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ENVIRONMENTAL STATUS OF THE HANFORD RESERVATION FOR 1971

Battelle
Pacific Northwest Laboratories
Richland, Washington 99352

SEPTEMBER 1972

Prepared for the U.S. Atomic Energy Commission under Contract AT(45-1):1830

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PRELIMINARY REPORT

This report contains information of a preliminary nature prepared in the course of work under Atomic Energy Commission Contract AT(45-1)-1857. This information is subject to correction or modification upon the collection and evaluation of additional data.

NOTICE

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ENVIRONMENTAL STATUS OF THE HANFORD RESERVATION FOR 1971

by

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Occupational and Environmental Safety Department

September 1972

NOTICE

This document contains primary 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 1971

I. INTRODUCTION

This report summarizes data collected during 1971 from locations within the Hanford plant boundaries 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-C-96, "Environmental Status of the Hanford Reservation for 1970." Graphs in this report show 14 months of data---the subject 12 months and the preceeding two. Groundwater data are not included in this report but are presented most recently in BNWL-1649[1] and BNWL-1680.[2] Data from off-site sampling locations for 1971 are summarized in BNWL-1683.[3] Some data from off-site locations are included in this report for comparison with similar measurements made on-site.

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 cooling. Some low-level radioactive wastes continued to be discharged to the ground and to the river during the year.

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" were chosen to represent upper bounds to these fluctuating detection limits.

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(1) Radiological Status of the Groundwater Beneath the Hanford Project, January-June 1971, BNWL-1649, April 1972.

(2) Radiological Status of the Groundwater Beneath the Hanford Project, July-December 1971, BNWL-1680, November 1972.

(3) Environmental Surveillance at Hanford for CY-1971, BNWL-1683, August 1972.

II. SURVEILLANCE HIGHLIGHTS

Columbia River Water

Measured concentrations of Sr-90 and total alpha activity in river water averaged, respectively, 0.36 and 0.84×10^{-9} μCi/ml at Richland during the year. Tritium concentrations averaged 1100×10^{-9} μCi/ml at Vernita and 780×10^{-9} μCi/ml at Richland.

Average radionuclide transport rates for other radionuclides measured at Richland during this period were less than the comparable averages for 1970, primarily due to shutdown of the KE Reactor. The estimated annual GI Tract dose for employees' drinking 100-N water was 28 mrem, a decrease of about a factor of 3 from 1970. Average concentrations of coliform bacteria in Columbia River water were relatively unchanged from 1970 averages.

Swamps, Ditches, and Ponds

Radionuclide concentrations in samples collected from open waters on the Hanford project during 1971 were, in general, within their expected range of variation and were well below the plant working limit of $50{,}000 \times 10^{-9}$ μCi/ml.

Concentrations of radionuclides in gamebirds and mammals sampled on or near Hanford swamps and ponds were generally below levels recorded in 1970.

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 300 Area leach trench were generally higher than for 1970, but concentrations in the river shoreline seepage area were slightly lower than for 1970.

Airborne Radioactivity

Concentrations of I-131 in the atmosphere, measured in charcoal samplers, was about 0.04×10^{-12} μCi/ml. The maximum sample concentration measured during this reporting period was 0.8×10^{-12} μCi/ml, noted in June at the 300 Area. For comparison, the maximum I-131 concentration measured during 1970 was 0.52×10^{-12} μCi/ml at the 200 West Area.

Airborne Radioactivity (Continued)

At most locations, both on-site and off-site, the average total beta activity decreased during the year. The maximum measured beta activity, 4.9×10^{-12} μCi/ml, occurred in January at a 200 East Area location. Annual average activity ranged from 0.2 to 0.4, and 0.4 to 1.7×10^{-12} μCi/ml in the 100 and 200 Areas, respectively. Off-site beta activity ranged from 0.03 to 1.3 and averaged about 0.4×10^{-12} μCi/ml.

Total alpha concentrations in air during 1971 averaged about 0.004×10^{-12} μCi/ml at most locations. Monthly averages at several locations occasionally reached 0.01×10^{-12} μCi/ml. The peak weekly concentration of 0.25×10^{-12} μCi/ml occurred in February at 200 ENC location. Analyses of several of the higher samples all showed less than 6×10^{-17} μCi/ml plutonium.

Soil and Vegetation

Plutonium concentrations in soil and vegetation at on-site and perimeter sampling locations were typical of general regional levels for the arid western states. Strontium-90 and some gamma-emitting radionuclides were present in on-site soil and vegetation samples at higher concentrations than at perimeter sites and may be related to Hanford operations. Concentrations of gamma-emitting radionuclides and strontium-90 at perimeter sites are believed to be the result of regional fallout.

Radiation Surveys

Several radioactive particles were found on Hanford roadways during the monthly road surveys. The most active particle had a beta dose rate of 10 rads/hr, uncorrected for source size. Radionuclides comprising most of the activity of particles which were radioanalyzed were Ce-Pr-144, Ru-106, Cs-134, 137, and Sb-125. The annual railroad survey in October also revealed several spots of contamination ranging from 600 to 50,000 cpm (GM). Primary radionuclides were Co-60 and Cs-134, 137. The occurrences were attributed to interarea waste hauling operations.

Contaminated particles were found on control plots on only one occasion (near 200-East Area), with a maximum instrument reading of 2500 counts/min on a GM survey instrument. This was attributed to wind-borne particulates from waste tank farm areas. No particulate activity was found on control plots or roads associated with the higher air concentration on the north side of 200-East Area.

Radiation Survey (Continued)

Waste disposal site conditions were generally good during 1971. On several occasions, however, contaminated material was found outside the disposal site.

There was a general downward trend in external exposure rates at most locations. The maximum biweekly average exposure rate noted was 1.9 mR/day at 200-East Area. On the basis of exposure rate measurements at Richland and at 100-N, the whole-body dose to WPPSS personnel from Hanford sources of external radiation at 100-N during 1971 was estimated to be 5 mrem.

Following the KE Reactor shutdown, the exposure rates and surface contamination levels at shoreline locations downstream from the operating reactors during 1971 were generally less than for 1970. The maximum shoreline exposure rate during 1971, 86 μR/hr, was detected at three locations in January. The maximum shoreline contamination level encountered during 1971 of 750 c/m (GM) was observed at the 100-F Slough in January.

Radiation levels from shoreline contamination below the plant boundary were generally less than 200 c/m (GM). The average Columbia River immersion dose rates in 1971 were lower than the 1970 levels, as expected following the KE Reactor shutdown.

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, 0.36 and 0.84×10^{-9} μCi/ml at Vernita and 0.85 and 1.01×10^{-9} μCi/ml at Richland during the year. Measured tritium concentrations averaged 1100×10^{-9} μCi/ml at Vernita and 780×10^{-9} μCi/ml at Richland. Averages were based on the actual sample results, which in many instances were less than the analytical limits. With the shutdown of KE Reactor, the major Hanford source of P-32, Na-24, and I-131 in river water was eliminated. Therefore, when concentrations of these radionuclides reached the analytical detection limits, the analysis was discontinued.

Average radionuclide transport rates for other radionuclides measured at Richland during 1971 were less than the comparable averages for 1970, primarily due to shutdown of the KE Reactor.

Biological measurements of Columbia River water samples collected semi-monthly from Vernita, 100-F, 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

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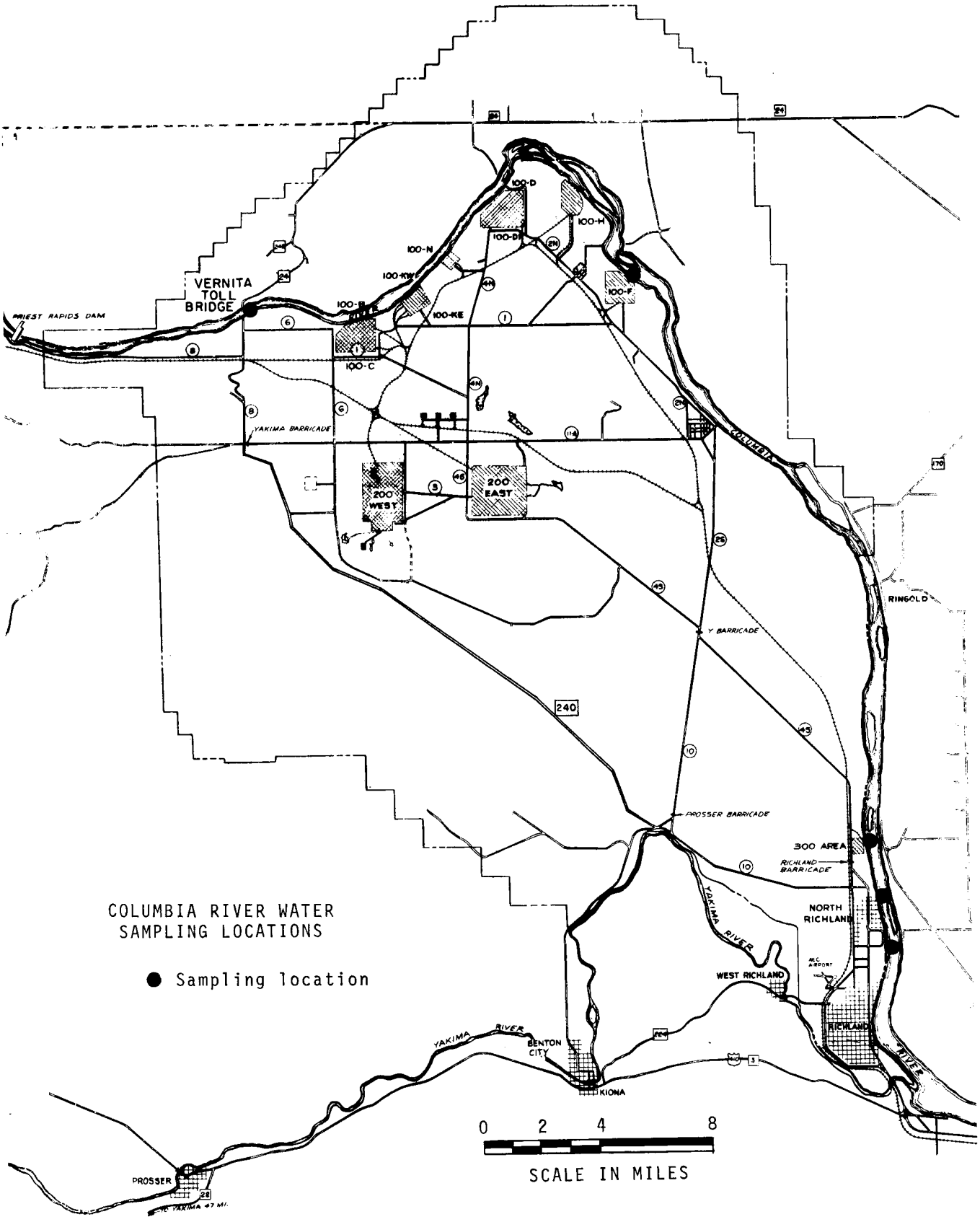
* "Implementation and Enforcement Plan for Water Quality Standards, Surface Waters," State of Washington, Dept. of Ecology, Sept. 1970

III. COLUMBIA RIVER WATER (Continued)

fecal origin. Normal seasonal peaking was observed during the summer months. Standards do not appear to have been exceeded at any time during the year. Riverbank spring sampling indicates that the increase in the average coliform count between Vernita and North Richland (from 34 to 65) is not related to Hanford operations.

Chemical analyses of river water grab samples collected at Vernita and 100-F (above and below N Reactor) as reported by Douglas United Nuclear are presented in Tables 2 and 3. Nitrate analysis was also performed on the weekly samples of river water from Vernita and Richland. Hexavalent chromium was monitored continuously through August, 1971, by the Technicon Analyzer at the 300 Area Columbia River Monitoring Station (ACRMS). The monitor has a detection level of 1 ppb of Cr^{+6}. These data are presented in Figure 1. Monitoring for Cr^{+6} was discontinued in August, since Cr^{+6} was no longer being used in significant quantities in reactor cooling water.



COLUMBIA RIVER WATER SAMPLING LOCATIONS

● Sampling location

MAP 1

TABLE 1: BIOLOGICAL MEASUREMENTS IN THE COLUMBIA RIVER FOR 1971

	Vernita			100-F			North Richland		
Date	Coliform Count/100 mℓ	Enterococci Count/100 mℓ	BOD mg/ℓ	Coliform Count/100 mℓ	Enterococci Count/100 mℓ	BOD mg/ℓ	Coliform Count/100 mℓ	Enterococci Count/100 mℓ	BOD mg/ℓ
2/16/71	13.	2.	3.7				15.	2.	4.2
3/16/71	21.	1.	4.0				30.	1.	5.0
4/20/71	34.	8.	2.8	36.	4.	3.7	90.	5.	3.0
5/18/71	60.	6.	3.2				40.	18.	3.5
6/22/71	74.	8.	4.5				68.	21.	4.2
7/13/71	30.	10.	1.8				85.	18.	1.4
8/17/71	40.	60.	3.4	50.	52.	3.6	100	66.	3.0
9/14/71	40.	35.	2.8	55.	92.	3.0	50.	41.	3.4
10/12/71	40.	97.	1.4	25.	88.	1.6	200	110	1.7
11/16/71	13.	7.	3.4	13.	14.	2.2	30.	17.	2.2
12/14/71	4.	6.	2.6	4.	21.	2.5	13.	4.	1.6
Annual, 1971	34.	22.	3.0				65.	28.	3.0

No entry indicates no measurement was made.

TABLE 2: CHEMICAL CHARACTERISTICS OF COLUMBIA RIVER WATER AT VERNITA - 1971
Units of Parts per Million

Date	Mg	Fe	Cu	Ca	SO_4	PO_4	Cl	Phth Alk.	M.O. Alk.	Hardness	Solids	Ph
1/5	6.0	0.02	0.003	17.	13.	0.18	0.33	2.	60.	68.	97.	
1/19	6.0	0.01	0.004	17.	15.	0.15	0.60	1.	63.	66.	110	
2/2	5.4	0.02	0.006	18.	14.	0.05	0.50	2.	66.	67.	110	
2/17	4.2	0.03	0.004	19.	16.	0.01	0.58	2.	65.	66.	70.	
3/2	4.7	0.03	0.003	19.	17.	0.01	0.65	2.	64.	66.	87.	
3/16	4.5	0.17	0.004	17.	17.	0.10	0.73	1.	62.	63.	90.	
3/30	5.9	0.07	0.005	18.	25.	0.04	0.70	1.	68.	69.	89.	
4/13	5.8	0.06	0.003	19.	20.	0.02	0.40	1.	59.	71.	69.	
5/4	5.8	0.08	0.003	18.	22.	0.02	0.40	2.	63.	70.	93.	
5/18	4.0	0.17	0.004	15.	18.	0.02	0.45	1.	51.	54.	86.	
6/1	4.0	0.12	0.004	18.	12.	0.01	0.63	1.	44.	50.	63.	
6/15	3.7	0.05	0.003	15.	12.	0.02	0.43	1.	49.	52.	80.	
6/29	3.7	0.06	0.002	15.	12.	0.02	0.33	1.	50.	55.	72.	
8/3												6.8
8/17												7.9
8/24												8.0
8/31												8.5
9/14												7.9
9/28												7.7
10/12												7.7
10/26												9.2
11/2												
11/9												7.8
11/16												7.8
11/23												7.8
11/20												7.4
12/7												8.1
12/14												8.1
12/21												8.1
12/28												7.8
6-Month Average												
	5.0	0.07	0.004	17.	17.	0.05	0.52	1.4	60.	64.	86.	7.9
Annual Average												

No entry indicates no specific isotopic analysis was made for the specific chemical.

TABLE 3: CHEMICAL CHARACTERISTICS OF COLUMBIA RIVER WATER AT 100-F - 1971
Units of Parts per Million

Date	Mg	Fe	Cu	Ca	SO_4	PO_4	Cl	Diss O_2	Phth Alk.	M.O. Alk.	Hardness	Solids
1/5	5.2	.03	.003	18.	14.	0.11	0.40	8.8	1.	63.	67.	88.
1/19	6.0	.004	.002	17.	17.	0.11	0.46		1.	66.	68.	96.
2/2	4.7	.02	.005	21.	16.	0.05	0.59	11.	2.	68.	73.	100
2/17	4.3	.03	.005	21.	16.	0.01	0.50		2.	62.	69.	80.
3/2	4.9	.03	.004	19.	17.	0.01	0.63	13.	3.	65.	68.	89.
3/16	4.1	.18	.003	18.	16.	0.03	0.71	12.	2.	63.	63.	79.
3/31	5.9	.09	.007	17.	27.	0.07	0.60	13.	1.	70.	67.	93.
4/13	5.8	.06	.002	18.	21.	0.02	0.40	12.	1.	60.	70.	80.
5/4	5.8	.08	.004	18.	21.	0.02	0.45	11.	1.	59.	70.	99.
5/18	4.4	.14	.003	14.	15.	0.005	0.45	12.	1.	51.	54.	84.
6/1	4.6	.10	.005	18.	12.	0.01	0.42	12.	1.	45.	50.	76.
6/15	3.0	.05	.003	13.	12.	0.02	0.42	11.	2.	49.	45.	75.
6/29	3.4	.06	.002	16.	11.	0.02	0.20	11.	1.	47.	53.	78.
Discontinued												
6-Month Average	4.9	.07	.004	18.	17.	0.04	0.49	11.	1.3	60.	64.	87.

