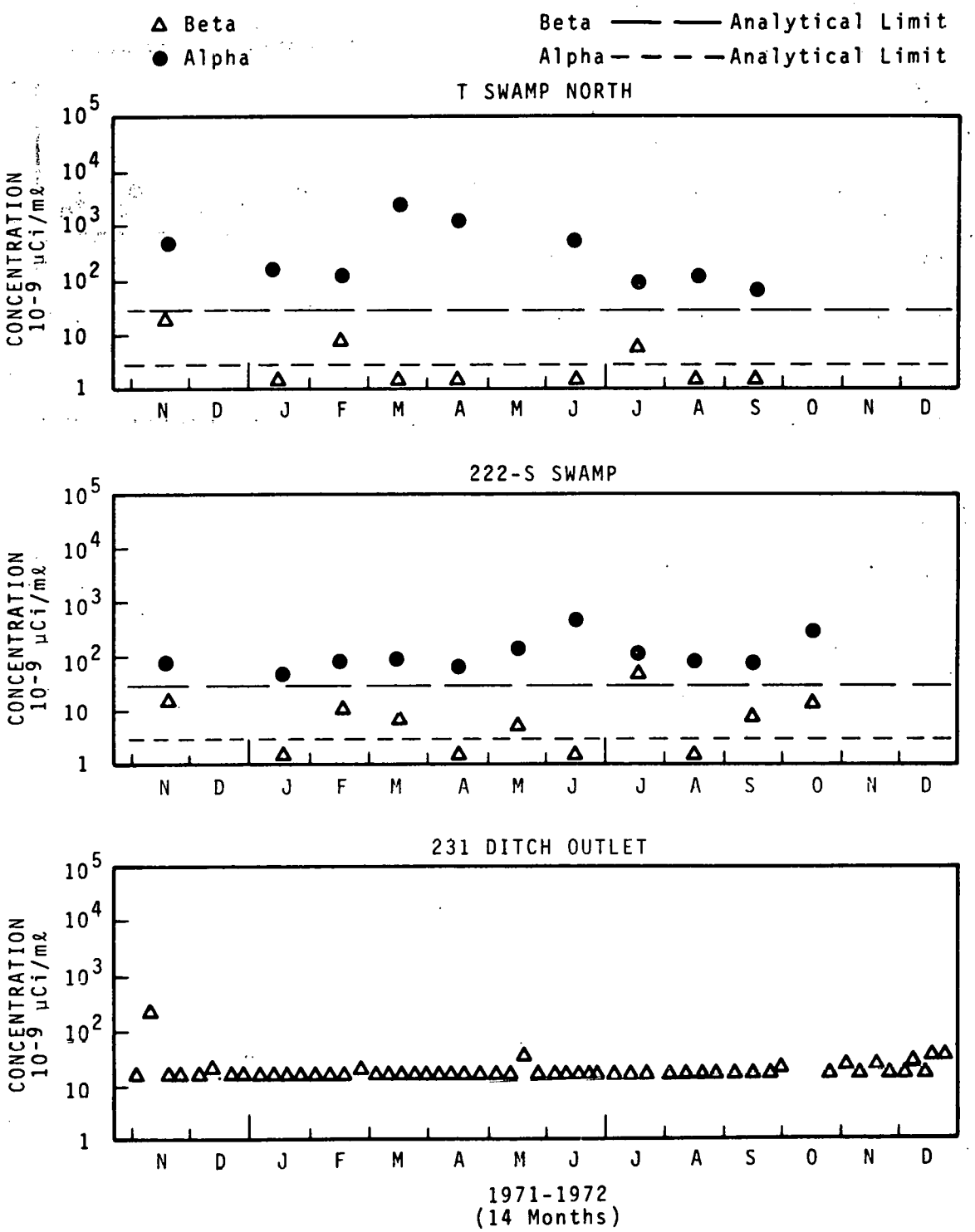


FIGURE 5

RADIOACTIVITY OF WASTE WATER SAMPLES 200W, 100F AREAS

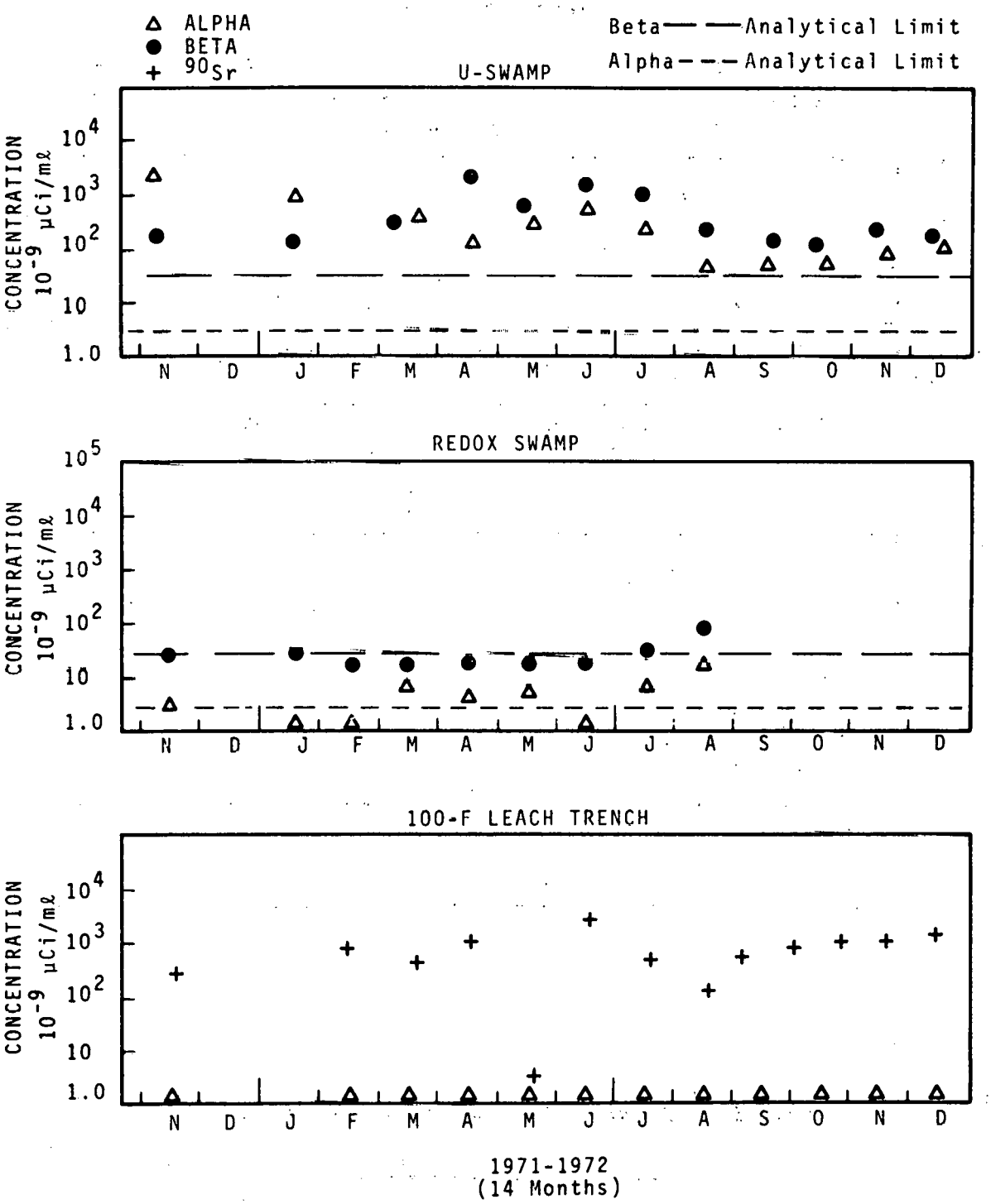


TABLE 4

GAMMA ACTIVITY IN WASTE WATER SAMPLES - 1972

Units of 10^{-9} μCi/ml

Location	Date	^{46}Sc	^{51}Cr	^{60}Co	^{65}Zn	$^{95}ZrNb$	$^{106}RuRh$	^{137}Cs	$^{140}BaLa$	$^{144}CePr$
Honey Hill Pond	6/2	*	*	*	*	*	*	*	*	*
	10/13	*	*	*	*	*	*	*	*	*
Gable Swamp	1/14	*	*	*	*	*	*	9.4	*	*
	4/7	*	*	*	*	*	*	37.	*	*
	7/7	*	*	*	*	*	*	90.	*	*
	10/13	*	*	*	*	*	*	32.	*	*
B Swamp	1/14	*	*	*	*	59.	*	*	*	*
	4/7	*	*	*	*	*	*	*	*	*
	7/7	*	*	*	*	*	*	*	*	*
	10/13	*	*	*	*	*	*	*	*	*
T Swamp	1/14	*	*	*	*	*	*	35.	*	*
	4/7	*	*	*	*	*	*	*	*	*
	7/7	*	*	*	*	*	*	*	*	*
S Swamp	1/14	*	*	*	*	*	*	62.	*	*
	4/7	*	*	*	*	*	*	40.	*	*
	7/7	*	*	*	*	*	*	170.	*	*
	10/13	*	*	*	*	*	*	*	*	*
U Swamp	1/14	*	*	*	*	*	*	*	*	*
	4/7	*	*	*	*	*	*	*	*	*
	7/7	*	*	*	*	*	*	220.	*	*
	10/13	*	*	*	*	*	*	*	*	*
Redox Swamp	1/14	*	*	*	*	*	*	*	*	*
	4/7	*	*	*	*	*	*	*	330.	*
	7/7	*	*	*	*	*	*	*	*	*
216 B 63 Ditch	1/14	*	*	*	*	*	*	*	*	*
	4/7	*	*	*	*	*	*	*	*	*
	7/7	*	*	*	*	*	*	*	*	*
	10/13	*	*	*	*	*	*	*	*	*
331 Pond	1/11	*	*	*	*	*	*	*	*	*
	4/4	*	*	*	*	*	*	*	*	*
	7/11	*	440.	*	*	*	*	*	*	*
	10/10	*	*	*	*	*	*	*	*	*

*Less than analytical limit.

FIGURE 6

WASTE WATER ANALYSES
300 AREA

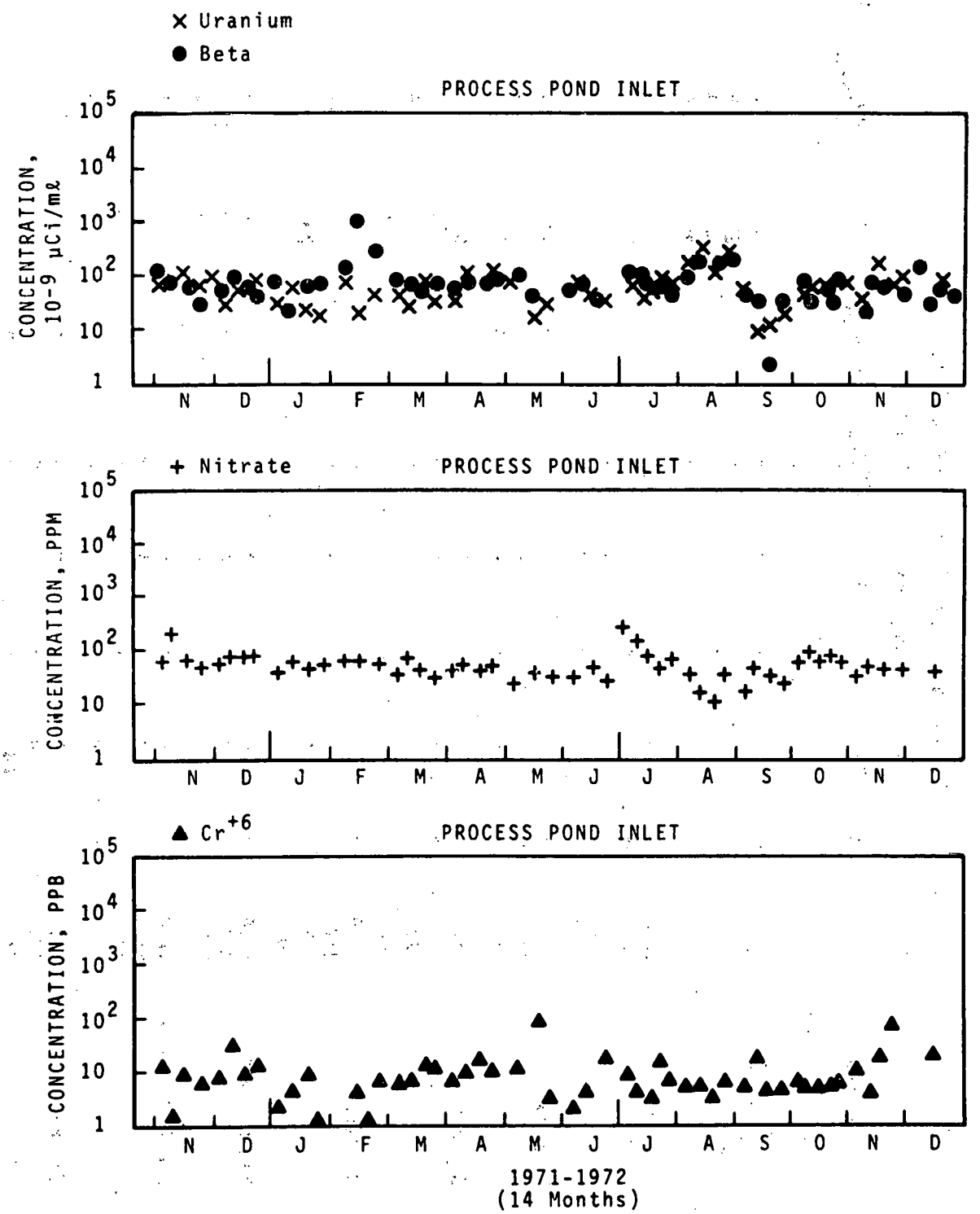


TABLE 5

FLUORIDE ION CONCENTRATIONS IN THE 300 AREA PROCESS POND - 1972

Month	F- ppm
January*	3.0
February	4.5
March	1.7
April	2.2
May*	1.1
June*	0.9
July	2.2
August	0.1
September	1.2
October	3.1
November	2.8
December	2.9
Average	2.1

*No analyses were made for the periods: 1/24/72 to 2/7/72, 5/1/72 to 5/15/72, and 6/5/72 to 6/12/72.

TABLE 6

BIOLOGICAL MEASUREMENTS OF SAMPLES COLLECTED FROM THE 300 AREA LEACHING TRENCH AND ITS ASSOCIATED RIVER SHORELINE SEEPAGE AREA - 1972

300 LEACHING TRENCH

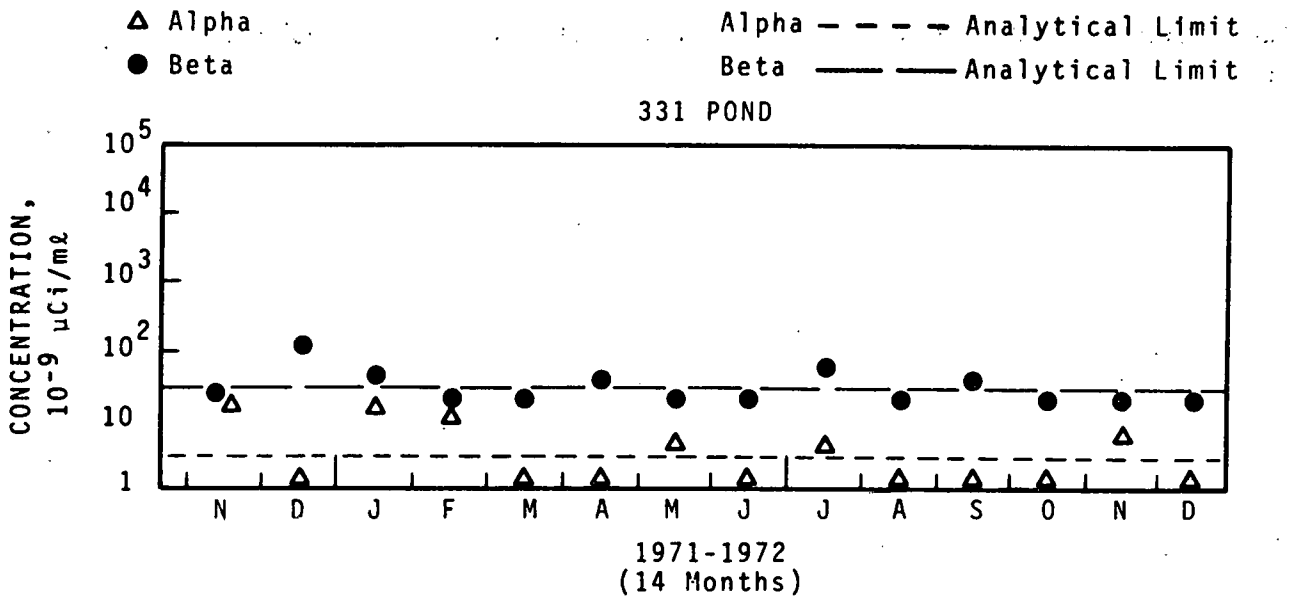
Date	Coliform N/100 ml	Enterococci N/100 ml	BOD mg/ℓ
1/11	330,000	3,300	7.0
2/8	190,000	5,000	6.7
3/14	1,280,000	6,500	5.9
4/4	720,000	29,000	2.6
6/20	640,000	7,500	4.2
7/11	1,320,000	12,000	4.0
8/8	500,000	23,000	4.6
9/5	3,000,000	17,000	3.6
10/3	850,000	33,500	2.0
11/14	320,000	11,000	1.9
12/12	264,000	8,000	1.4
Average	855,818	14,164	4.0

RIVER SHORELINE SEEPAGE AREA

Date	Coliform N/100 ml	Enterococci N/100 ml	BOD mg/ℓ
1/11	23.	16.	3.4
2/8	2.	5.	1.2
3/14	7.	4.	3.1
4/4	6.	10.	3.4
6/20	105.	20.	4.0
7/11	250.	28.	4.0
8/8	60.	17.	2.8
8/22	130.	25.	1.2
9/5	30.	13.	0.45
9/19	98.	55.	1.9
10/3	25.	18.	1.6
10/24	115.	148.	1.6
11/14	6.	120.	1.4
12/12	8.	7.	1.8
Average	62.	35.	2.3

FIGURE 7

RADIOACTIVITY OF WASTE WATER SAMPLES
300 AREA



VI. GROUNDWATER

Results of the groundwater surveillance program for 1972 have been reported separately in BNWL-1737, "Radiological Status of the Groundwater Beneath the Hanford Project, January-June, 1972," and BNWL-1752, "Radiological Status of the Groundwater Beneath the Hanford Project, July-December, 1972."

VII. BIRDS AND MAMMALS

Migratory waterfowl utilize, as nesting places, Hanford Reservation swamps and ponds which receive low-level radioactive wastes. Ingestion of the waste or waste-contaminated vegetation may result in measurable quantities of radionuclides in the waterfowl's tissues and organs. Some resident waterfowl, other gamebirds such as pheasants, and a variety of mammals also have access to the waste waters and potentially contaminated vegetation.

Gamma scan and strontium-90 analyses were obtained on muscle samples of most gamebirds and mammals collected. At several locations, the liver was sampled for plutonium-239 or uranium analysis. When several birds of the same species and location were collected on the same day, muscle from one to five birds was composited for a gamma scan. The gamma scan of the composite obviated the gamma scans of the individual birds.

Waterfowl

Radionuclide concentrations in twenty-two waterfowl sampled from swamps and ponds in 1972 were generally below the concentrations recorded in 1971. Tables 7 and 8 present the average analysis results for ducks (71) and geese (32) sampled from the Columbia River in the vicinity of the reactor areas. The average Cs-137 was much lower in the river waterfowl than the swamp and pond waterfowl indicating that the river waterfowl, most subject to public hunting do not frequent the 200 Area swamps and ponds.

Pheasants

No unusual radionuclide concentrations were detected in twenty-four pheasants. Cs-137, Sr-90, and Zn-65 concentrations were similar to the values observed in geese.

Deer

The deer population sampled is assumed to be resident on the Hanford plant; relaxation of access control of sportsmen on Wahluke Slope increases the probability of hunters bagging Hanford deer.

VII. BIRDS AND MAMMALS (Continued)

Deer (Continued)

Deer were sampled as part of the environmental sampling program in January, September, and November. Generally, the radionuclide concentrations detected in muscle tissue (Table 9) were comparable to 1971 samples. Cs-137 concentration in the muscle of the November deer was higher than any deer sample of 1971 but less than deer samples of 1970. This deer was possibly using the 200 Area waste water ponds as a source of water. Sr-90 concentrations observed in the Hanford deer are similar to the concentrations in deer from other parts of the country and are attributed to fallout.

Small Mammals

Sampling of mice and rabbits (Table 10) was conducted near liquid waste trenches and ponds in the 100, 200, and 300 Areas. The results serve as an indicator of potential transport of radioactivity away from waste sites by mammals even though no direct pathway to man of radiation exposure from such mammals is believed to exist. Radionuclide concentrations in mammals collected in 1972 were generally lower than in 1971. Mice collected from the vicinity of the 100-N trench continued to show radionuclide concentrations orders of magnitude above specimens from other Hanford locations, probably as a result of ingestion of water from 100-N trench. However, a mouse trapped at the 100-F Leach Trench contained the highest Sr-90 concentration.

Radionuclide concentrations in rabbits were somewhat lower in 1972 except for Cs-137 which was notably higher in a rabbit taken near 222-S Swamp.

Coyote

A road-killed coyote was sampled in January (Table 9). Radionuclide concentrations were generally higher than deer but less than the mice and rabbits.

TABLE 7

AVERAGE RADIONUCLIDE CONCENTRATIONS IN MUSCLE OF GAMEBIRDS - 1972

Units of 10^{-6} μCi/gm (wet weight)

Location	Species	No. of Samples	^{58}Co	^{60}Co	^{65}Zn	^{90}Sr	^{137}Cs	^{141}Ce
Analytical Limit			0.15	0.15	0.20	0.002	0.1	
U Swamp	Ducks	2	*	*	*	0.006	27.	*
Redox Swamp	Ducks	2	*	*	*	0.054	3.1	*
Gable Swamp	Ducks	4	*	*	*	0.003	26.	*
B Swamp	Ducks	4	*	*	0.11	0.003	3.3	*
300 Pond	Ducks	5	*	*	*	*	*	*
100-F Trench	Ducks	3	*	*	0.14	0.11	0.14	*
T Swamp	Ducks	1	*	0.20	0.40	0.003	70.	*
Honey Hill Pond	Ducks	1	*	*	*	*	4.2	*
Columbia River	Ducks	71	*	*	0.096	0.003	0.070	*
Columbia River	Geese	32	*	*	0.079	0.003	0.11	*
100 Areas	Pheasants	24	*	*	.073	0.003	0.084	*

*Less than the analytical limit.

TABLE 8

AVERAGE CONCENTRATIONS OF SELECTED RADIONUCLIDES IN THE LIVERS OF WATERFOWL SAMPLES IN THE HANFORD ENVIRONS - 1972

Units of 10^{-6} μCi/gm (wet weight)

Location	No. of Samples	U	^{239}Pu
Analytical Limit		0.016	0.05
300 Pond	5	0.046	*
100-F Trench	2		*
Honey Hill Pond	1	*	
U Swamp	2		0.24

*Less than the analytical limit.
No entry indicates no analysis was performed.

TABLE 9

CONCENTRATION OF SEVERAL RADIONUCLIDES IN DEER AND COYOTE - 1972

Units of 10^{-6} μCi/gm (wet weight)

Location	Date	Tissue	^{65}Zn	^{90}Sr	^{137}Cs	^{239}Pu
Deer						
Rt. 11A, Mi. 1.5	1/20	Muscle	*	*	0.048	
Rt. 11A, Mi. 1.5	1/20	Bone	*	0.48	*	0.009
Rt. 11A, Mi. 1.5	1/20	Liver				0.00008
300 Area	9/28	Muscle	0.081	*	0.071	
300 Area	9/28	Liver				0.00005
Rt. 4S, Mi. 13	11/7	Muscle	0.054	*	0.24	
Rt. 4S, Mi. 13	11/7	Liver				*
Coyote						
Rt. 4S, Mi. 20	1/20	Muscle	*	*	0.18	
Rt. 4S, Mi. 20	1/20	Liver	0.28	0.009	0.11	0.0001

*Less than the analytical limit.
No entry indicates no analysis was performed.

TABLE 10

CONCENTRATIONS OF SEVERAL RADIONUCLIDES IN SMALL ANIMALS

Units of 10^{-6} μCi/gm (in muscle)

Date	Location	^{24}Na	^{40}K	^{54}Mn	^{58}Co	^{59}Fe	^{60}Co	^{65}Zn	^{90}Sr	$^{95}ZrNb$
Mice										
2/16	300 Pond	*	*	*	*	*	*	*	0.065	*
2/24	100-N Trench	*	*	*	650.	*	820.	110.	7.9	*
	(Special Diode Count)	*	81.	*	850.	*	*	170.	*	*
2/24	200-E Chem. Ditch	*	*	*	*	*	*	*	0.92	*
4/25	100-N Trench	*	270.	*	640.	*	850.	350.	16.	*
6/14	100-N Trench	*	100.	210.	*	*	210.	55.	30.	*
6/15	U Swamp	*	*	*	*	*	*	*	9.9	*
7/20	100-F	*	*	*	*	*	*	*	52.	*
11/29	100-N Trench	*	5.7	5400.	*	7100.	11,000	*	31.	2900.
11/29	300 Pond	*	*	*	*	*	*	*	0.33	*
11/30	200 West	*	*	*	*	*	*	*	0.018	*
Rabbit										
3/15	222 S Swamp	*	*	*	*	*	*	*	0.066	*
5/25	300 Pond	*	4.7	*	*	*	*	*	0.010	*
7/31	200-E Area	*	3.2	*	*	*	*	0.14	0.020	*
11/20	100-N Area	*	2.4	*	*	*	*	*	0.004	*

*Less than the analytical limit.

TABLE 10 (Continued)

CONCENTRATIONS OF SELECTED RADIONUCLIDES IN SMALL ANIMALS

Units of 10^{-6} μCi/gm (in muscle)

Date	Location	^{103}Ru	^{106}Ru	^{131}I	^{134}Cs	^{137}Cs	$^{140}BaLa$	^{141}Ce	$^{144}CePr$	U	^{239}Pu
Mice											
2/16	300 Pond	*	*	*	*	*	*	*	*	0.099	0.0002
2/24	100-N Trench	*	*	*	*	58.	*	*	*		0.15
	(Special Diode Count)	*	*	*	*	26.	*	*	*		
2/24	200-E Chem. Ditch	*	*	*	*	3.4	*	*	*		0.006
4/25	100-N Trench	*	*	*	*	180.	*	*	*		
6/14	100-N Trench	*	*	*	*	50.	*	*	27.		0.051
6/15	U Swamp	*	*	*	*	21.	*	*	*	0.34	0.037
7/20	100-F	*	*	*	*	*	*	*	*		0.002
11/29	100-N Trench	350.	2400.	1500.	140.	120.	140.	510.	3800.		
11/29	300 Pond	*	*	*	*	*	*	*	*	0.006	0.010
11/30	200 West	*	*	*	*	1.0	*	*	*		0.0006
Rabbit											
3/15	222 S Swamp	*	*	*	*	9.8	*	*	*		0.004(a)
5/25	300 Pond	*	*	*	*	*	*	*	*	0.021(a)	*
7/31	200-E Area	*	*	*	*	1.3	*	*	*		0.0003(a)
11/20	100-N Area	*	*	*	*	0.13	*	*	*		*

(a) Concentration in liver tissue.

*Less than the analytical limit.

No entry indicates no analysis was performed.

VIII. AIRBORNE RADIOACTIVITY

Results of routine sampling of the atmosphere for radioactivity at 18 locations within the Hanford reservation (Map 4) are presented in Figures 8 through 18. For comparison, data from 18 off-site locations (Map 5) are included in the following discussion. Sampling for chemical pollutants and particulates in the atmosphere is conducted and reported by the Hanford Environmental Health Foundation.

The sampling equipment, sheltered in small buildings, draws air at a flow rate of 2.5 m^3/hr (1.5 cfm) through HV-70 or Acropor filter paper, and then through activated charcoal cartridges for radioiodine collection. The normal sampling period was one week through June, but several of the sampling locations were changed to bi-weekly after June. "Total beta" represents the gross beta activity (Sr-Y-90 calibration) and "total alpha" represents the gross alpha activity (Pu-239 calibration) of particulates collected on the filter paper during the sampling period.

Table II shows the annual average I-131, particulate total beta, and particulate total alpha activity in air at various locations for 1968-1972. Results of gamma scans, gross alpha, and gross beta analyses on selected environmental air filters are presented in Tables 12 and 13. Concentration Guides shown are taken from AECM 0524, Annex A, Table II, Column 1, and are applicable to individuals not occupationally exposed.

A. Iodine-131

Concentrations of I-131 in the atmosphere during 1972 averaged less than the analytical limit of 2×10^{-14} μCi/ml for on-site locations and off-site locations. The maximum individual weekly average concentration measured during this reporting period was 10^{-13} μCi/ml, noted in May at 300 Area. For comparison, the maximum I-131 concentration measured during 1971 was 8×10^{-13} μCi/ml at 300 Area.

B. Total Beta

During 1972, environmental air filters from 18 on-site locations and 18 off-site locations were examined weekly or biweekly for particulate total beta activity. Tables 11 and 12 show the average particulate total beta activity in air at various locations. Airborne radio-

VIII. AIRBORNE RADIOACTIVITY (Continued)

B. Total Beta (Continued)

activity measurements were discontinued at 100-H in December, after a private manufacturing venture had been completed.

Beta activity has, in the past, been characterized by seasonal peaking about mid-year. This was not as apparent in 1972 as in previous years as shown in Figures 8-14. Concentrations in and near the 100 Areas were quite uniform during any given period, indicating the lack of a significant source at the Reactor Areas. This was not true of the 200 Areas, notably the East North Center (ENC) locations which are affected by a dose in 200-East Area waste disposal operation. The maximum measured concentrations, 3×10^{-11} μCi/ml (total beta), occurred in October at the 200 ENC location. Annual average concentrations were similar to 1971, ranging from 10^{-13} to 2×10^{-13} μCi/ml in the 100 Areas and from 2×10^{-13} to 3×10^{-13} μCi/ml in the 200 Areas except for 200 ENC which averaged 4.6×10^{-12} μCi/ml.

The maximum measured concentration at an off-site location, 3.6×10^{-12} μCi/ml, occurred in May at McNary. Annual average concentrations at off-site locations ranged from about 10^{-11} to 3×10^{-11} μCi/ml.

C. Total Alpha

The weekly filters analyzed for beta-gamma emitting radionuclides were also analyzed for alpha activity. These data are presented in Tables 11 and 12. Alpha counting of the filters was normally performed after seven days to allow for the decay of short-lived activity from naturally-occurring radon daughters. Total alpha concentrations during 1972 averaged about 2×10^{-15} μCi/ml at most on-site locations compared to 4×10^{-15} in 1971. The highest annual average was 4×10^{-15} μCi/ml at ENC compared to 2.4×10^{-14} μCi/ml at ENC for 1971. Analysis of composite samples (Table 13) all showed less than 10^{-16} μCi/ml of plutonium.

D. Other Radionuclides

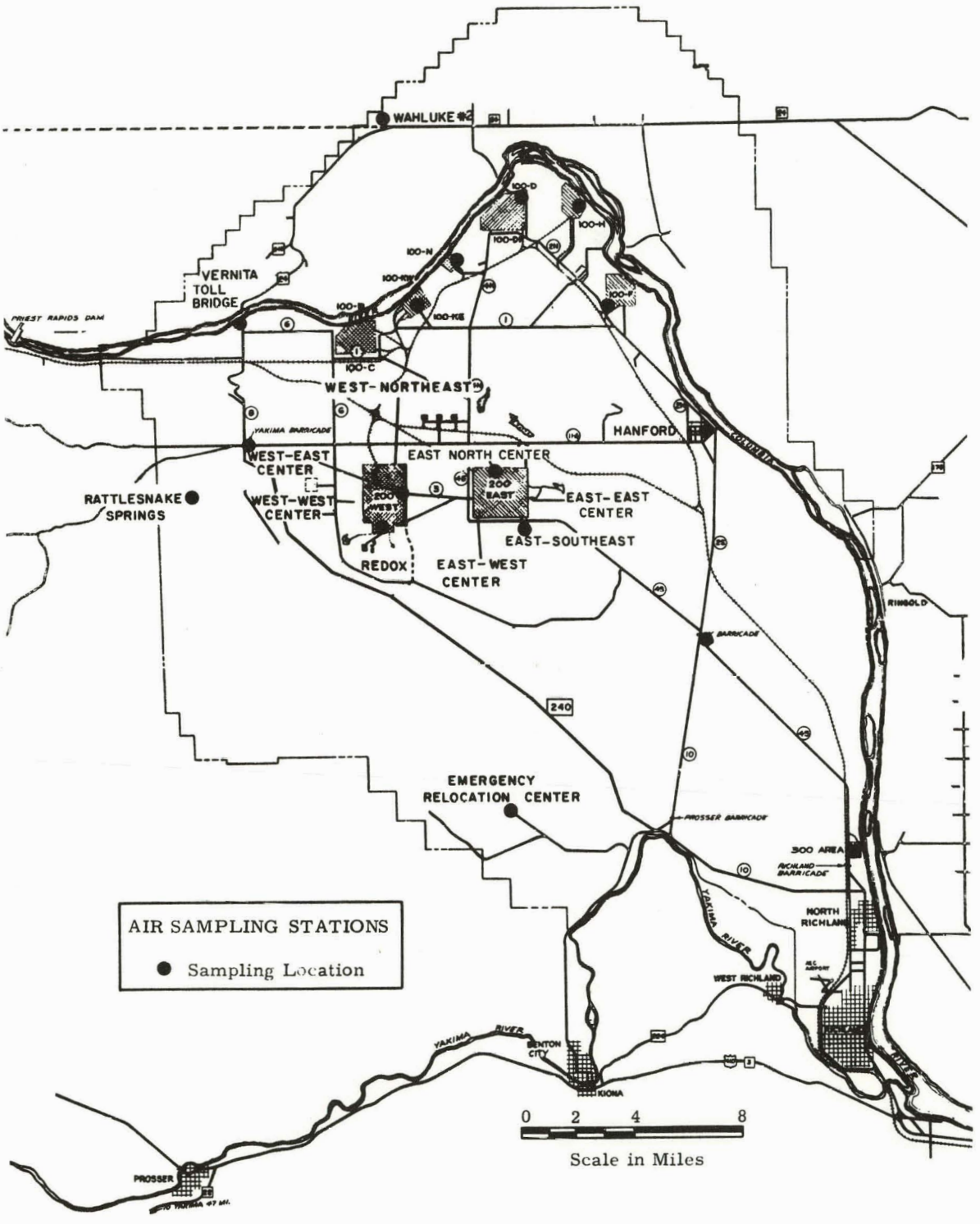
Gamma spectrum analysis was performed on a number of monthly composites of selected air filters. Quarterly analysis for Sr-90 and

VIII. AIRBORNE RADIOACTIVITY (Continued)

D. Other Radionuclides (Continued)

Pu-239 of the composites was also performed. Table 13 presents the results of these special analyses. At most sampling locations, average concentrations of gamma emitters for 1972 were lower than 1971. Average gamma emitter concentrations in Active Area #5, comprised of 100-N, 100-K, and 100-D Areas, were somewhat above the 1971 average as was 200 ENC. Also, Ba-La-140 was higher than in 1971 primarily in the last quarter of the year.