No entry indicates no specific isotopic analysis was made for the specific chemical.

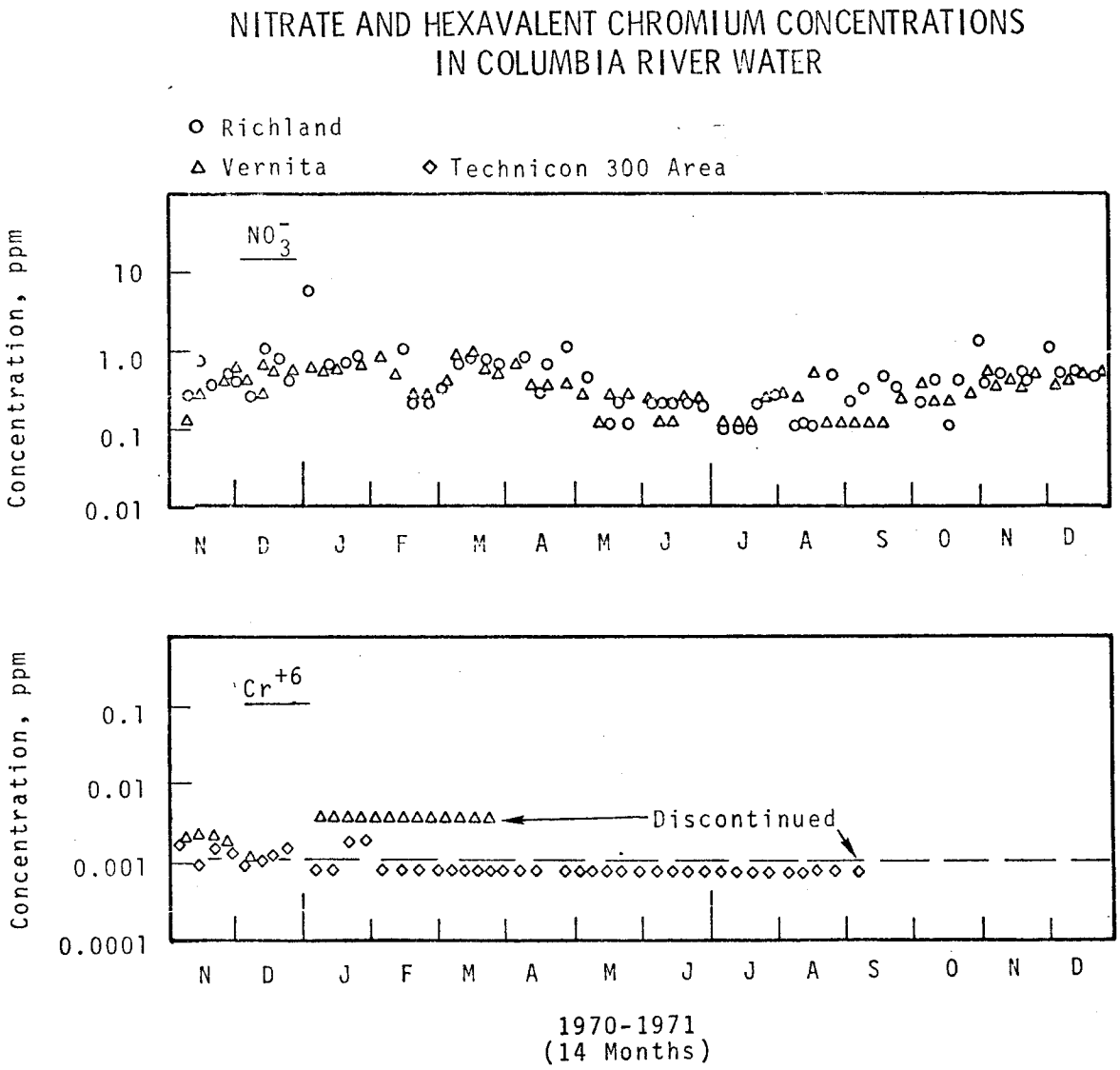

NITRATE AND HEXAVALENT CHROMIUM CONCENTRATIONS
IN COLUMBIA RIVER WATER
Richland
Vernita
Technicon 300 Area
NO_3^-
Concentration, ppm
10
1.0
0.1
0.01
N D J F M A M J J A S O N D
Cr^{+6}
Concentration, ppm
0.1
0.01
0.001
0.0001
Discontinued
N D J F M A M J J A S O N D
1970-1971
(14 Months)

FIGURE 1

IV. DRINKING WATER

Drinking water was sampled at the four locations shown in Map 2. Total beta activity at two of the locations is presented in Figure 2. Total beta analyses of B-Y Telephone Exchange drinking water were discontinued in May, 1971. Concentrations had been at or below the analytical limit of 0.1 c/m/ml since September, 1969. 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.

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 per week, 50 weeks per year, as reported previously.(4) The GI Tract dose from drinking 100-N water was about 2.8 mrem during 1971, compared with 9.5 mrem during 1970 and 29 mrem during 1969. These GI Tract doses represented 0.2, 0.6, and 1.9 percent, respectively, of the 1500 mrem per year dose standard for non-occupationally exposed individuals, or 0.02, 0.06 and 0.14 percent of the yearly dose standard for occupationally exposed individuals (15,000 mrem/year). The value for 1969 is greater than previously reported(5) due to an error in the Mn-56 dose factor previously used in calculating dose.

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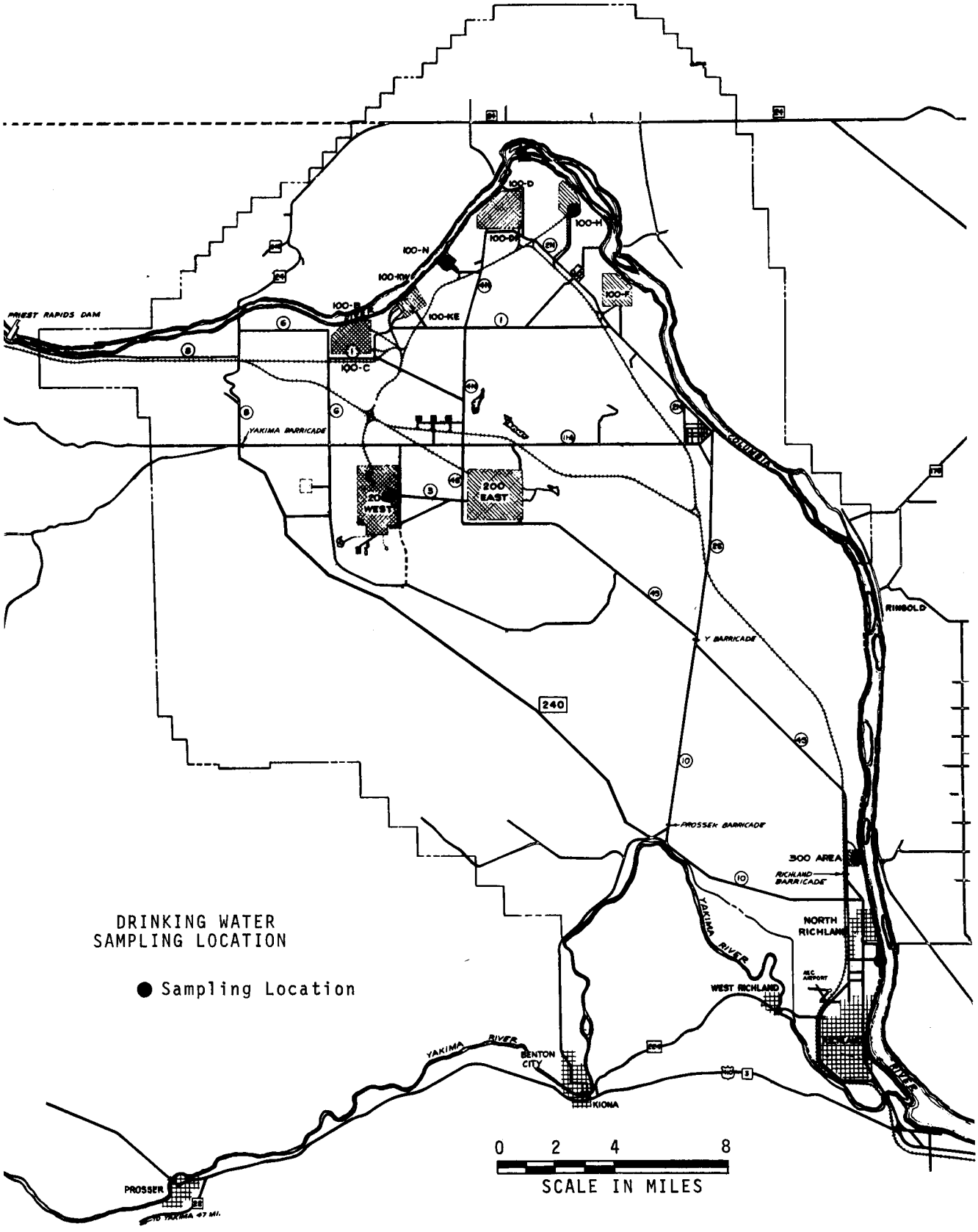
(4) BNWL-C-96, "Environmental Status of the Hanford Reservation for 1970," Edited by P. E. Bramson.

(5) BNWL-CC-2583, "Environmental Status of the Hanford Reservation for July-December 1969," Edited by C. B. Wilson and T. H. Essig.


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

MAP 2

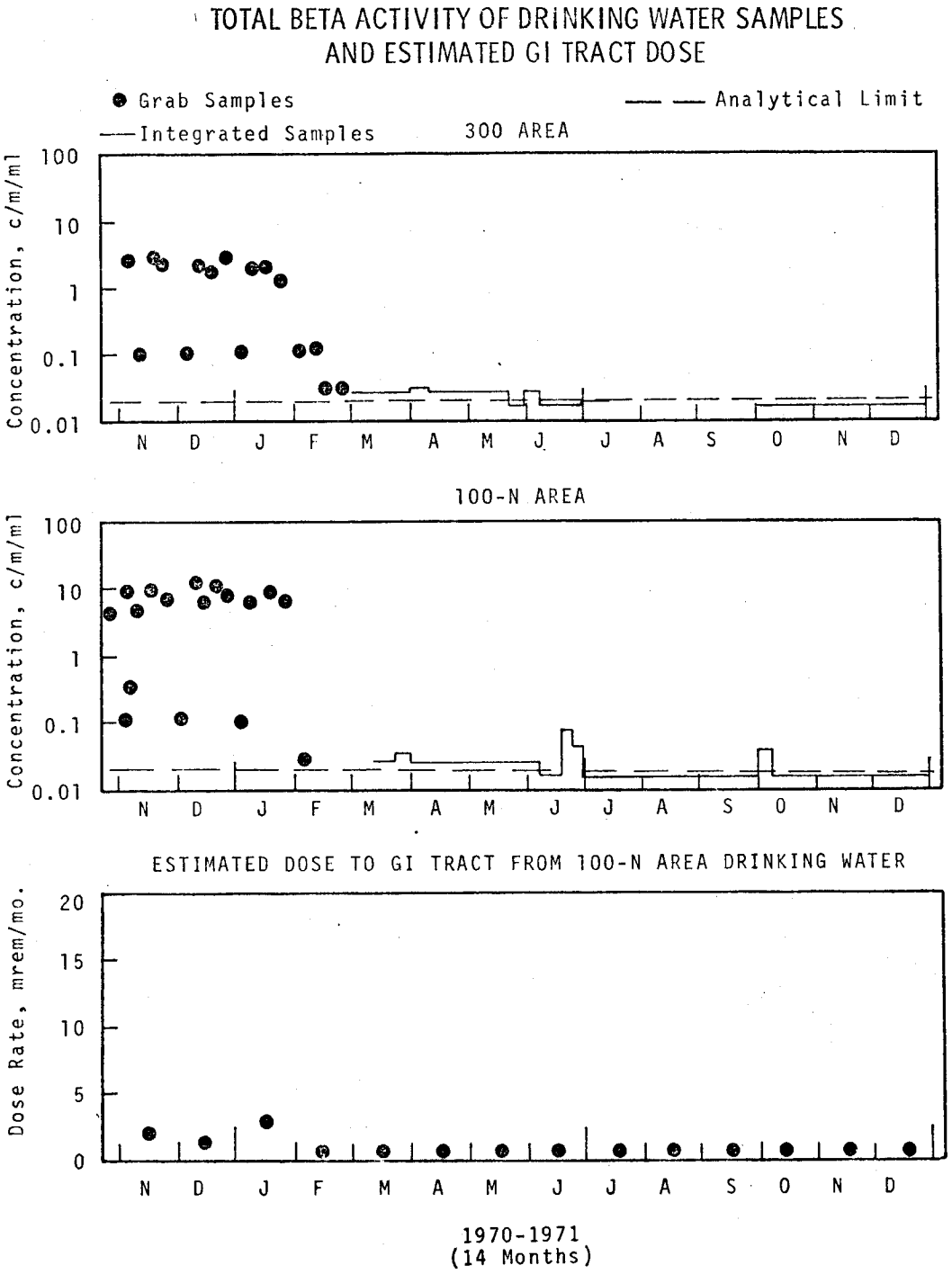

TOTAL BETA ACTIVITY OF DRINKING WATER SAMPLES
AND ESTIMATED GI TRACT DOSE
Grab Samples
Integrated Samples
Analytical Limit
300 AREA
Concentration, c/m/ml
100
10
1
0.1
0.01
N D J F M A M J J A S O N D
100-N AREA
Concentration, c/m/ml
100
10
1
0.1
0.01
N D J F M A M J J A S O N D
ESTIMATED DOSE TO GI TRACT FROM 100-N AREA DRINKING WATER
Dose Rate, mrem/mo.
20
15
10
5
0
N D J F M A M J J A S O N D
1970-1971
(14 Months)

FIGURE 2

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 $50{,}000 \times 10^{-9}$ μCi/ml, the limit for open waters (AEC Manual RL Supplement 0510).

300 Area Process Pond samples received both radiochemical and chemical analyses. Biological measurements were obtained on samples from the 300 Area Leach Trench and its associated river shoreline seepage area. No samples were obtained from several sites during December when the ponds were covered with ice.

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), and 231-Z Ditch (216-Z-11). Analysis results are presented in Figures 3, 4, and 5, and Table 4. Beta activity in all swamps was within the normal range of fluctuation. Alpha activity rose to an unusually high level for November in U-Swamp, 231 Ditch, Gable Swamp and B-Swamp. The reason for the increase could not be determined. Due to ice, no samples could be obtained until January, 1972, at which time alpha activity had returned to normal levels at all but U-Swamp.

Swamp samples received a quarterly gamma scan analysis (Table 4). From time-to-time the activation products 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.

V. SWAMPS, DITCHES, AND PONDS (Continued)

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 3650×10^{-9} and 0.29×10^{-9} μCi/ml, respectively, for 100-F Leach Trench.

300 Area Waste Waters

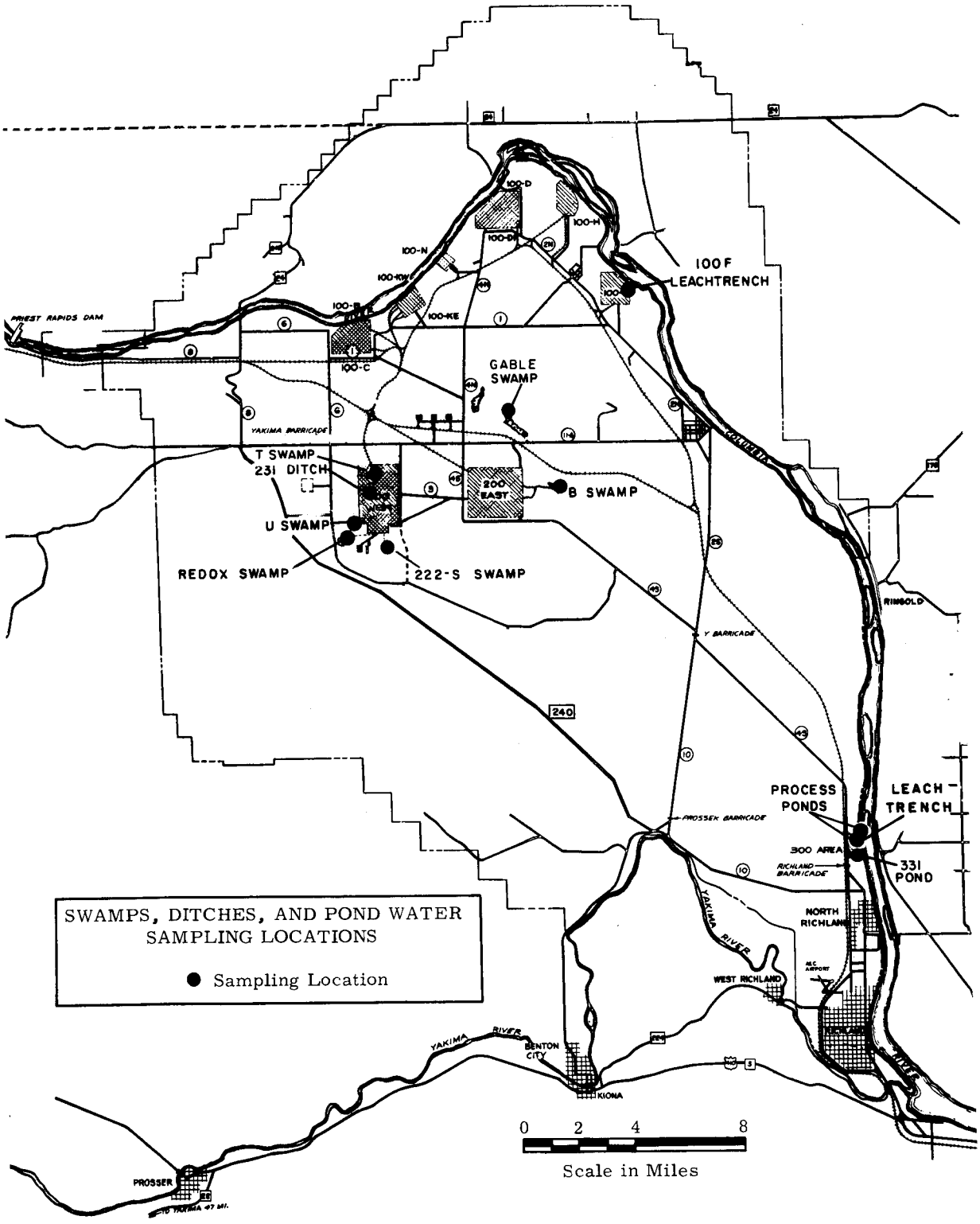
300 Area process pond receives manufacturing process and cooling water from fuel fabrication processes as well as cooling water and small amounts of laboratory waste waters from the laboratory operations.