MAP 4


WAHLUKE
VERNITA TOLL BRIDGE
PRIEST RAPIDS DAM
100-D
100-H
100-N
100-F
100-C
WEST-NORTHEAST
YAKIMA BARRICADE
HANFORD
WEST-EAST CENTER
EAST NORTH CENTER
RATTLESNAKE SPRINGS
WEST-WEST CENTER
200 WEST
200 EAST
EAST-EAST CENTER
EAST-SOUTHEAST
REDOX
EAST-WEST CENTER
RICHLAND
BARRICADE
240
EMERGENCY RELOCATION CENTER
PROSSER BARRICADE
300 AREA
RICHLAND BARRICADE
NORTH RICHLAND
YAKIMA RIVER
WEST RICHLAND
BENTON CITY
KIONA
PROSSER
AIR SAMPLING STATIONS
Sampling Location
0 2 4 8
Scale in Miles

MAP 5

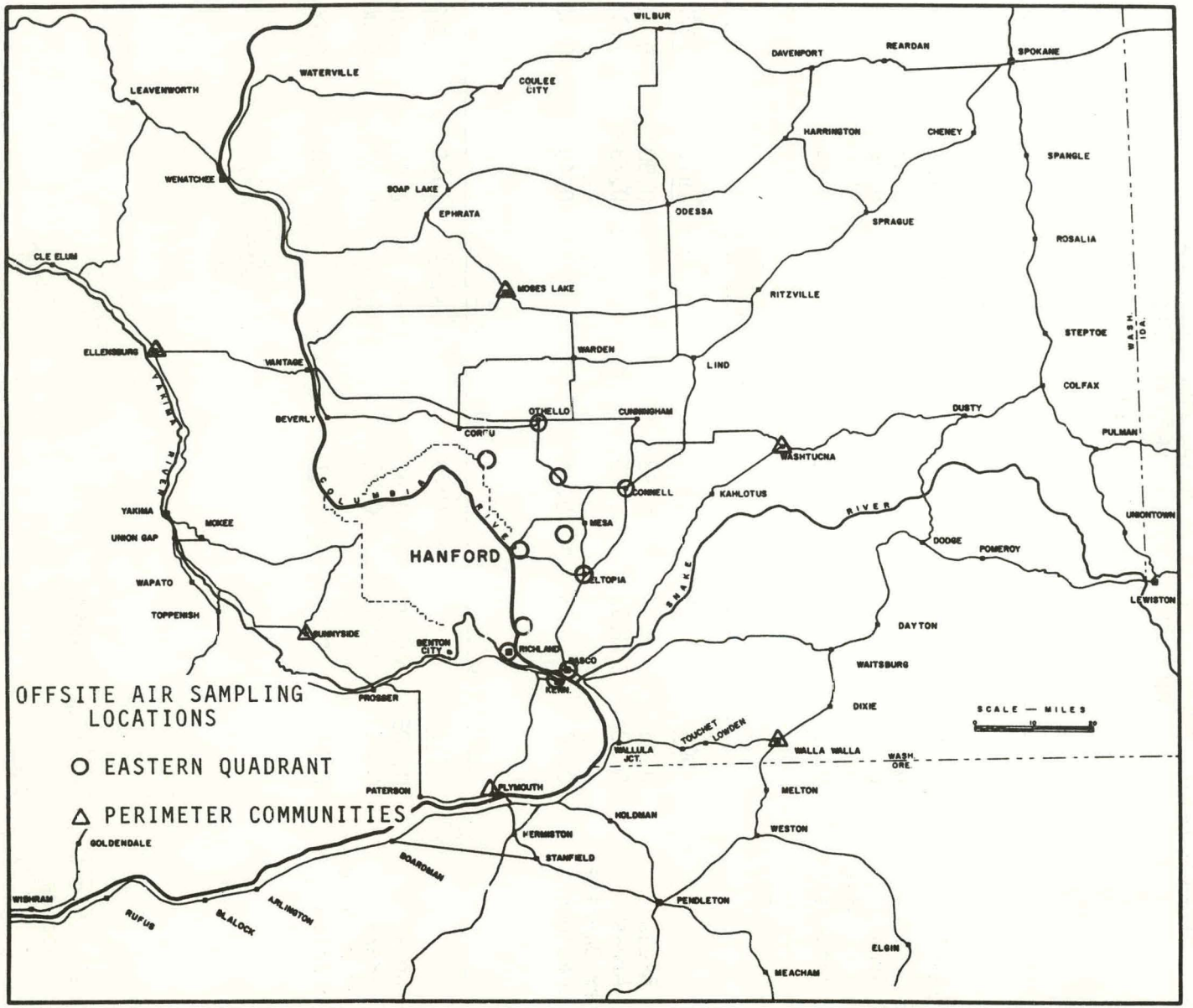

WILBUR
DAVENPORT
REARDAN
SPOKANE
WATERVILLE
COULEE CITY
LEAVENWORTH
HARRINGTON
CHENEY
SPANGLE
WENATCHEE
SOAP LAKE
EPHRATA
ODESSA
SPRAGUE
ROSALIA
CLE ELUM
MOSES LAKE
RITZVILLE
STEPTOE
WASH.
IDA.
ELLENSBURG
YAKIMA RIVER
VANTAGE
WARDEN
LIND
COLFAX
BEVERLY
OTHELLO
CUNNINGHAM
DUSTY
PULLMAN
CORFU
WASHTUCNA
COLUMBIA RIVER
CONNELL
KAHLOTUS
YAKIMA
MOXEE
MESA
UNIONTOWN
UNION GAP
HANFORD
DODGE
POMEROY
ELTOPIA
SNAKE RIVER
WAPATO
LEWISTON
TOPPENISH
SUNNYSIDE
DAYTON
BENTON CITY
RICHLAND
PASCO
WAITSBURG
KENN.
PROSSER
DIXIE
SCALE — MILES
TOUCHET
LOWDEN
WALLULA JCT.
WALLA WALLA
WASH.
ORE.
PATERSON
PLYMOUTH
MELTON
HOLDMAN
WESTON
HERMISTON
STANFIELD
GOLDENDALE
BOARDMAN
PENDLETON
WISHRAM
RUFUS
BLALOCK
ARLINGTON
ELGIN
MEACHAM
OFFSITE AIR SAMPLING LOCATIONS
EASTERN QUADRANT
PERIMETER COMMUNITIES

TABLE 11

AVERAGE I-131, PARTICULATE TOTAL BETA, AND PARTICULATE TOTAL ALPHA CONCENTRATIONS IN THE ATMOSPHERE

Units of 10^{-12} μCi/ml

	I-131†					
			Jan-June	Jul-Dec		
Location	1968**	1969**	1970**	1970***	1971***	1972***
100 Areas	0.02	0.01	0.007	0.06	0.03	*
200 Areas	0.03	0.01	0.01	0.09	0.04	*
Other On-Site Locations	0.02	0.02	0.02	0.08	0.04	*

	Total Beta				
	1968	1969	1970	1971	1972
100 Areas	0.30	0.33	0.43	0.30	0.13
200 Areas	0.28	0.53	0.65	0.73	1.3
Other On-Site Locations	0.20	0.28	0.35	0.49	0.18

	Total Alpha				
	1968	1969	1970	1971	1972
100 Areas	0.006	0.007	0.01	0.002	0.002
200 Areas	0.008	0.01	0.02	0.009	0.003
Other On-Site Locations	0.01	0.008	0.01	0.003	0.002

*Less than the analytical limit.
**Scrubbers
***Charcoal Cartridges
†Most restrictive Concentration Guide - 1×10^{-10} μCi/ml

TABLE 12

I-131, PARTICULATE TOTAL BETA, AND PARTICULATE TOTAL ALPHA IN THE ATMOSPHERE - 1972

Units of 10^{-12} μCi/ml

On-Site

	Beta			I-131			Alpha		
Analytical Limit	0.02			0.02			0.001		
Location	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
200 ENC	30.	0.19	4.6	*	*	*	0.060	*	0.004
200 ESE	0.56	0.014	0.294	0.062	*	*	0.012	*	0.002
200 WEC	0.69	0.029	0.228	*	*	*	0.053	*	0.003
Redox	0.58	0.043	0.220	0.043	*	*	0.005	*	0.002
300 Area	0.70	0.016	0.138	0.112	*	*	0.008	*	0.002
ACRMS	1.2	*	0.124	*	*	*			
100-K	0.48	*	0.147						
100-N	0.40	0.023	0.130	0.073	*	*	0.007	*	0.002
100-D	0.46	0.018	0.128						
100-H	0.53	*	0.144				0.008	*	0.002
100-F	0.51	0.022	0.124						
Hanford	1.7	0.015	0.212				0.010	0.001	0.002
Wye Barricade	0.55	0.089	0.243	*	*	*	0.005	*	0.002
Rattlesnake	0.66	0.062	0.187						
ERC	0.41	0.046	0.163						
Yakima Barricade	0.62	0.069	0.189	*	*	*	0.005	0.001	0.002
Vernita	0.36	0.013	0.158						
Wahluke #2	0.43	0.016	0.165						

*Less than the analytical limit.
No entry indicates no anlysis was performed.

TABLE 12 (Continued)

I-131, PARTICULATE TOTAL BETA, AND PARTICULATE TOTAL ALPHA IN THE ATMOSPHERE - 1972

Units of 10^{-12} μCi/ml

Off-Site

	Beta			I-131			Alpha		
Analytical Limit	0.02			0.02			0.001		
Location	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
Byers Landing	0.45	0.048	0.163	0.071	*	*	0.006	*	0.002
Ringold	0.57	0.030	0.183	0.026	*	*	0.006	0.001	0.002
Richland	0.43	0.042	0.170	0.050	*	*	0.005	0.001	0.002
Pasco	0.43	0.037	0.166	*	*	*	0.005	*	0.002
Kennewick	0.44	0.069	0.156						
Eltopia	0.40	0.035	0.147						
Walla Walla	0.45	0.021	0.150				0.004	*	0.001
McNary	3.6	0.042	0.286				0.006	0.001	0.002
Ellensburg	0.20	0.021	0.102						
Sunnyside	0.37	*	0.121						
Othello	0.44	0.032	0.176	*	*	*	0.006	*	0.002
Connell	0.58	*	0.163	*	*	*			
Berg Ranch	0.92	0.030	0.215	0.056	*	*	0.006	*	0.002
Wahluke Wm.	0.50	0.013	0.143	*	*	*			
New Moon	0.46	0.026	0.157	0.043	*	*			
Moses Lake	0.35	0.027	0.141						
Washtucna	0.42	0.058	0.159						
Benton City	0.41	0.045	0.174	*	*	*	0.005	*	0.002

*Less than the analytical limit.
No entry indicates no analysis was performed.

TABLE 13

AVERAGE CONCENTRATIONS OF GAMMA EMITTERS AND PLUTONIUM
ON SELECTED AIR FILTERS - 1972

Units of 10^{-12} μCi/ml

	^{90}Sr	$^{95}ZrNb$	$^{106}RuRh$	^{134}Cs	^{137}Cs-^{137m}Ba	$^{140}BaLa$	$^{144}CePr$	Total Pu
Concentration Guides	200	1000	200	400	500	1000	200	1
Active Areas								
Active Area #1	0.021	0.68	*0.80	0.06	3.1	0.61	*	0.00004
Active Area #2	0.003							0.0002
Active Area #3	0.003	0.044	0.16	*0.003	0.049	0.053	0.035	0.0001
Active Area #4	0.001	0.024	0.20	*0.002	0.004	0.047	0.042	0.000004
Active Area #5		0.027	0.24	0.007	0.01	0.13	0.055	
Inner Ring								
Inner SW Quadrant	0.002	0.032	0.26	*0.002	*0.002	*	0.038	0.00003
Inner NW Quadrant	0.001	0.030	0.22	*0.001	0.005	*	0.032	0.000009
Inner East Quadrant	0.001	0.036	0.27	*	0.012	*	0.042	0.00006
Eastern Quadrant								
Inner NE Quadrant	*0.0008	0.035	0.24	*	*0.0007	*	0.037	0.00002
Inner SE Quadrant	0.001	0.027	0.26	*0.0009	*0.001	*	0.044	0.00002
Perimeter Communities								
Outer NE Quadrant	0.001	0.022	0.17	*0.004	*0.002	0.14	0.047	0.00002
Outer SE Quadrant	*0.0008	0.026	0.24	*0.003	*0.001	0.028	0.061	0.00002
Outer West Quadrant	0.001	0.020	0.20	*0.002	*0.0007	*	*0.038	0.00003

*Less than analytical limit.