Total beta, uranium, nitrate ion, and hexavalent chromium concentrations measured in weekly cumulative samples, collected near the inlet of the 300 Area process 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 1971 was approximately the same as for 1970.

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.

Commencing in April, 1971, monthly grab 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.


100 F
LEACHTRENCH
GABLE
SWAMP
T SWAMP
231 DITCH
U SWAMP
REDOX SWAMP
222-S SWAMP
B SWAMP
200
EAST
PROCESS
PONDS
LEACH
TRENCH
300 AREA
331
POND
YAKIMA BARRICADE
PROSSER BARRICADE
RICHLAND
BARRICADE
Y BARRICADE
YAKIMA RIVER
NORTH
RICHLAND
WEST RICHLAND
BENTON
CITY
KIONA
PROSSER
RIVER
RIESOLD
240
SWAMPS, DITCHES, AND POND WATER
SAMPLING LOCATIONS
Sampling Location
0 2 4 8
Scale in Miles

MAP 3

RADIOACTIVITY OF WASTE WATER SAMPLES
200-EAST AREA

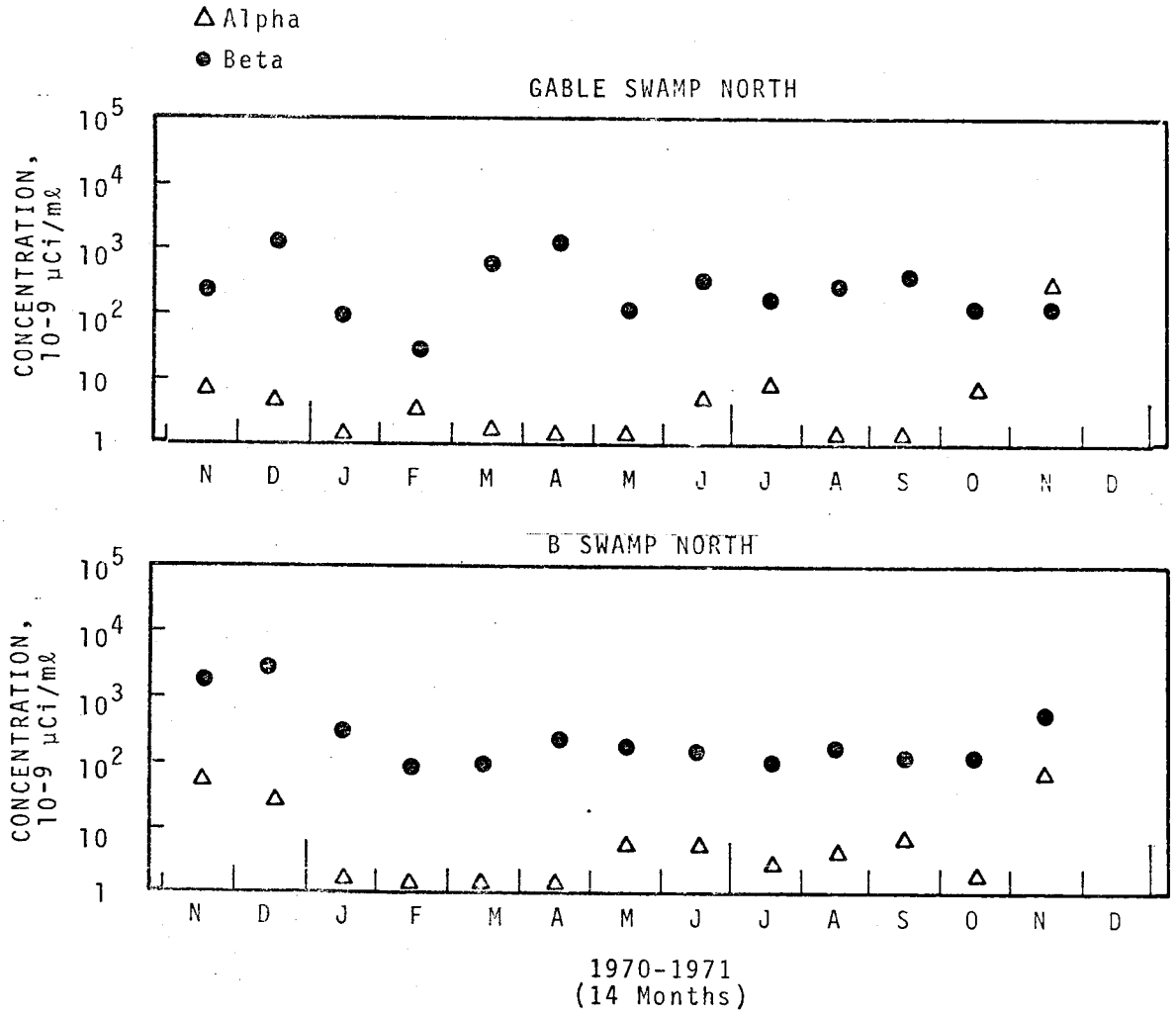


FIGURE 3

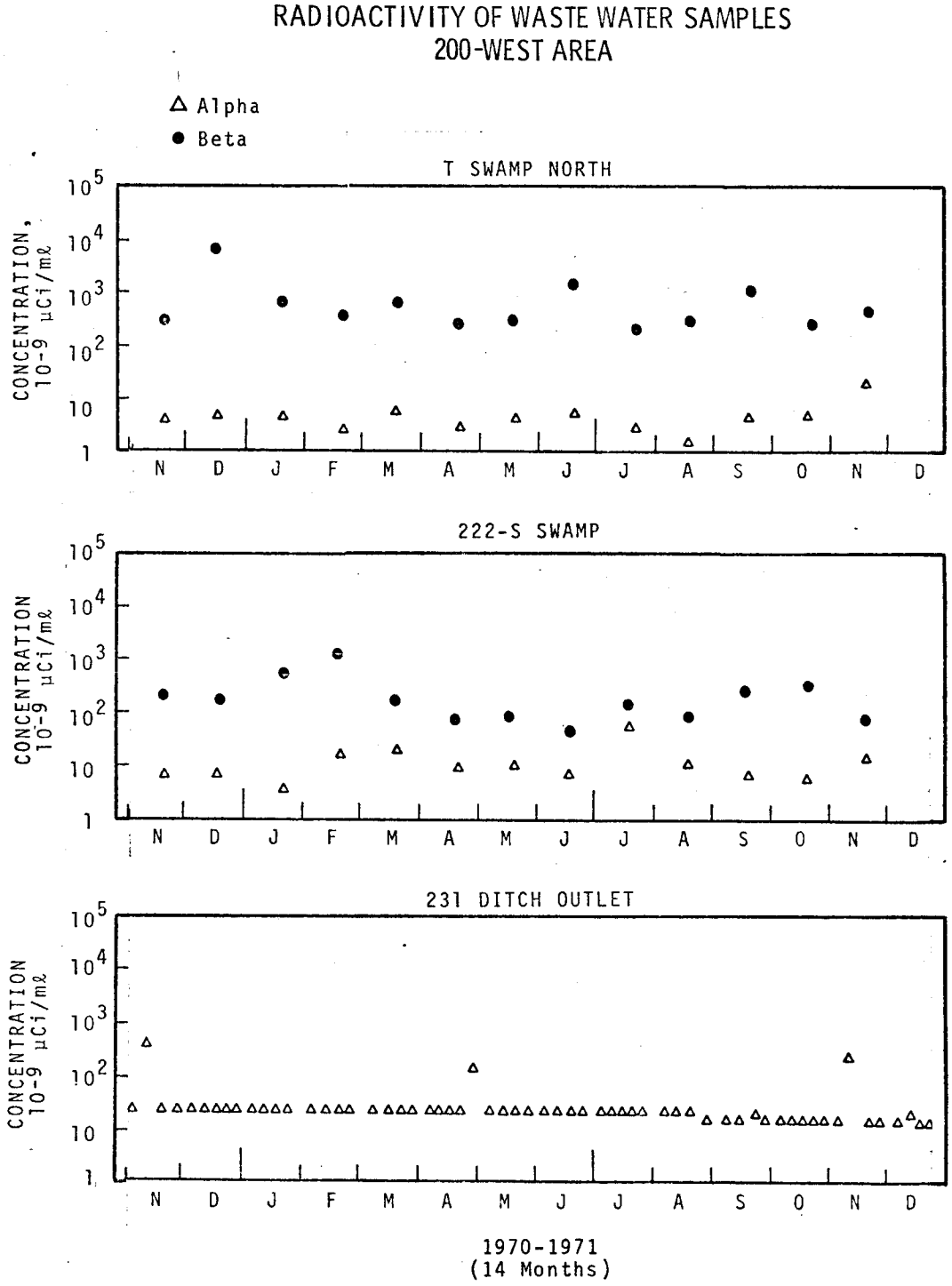

RADIOACTIVITY OF WASTE WATER SAMPLES
200-WEST AREA
Alpha
Beta
T SWAMP NORTH
222-S SWAMP
231 DITCH OUTLET
CONCENTRATION, 10-9 µCi/mℓ
10^5
10^4
10^3
10^2
10
1
N D J F M A M J J A S O N D
1970-1971
(14 Months)

FIGURE 4

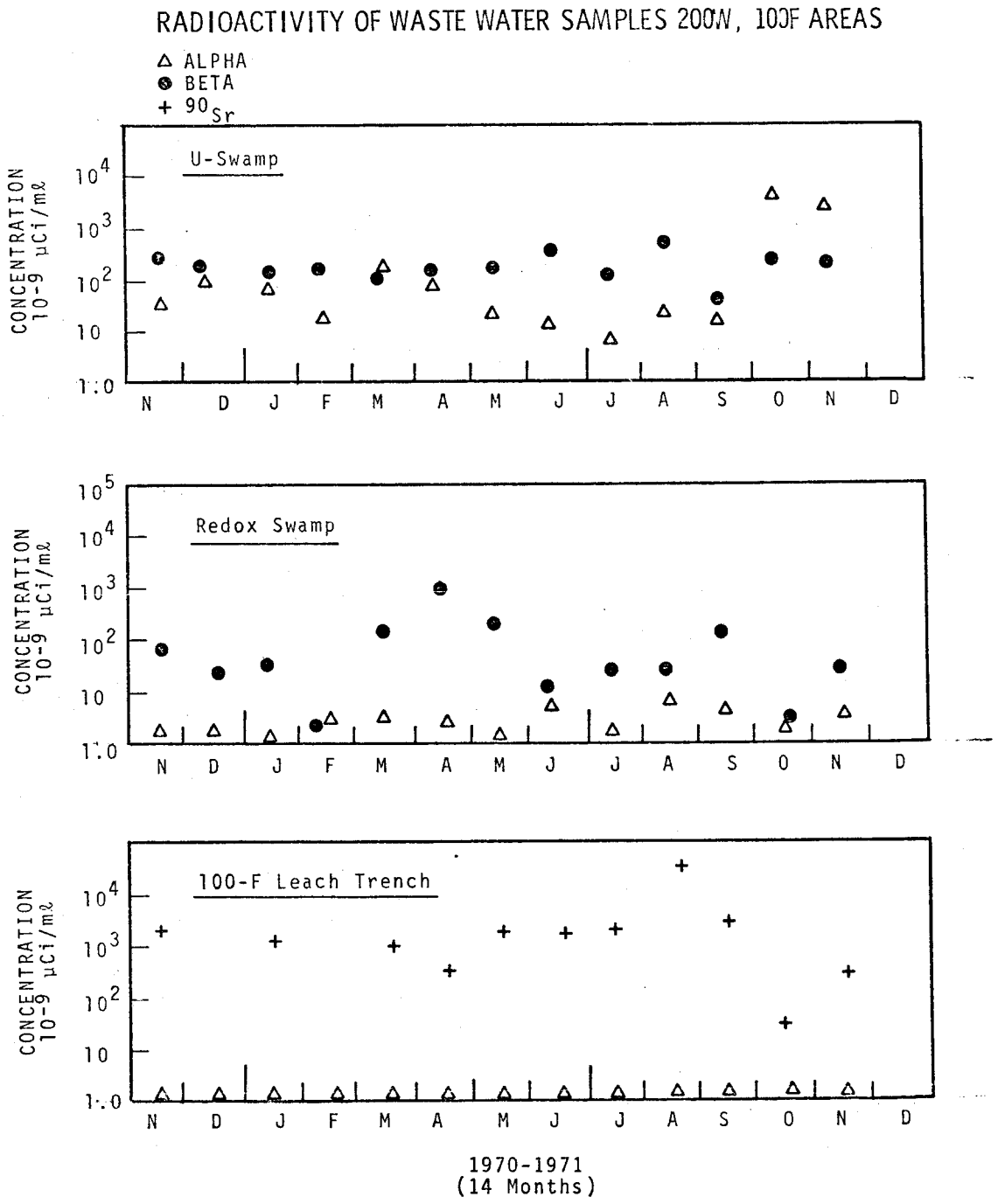

RADIOACTIVITY OF WASTE WATER SAMPLES 200W, 100F AREAS
△ ALPHA
● BETA
+ 90Sr
U-Swamp
Redox Swamp
100-F Leach Trench
CONCENTRATION 10-9 µCi/mℓ
10^5
10^4
10^3
10^2
10
1.0
N D J F M A M J J A S O N D
1970-1971
(14 Months)

FIGURE 5

TABLE 4: GAMMA ACTIVITY IN WASTE WATER SAMPLES

Units of 10^{-9} μCi/ml

Location	Date	^{46}Sc	^{51}Cr	^{60}Co	^{65}Zn	$^{95}ZrNb$	^{106}Ru	^{137}Cs	$^{140}BaLa$	$^{144}CePr$
Gable Swamp	1/22/71							*24.	*70.	
	4/16/71				77.			40.		
	7/16/71	*-57.	720.		*38.			100.	430.	*-52.
	10/15/71	*7.5	*98.	*21.	*-18.			96.		
B Swamp	1/22/71						2700.	*-110.		
	4/16/71							31.		
	7/16/71	*.99	560.		*21.			41.	250.	*220.
	10/15/71	*5.6	*-12.		*-1.6			*35.		
T Swamp	1/22/71					29.	*92.	320.	*-8.9	
	4/16/71		*130.			*7.3		100.		
	7/16/71	*29.	*20.		*12.			110.		
	10/15/71	*15.	*120.	*6.8	*-15.			33.		
S Swamp	1/22/71					37.	*54.	410.		
	4/16/71				*15.			*24.		
	7/16/71	*9.4	*94.		*51.			54.		
	10/15/71		*36.	*25.		* 0.11		*130.		
U Swamp	1/22/71					*-2.2		52.		
	4/16/71							49.		
	7/16/71	*.62	150.		*34.			60.		
	10/15/71	*.63	*27.		*2.3			41.		
Redox Swamp	1/22/71							*0.0	*0.0	
	4/16/71		*470.		59.			*17.		
	7/16/71	*18.	*200.		*.91					
	10/15/71	*17.	*170.		*-9.1			*13.		
331 Pond	4/13/71				*22.					
	6/15/71						*170	*13.		
	7/13/71	*36.	*230.		*18.					
	10/12/71	*7.8	*-12.	*.75	*28.					

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

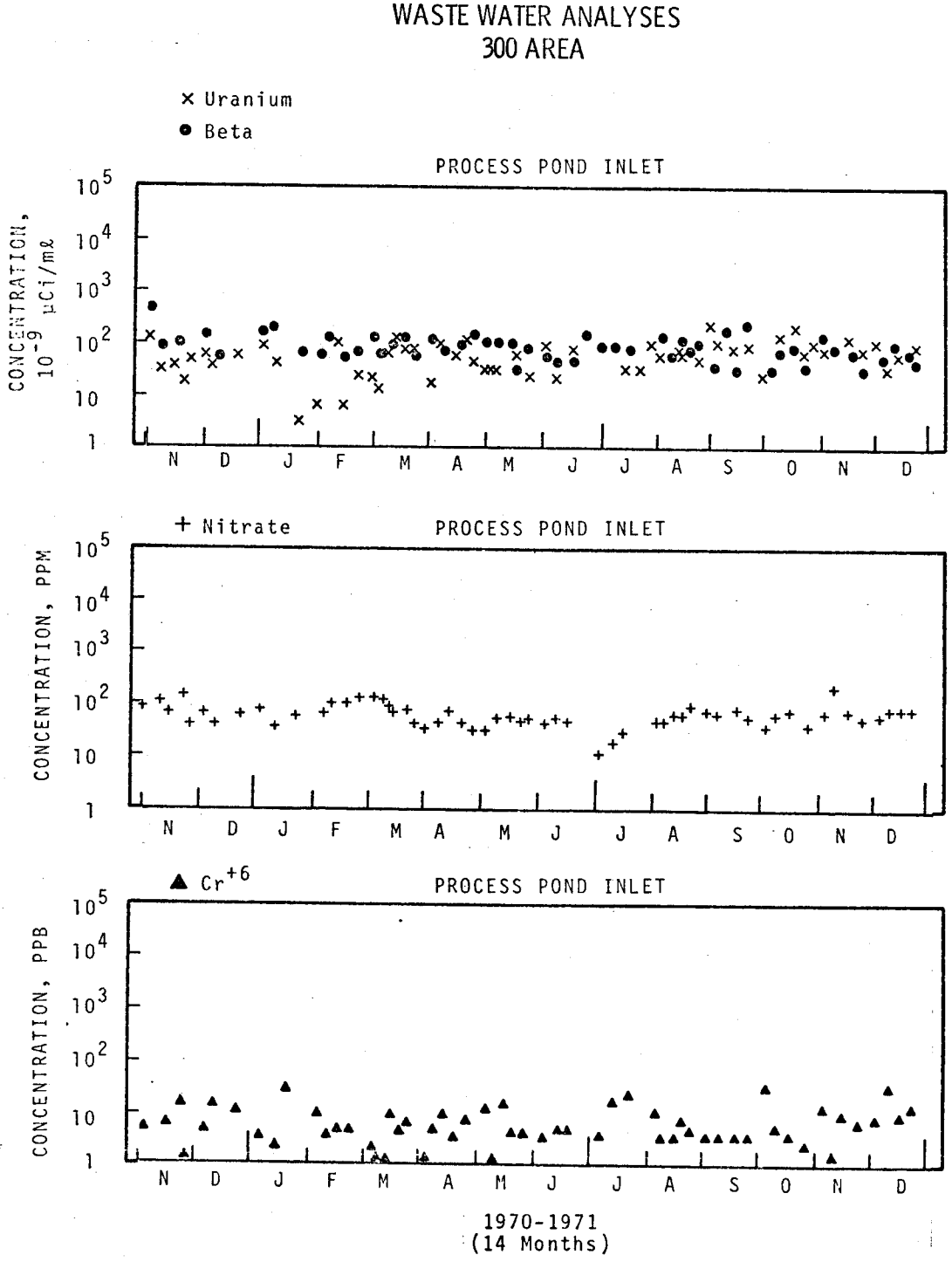

WASTE WATER ANALYSES
300 AREA
× Uranium
● Beta
PROCESS POND INLET
CONCENTRATION, 10^{-9} µCi/mℓ
10^5
10^4
10^3
10^2
10
1
N D J F M A M J J A S O N D
+ Nitrate
PROCESS POND INLET
CONCENTRATION, PPM
▲ Cr^{+6}
PROCESS POND INLET
CONCENTRATION, PPB
1970-1971
(14 Months)

FIGURE 6

TABLE 5: FLUORIDE ION CONCENTRATIONS IN THE 300 AREA PROCESS POND, 1971

Month	F- ppm
January	3.0
February	1.1
March	2.1
April	0.92
May	1.7
June*	3.1
July	0.73
August	1.6
September	1.6
October	2.2
November*	3.5
December	3.3
Average	2.1

* No analyses were made for the periods: 6/21/71 to 6/28/71, and 11/1/71 to 11/8/71.

TABLE 6: BIOLOGICAL MEASUREMENTS OF SAMPLES COLLECTED FROM THE 300 AREA LEACHING TRENCH AND ITS ASSOCIATED RIVER SHORELINE SEEPAGE AREA

300 Area Leaching Trench

Date	Coliform/100 mℓ	Enterococci/100 mℓ	BOD mg/ℓ
5/18/71	450,000	6,000	7.4
6/22/71	860,000	22,000	6.7
7/13/71	890,000	123,000	4.4
8/17/71	700,000	80,000	2.8
9/14/71	1,060,000	62,000	2.0
10/12/71	90,000	4,000	1.8
11/16/71	39,000	3,000	3.6
12/14/71	290,000	1,900	7.0

River Shoreline Seepage Area

Date	Coliform/100 mℓ	Enterococci/100 mℓ	BOD mg/ℓ
4/20/71	8.	45.	2.6
5/18/71	22.	16.	3.4
6/22/71	82.	66.	4.2
7/13/71	60.	60.	2.0
8/17/71	80.	82.	3.9
9/14/71	35.	73.	2.6
10/12/71	35.	85.	1.2
11/16/71	20.	11.	2.0
12/14/71	9.	5.	2.0

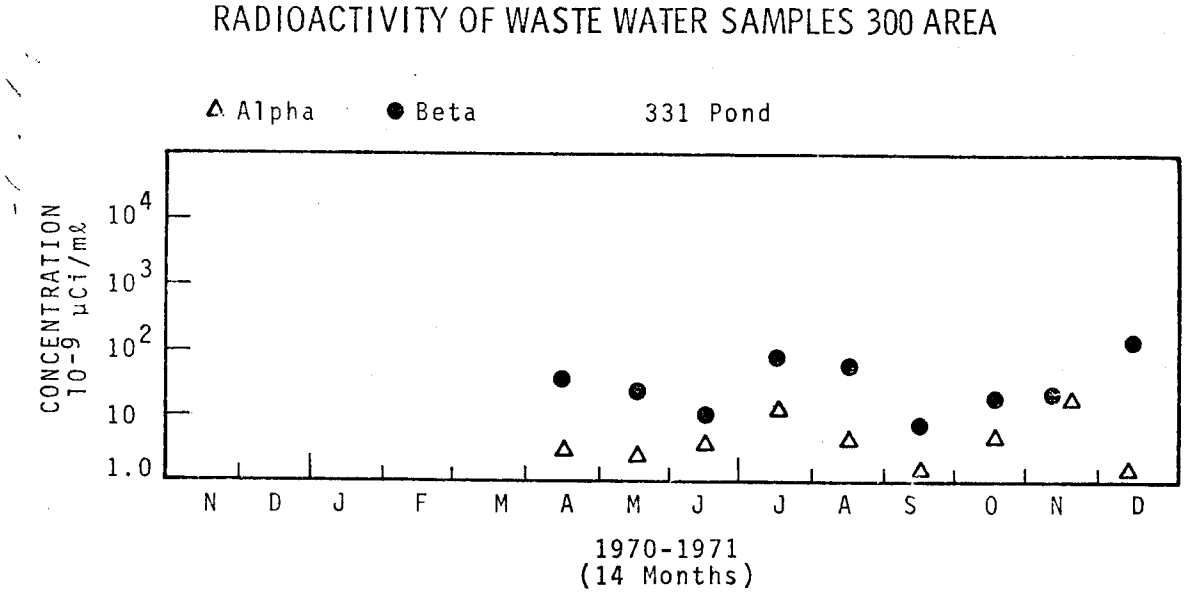

RADIOACTIVITY OF WASTE WATER SAMPLES 300 AREA
Alpha
Beta
331 Pond
CONCENTRATION
10-9 µCi/mℓ
10^4
10^3
10^2
10
1.0
N D J F M A M J J A S O N D
1970-1971
(14 Months)

FIGURE 7

VI. GROUNDWATER

Results of the groundwater surveillance program for 1971 have been reported separately in BNWL-1649, "Radiological Status of the Groundwater Beneath the Hanford Project, January-June 1971," and BNWL-1680, "Radiological Status of the Groundwater Beneath the Hanford Project, July-December 1971."

VII. BIRDS AND MAMMALS

Migratory waterfowl utilize swamps and ponds within the Hanford Reservation 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. Likewise 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 analysis was obtained on muscle samples of most gamebirds and mammals. At several locations, the liver was sampled for plutonium-239, uranium or americium-241 analysis. When several birds of the same species and location were collected on the same day, muscle from up to five birds was composited for a gamma scan. The gamma scan of the composite obviated the gamma scans of those individual birds.

Waterfowl

Radionuclide concentrations in twenty waterfowl sampled from swamps and ponds in 1971 were generally below the concentrations recorded in 1970. Tables 7 and 8 present the average analysis results for ducks (79) and geese (10) 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 do not frequent the 200 Area swamps and ponds.

Pheasants

No unusual radionuclide concentrations were detected in sixteen pheasants. Cs-137 concentrations were similar to the values observed in geese.

Deer

On November 19 and December 17, deer were shot as part of the environmental sampling program. The November deer was a fawn which had been reared in the vicinity of the 100-F Trench, a potential source of Sr-90. No unusual Sr-90 deposition was noted either in the tissues or bone. Generally, the radionuclide concentrations detected in muscle tissue and listed in Table 9, were lower than 1970 samples. Sr-90 concentrations observed in the Hanford deer are similar to the concentrations in deer from other parts of the country and are the result of fallout. The deer

VII. BIRDS AND MAMMALS (Continued)

Deer (Continued)

population sampled is assumed to be resident on the Hanford plant, but recent relaxation of access control on Wahluke Slope increases the probability of hunters bagging Hanford deer.

Small Animals

Sampling of mice, muskrats and rabbits (Table 10) was conducted in or near trenches and ponds in the 100, 200, and 300 Areas as an indicator of potential transport of radioactivity away from waste sites by mammals. Radionuclide concentrations in rabbits collected in 1971 were generally lower than in 1970 except for one collected in January near the southeast corner of 200-East Area (Route 4S, Mile 5). The Sr-90 concentration was over a factor of four higher than the maximum observed in 1970.

Sampling of mice was much more extensive in 1971 than previously, in part as a substitute for the larger rodents. Levels of radionuclides detected in mice were generally higher than the four mice collected in 1970. A mouse collected from the vicinity of the 100-N Trench in May contained radionuclide concentration orders of magnitude above specimens from other Hanford locations. In October, another mouse was sampled from the vicinity of 100-N Trench which was also more radioactive than other mouse samples for the year. These two mice probably had been ingesting water from N Trench.

Muskrat trapping was not productive in 1971.

TABLE 7: AVERAGE RADIONUCLIDE CONCENTRATIONS IN MUSCLE OF GAMEBIRDS FOR 1971

Units of 10^{-6} μCi/gm (wet weight)

Location	Species	No. of Samples	^{24}Na	^{32}P	^{58}Co	^{60}Co	^{65}Zn	^{90}Sr	^{137}Cs
Analytical Limit			0.6	1.0	0.15	0.15	0.2	0.002	0.1
U-Swamp	Ducks	4	*0.62		0.94	*	*	0.001	78.
Redox Swamp	Ducks	4	*		*	*	*0.12	0.005	51.
Gable Swamp	Ducks	4	*		*	*	0.34	0.005	34.
B-Swamp	Ducks	4	*		*	*	*0.03	0.04	2.2
300 Pond	Ducks	2	*		*	*	*0.04	0.001	*0.06
100-F Trench	Ducks	2	*		*	*	0.36	0.11	0.17
Col. River	Ducks	79	0.97	19.	*	*	0.63		0.046
Col. River	Geese	10	*	*0.24	*	*	0.57		0.097
100 Areas	Pheasants	16			*	*	*		0.08

* Less than the analytical limit.

No entry indicates no analysis was performed.

TABLE 8: AVERAGE CONCENTRATIONS OF SELECTED RADIONUCLIDES IN THE LIVERS OF WATERFOWL SAMPLES IN THE HANFORD ENVIRONS FOR 1971

Units of 10^{-6} μCi/gm (wet weight)

Location	No. of Samples	U	^{239}Pu	^{241}Am
Analytical Limit		0.016	0.05	0.02
U-Swamp	4		0.42	
Redox	1		0.11	0.03
300 Pond	2	*0.004	*0.004	
100-F Trench	2		*0.004	

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

TABLE 9: CONCENTRATION OF SEVERAL RADIONUCLIDES IN DEER

Units of 10^{-6} μCi/gm (wet weight)

Location	Date	Tissue	^{65}Zn	^{90}Sr	^{137}Cs	Pu
100-F	11/19	Muscle	*0.05	0.004	0.06	
100-F	11/19	Liver				*0.0002
100-F	11/19	Heart	*0.09	0.008	0.07	
100-F	11/19	Lung	*0.06	0.02	*0.03	
100-D	12/17	Muscle	0.11	*0.0	0.06	
100-D	12/17	Liver				0.01

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

TABLE 10: CONCENTRATION OF SEVERAL RADIONUCLIDES IN SMALL ANIMALS

Units of 10^{-6} μCi/gm (in muscle)

Date	Species	Location	^{40}K	^{51}Cr	^{54}Mn	^{58}Co	^{59}Fe	^{60}Co	^{65}Zn	^{90}Sr	$^{95}ZrNb$	^{99}Mo	^{103}Ru	^{106}Ru	^{134}Cs	^{137}Cs	^{144}Ce	^{154}Eu	Ta	U	^{131}I	Pu
1/27	Rabbit	Wye Barr.	1.8							0.02						1.0						*0.0002
1/29	Rabbit	4S Mile S	*0.83							0.98						2.8						*0.0001
2/3	Mouse	181 F	-0.02						12.							*0.18			7.3			
2/3	Mouse	107 DR	16.						8.7							1.0			8.6			
2/18	Mouse	100-D	54.						29.							4.7			1.9			
2/19	Mouse	100-H	5.4						6.7							15.			1.6			
2/19	Mouse	200-W														11.			5.1			
2/22	Mice (2)	100-D	9.4					1.9	22.					2.6		13.			1.5			
2/22	Mouse	100-B														*0.003			0.27			
3/1	Mouse	Cal. Nucl.														0.57			8.5			
4/2	Mice	200 ESE	0.04						0.05	0.37						*0.07			17.			
4/5	Mouse	100-K	*0.11							0.09									*0.13			
4/6	Rabbit	200-E	2.9						0.03	*0.02						0.28						*0.0002 (a)
4/19	Mouse	100-B	*2.8						1.4							0.53			1.9			
4/19	Mouse	100-D	12.					1.4	7.1							1.2			6.6			
4/20	Mouse	100-H	6.4					1.6	4.9							3.3			7.7			
5/6	Mouse	100-N Trench								7800									31,000			
Special Diode Count				880	10,000	450	3900	24,000			3700		180	5800	400	1900	1600	150				
5/6	Mouse	B-Swamp	13.						4.5	0.85						4.2			12.			
5/25	Mouse	300 Area	*0.05							0.12						*0.004				0.27		*0.0005 (a)
5/26	Mouse	Gable Swamp	8.9							27.						*0.36						*0.0003 (a)
6/4	Mouse	100-F		*1.4						0.17						*0.33						*0.0009 (a)
6/17	Mouse	U-Swamp	*7.1							3.0						4.0				0.06		*0.0007 (a)
6/29	Mouse	300 Area	3.4						0.09	*0.002						*0.05				0.008		
6/29	Rabbit	300 Area	6.1						*0.20													*0.005 (a)
7/19	Bat	200-E	21.						3.2	0.62						2.1						0.003 (a)
8/11	Rabbit	222-S								0.007												*0.004 (a)
9/21	Mouse	U-Swamp	5.1					0.31	*0.38	9.1						65.						0.02 (a)
9/22	Mouse	U-Swamp	5.5					*0.12	*0.95	8.7						25.				0.20		0.02 (a)
10/25	Mouse	300 Pond	*3.5					*0.09	*0.13	0.12						*0.19				0.24		0.02 (a)
10/29	Mouse	100-N Trench			220	21.	84.	240		3.7	55.	43.	2.1	2.0	29.	190				0.52		0.001 (a)
11/15	Mouse	Cal. Nucl.	*3.2						*0.06	0.52						*0.42				0.03	74.	1.5 (a)
12/17	Rabbit	200-E (BC Crib)	3.1						*0.01	*0.002						0.99						

(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 16 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 are on a bi-weekly schedule. "Total beta" represents the gross beta activity (Sr-90-Y calibration) and "total alpha" represents the gross alpha activity (Pu-239 calibration) of particulates collected on the filter paper during the sampling period.

Table 11 shows the annual average I-131, particulate total beta, and particulate total alpha activity in air at various locations for 1967-1971. Results of gamma scans, gross alpha, and gross beta analyses on selected environmental air filters are presented in Table 12. 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 1971 averaged about 0.04×10^{-12} µCi/ml for on-site locations. Annual concentration averages at individual on-site sampling locations ranged from 0.03×10^{-12} µCi/ml (100-N) to 0.06×10^{-12} µCi/ml (300 Area). The highest monthly average, 0.21×10^{-12} µCi/ml, occurred in June at 300 Area. For comparison, off-site annual averages ranged from 0.01×10^{-12} µCi/ml (Wahluke Watermaster) to 0.07×10^{-12} µCi/ml (Connell) and the highest monthly off-site average, 0.35×10^{-12} µCi/ml, occurred in May at Connell. The maximum individual weekly average concentration measured during this reporting period was 0.80×10^{-12} µCi/ml, noted in June at 300 Area. For comparison, the maximum I-131 concentration measured during 1970 was 0.52×10^{-12} µCi/ml at 200-West Area. The apparently increased

VIII. AIRBORNE RADIOACTIVITY (Continued)

A. Iodine-131 (Continued)

radioiodine concentrations during the last half of 1970 and for 1971 resulted from the greater collection efficiency of charcoal for organic-bound iodine, rather than an actual increase in airborne radioiodine. Lower efficiency caustic scrubbers were used prior to July, 1970.