FIGURE 8

TOTAL BETA ACTIVITY IN THE ATMOSPHERE
100-AREAS AND VICINITY

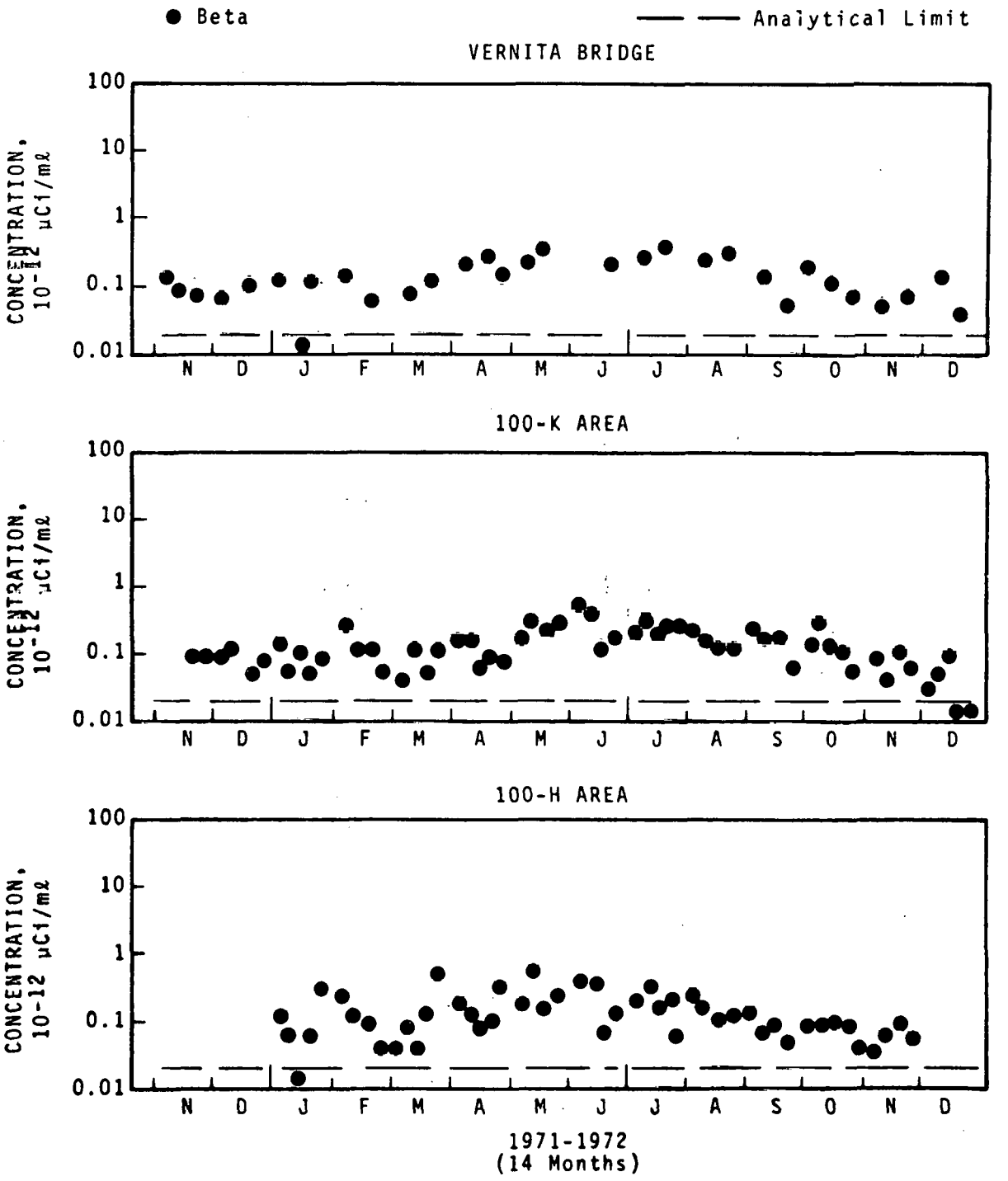


FIGURE 9

TOTAL BETA ACTIVITY IN THE ATMOSPHERE
100-AREAS AND VICINITY

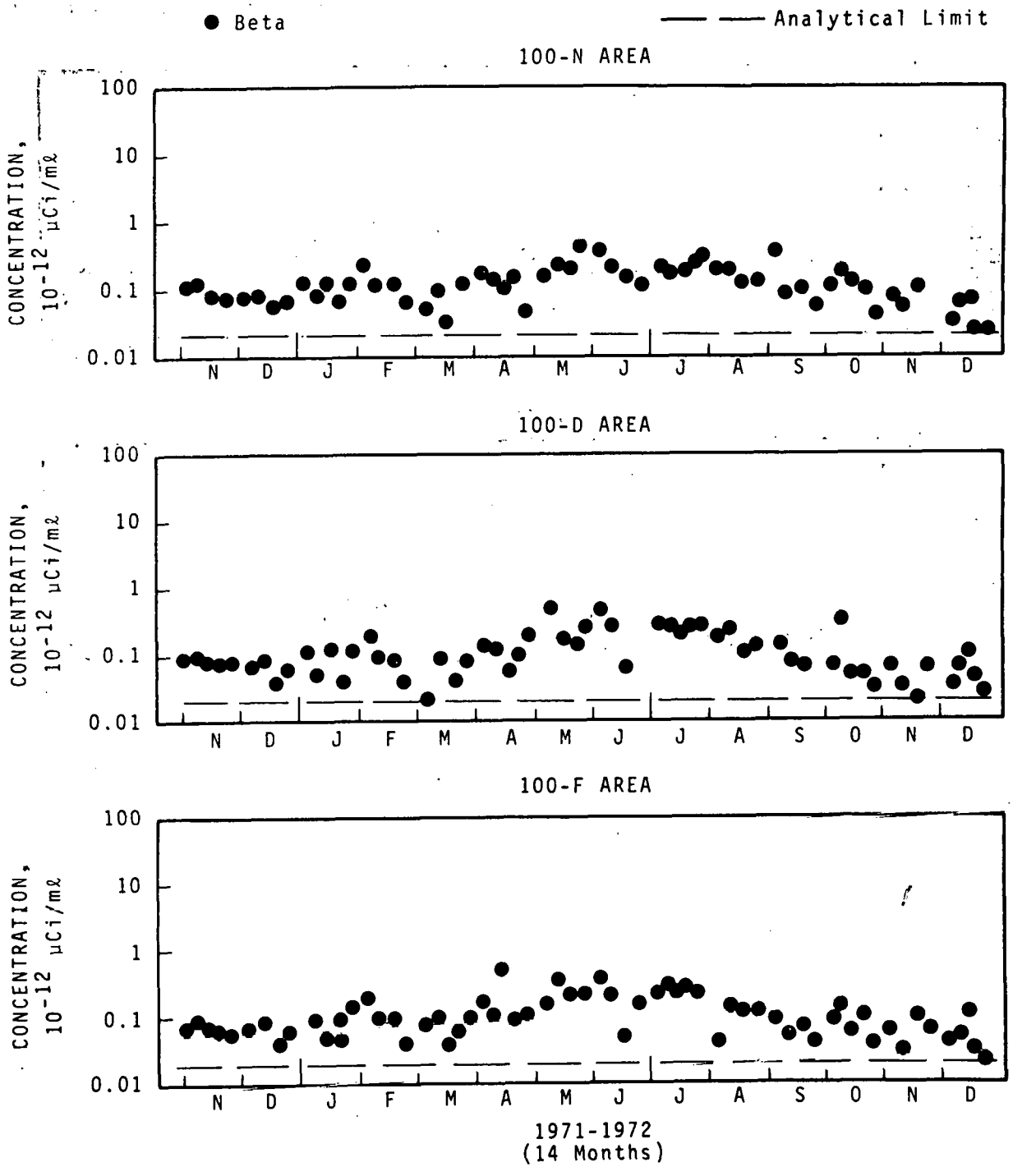


FIGURE 10

TOTAL BETA ACTIVITY IN THE ATMOSPHERE

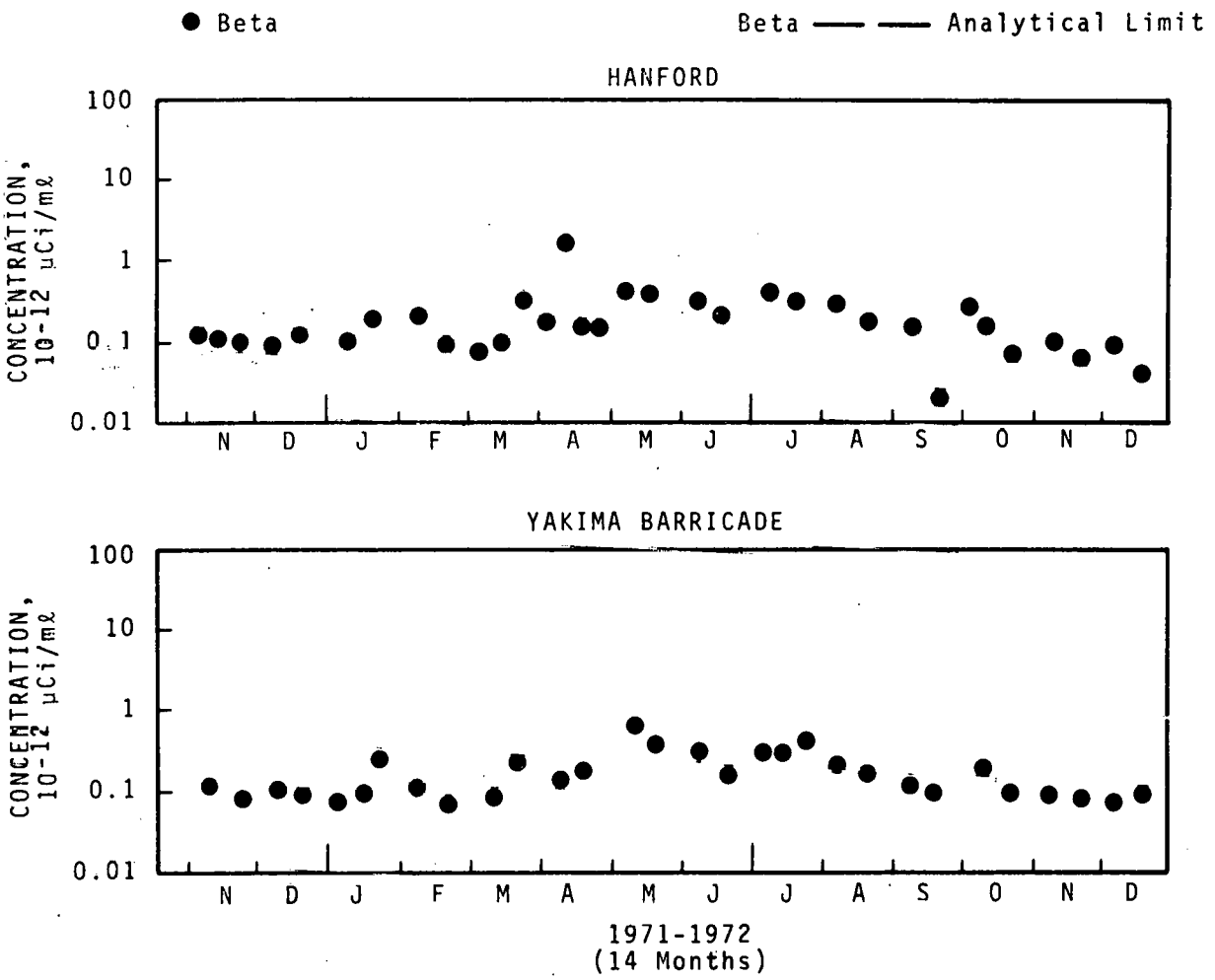


FIGURE 11

TOTAL BETA ACTIVITY IN THE ATMOSPHERE
200 AREAS

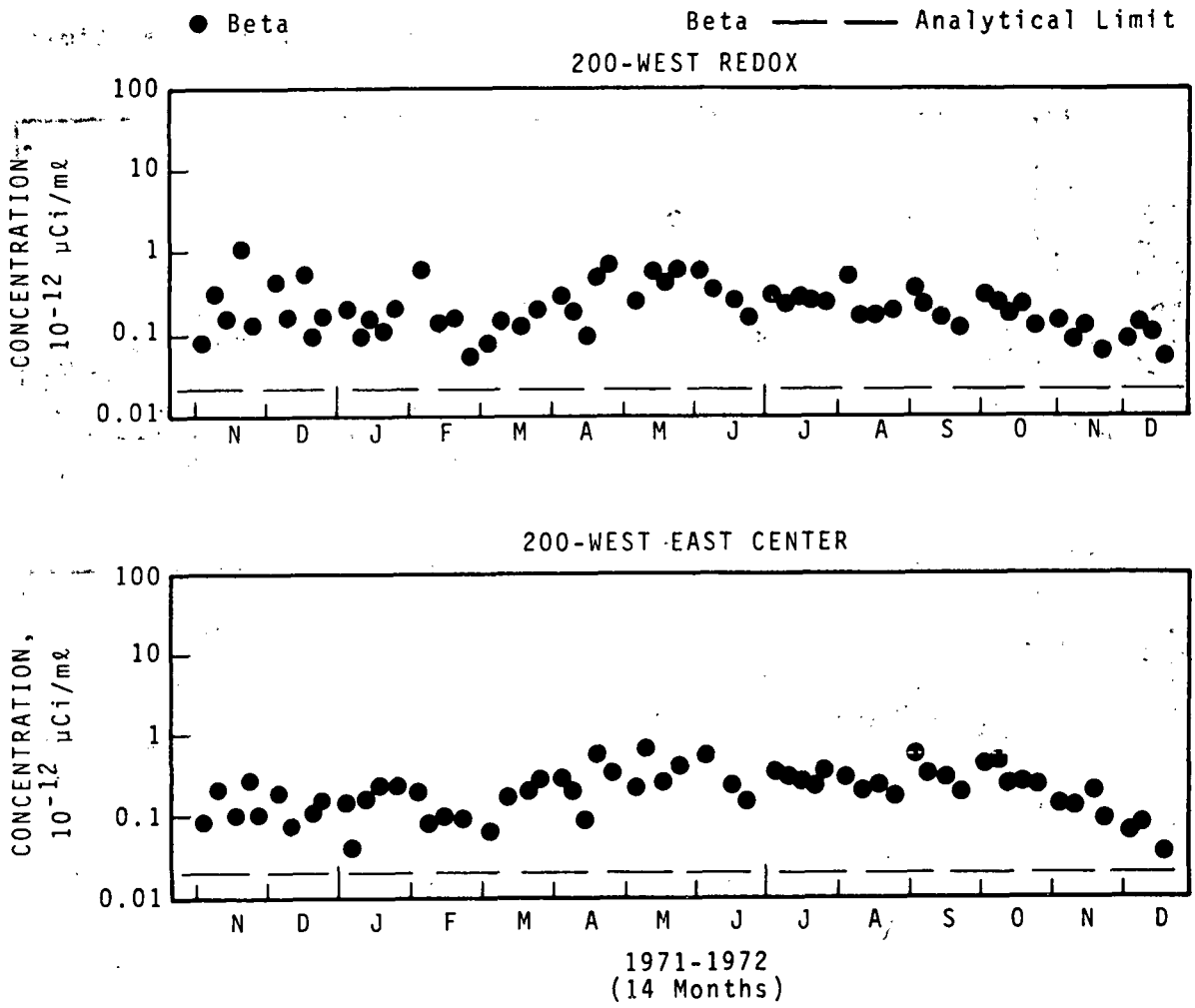


FIGURE 12

TOTAL BETA ACTIVITY IN THE ATMOSPHERE
200 AREAS AND INTERMEDIATE AREAS

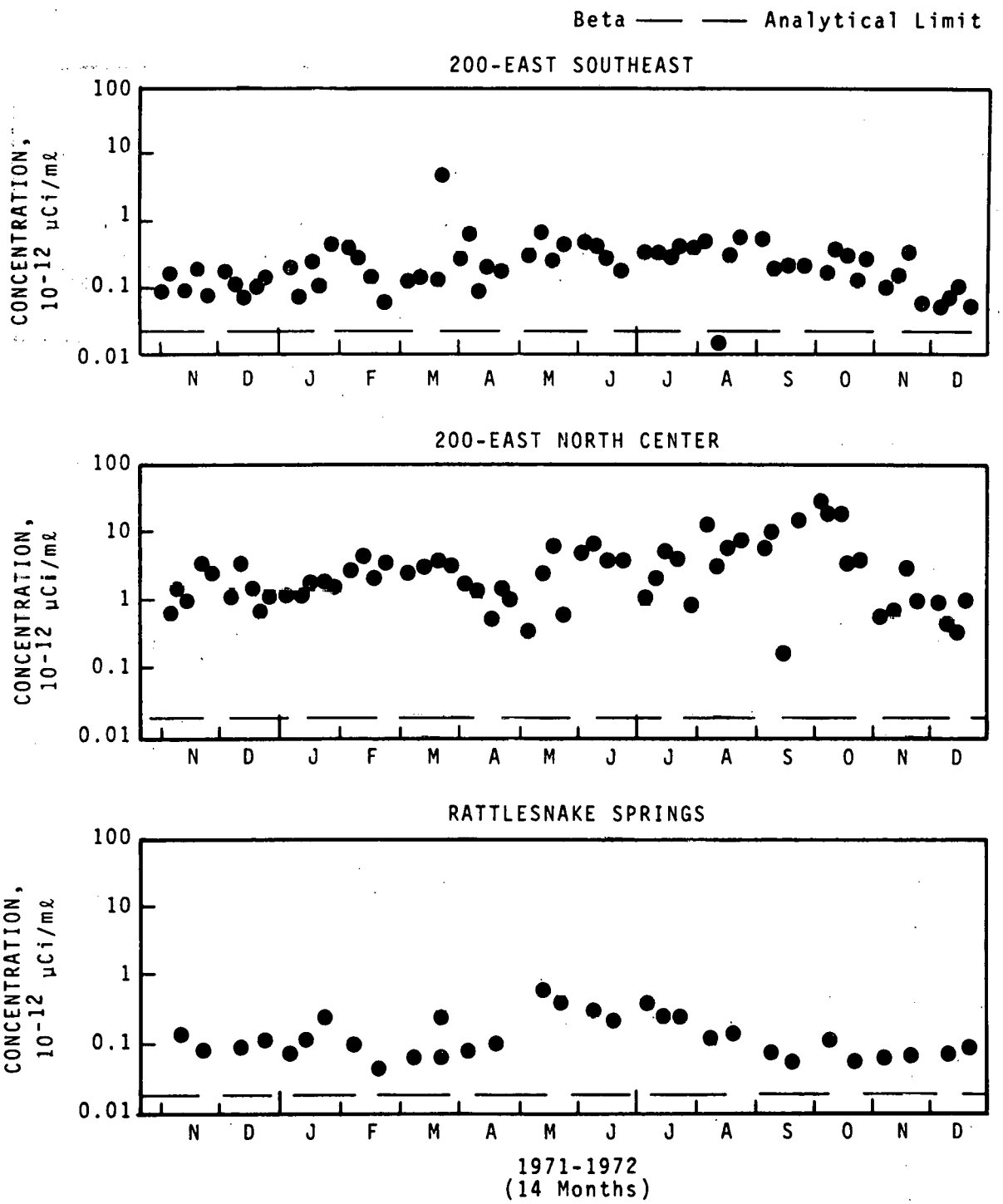


FIGURE 13

TOTAL BETA ACTIVITY IN THE ATMOSPHERE
INTERMEDIATE AREAS

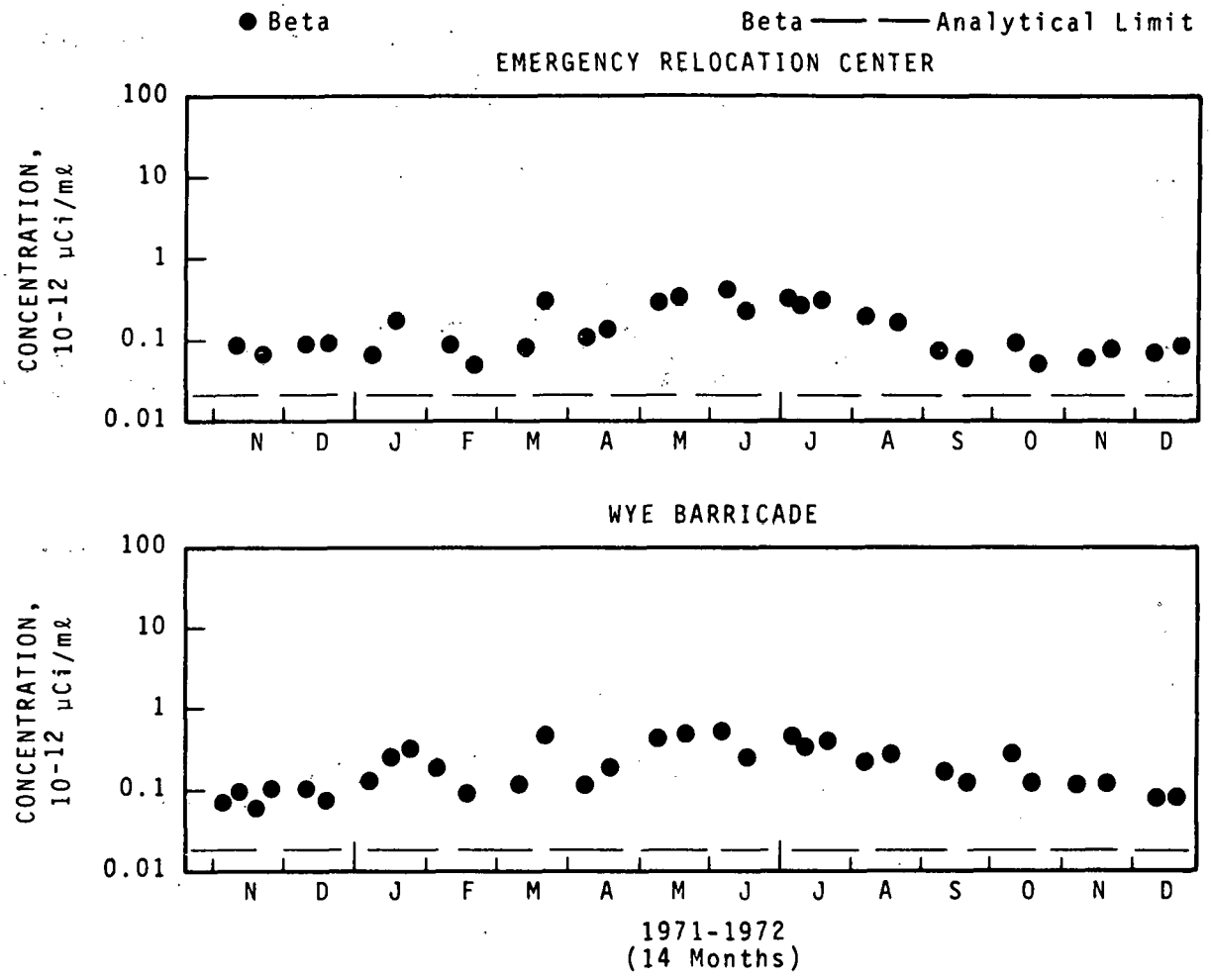
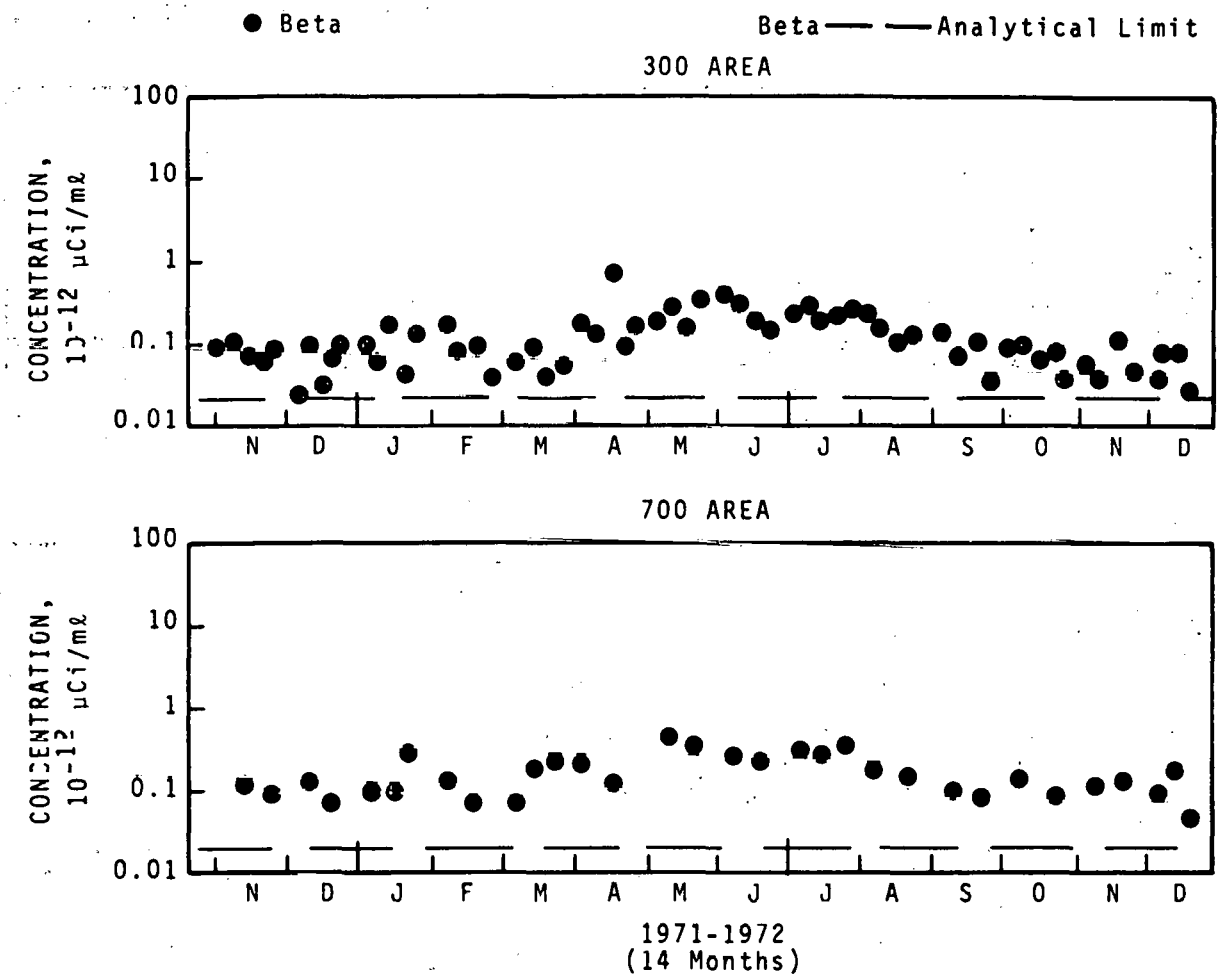


FIGURE 14

TOTAL BETA ACTIVITY IN THE ATMOSPHERE
300 AND 700 AREAS



IX. SOIL AND VEGETATION

Twenty-four locations for routine soil and vegetation sampling were established on and around the Hanford reservation in 1971. Specific locations are given in Map 6. Samples of the top two inches of soil and native vegetation (perennial) were taken at each of these locations at the end of September, 1972 and analyzed for plutonium, Sr-90, and gamma emitters. Gamma emitters in soil samples were measured with a lithium-drifted germanium detector, in vegetation samples with a sodium iodide crystal. As a result, slight differences in the gamma spectra were reported. Since the bulk of the vegetation was perennial, no conclusions should be drawn as to uptake of radionuclides from the soil.

The soil and vegetation results from thirteen perimeter and ten on-site locations are given in Tables 14 and 15. Concentrations averaged about the same as for 1971 except for Ru-106 and Cs-137 which were about a factor of four higher in 1972. CePr-144 was lower by a factor of ten from 1971 concentrations. Individual results showed no particular geographical pattern, and the concentrations measured are believed to be the result of regional fallout. The plutonium concentrations are believed to be typical of general regional levels for the arid western states. As in 1971, average concentrations of several radionuclides in soil were marginally higher in the on-site samples compared to the perimeter samples. On-site plutonium-238 concentrations in soil and vegetation were statistically the same as the perimeter. The average plutonium-239 concentration appears to be higher in the surface inch of soil for on-site locations as compared to off-site. This is primarily the result of a reduction in the reported off-site plutonium concentrations compared to 1971 measurements. Relatively high Pu-239 concentrations were found in soil from Hanford, 200 fire station, 200-E Hill, and Army Loop Road.

MAP 6

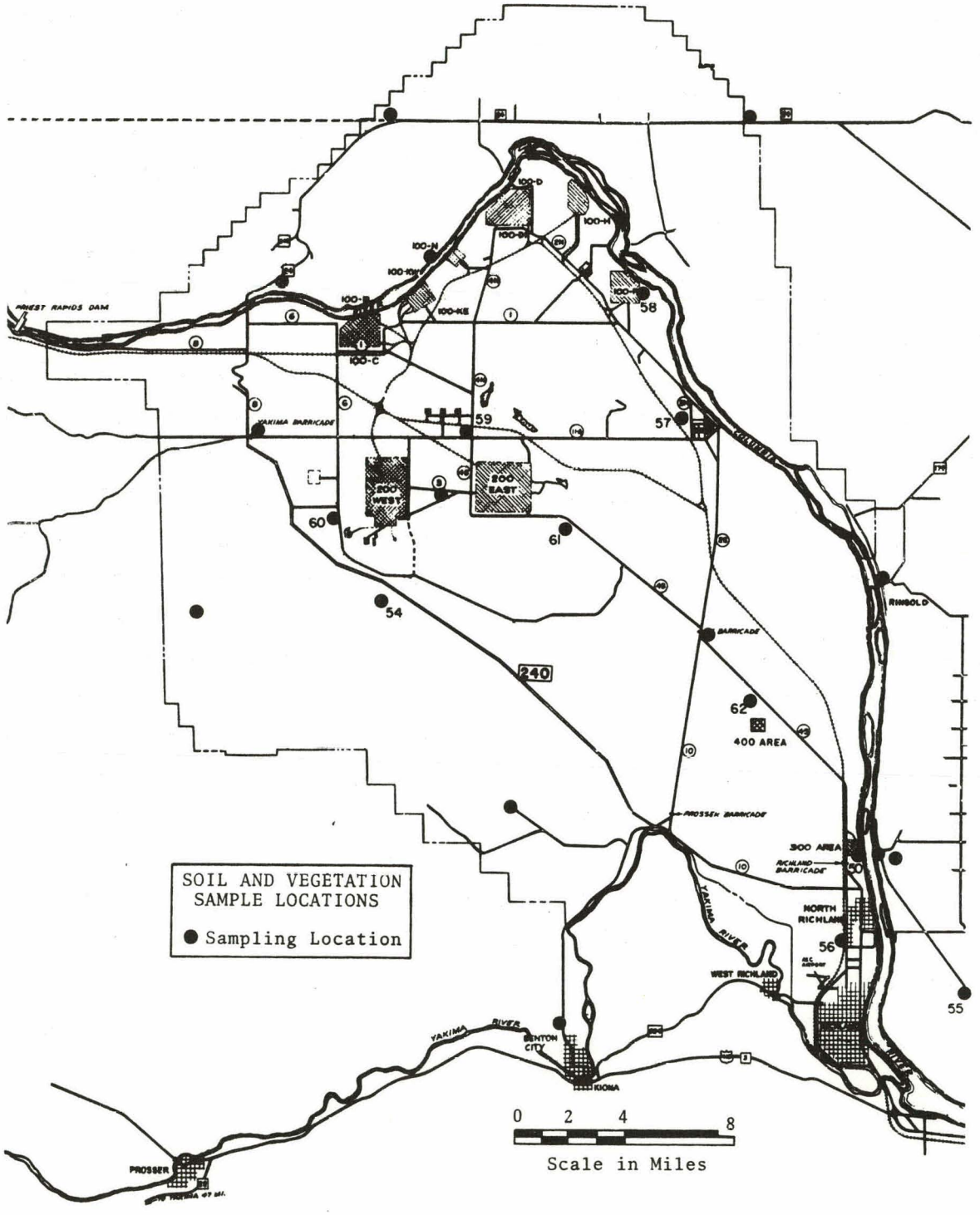

SOIL AND VEGETATION
SAMPLE LOCATIONS
● Sampling Location
0 2 4 8
Scale in Miles
PRIEST RAPIDS DAM
100-D
100-H
100-N
100-K
100-C
58
59
57
YAKIMA BARRICADE
200 WEST
200 EAST
60
61
54
240
62
400 AREA
PROSSER BARRICADE
300 AREA
RICHLAND BARRICADE
50
NORTH RICHLAND
56
WEST RICHLAND
55
YAKIMA RIVER
BENTON CITY
KIONA
PROSSER
RINGOLD
BARRICADE

TABLE 14

CONCENTRATIONS OF RADIONUCLIDES IN SOIL SAMPLES - 1972

Units of 10^{-6} μCi/gm

Location	^{40}K		^{58}Co		^{60}Co		^{65}Zn		^{90}Sr		$^{95}ZrNb$		^{106}Ru	
	1 in.	2 in.	1 in.	2 in.	1 in.	2 in.	1 in.	2 in.	1 in.	2 in.	1 in.	2 in.	1 in.	2 in.
On-Site														
W. of 100-N	16.	16.	.03	.11	.08	*	*	*	.04	.05	.29	.31	*	.89