B. Total Beta

During 1971, environmental air filters from 16 on-site locations and 18 off-site locations were examined weekly for total beta activity. Tables 11 and 12 show the average particulate total beta activity in air at various locations. Airborne radioactivity measurements were discontinued at 100-K and 100-D in April, after all the production reactors had been shut down. Beta and iodine measurements were resumed at these locations after 100-N startup.

At most locations, both on-site and off-site, beta activity was characterized by seasonal peaking about mid-year, as shown in Figures 12-18. 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 also was true of the 200 Areas, except for the East North Center (ENC), which was affected by 200-East Area waste disposal operations. The maximum measured concentration, 4.9×10^{-12} μCi/ml (total beta), occurred in January at the 200 ENC location. Monthly average concentrations measured in the 100 and 200 Areas generally ranged from about 0.1×10^{-12} to 2.6×10^{-12} μCi/ml during the year. Annual average concentrations were similar to 1970, ranging from 0.2×10^{-12} to 0.4×10^{-12} in the 100 Areas and from 0.4×10^{-12} to 1.7×10^{-12} μCi/ml in the 200 Areas.

The maximum measured concentration at an off-site location, 1.4×10^{-12} μCi/ml, occurred in July at Benton City. Monthly average concentrations measured at off-site locations generally ranged from about 0.1×10^{-12} to 1.0×10^{-12} μCi/ml during the year. Annual average concentrations at off-site locations ranged from about 0.3×10^{-12} to 0.4×10^{-12} μCi/ml.

VIII. AIRBORNE RADIOACTIVITY (Continued)

C. Total Alpha

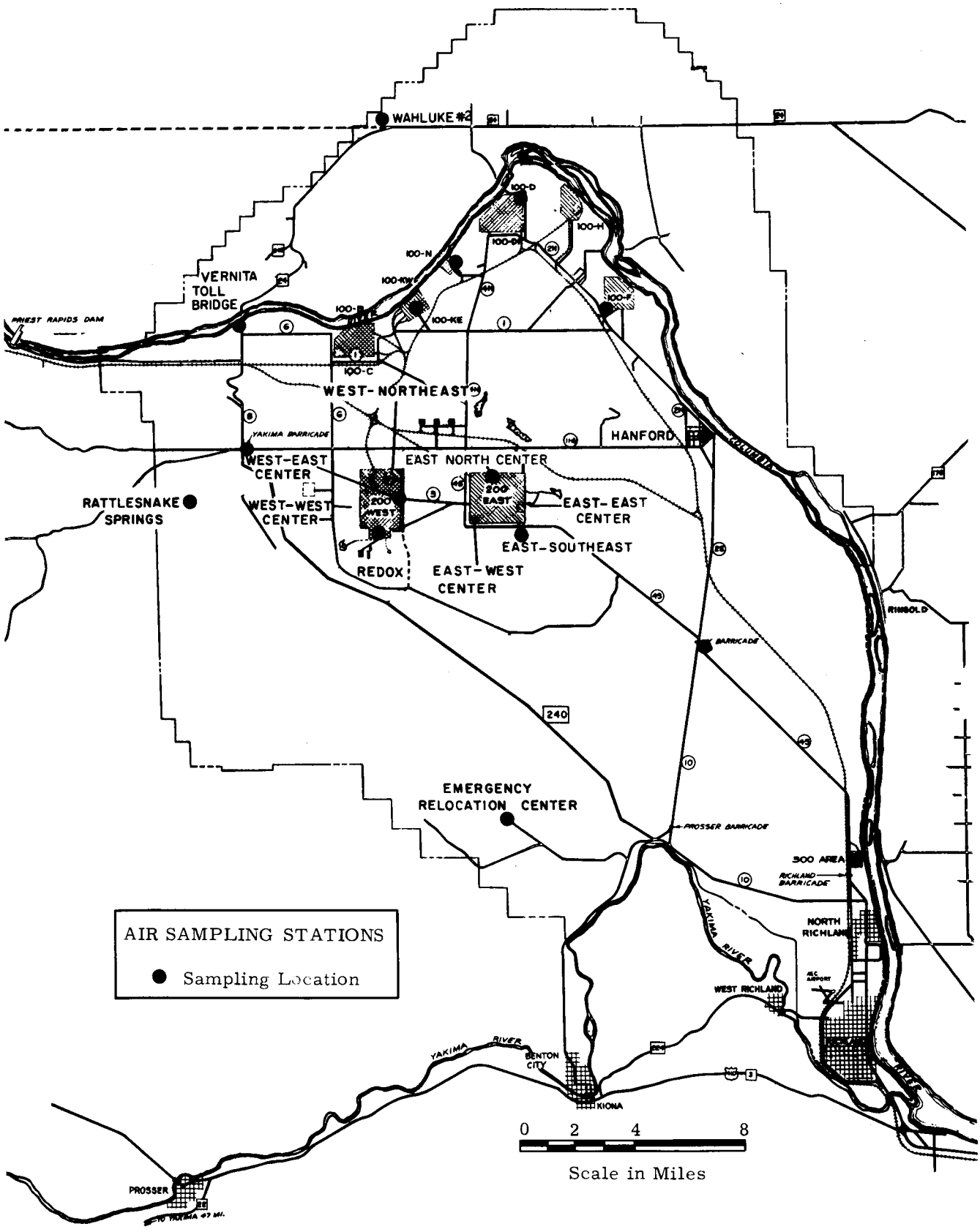
The weekly filters analyzed for beta-gamma emitting radionuclides were also analyzed for alpha activity. These data are presented in Figures 15-18. Measurement of atmospheric alpha activity at 100-K was discontinued in mid-april and Kennewick was discontinued in March.

Alpha counting of the filters was normally performed after seven days to allow for the decay of short-lived activity from naturally-occurring radon and thoron daughters. Because the analytical limit for total alpha concentrations (0.01×10^{-12} μCi/ml) is a significant fraction of the Concentration Guide for Pu-239 in air for individuals in uncontrolled areas (0.06×10^{-12} μCi/ml) results only slightly above the analytical limit are of interest.

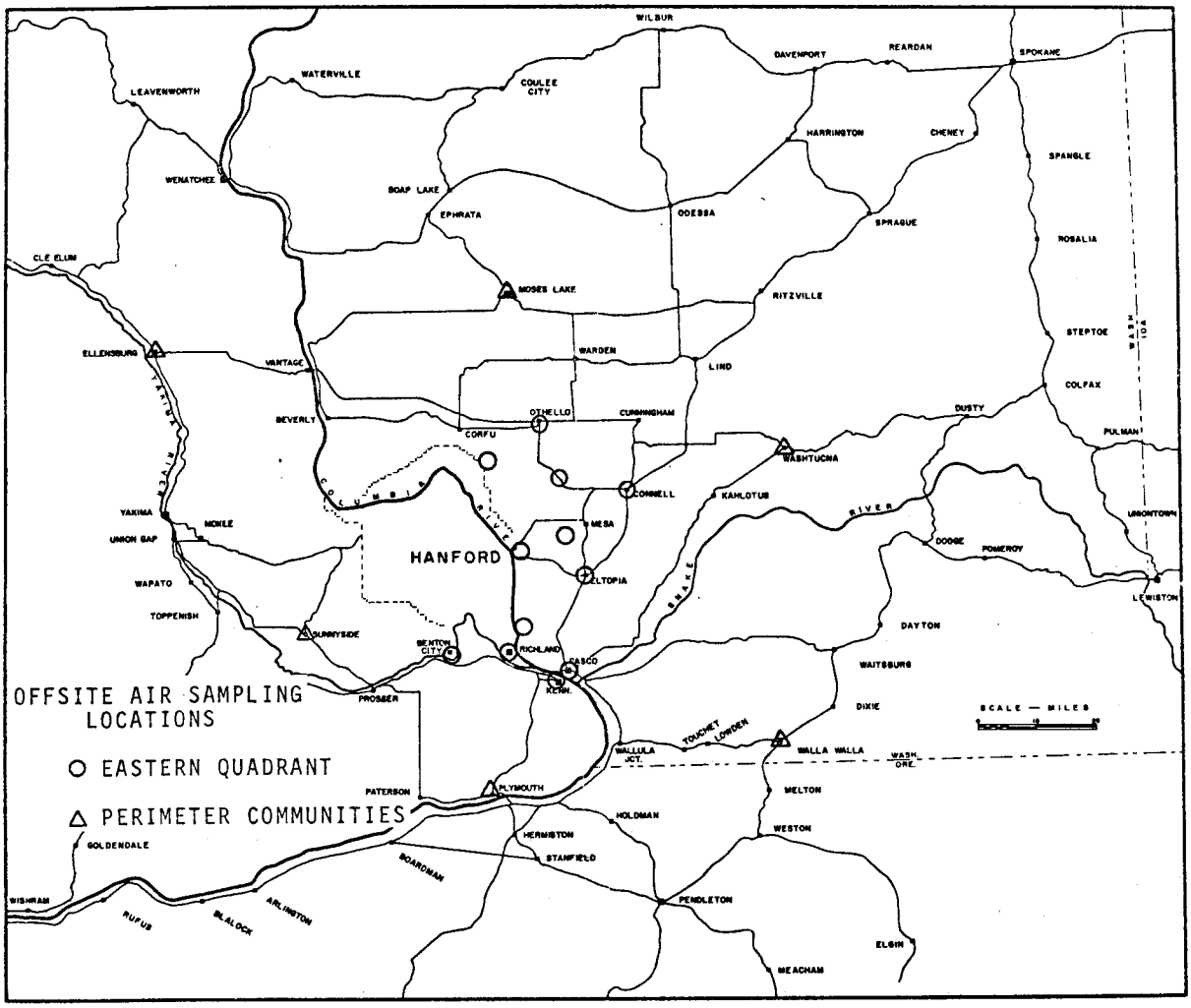
Total alpha concentrations during 1971 averaged about 0.004×10^{-12} μCi/ml at most on-site locations. 200 ENC was the notable exception with an annual average of 0.024×10^{-12} μCi/ml. Monthly averages at several locations occasionally approached 0.01×10^{-12} μCi/ml. Alpha activity peaked at most locations in February, corresponding in time with the peak weekly concentration of 0.25×10^{-12} μCi/ml registered at 200 ENC during the first week of February.

D. Other Radionuclides

Gamma spectrum analysis was performed on a number of monthly composites of selected air filters. Quarterly analysis for Sr-90 and Pu-239 of the composites was also performed. Table 12 presents the results of these special analyses. Average concentrations of gamma emitters for 1971 were similar to 1970. Ru-Rh-106 concentration averages of about 0.3×10^{-12} μCi/ml for 1971 are comparable to the Ru-Rh-106 averages of about 0.15×10^{-12} for 1970.


WAHLUKE #2
100-D
100-H
100-DR
100-N
100-KW
100-KE
100-F
100-B
100-C
VERNITA TOLL BRIDGE
PRIEST RAPIDS DAM
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
RINGOLD
BARRICADE
240
EMERGENCY RELOCATION CENTER
PROSSER BARRICADE
300 AREA
RICHLAND BARRICADE
YAKIMA RIVER
NORTH RICHLAND
WEST RICHLAND
AIR SAMPLING STATIONS
Sampling Location
BENTON CITY
KIONA
PROSSER
0 2 4 8
Scale in Miles

MAP 4


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

MAP 5

TABLE 11: AVERAGE I-131, PARTICULATE TOTAL BETA, AND PARTICULATE TOTAL ALPHA CONCENTRATIONS IN THE ATMOSPHERE

Units of 10^{-12} μCi/ml

	I-131†					
Location	1967*	1968*	1969*	Jan-June 1970*	July-Dec 1970**	1971**
100 Areas	0.02	0.02	0.01	0.007	0.06	0.03
200 Areas	0.09	0.03	0.01	0.01	0.09	0.04
Other On-Site Locations	0.04	0.02	0.02	0.02	0.08	0.04

	Total Beta				
	1967	1968	1969	1970	1971
100 Areas	0.34	0.30	0.33	0.43	0.30
200 Areas	0.41	0.28	0.53	0.65	0.73
Other On-Site Locations	0.26	0.20	0.28	0.35	0.49

	Total Alpha				
	1967	1968	1969	1970	1971
100 Areas	0.01	0.006	0.007	0.01	0.002
200 Areas	0.01	0.008	0.01	0.02	0.009
Other On-Site Locations	0.009	0.01	0.008	0.01	0.003

* Scrubbers

** Charcoal Cartridges

† Most restrictive Concentration Guide - 100×10^{-12} μCi/ml

TABLE 12: AVERAGE CONCENTRATION OF GAMMA EMITTERS, TOTAL ALPHA, AND TOTAL BETA ACTIVITY ON SELECTED AIR FILTERS - 1971

Units of 10^{-12} μCi/ml

	^{90}Sr	$^{95}ZrNb$	$^{106}RuRh$	^{134}Cs	^{137}Cs-^{137m}Ba	$^{140}BaLa$	$^{144}CePr$	^{239}Pu	Total Alpha	Total Beta
Concentration Guide	200	1000	200	400	500	1000	200	1		
ACTIVE AREAS										
Active Area #1	0.032	0.41	*	0.012	1.0	0.19	*0.016	0.0003		
200 ENC									0.024	1.7
Active Area #2	0.005							0.0003		
200 ESE									0.004	0.37
Active Area #3	0.007	0.14	0.23	*0.003	0.064	*0.022	0.13	0.0002		
200 WEC									0.003	0.36
Redox									0.004	0.51
Active Area #4	0.003	0.11	0.24	*0.002	0.004	*0.022	0.12	0.0002		
300 Area									0.004	0.35
Byers Landing									0.002	0.39
Active Area #5		0.022	0.074	*	*0.005	*0.037	*0.026			
100-K									0.001	0.22
100-N									0.002	0.33
100-D										0.22
INNER RING										
Inner SW Quadrant	0.004	0.13	0.30	*0.002	0.002	*	0.13	0.00008		
Rattlesnake Springs										0.46
ERC										0.39
Benton City									0.001	0.42
Inner NW Quadrant	0.004	0.12	0.26	*0.002	0.004	*0.014	0.11	0.00004		
Yakima Barricade									0.003	0.42
Vernita										0.47
Wahluke #2										0.42
Inner East. Quadrant	0.003	0.11	0.26	*0.002	0.004	*	0.11	0.00008		
100-F										0.35
Hanford									0.003	0.44
Ringold									0.003	0.39
Wye Barricade										0.40

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

TABLE 12 (Continued): AVERAGE CONCENTRATION OF GAMMA EMITTERS, TOTAL ALPHA, AND TOTAL BETA ACTIVITY ON SELECTED AIR FILTERS - 1971

Units of 10^{-12} μCi/ml

	^{90}Sr	$^{95}ZrNb$	$^{106}RuRh$	^{134}Cs	^{137}Cs-^{137m}Ba	$^{140}BaLa$	$^{144}CePr$	^{239}Pu	Total Alpha	Total Beta
EASTERN QUADRANT										
Inner NE Quadrant	0.003	0.12	0.27	*0.002	0.002	*0.008	0.14	0.00006		
Othello									0.001	0.38
Connell										0.44
Berg Ranch									0.002	0.44
Wahluke WM										0.38
New Moon									0.001	0.30
Inner SE Quadrant	0.003	0.12	0.28	*0.002	0.004	*0.0006	0.12	0.00006		
Richland									0.001	0.42
Pasco									0.003	0.42
Kennewick										0.38
Eltopia										0.39
PERIMETER COMMUNITIES										
Outer NE Quadrant	0.002	0.11	0.29	*0.003	0.005	0.013	0.12	0.00006		
Moses Lake										0.40
Washtucna										0.37
Outer SE Quadrant	0.003	0.11	0.27	*0.002	0.005	*0.010	0.10	0.00004		
Walla Walla									0.001	0.35
McNary									0.002	0.41
Outer West. Quadrant	0.002	0.097	0.20	*0.002	0.002	*0.027	0.10	0.00003		
Ellensburg										0.31
Sunnyside										0.34

* Less than the analytical limit.

No entry indicates no analysis was performed.