331	16.	16.	*	.04	.11	*	*	*	.05	.06	.20	*	*	.84
FFTF	14.	14.	.07	.04	*	.11	.19	*	.05	.02	.29	.21	.51	.43
Wye Barricade	15.	17.	.03	*	*	*	*	*	.28	.18	.21	*	*	.60
Hanford	13.	14.	.06	*	.10	.10	*	*	.33	.26	*	.14	1.4	.49
100-F	11.	14.	.02	.03	*	*	*	*	.28	.10	*	*	1.2	1.2
200 Fire Station	14.	16.	.03	.03	*	*	*	*	.22	.11	.40	.20	.73	1.4
200-E Hill	15.	11.	*	*	*	*	*	*	.71	.30	*	.42	.53	*
Rt. 4x11A	16.	16.	*	*	*	*	*	*	.21	.05	*	*	.98	.59
Army Loop Road	12.	13.	*	*	*	*	*	*	.39	.05	.33	.38	1.4	.43
Average On-Site	14.	15.	.03	.03	.03	.03	.05	*	.26	.12	.22	.21	.73	.72
Perimeter														
Benton City	14.	14.	*	*	*	*	*	*	.38	.27	.27	*	*	1.6
ERC	16.	15.	*	*	.07	*	.18	*	.10	.03	*	*	1.5	.72
Rt. 240 CP54	14.	15.	*	*	.04	*	*	*	.20	.09	*	*	.81	*
Rattlesnake Springs	12.	14.	*	*	.10	*	*	*	.01	.03	*	*	.55	*
Yakima Barricade	13.	12.	*	*	*	*	*	*	.12	.11	.24	.04	*	*
Vernita	16.	16.	*	.041	*	.06	.10	*	.10	.04	.25	*	.57	.91
Wahluke #2	12.	14.	*	*	.04	*	*	*	.30	.13	*	.36	.48	*
Berg Ranch	12.	13.	*	.05	*	*	*	*	.20	.07	.25	.30	*	*
Ringold	16.	14.	.11	*	*	*	*	*	.12	.08	.54	*	1.3	*
Byers P.H.	20.	18.	*	*	*	*	*	*	.08	.09	1.2	.28	*	*
Byers Landing	18.	13.	*	*	*	*	*	*	.13	.18	.34	.13	*	*
Riverview	14.	13.	*	*	.15	*	*	*	.23	.17	*	*	.84	.70
North Richland	16.	14.	*	*	*	*	*	*	.32	.18	.23	*	2.2	*
Average Perimeter	15.	14.	.01	.01	.04	*	.02	*	.18	.11	.28	.12	.64	.36

*Less than the analytical limit.

TABLE 14 (Continued)

CONCENTRATIONS OF RADIONUCLIDES IN SOIL SAMPLES - 1972

Units of 10^{-6} μCi/gm

Location	^{134}Cs		^{137}Cs		$^{144}CePr$		^{224}Ra		^{226}Ra		^{238}Pu		^{239}Pu	
	1 in.	2 in.	1 in.	2 in.	1 in.	2 in.	1 in.	2 in.	1 in.	2 in.	1 in.	2 in.	1 in.	2 in.
On-Site														
W. of 100-N	*	.27	.65	.48	1.2	.76	2.1	1.6	*	.61	*	.006	.015	.022
331	*	*	.15	.25	.41	*	1.7	.88	.59	.62	*	.012	.003	.003
FFTF	.05	*	.13	.06	.39	*	1.0	1.2	*	.47	.004	.006	.005	.011
Wye Barricade	*	*	.76	.42	.79	1.3	1.5	2.4	.50	.79	.003	.005	.014	.016
Hanford	.18	.09	1.2	.31	.53	.89	.54	1.8	*	.56	.005	*	.024	.004
100-F	*	.06	.65	.41	.97	.74	1.6	1.3	*	.44	*	*	.009	.005
200 Fire Station	*	.06	.24	.29	.55	.80	1.2	2.4	.62	.64	*	*	.017	.012
200-E Hill	.08	.04	1.8	.14	.81	.75	.88	1.6	.59	.51	*	*	.023	.008
Rt. 4x11A	*	.07	.49	.30	.40	.51	2.1	2.4	.80	.59	*	*	.009	.009
Army Loop Road	*	*	1.4	.31	*	.84	1.3	3.2	.56	.88	*	.006	.021	.009
Average On-Site	.04	.06	.75	.30	.50	.68	1.4	1.9	.50	.61	.002	.004	.014	.010
Perimeter														
Benton City	*	.10	1.1	.84	1.3	1.4	1.6	1.8	.61	.55	*	*	.023	.011
ERC	*	.06	.04	*	.68	1.1	2.7	2.2	.69	.47	*	.011	.001	.013
Rt. 240 CP54	.04	.01	.51	.19	1.2	.32	1.9	2.3	.84	.77	.003	.004	.006	.004
Rattlesnake Springs	*	.13	1.5	.35	1.4	*	1.9	1.6	1.3	.86	*	*	.011	.006
Yakima Barricade	*	.07	.26	.36	.52	.93	1.6	1.6	.72	.56	.003	*	.005	.005
Vernita	*	.01	.26	.17	.73	*	.93	2.1	*	*	.008	*	.003	.001
Wahluke #2	*	.14	.72	.16	1.1	1.0	1.3	1.3	*	.81	*	.006	.010	.003
Berg Ranch	*	.12	.23	*	1.1	.65	1.4	1.2	.57	.66	*	.016	.007	.002
Ringold	*	*	.40	.048	.92	.49	1.8	1.8	.48	.94	.005	.016	.008	.022
Byers P.H.	.04	.08	.42	.59	1.8	1.2	1.4	2.6	.78	.88	*	*	.003	.003
Byers Landing	.05	*	.84	.88	1.5	.57	2.6	2.4	.56	.79	*	.003	.006	.013
Riverview	.05	*	.55	.45	.66	.52	1.4	1.6	*	.65	*	*	.008	.009
North Richland	*	*	.75	.36	*	.52	1.3	2.2	.52	.48	.012	.010	.009	.006
Average Perimeter	.01	.06	.58	.34	.99	.67	1.7	1.9	.62	.67	.003	.005	.008	.008

*Less than the analytical limit.

TABLE 15

CONCENTRATIONS OF RADIONUCLIDES IN VEGETATION - 1972

Units 10^{-6} μCi/gm of Vegetation

On-Site

Location	^{40}K	^{60}Co	^{65}Zn	^{90}Sr	$^{95}ZrNb$	^{106}Ru	^{137}Cs	$^{144}CePr$	^{238}Pu	^{239}Pu	U (μgm/gm)
W of 100-N	12.	*	-	.05	.44	3.0	1.2	*	*	.001	.13
331	12.	*	-	.05	.91	3.0	.14	.88	*	*	.22
FFTF	4.7	.16	-	.08	.79	2.5	1.9	*	*	.004	.05
Wye Barricade	6.9	.12	.46	.17	3.2	*	16.	*	*	.004	*
Hanford	6.5	*	-	.04	1.7	5.0	4.2	*	.005	.003	.01
100-F	5.8	.15	-	.13	2.6	7.2	7.0	.88	*	.002	.05
Rt 4 x 11A	11.	*	-	.04	.73	1.7	1.6	*	*	*	.02
Redox P.S.	26.	.13	5.5	.34	18.	*	120.	*	*	.007	.05
200 Fire Station	8.9	.11	.44	.13	2.7	*	12.	*	*	.006	.16
200 E. Hill	14.	.11	2.5	.03	8.7	*	55.	*	*	.008	.03
Average On-Site	11.	.09	.89	.10	4.0	*	22.	*	.001	.004	.07

Perimeter

Benton City	5.2	*	*	.08	.96	5.2	.73	1.2	.003	.002	.04
ERC	2.7	*	*	.11	2.1	5.7	1.9	4.4	.003	.007	.02
Rt 240 CP54	3.8	*	*	.12	1.5	5.2	2.7	*	*	.002	.02
Rattlesnake Spring	9.7	*	*	.03	1.0	2.9	.97	1.2	*	.010	.03
Yakima Barricade	10.	*	*	.07	1.1	4.6	1.7	*	*	.001	.12
Vernita	7.1	*	*	.11	2.0	3.8	5.8	*	*	.005	.04
Wahluke #2	9.8	*	*	.06	.66	5.7	.71	*	*	.006	.04
Berg Ranch	11.	.09	*	.10	1.4	1.9	1.2	*	*	.004	.13
Ringold	4.2	*	*	.05	.59	2.4	.56	*	.005	*	.02
Byers P.H.	11.	*	*	.05	.84	2.5	3.8	*	.003	.003	.23
Byers Landing	21.	*	*	.07	.34	2.1	1.0	*	.007	.010	.02
Riverview	15.	*	*	.85	.14	*	.24	*	*	.001	.04
North Richland	7.9	*	*	.04	.70	2.4	.79	.82	*	.001	.10
Average Perimeter	9.1	*	*	.13	1.0	3.5	1.7	.30	.003	.004	.06

*Less than the analytical limit.

X. RADIATION SURVEYS

A. Surface Contamination

1. Hanford Roads Survey

Hanford roads are routinely surveyed (Map 7) with a bioplastic scintillation detector attached to the front end of a truck and positioned about 0.6 meters (2 ft.) above the road surface. This road monitor has been described in BNWL-62.[4] Most traveled roads within the Hanford reservation were surveyed monthly.

During the year, several radioactive particles were found on or near Hanford roadways. The most significant of these occurrences was at the NE corner of 200-East on 9/21/72, and was associated with a spot along the railroad, as reported in Section X.2, Railroad Survey.

Other contaminated objects detected by road surveys are as follows. All of these objects were removed.

April 20: One speck found outside of 100-N on main road, approximately 30,000 c/m. This was attributed to the waste hauling operation.

September 8: Three specks, maximum of 3,000 c/m, were found on the west shoulder of the road between 100-N and the railroad tracks.

2. Railroad Survey

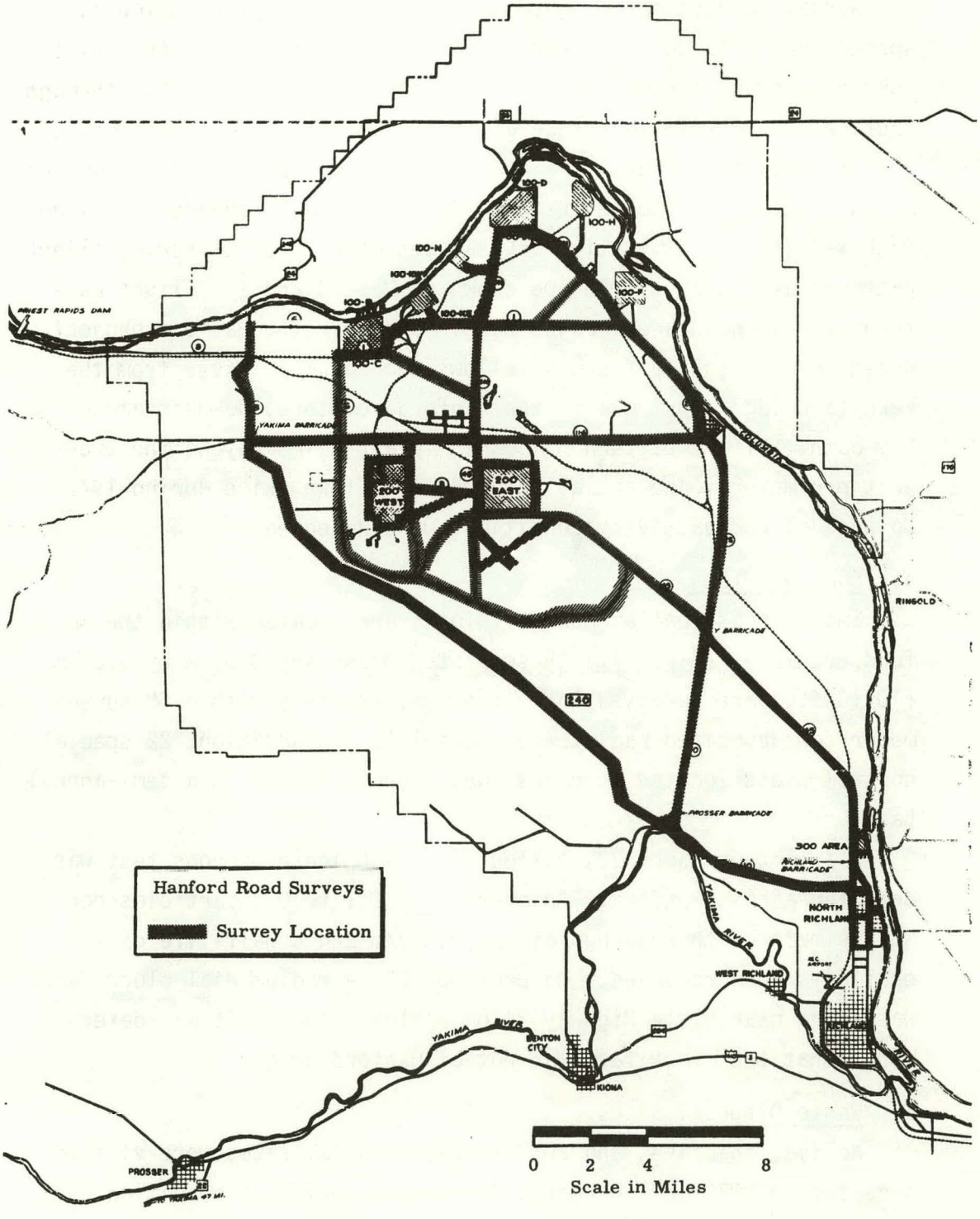
All Hanford railroad tracks located outside area fences are surveyed annually with the previously described road survey detector attached to a railroad maintenance car.

Only one contaminated spot was located this year. On Sept. 21, 1-1/2 miles west of 200-East gate at Station 84 in the track maintenance roadway a spot was found that read approximately 100,000 c/m at 2 feet above the ground. The recovered soil read 7.5 rads/hr. Radioanalysis yielded the following results:

Sr-Y-90	.018 μCi/gm
Ce-Pr-144	.001 μCi/gm
Ru-Rh-106	.0002 μCi/gm
Cs-137	.0001 μCi/gm

(4) Philipp, L.D. and E.M. Sheen, Aerial and Ground Survey Monitors, BNWL-62, Battelle-Northwest Laboratories, May, 1965.

MAP 7


Hanford Road Surveys
Survey Location
PRIEST RAPIDS DAM
100-D
100-H
100-N
100-F
100-B
100-C
YAKIMA BARRICADE
200 WEST
200 EAST
RINGOLD
240
PROSSER BARRICADE
300 AREA
RICHLAND BARRICADE
NORTH RICHLAND
YAKIMA RIVER
WEST RICHLAND
YAKIMA RIVER
BENTON CITY
KIONA
PROSSER
0 2 4 8
Scale in Miles

X. RADIATION SURVEYS (Continued)

3. Aerial Surveys

Aerial surveys can be used to detect contamination which is spread over a large land area. Like road, rail, and control plot surveys, aerial surveys are only qualitative in nature, but through routine use of this technique a capability for rapid assessment of an emergency situation is maintained. Aerial surveys are conducted at an altitude of 150 meters (500 ft.) using a three-inch by five-inch NaI (Tl) scintillation crystal detector. Aerial survey flight patterns used during 1972 are shown on Maps 8 and 9. Flight patterns 1, 2, and 3 are located within and near the Hanford project perimeter. Flight pattern 4 follows the Columbia River from the Vernita Bridge (upstream of the Hanford reactors) downstream to Plymouth. Flight pattern 5 lies 15-40 air miles beyond the project perimeter. The aerial surveys were flown twice during 1972. No unusual radioactivity conditions were detected.

4. Control Plots

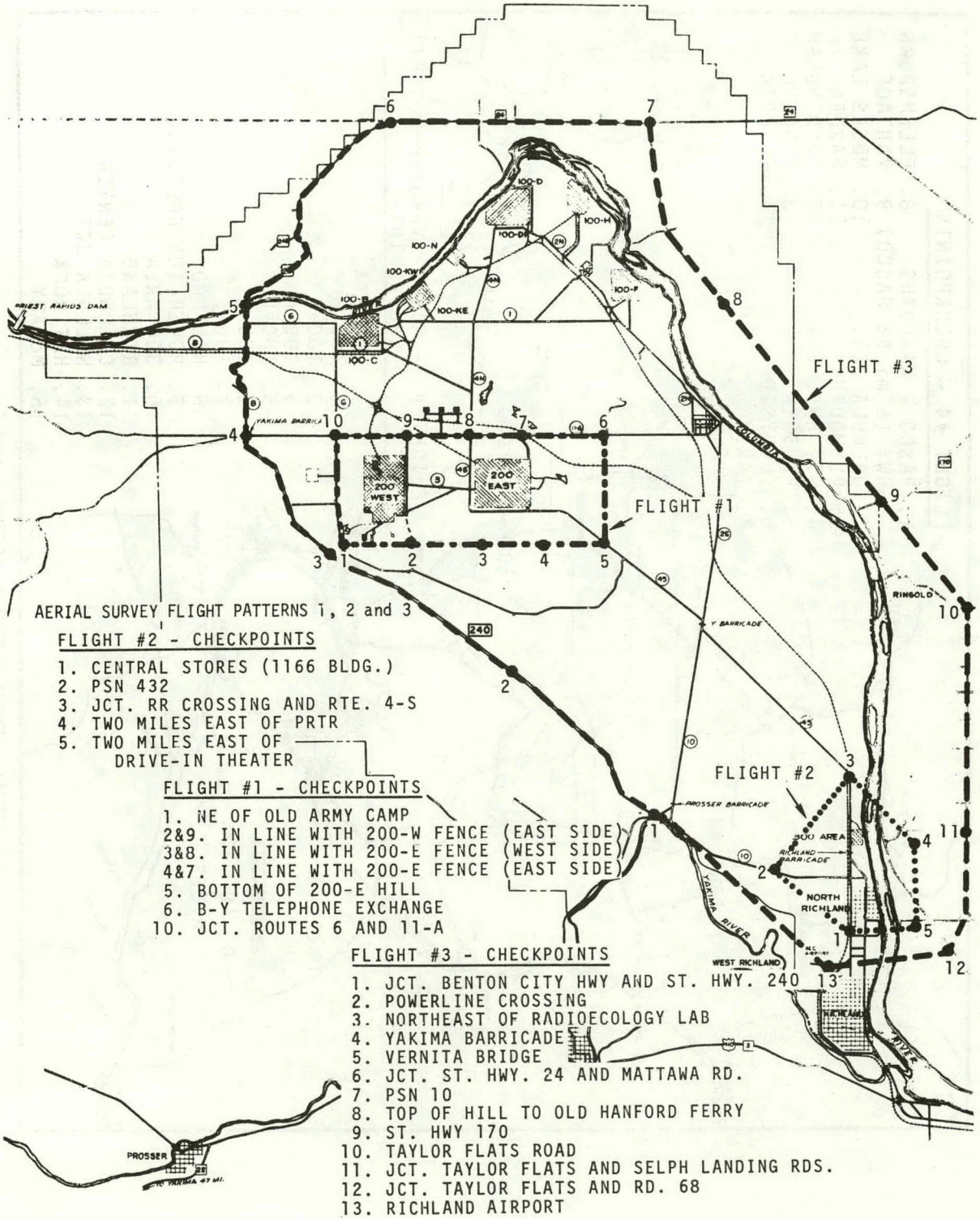
Small areas, called control plots, are located within the Hanford boudaries (Map 10). These plots, measuring 3.05 m by 3.05 m (10x10 ft.) are surveyed monthly or semi-monthly with a GM survey meter for deposited radioactive material. In addition, 22 special control plots located near test wells are surveyed on a semi-annual basis.

Starting on March 22, fallout from a Chinese weapons test was detected across Hanford. An average of 0.1 to 0.2 particles per square meter with readings of $\leq$20,000 c/m and a half-life of several days were recorded. On December 27, a radium dial clock face was found near State Highway 24 on Wahluke Slope. It was determined that the clock face was not of Hanford origin.

5. Waste Disposal Sites

Active, inactive, and retired waste burial sites were visited once during 1972 and inspected for general physical condition and evidence of disturbance. The locations of such sites outside plant

MAP 8



AERIAL SURVEY FLIGHT PATTERNS 1, 2 and 3

FLIGHT #2 - CHECKPOINTS

1. CENTRAL STORES (1166 BLDG.)
2. PSN 432
3. JCT. RR CROSSING AND RTE. 4-S
4. TWO MILES EAST OF PRTR
5. TWO MILES EAST OF DRIVE-IN THEATER

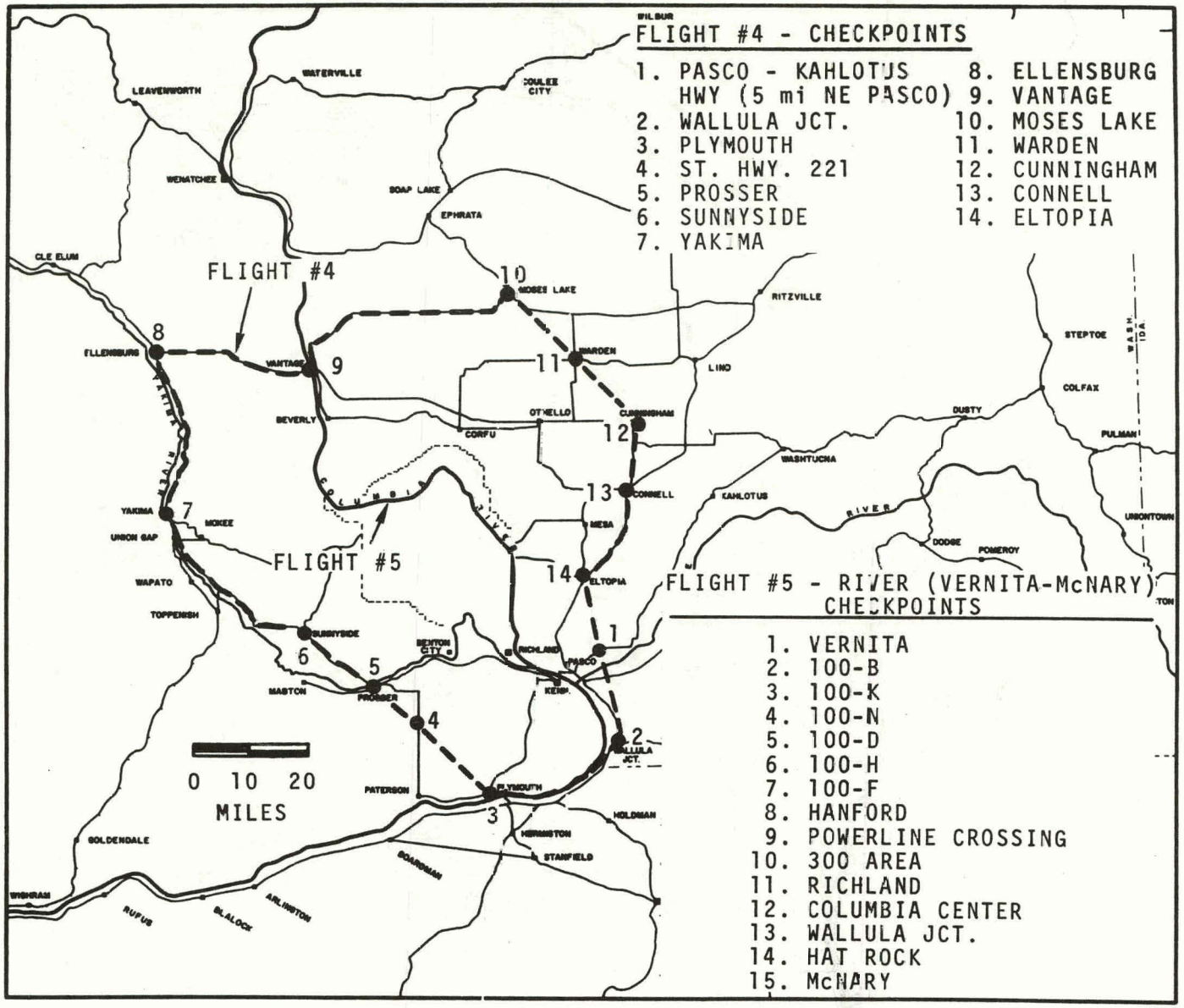
FLIGHT #1 - CHECKPOINTS

1. NE OF OLD ARMY CAMP
2&9. IN LINE WITH 200-W FENCE (EAST SIDE)
3&8. IN LINE WITH 200-E FENCE (WEST SIDE)
4&7. IN LINE WITH 200-E FENCE (EAST SIDE)
5. BOTTOM OF 200-E HILL
6. B-Y TELEPHONE EXCHANGE
10. JCT. ROUTES 6 AND 11-A