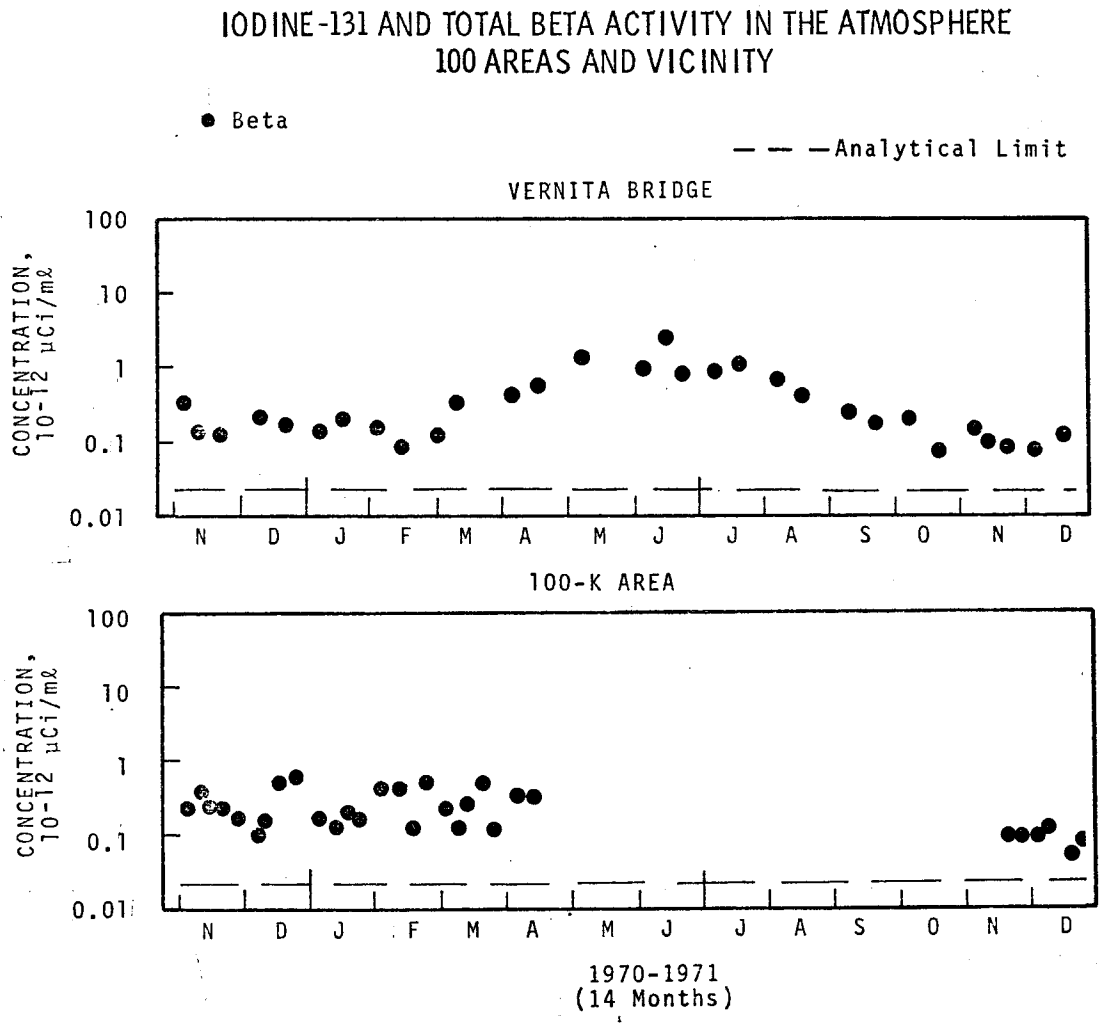

IODINE-131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE
100 AREAS AND VICINITY
● Beta
— — —Analytical Limit
VERNITA BRIDGE
CONCENTRATION, 10-12 µCi/mℓ
100
10
1
0.1
0.01
N D J F M A M J J A S O N D
100-K AREA
CONCENTRATION, 10-12 µCi/mℓ
100
10
1
0.1
0.01
N D J F M A M J J A S O N D
1970-1971
(14 Months)

FIGURE 8

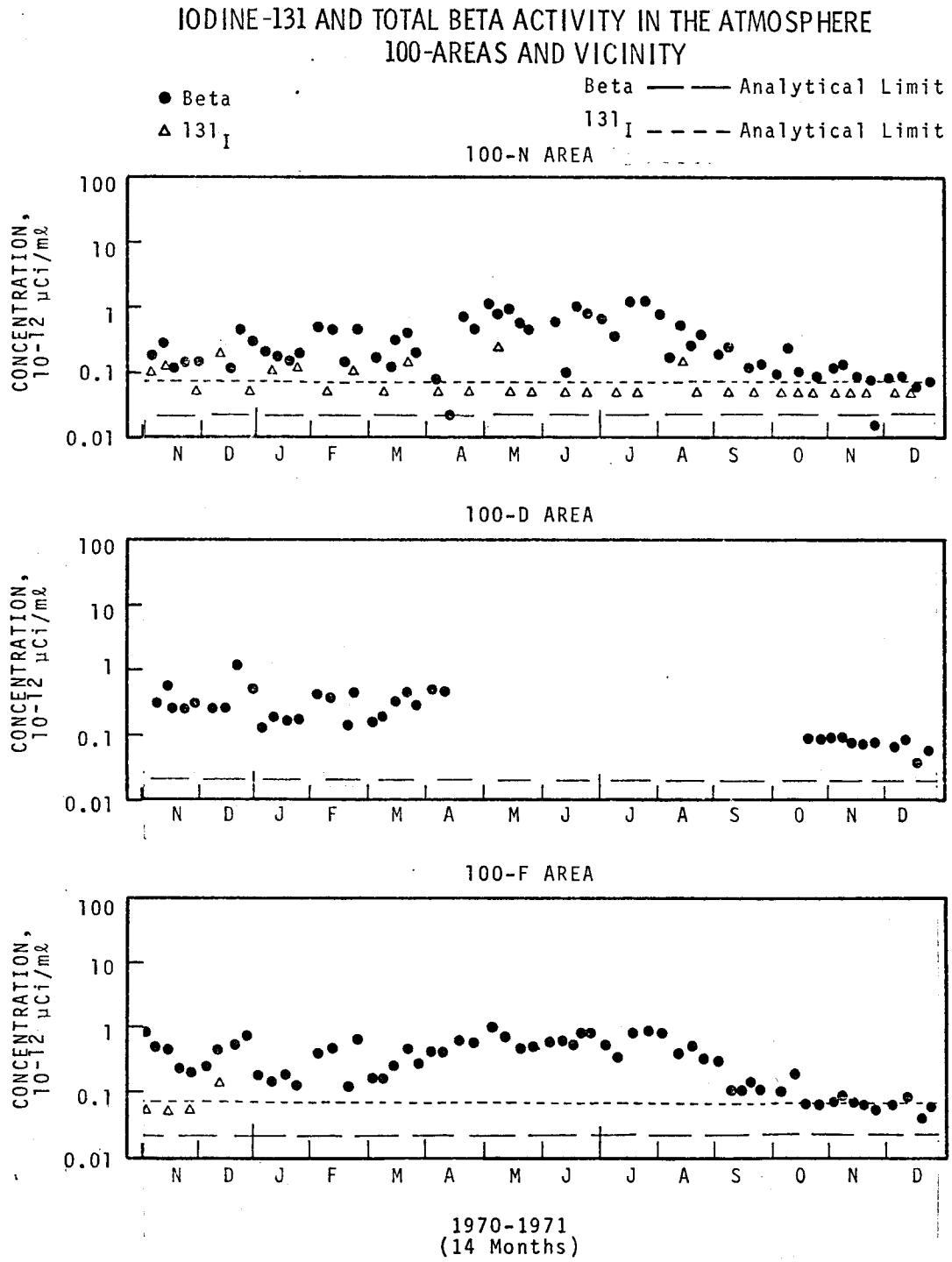

IODINE-131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE
100-AREAS AND VICINITY
● Beta
△ 131I
Beta —— —— Analytical Limit
131I - - - - Analytical Limit
100-N AREA
100-D AREA
100-F AREA
CONCENTRATION, 10-12 µCi/mℓ
100
10
1
0.1
0.01
N D J F M A M J J A S O N D
1970-1971
(14 Months)

FIGURE 9

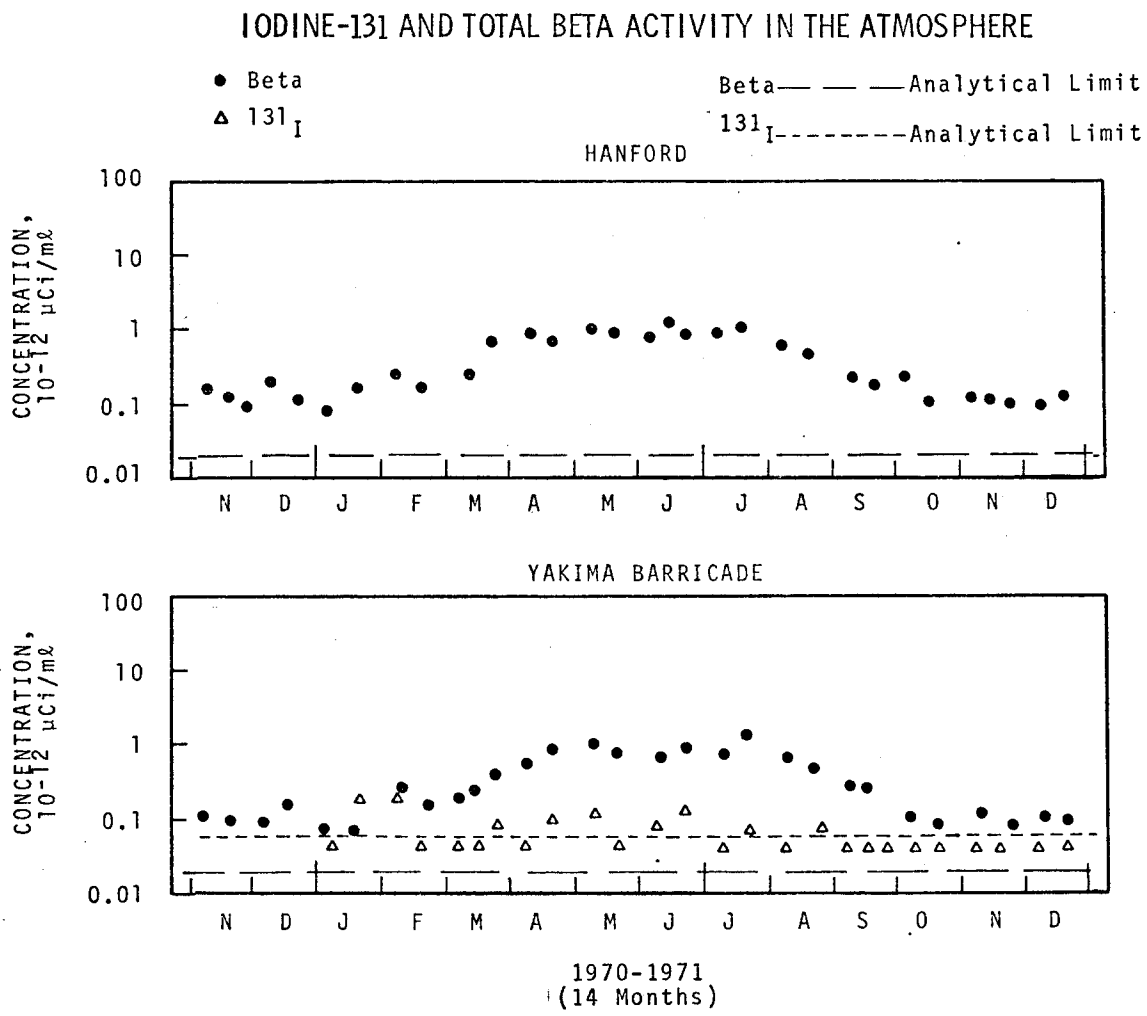

IODINE-131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE
● Beta
△ 131I
Beta— — —Analytical Limit
131I--------Analytical Limit
HANFORD
CONCENTRATION, 10-12 µCi/mℓ
100
10
1
0.1
0.01
N D J F M A M J J A S O N D
YAKIMA BARRICADE
CONCENTRATION, 10-12 µCi/mℓ
100
10
1
0.1
0.01
N D J F M A M J J A S O N D
1970-1971
(14 Months)

FIGURE 10

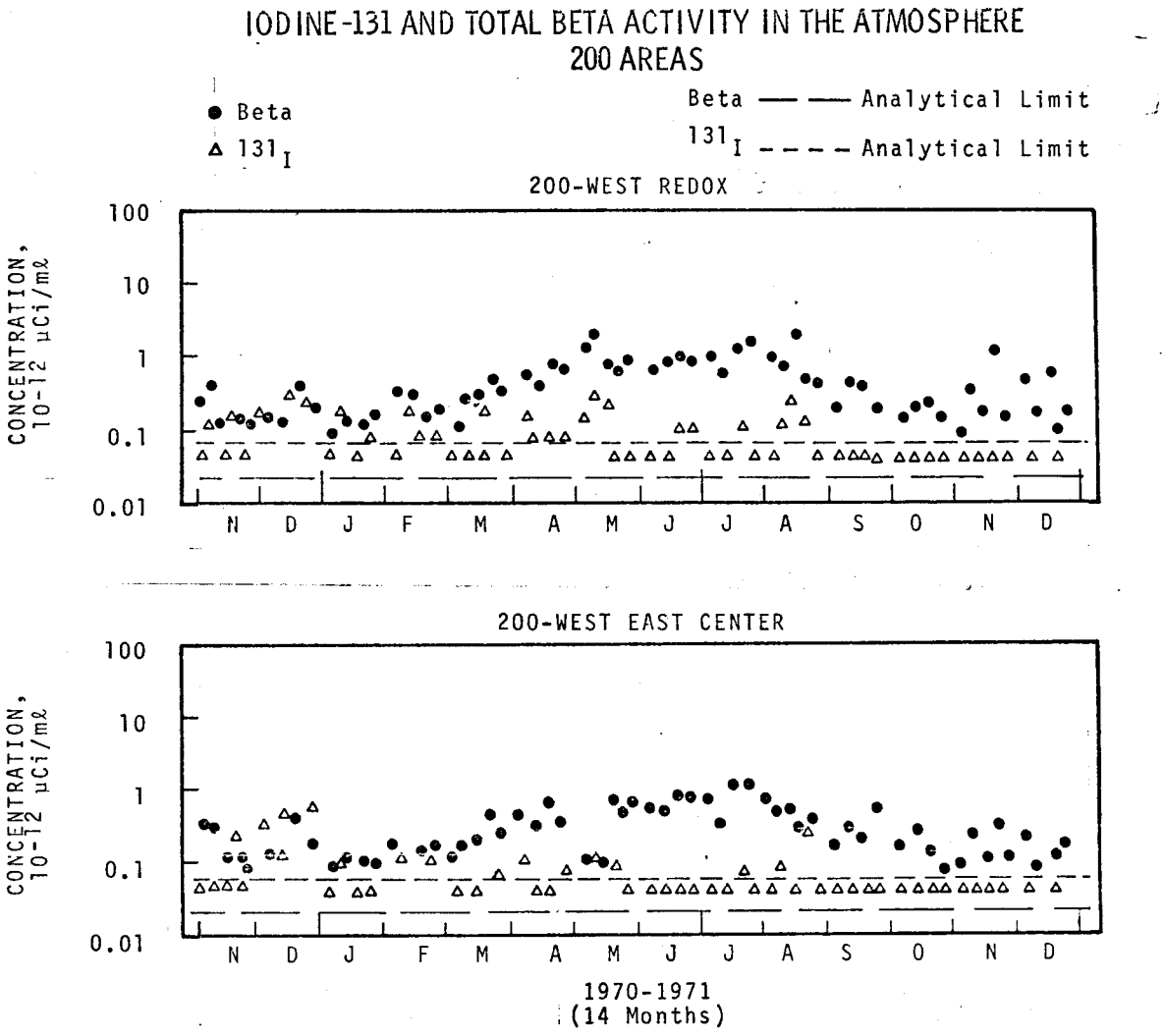

IODINE-131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE
200 AREAS
● Beta
△ 131I
Beta —— —— Analytical Limit
131I - - - - Analytical Limit
200-WEST REDOX
CONCENTRATION, 10-12 µCi/mℓ
100
10
1
0.1
0.01
N D J F M A M J J A S O N D
200-WEST EAST CENTER
CONCENTRATION, 10-12 µCi/mℓ
100
10
1
0.1
0.01
N D J F M A M J J A S O N D
1970-1971
(14 Months)