FLIGHT #3 - CHECKPOINTS

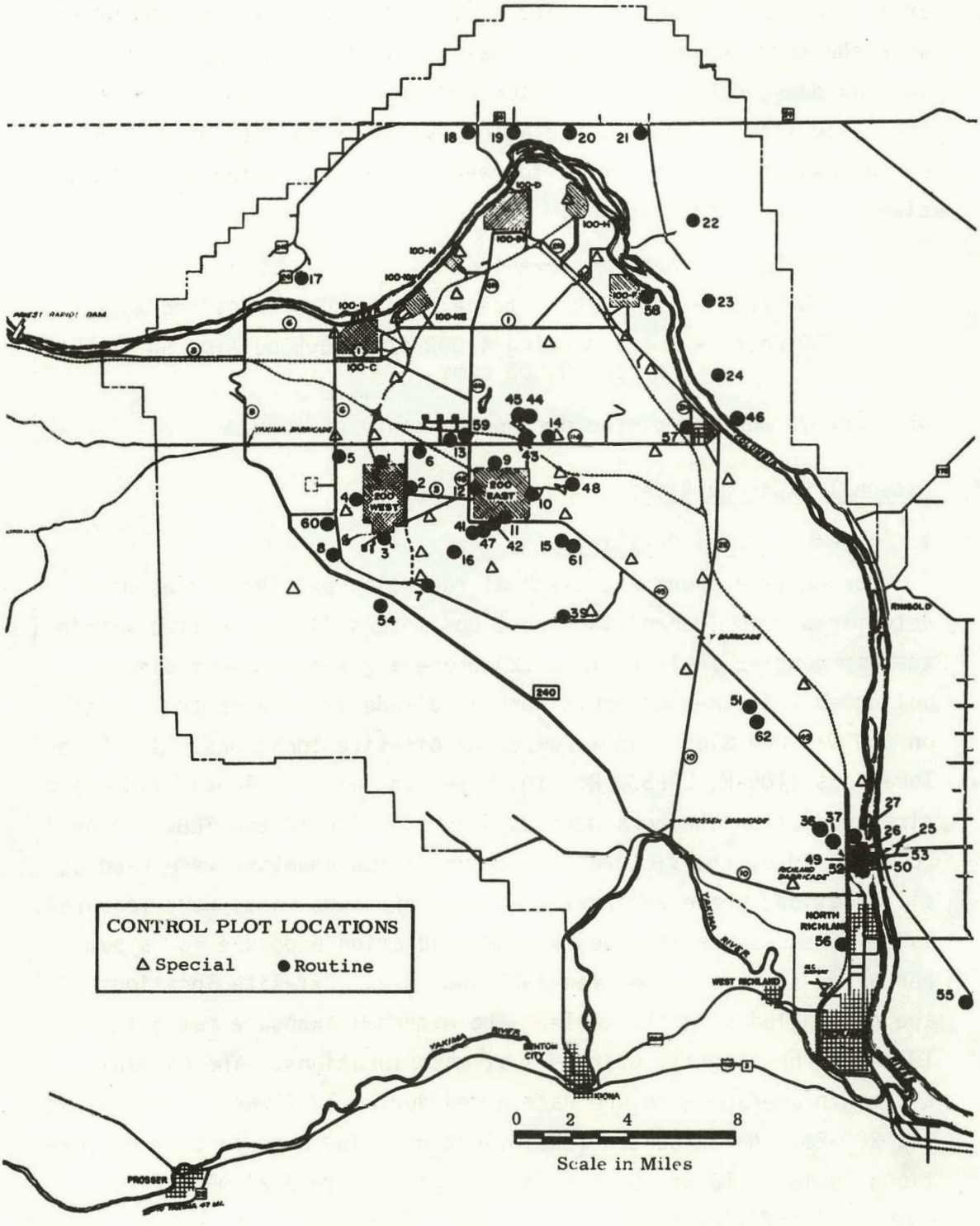
1. JCT. BENTON CITY HWY AND ST. HWY. 240
2. POWERLINE CROSSING
3. NORTHEAST OF RADIOECOLOGY LAB
4. YAKIMA BARRICADE
5. VERNITA BRIDGE
6. JCT. ST. HWY. 24 AND MATTAWA RD.
7. PSN 10
8. TOP OF HILL TO OLD HANFORD FERRY
9. ST. HWY 170
10. TAYLOR FLATS ROAD
11. JCT. TAYLOR FLATS AND SELPH LANDING RDS.
12. JCT. TAYLOR FLATS AND RD. 68
13. RICHLAND AIRPORT

MAP 9



AERIAL SURVEY FLIGHT PATTERNS 4 and 5

MAP 10


CONTROL PLOT LOCATIONS
△ Special ● Routine
0 2 4 8
Scale in Miles
200 WEST
200 EAST
100-D
100-H
100-N
100-B
100-C
100-F
YAKIMA BARRICADE
Y BARRICADE
PROSSER BARRICADE
RICHLAND BARRICADE
240
YAKIMA RIVER
WEST RICHLAND
NORTH RICHLAND
RICHLAND
BENTON CITY
KIONA
PROSSER
RINGOLD

X. RADIATION SURVEYS (Continued)

5. Waste Disposal Sites (Continued)

areas are shown on Map 11. The sites were generally in good order, with the most recurring problem being housekeeping, such as signs falling down, chains not in place and vegetation growing inside the waste sites. Unusual radiation levels or conditions were noted as follows and were reported to responsible contractor representatives for corrective action:

100-B	- Several cave-ins.
100 D/DR	- 100 mR/hr outside basin, some uncovered waste.
300-West	- Metal showing 4,000 c/m, junk outside SW corner 40,000 c/m.

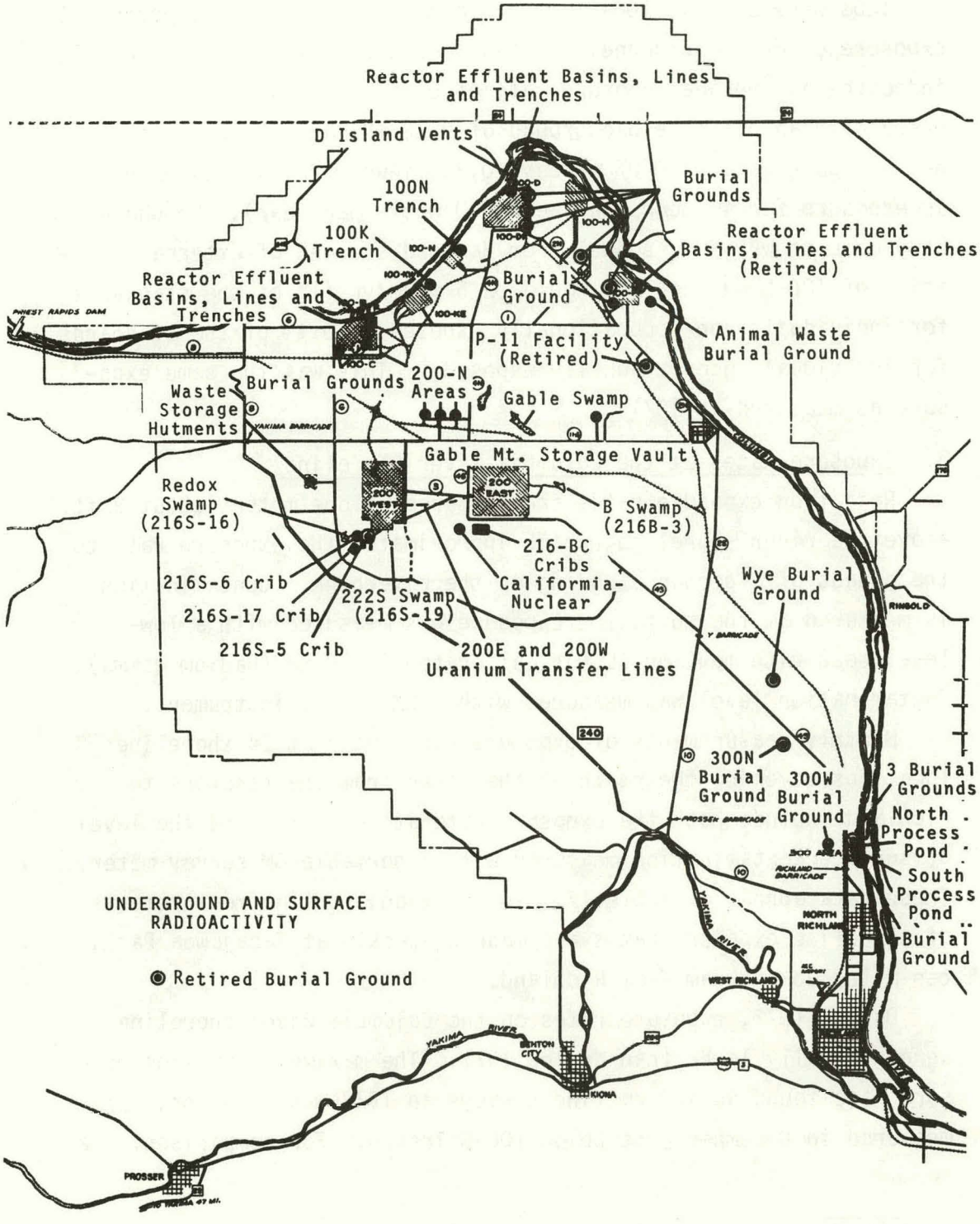
All surveys were completed during the month of June.

B. External Exposure Rates

1. Exposure Rates On-Plant

During 1972 trends in external radiation exposure rates were determined from Thermoluminescent Dosimeters (TLD), located within the air sampler shelters (Map 12) where air samples were also collected. TLD measurements were also made at nine control plots on the Wahluke Slope and a number of off-site locations. At three locations (100-N, WPPSS, Rt. 10, Mile 1.6, and 700-Area), Victoreen stray radiation chambers were used in addition to the TLD. Prior to July, 1970, the Victoreen stray radiation chambers were used at all locations where external radiation exposure rates were measured. Table 16 shows the average external radiation exposure for a number of on-site locations for 1971 and 1972. Off-site locations are not included in the table. The external exposure rates for 1972 were up slightly over 1971 at most locations. The maximum six-month average exposure rate noted during 1972 was 0.8 mR/day at the 200-East North Center (ENC) location. The average of the locations in Table 16 was 0.26 mR/day compared with 0.22 mR/day for a number of off-site locations. At most locations, the external exposure rate was relatively constant.

MAP 11


Reactor Effluent Basins, Lines and Trenches
D Island Vents
100N Trench
100K Trench
Burial Grounds
Reactor Effluent Basins, Lines and Trenches (Retired)
Reactor Effluent Basins, Lines and Trenches
Burial Ground
P-11 Facility (Retired)
Animal Waste Burial Ground
Waste Storage Hutments
Burial Grounds
200-N Areas
Gable Swamp
Gable Mt. Storage Vault
Redox Swamp (216S-16)
B Swamp (216B-3)
216-BC Cribs
California-Nuclear
Wye Burial Ground
216S-6 Crib
216S-17 Crib
216S-5 Crib
222S Swamp (216S-19)
200E and 200W Uranium Transfer Lines
300N Burial Ground
300W Burial Ground
3 Burial Grounds
North Process Pond
South Process Pond
Burial Ground
UNDERGROUND AND SURFACE RADIOACTIVITY
Retired Burial Ground
YAKIMA RIVER
PROSSER
KIONA
BENTON CITY
WEST RICHLAND
NORTH RICHLAND
RICHLAND
RINGOLD
240

X. RADIATION SURVEYS (Continued)

2. 100-N Area

TLDs were used at 100-N Area in order to estimate the potential exposure of WPPSS personnel. Measurements with the TLD during 1972 indicated an average exposure rate of 0.29 mR/day at 100-N compared with an off-site background of 0.22 mR/day. Based on the net exposure rate of 0.07 mR/day (0.29 minus 0.22) and assuming an exposure for 40 hours per week (50 weeks per year), the whole body dose to WPPSS personnel from Hanford sources of external radiation of 100-N during 1972 would be 5 mrem/yr (1% of the standards for individuals non-occupationally exposed or 0.1% of the standards for individuals occupationally exposed). This was the same exposure as measured in 1971.

3. Exposure Rates at the Columbia River Shoreline

Radiation exposure rates are measured at one meter (about 3 ft.) above the river shoreline, which approximates the exposure rate to the gonads of a person standing on the riverbank. Contamination is measured at the surface. Exposure was measured with a low-level dose rate monitor (LLM)* calibrated in μR/hr (Radium gamma). Contamination level was measured with a GM survey instrument.

Monthly measurements of exposure rates made at 24 shoreline locations covering the reach of the river from the reactors to Richland include both the exposure rate at one meter and the levels of surface contamination measured with a portable GM survey meter. These data appear in Table 17. In addition, routine measurements of shoreline exposure rates are made bi-weekly at Sacajawea Park, ten miles downstream from Richland.

During 1972, exposure rates on the Columbia River shoreline were generally lower than during 1971. The maximum shoreline exposure rate found during routine surveys in 1972 was 28 μR/hr, measured in December just below 100-N Trench. For comparison, the

*Manufactured by Nuclear Enterprises Limited, Canada.

X. RADIATION SURVEYS (Continued)

3. Exposure Rates at the Columbia River Shoreline (Cont'd)

maximum shoreline exposure rate measured during 1971 was 86 μR/hr at three locations---above 181 KE, 100-F Slough, and Hanford.

The maximum level of surface shoreline contamination encountered during 1972, 300 cpm (GM), was detected below 100-N Trench location in January.

4. Exposure Rates Below the Surface of the Columbia River

During 1972, exposure rates in the river were determined from TLD contained within submerged plastic bottles at the locations shown in Map 13.

Six-month averages for 1972 are shown in Table 18 with data from 1971 for comparison.

Exposure rates in the river during 1972 were about the same as the latter half of 1971. Prior to July, 1970, exposure rates in the river were determined from a cluster of five pencil ionization chambers.

MAP 12

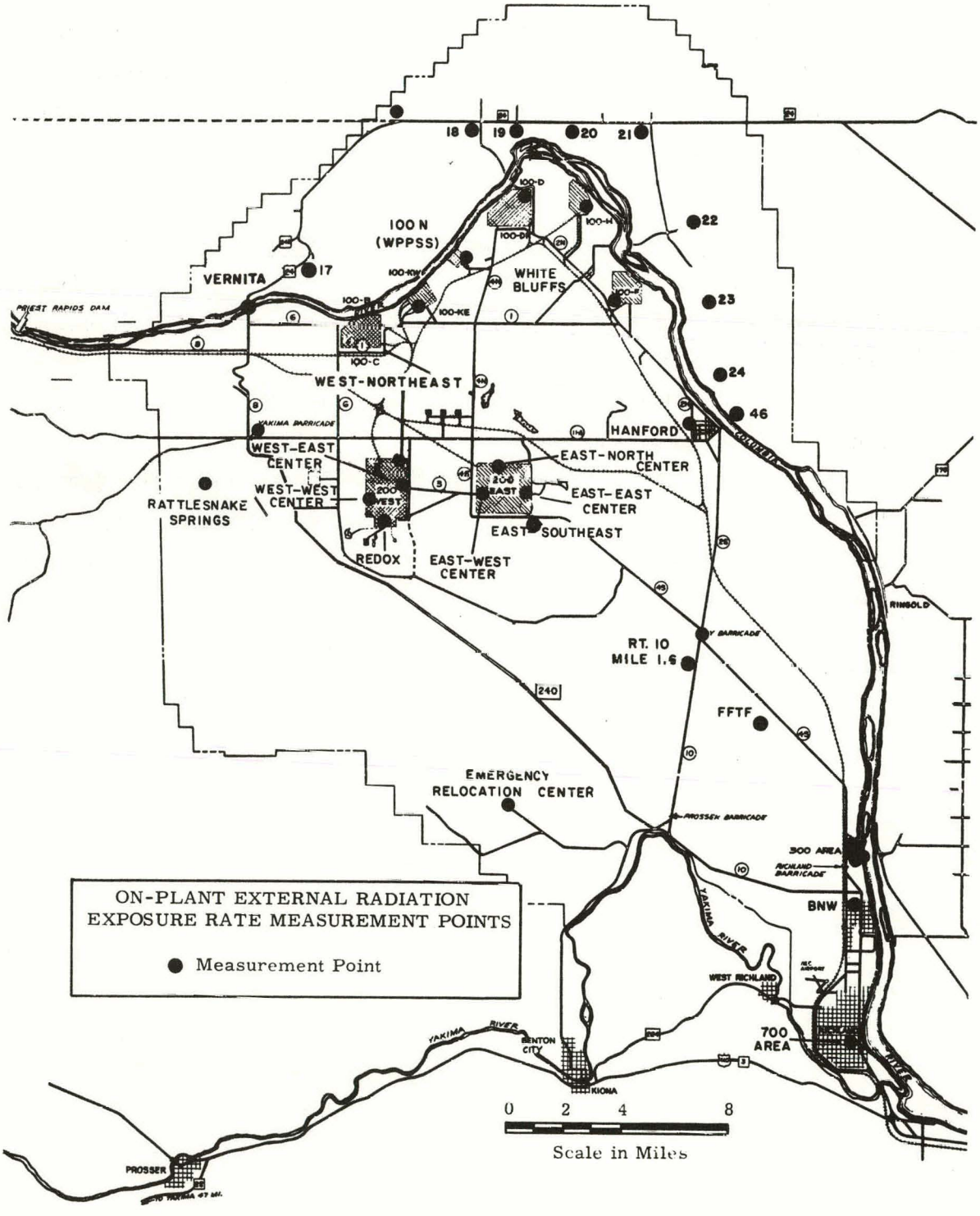

18
19
20
21
22
23
24
46
17
100 N
(WPPSS)
WHITE
BLUFFS
VERNITA
PRIEST RAPIDS DAM
100-D
100-H
100-DR
100-KW
100-KE
100-B
100-C
WEST-NORTHEAST
YAKIMA BARRICADE
HANFORD
WEST-EAST
CENTER
EAST-NORTH
CENTER
WEST-WEST
CENTER
200
WEST
200
EAST
EAST-EAST
CENTER
RATTLESNAKE
SPRINGS
EAST SOUTHEAST
REDOX
EAST-WEST
CENTER
RINGOLD
RT. 10
MILE 1.6
240
FFTF
EMERGENCY
RELOCATION CENTER
PROSSER BARRICADE
300 AREA
RICHLAND
BARRICADE
BNW
YAKIMA RIVER
WEST RICHLAND
700
AREA
YAKIMA RIVER
BENTON
CITY
KIONA
PROSSER
ON-PLANT EXTERNAL RADIATION
EXPOSURE RATE MEASUREMENT POINTS
Measurement Point
0 2 4 8
Scale in Miles

TABLE 16

AVERAGE EXTERNAL GAMMA EXPOSURE RATES

Units of mR/day

Location	1971 Jan-June	1971 July-Dec	1972 Jan-June	1972 July-Dec
100 Areas				
Vernita	0.22	0.20	0.24	0.26
Midway				
100-B				
100-K	0.21	0.21	0.31	0.28
100-N				
*100-N (WPPSS)	0.42*	0.41*	0.42*	0.49*
100-N (WPPSS)	0.20	0.20	0.28	0.30
100-D	0.16	0.25	0.22	0.20
100-F	0.22	0.15	0.23	0.23
Hanford	0.16	0.16	0.21	0.21
100-H			0.24	0.23
200-West Area				
Redox	0.31	0.23	0.25	0.27
West-Center	0.22	0.23	0.30	0.31
East-Center	0.16	0.16	0.22	0.21
West-Northeast	0.18	0.19	0.24	0.26
200-East Area				
North-Center	0.36	0.36	0.56	0.78
West-Center	0.45	0.29	0.21	0.21
Southeast	0.22	0.22	0.28	0.27
East-Center	0.80	0.22	0.34	0.24
Wahluke Slope				
C.P. 17	0.20	0.24	0.25	0.25
C.P. 18	0.20	0.20	0.26	0.25
C.P. 19	0.19	0.19	0.24	0.23
C.P. 20	0.20	0.20	0.24	0.25
C.P. 21	0.19	0.18	0.27	0.24
C.P. 22	0.20	0.18	0.24	0.25
C.P. 23	0.19	0.19	0.24	0.24
C.P. 24	0.20	0.20	0.25	0.25
C.P. 46	0.19	0.19	0.24	0.25
Other On-Site				
Yakima Barricade	0.18	0.20	0.28	0.25
Rattlesnake Springs	0.20	0.16	0.20	0.22
Emergency Relocation Center	0.21	0.21	0.24	0.26
FFTF Site	0.20	0.18	0.23	0.23
WYE Barricade	0.16	0.15	0.19	0.20
*Rt. 10 Mile 1.6	0.41*	0.39*	0.38*	0.42*
Rt. 10 Mile 1.6	0.18	0.17	0.26	0.25
300 Area (3705 Bldg)	0.22	0.21	0.26	0.24
300 Area (320 Bldg)	0.20	0.16	0.26	0.25
300 Area (331 Bldg)	0.23	0.17	0.22	0.23
300 Pond	0.26	0.22	0.40	0.25
ACRMS	0.18	0.16	0.24	0.24

*Measurements with stray radiation chambers.
No entry indicates no measurement was performed.

TABLE 17

MAXIMUM READINGS[a] FROM MONTHLY SHORELINE SURVEYS FOR 1972

(μR/hr with c/m in Parentheses)

A. COLUMBIA RIVER PLANT SHORE

Date	382.5 P[b] Above 181 KW		381.5 P Below 181 KE		379.4 P 100-N Trench		379.0 P Below 100-N		369.7 P White Bluff Ferry		368.3 P 100-F Slough		362.0 P Hanford		350.4 P Powerline Cross.		343.3 P Port of Benton		340.5 P Richland	
	LLM	(GM)	LLM	(GM)	LLM	(GM)	LLM	(GM)	LLM	(GM)	LLM	(GM)	LLM	(GM)	LLM	(GM)	LLM	(GM)	LLM	(GM)
1/20	12	(150)	13	(150)	25	(300)	18	(250)	13	(200)	10	(150)	15	(250)	15	(150)			12	(150)
2/23	12	(100)	12	(150)	15	(150)	12	(100)	11	(100)	12	(100)	12	(100)	13	(150)			12	(150)
3/16	10	(100)	8	(100)	15	(150)	10	(100)	8	(150)	9	(100)	8	(100)	7	(100)			10	(100)
4/26	8	(100)	12	(75)	14	(150)	12	(150)	14	(100)	15	(150)	17	(150)	22	(150)			12	(150)
5/23	12	(150)	12	(150)	18	(200)	15	(200)	14	(200)	14	(150)	12	(150)	13	(150)			12	(150)
6/21	12	(100)	10	(200)	20	(200)	10	(150)	10	(150)	11	(150)	11	(150)	11	(200)			12	(150)
7/24	13	(100)	10	(100)	22	(150)	10	(100)	8	(100)			12	(150)	13	(100)			7	(100)
8/18	15	(150)	15	(150)	15	(170)	22	(100)	15	(150)	15	(150)	15	(150)	15	(150)			15	(100)
9/25	10	(100)	12	(150)	22	(200)	11	(100)	10	(100)	15	(150)	15	(150)	11	(125)	10	(100)	12	(125)
10/20	12	(100)	20	(150)	23	(150)	14	(150)	16	(150)	18	(150)	15	(150)	17	(100)	11	(100)	12	(100)
11/16	9	(100)	9	(100)	20	(150)	12	(100)	11	(100)	12	(100)	11	(100)	11	(100)	10	(100)	10	(100)
12/19	10	(100)	11	(100)	28	(200)	11	(100)	13	(100)	12	(100)	14	(100)	12	(100)	13	(100)	12	(100)

B. COLUMBIA RIVER - ISLAND LOCATION

Date	377.4 I D Island		375.8 IF E Island		373.4 IP Locke Island		371.1 IP Locke Island		367.0 IF 100-F Slough		355.7 I[d] Near Ringold	
	LLM	(GM)	LLM	(GM)	LLM	(GM)	LLM	(GM)	LLM	(GM)	LLM	(GM)
1/20	20	(200)	12	(200)	9	(150)	12	(150)	13	(200)		
2/23	13	(150)	10	(100)	10	(100)	10	(100)	13	(150)	10	(100)
3/16	10	(100)	7	(100)	9	(100)	7	(150)	12	(100)	8	(100)
4/26	17	(150)	11	(100)	13	(100)	12	(100)	17	(150)	14	(100)
5/23	10	(150)	12	(150)			11	(100)	10	(150)	10	(100)
6/21	12	(150)	10	(150)			11	(150)	15	(150)	10	
7/24	13	(150)	12	(100)	13	(100)	12	(100)	10	(100)	13	(100)
8/18	20	(175)	12	(150)	12	(150)	14	(150)	18	(150)	15	(150)
9/25	15	(150)	12	(125)	13	(125)	12	(125)	12	(125)	12	(125)
10/20	15	(150)	15	(150)	13	(100)	13	(100)	12	(100)	14	(100)
11/16	9	(100)	10	(100)	9	(100)	10	(100)	11	(100)	10	(100)
12/19	15	(100)	13	(100)	17	(100)	11	(100)	14	(100)	13	(100)

TABLE 17 (Continued)

MAXIMUM READINGS[a] FROM MONTHLY SHORELINE SURVEYS FOR 1972
(μR/hr with c/m in Parentheses)

C. COLUMBIA RIVER - FAR SHORE

	381.0 F		378.4 F		369.8 F		362.0 F[d]		359.1 F		354.7 F[c]		350.4 F		345.2 F	
Date	100-K Trench		Above 181 D		White Bluffs Ferry		Hanford		Savage Island		Ringold		Powerline Cross.		Byers Landing	
	LLM	(GM)	LLM	(GM)	LLM	(GM)	LLM	(GM)	LLM	(GM)	LLM	(GM)	LLM	(GM)	LLM	(GM)
1/20	8	(100)	10	(150)	14	(200)	15	(250)	10	(150)	10	(150)	13	(150)	25	(200)
2/23	9	(100)	8	(100)	13	(150)	15	(150)	10	(100)	9	(100)	12	(150)	12	(150)
3/16	10	(100)	8	(100)	7	(150)	8	(100)	10	(100)	8	(100)	9	(100)	7	(100)
4/26	10	(75)	10	(150)	11	(100)	19	(150)	10	(100)	13	(150)	13	(150)	21	(150)
5/23	11	(100)	12	(100)	12	(150)	10	(100)	10	(100)	10	(100)	12	(150)	10	(150)
6/21	10	(100)	10	(150)	10	(150)	10	(150)	11	(150)	10	(150)	20	(200)	14	(150)
7/24	13	(100)	10	(100)	10	(100)	12	(100)	11	(100)	10	(150)	10	(100)	13	(150)
8/18	15	(150)	15	(100)	12	(150)	15	(150)	15	(150)	15	(150)	15	(150)	12	(150)
9/25	10	(100)	12	(125)	10	(100)	12	(125)	12	(125)	12	(125)	12	(125)	14	(150)
10/20	20	(150)	13	(150)	11	(100)	18	(150)	13	(100)	16	(75)	16	(75)	17	(125)
11/16	8	(100)	8	(100)	9	(100)	12	(100)	11	(100)	10	(100)	11	(100)	13	(100)
12/19	12	(100)	15	(100)	12	(100)	16	(100)	8	(100)	13	(100)	15	(100)	15	(100)

[a] Measurements reported in μR/hr are taken 1 meter above the ground and 1 meter back from the water's edge. Measurements reported in () are the maximum c/m found with a GM in the immediate vicinity of the water's edge.

[b] River miles measured from the mouth of the Columbia. Plant shore, far shore, and island are designated by P, F, and I, respectively.

[c] Point open to the general public during the entire year.

[d] Point only open to the general public on Wednesdays, Saturdays, and Sundays, during the hunting season.

No entry indicates no measurement was performed.

TABLE 18

AVERAGE EXPOSURE RATES BELOW THE SURFACE OF THE COLUMBIA RIVER (1970-1972)

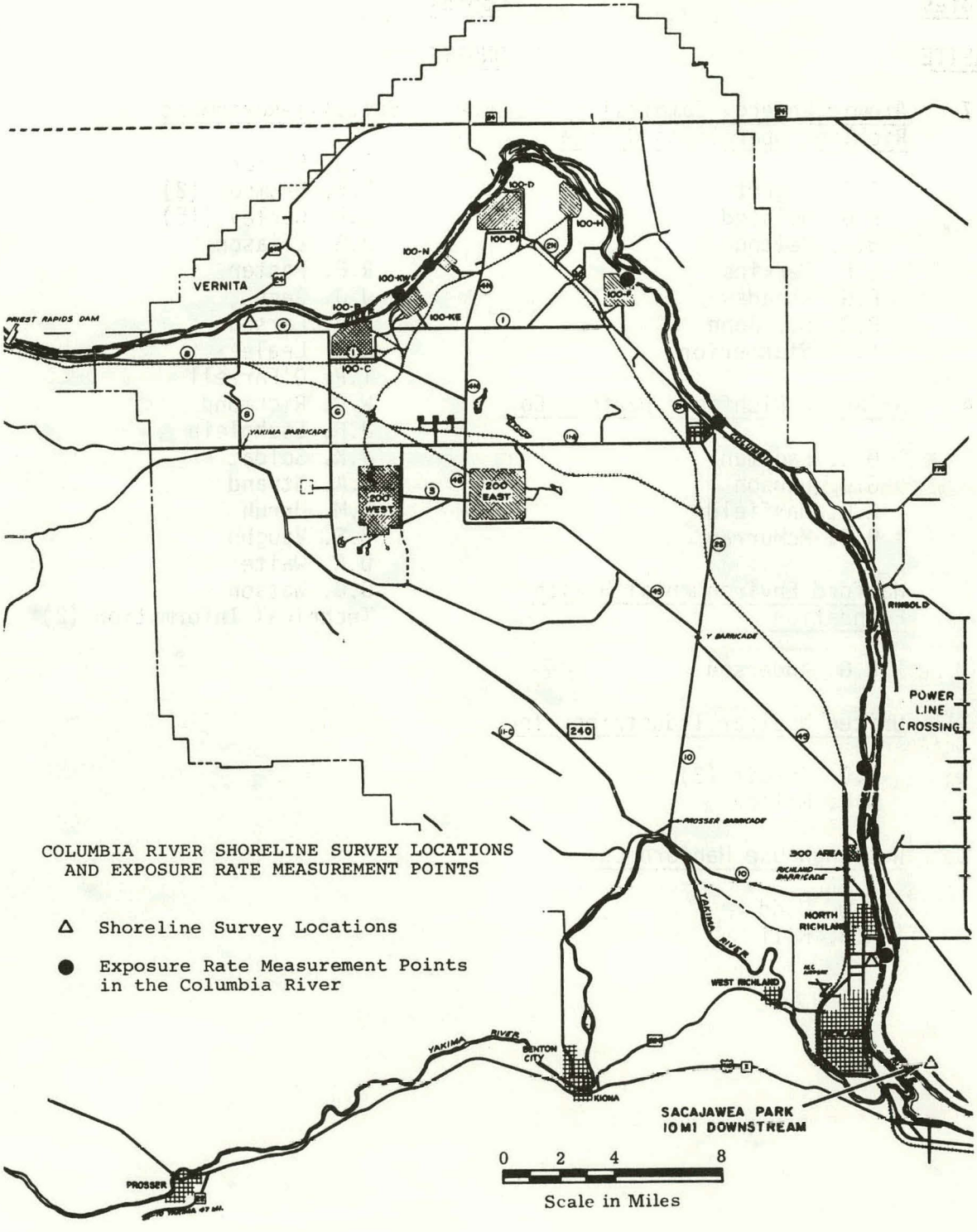
Units of mR/day

	1970	1971		1972	
	July-Dec	Jan-June	July-Dec	Jan-June	June-Dec
Vernita	0.1[b]	0.10[a]			
100-K Barge		1.9	0.13	0.14	0.18
D-Island		1.4[a]	0.68	0.20	0.19
100-F Area	0.7[c]	0.45[a]		0.23[e]	0.17
S. Wooded Island	0.6[d]	0.49	0.14	0.18	0.19[g]
Richland Pumphouse	0.6[d]	0.30	0.13	0.14[f]	0.13
Above 100-D				0.15[e]	0.18
Below 100-N				0.16[e]	0.19
Hanford Powerline					0.29[c]

[a] January, February
[b] July, November, December
[c] October-December
[d] May-June
[e] March-June
[f] Jan-April
[g] September, November, December

No entry indicates no measurement was performed.

MAP 13



COLUMBIA RIVER SHORELINE SURVEY LOCATIONS
AND EXPOSURE RATE MEASUREMENT POINTS

△ Shoreline Survey Locations

● Exposure Rate Measurement Points in the Columbia River

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