FIGURE 11

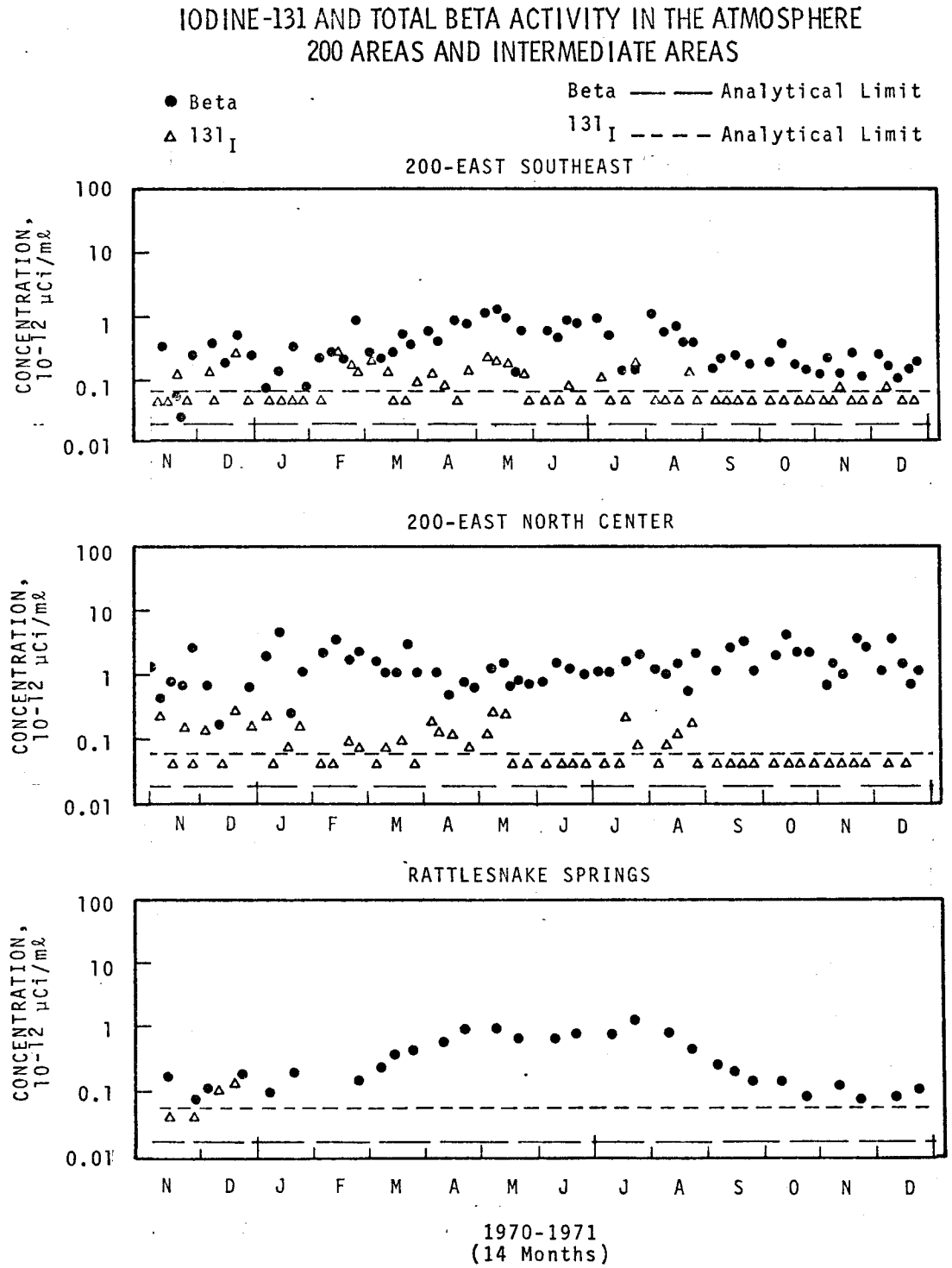

IODINE-131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE
200 AREAS AND INTERMEDIATE AREAS
● Beta
△ 131I
Beta —— —— Analytical Limit
131I – – – – Analytical Limit
200-EAST SOUTHEAST
200-EAST NORTH CENTER
RATTLESNAKE SPRINGS
CONCENTRATION, 10-12 µCi/mℓ
100
10
1
0.1
0.01
N D J F M A M J J A S O N D
1970-1971
(14 Months)

FIGURE 12

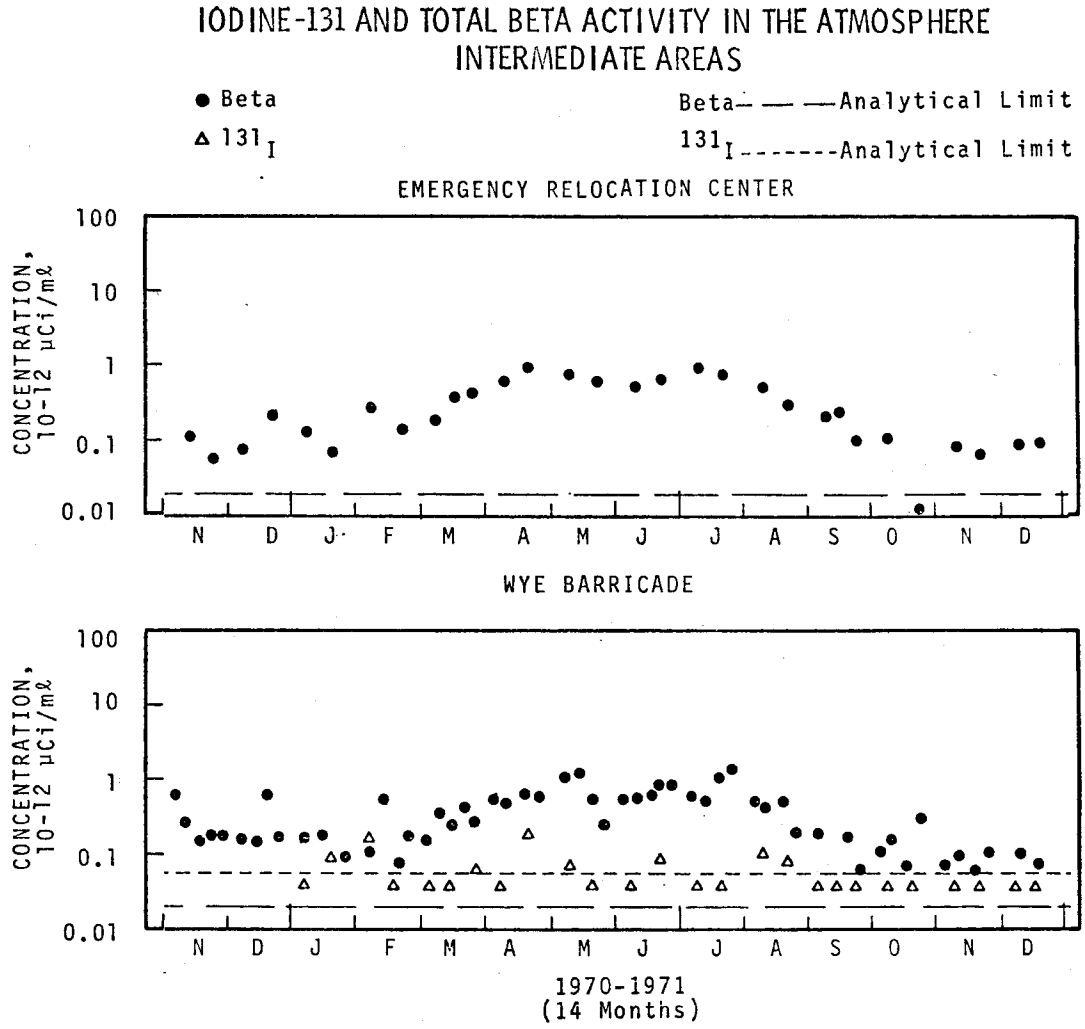

IODINE-131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE
INTERMEDIATE AREAS
● Beta
Δ 131I
Beta — — —Analytical Limit
131I -------Analytical Limit
EMERGENCY RELOCATION CENTER
CONCENTRATION, 10-12 µCi/mℓ
100
10
1
0.1
0.01
N D J F M A M J J A S O N D
WYE BARRICADE
CONCENTRATION, 10-12 µCi/mℓ
100
10
1
0.1
0.01
N D J F M A M J J A S O N D
1970-1971
(14 Months)

FIGURE 13

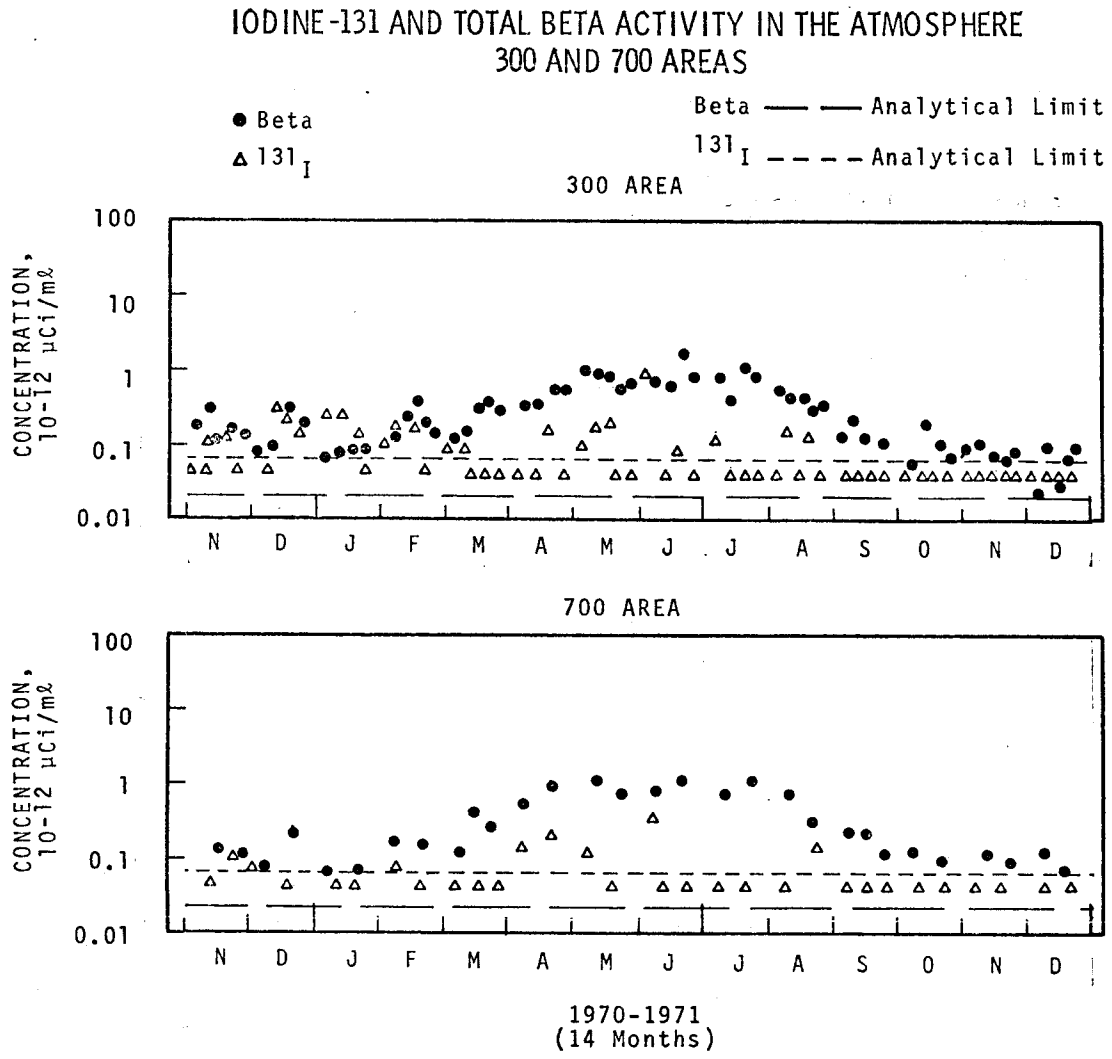

IODINE-131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE
300 AND 700 AREAS
● Beta
△ 131I
Beta —— —— Analytical Limit
131I – – – – Analytical Limit
300 AREA
CONCENTRATION, 10-12 µCi/mℓ
100
10
1
0.1
0.01
N D J F M A M J J A S O N D
700 AREA
CONCENTRATION, 10-12 µCi/mℓ
100
10
1
0.1
0.01
N D J F M A M J J A S O N D
1970-1971
(14 Months)

FIGURE 14

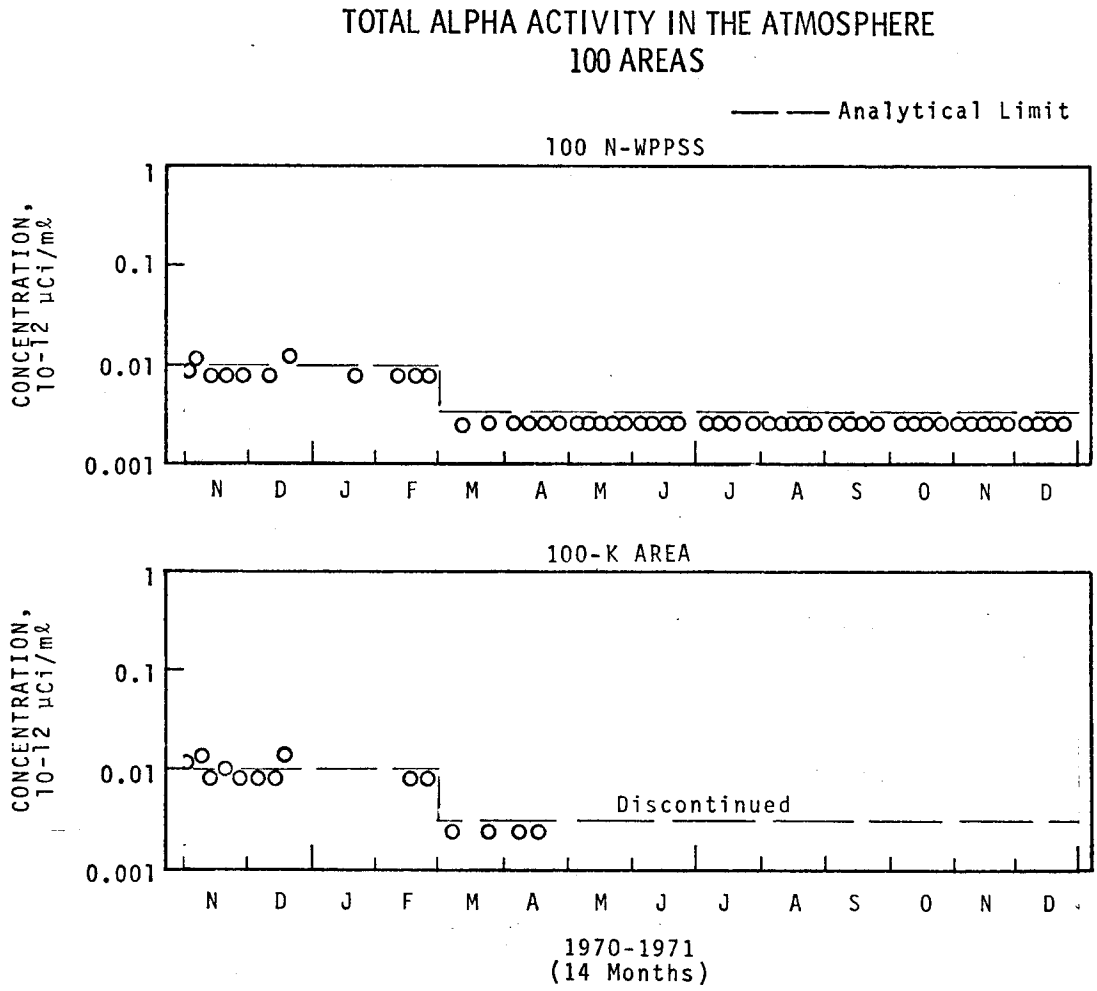

TOTAL ALPHA ACTIVITY IN THE ATMOSPHERE
100 AREAS
Analytical Limit
100 N-WPPSS
CONCENTRATION, 10-12 µCi/mℓ
1
0.1
0.01
0.001
N D J F M A M J J A S O N D
100-K AREA
CONCENTRATION, 10-12 µCi/mℓ
Discontinued
1970-1971
(14 Months)

FIGURE 15

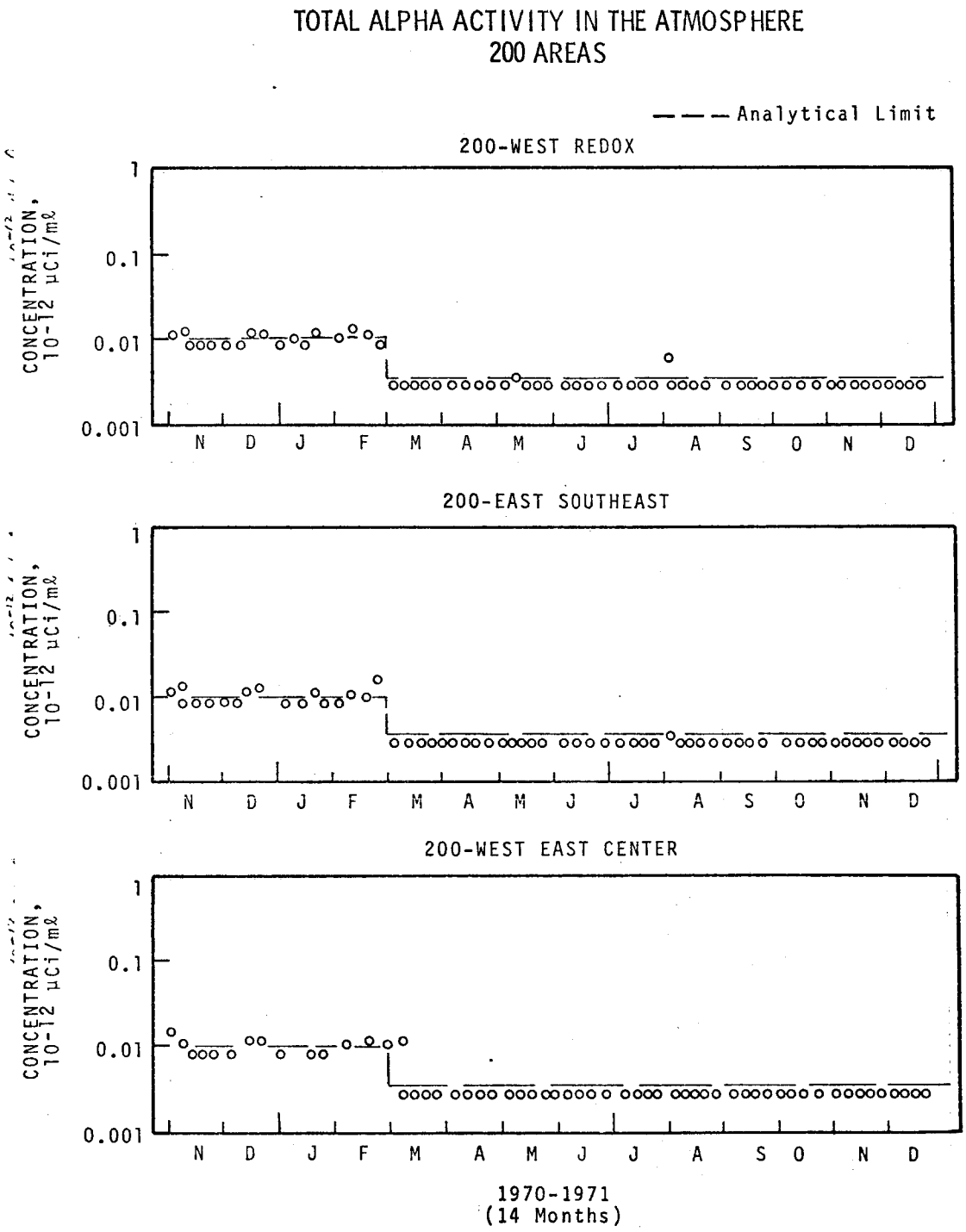

TOTAL ALPHA ACTIVITY IN THE ATMOSPHERE
200 AREAS
Analytical Limit
200-WEST REDOX
200-EAST SOUTHEAST
200-WEST EAST CENTER
CONCENTRATION, 10-12 µCi/mℓ
1
0.1
0.01
0.001
N D J F M A M J J A S O N D
1970-1971
(14 Months)

FIGURE 16

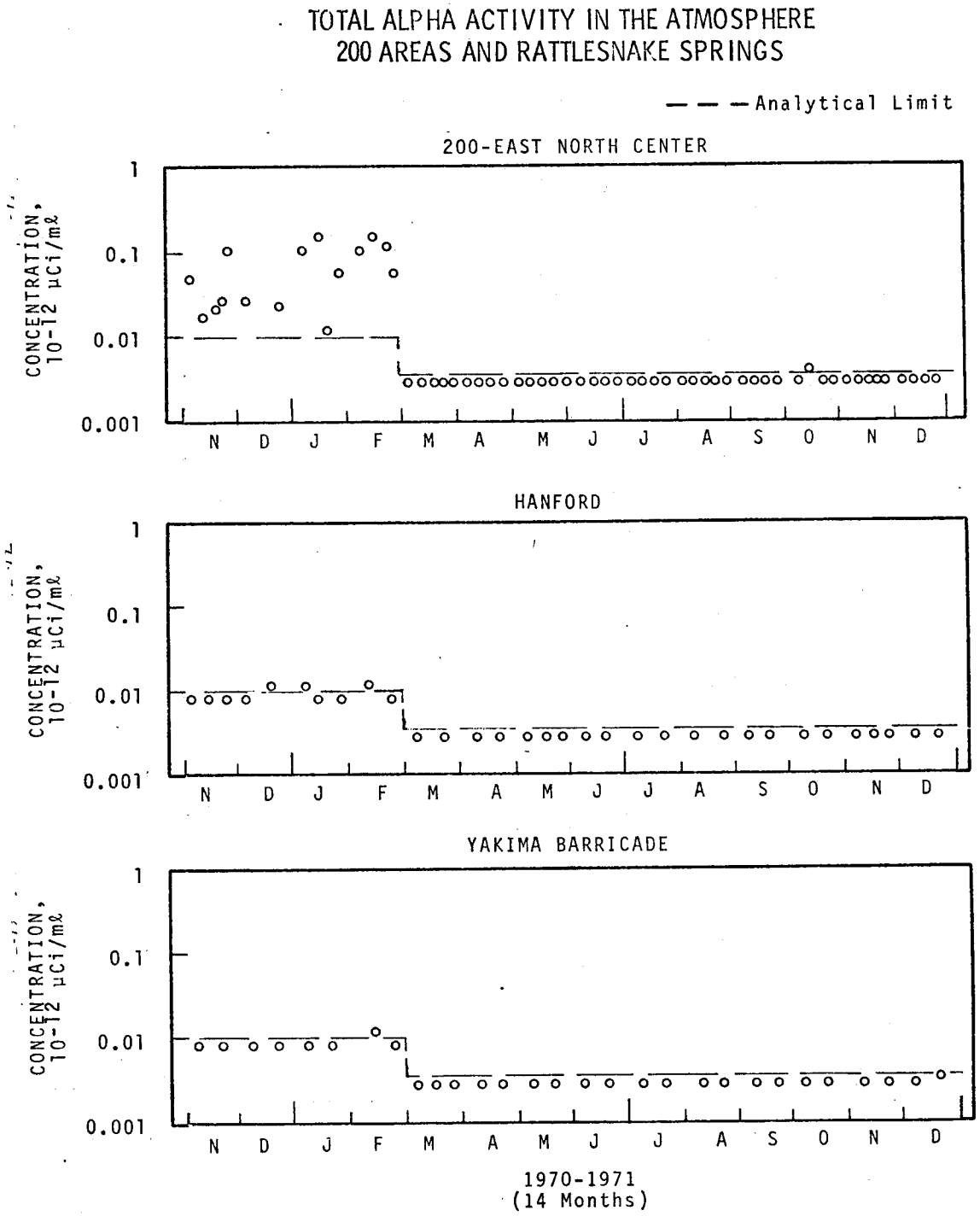

TOTAL ALPHA ACTIVITY IN THE ATMOSPHERE
200 AREAS AND RATTLESNAKE SPRINGS
— — — Analytical Limit
200-EAST NORTH CENTER
HANFORD
YAKIMA BARRICADE
CONCENTRATION, 10-12 µCi/mℓ
1
0.1
0.01
0.001
N D J F M A M J J A S O N D
1970-1971
(14 Months)

FIGURE 17

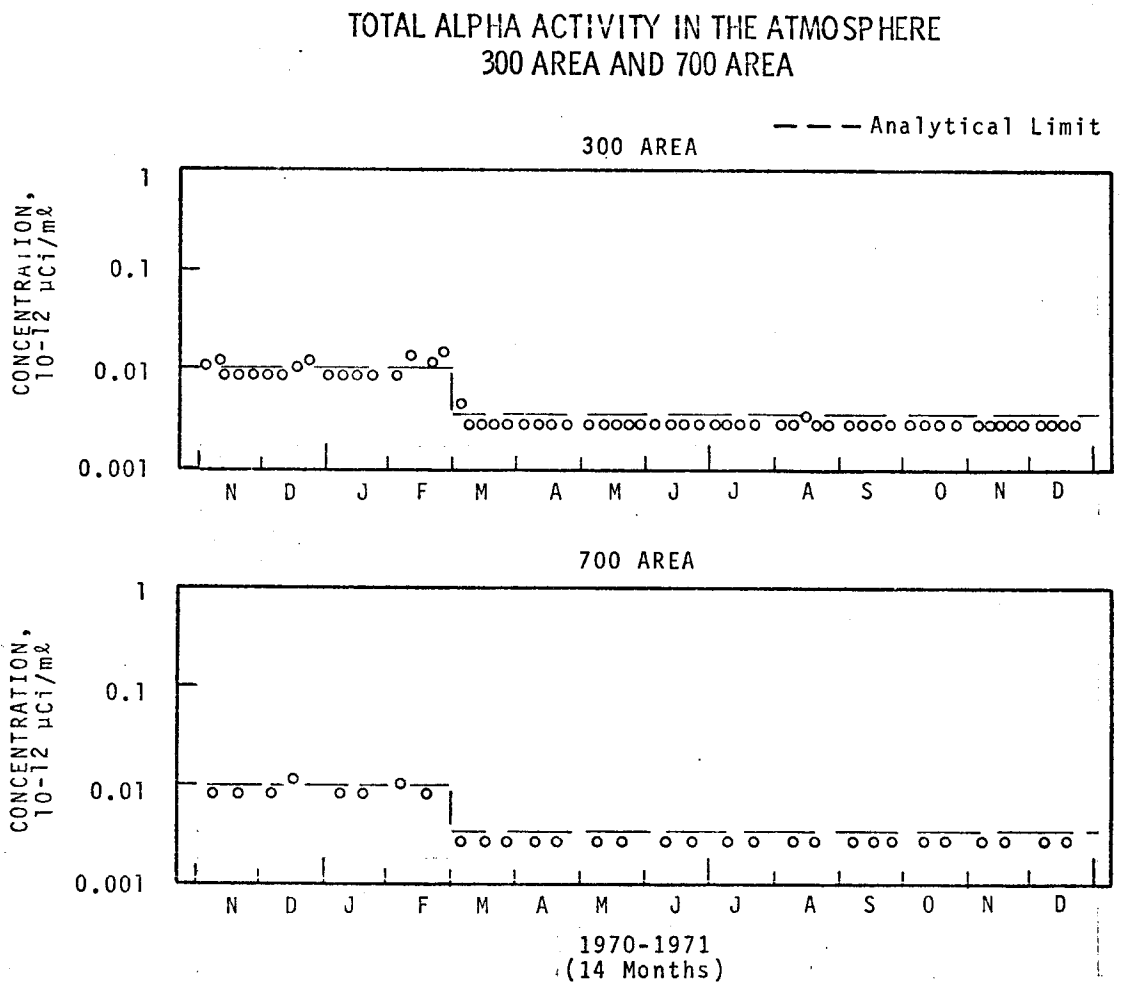

TOTAL ALPHA ACTIVITY IN THE ATMOSPHERE
300 AREA AND 700 AREA
Analytical Limit
300 AREA
CONCENTRATION, 10-12 µCi/mℓ
1
0.1
0.01
0.001
N D J F M A M J J A S O N D
700 AREA
CONCENTRATION, 10-12 µCi/mℓ
1
0.1
0.01
0.001
N D J F M A M J J A S O N D
1970-1971
(14 Months)

FIGURE 18

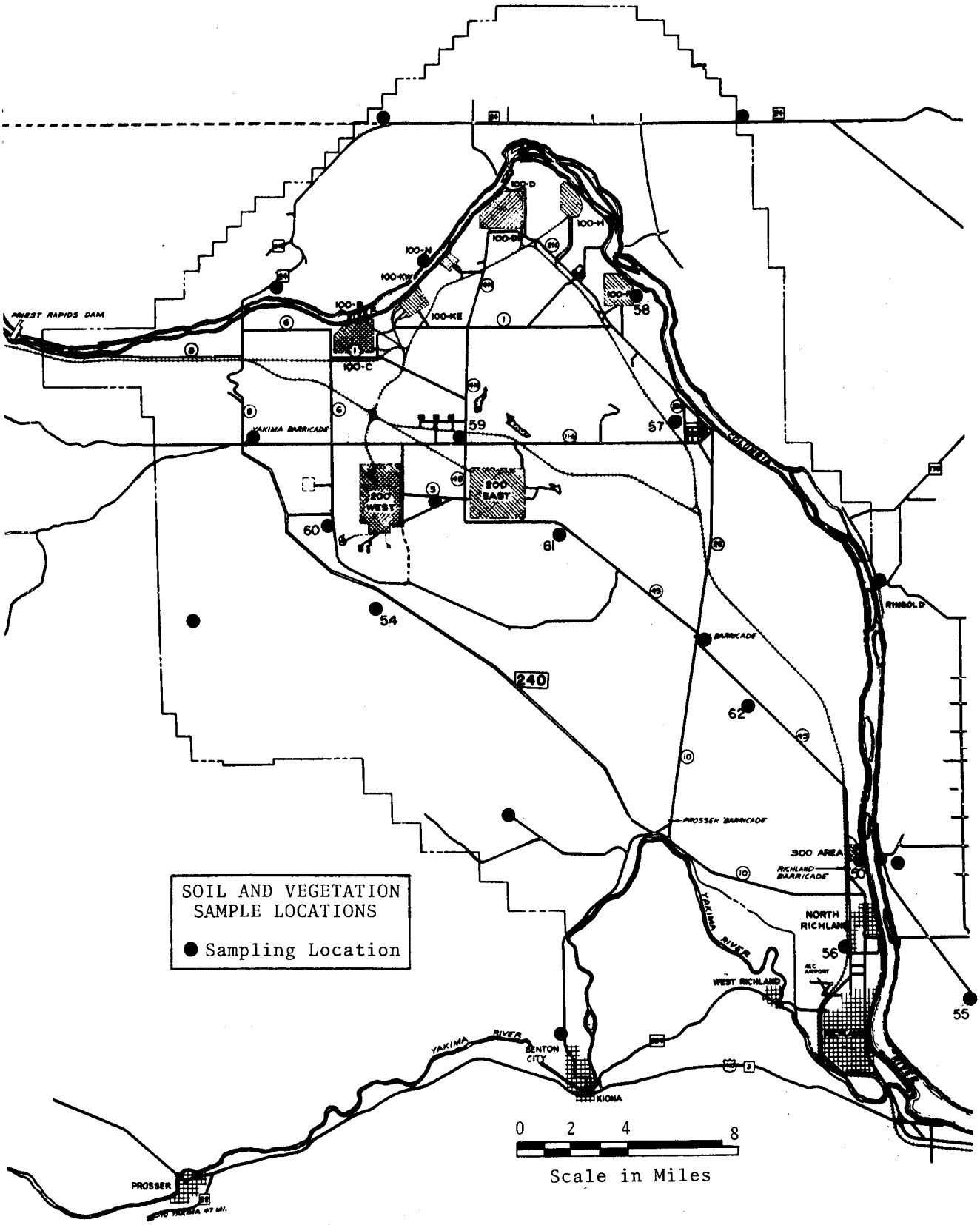
IX. SOIL AND VEGETATION

Twenty-four stations 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 stations at the end of September 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 stations are given in Tables 13 and 14. Individual results showed no particular geographical pattern, and the concentrations measured are believed to be the result of regional fallout. The plutonium concentrations are typical of general regional levels for the arid western states.

Results of soil and vegetation from eleven on-site stations are presented in Tables 13 and 15. Average concentrations of several radionuclides in soil were marginally higher in the on-site samples compared to the perimeter samples. Sr-90 and Cs-137 were the most significant in this group. On-site plutonium concentrations in soil and vegetation were statistically the same as the perimeter stations. Concentrations of Zr-Nb-95, Ru-103, and Cs-137 were somewhat higher in on-site vegetation compared to the perimeter.

For most locations, the greater radionuclide concentration was detected in the top inch of soil. Some exceptions can be observed in the tables, however, in which an apparently greater concentration was measured in the second inch of sample.


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

MAP 6

TABLE 13: CONCENTRATION OF RADIONUCLIDES IN SOIL SAMPLES - 1971

Units of 10^{-6} μCi/gm

Location	^{90}Sr		Pu		^{238}Pu		^{40}K		^{60}Co		^{65}Zn		^{58}Co		^{137}Cs		^{134}Cs		^{106}Ru		$^{144}Ce\text{-}Pr$	
	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.	1 in.	2 in.	1 in.	2 in.	1 in.	2 in.	1 in.	2 in.
ON-SITE																						
FFTF-SA	.098	.186	.019	.009	.000*	.005	13.4	13.6	.023	.000*	.000*	.000*	.058	.000*	.863	.222	.114	.015	.740	.167*	.676	.363
331	.276	.196	.014	.005	.002	.000*	12.2	14.7	.150	.238	.000*	.086	.000*	.000*	.129	.204	.000*	.000*	.482	.000*	.000*	.000*
North of 100-N	.128	.156	.009	.003	.003	.003*	16.6	21.9	.000*	.000*	.017	.000*	.000*	.000*	.818	.075	.098	.049	.850	.000*	.235	.000*
200-E Hill	.757	.122	.017	.007	.001	.002*	11.1	12.5	.021	.038	.241	.194	.000*	.000*	1.42	.107	.000*	.042	.719	.000*	.504	.062*
200 Fire Sta.	.221	.031	.008	.003	.005	.003*	12.7	14.3	.000*	.004*	.215	.000*	.078	.000*	.609	.126	.123	.015*	.206	.000*	.441	.000*
Rt. 4 x 11 A	.652	.110	.029	.002	.008	.000*	11.0	9.56	.000*	.000*	.000*	.000*	.024	.080	1.64	.119	.000*	.136	.144	.000*	.358	.000*
Redox P.S.	.102	.885	.002*	.003	.001*	.002*	12.1	12.0	.056	.066	.029	.000*	.012	.044	.129	.054	.084	.085	.000*	.000*	.104	.000*
Y Barricade	.217	.013	.014	.009	.000*	.000*	16.1	11.7	.068	.000*	.237	.000*	.000*	.002*	.525	.294	.000*	.101	.810	.000*	.704	.723
Hanford	.672	.076	.022	.000*	.000*	.003*	16.0	12.6	.000*	.000*	.142	.000*	.068	.000*	.983	.041	.093	.000*	.469	.000*	.030*	.033
100-F	.409	.002	.013	.002	.003*	.000*	13.5	13.5	.047	.007*	.022*	.000*	.052	.000*	.512	.000*	.084	.021*	.421	.000*	.681	.000*
FFTF #4	.091	.007	.004	.000*	.002	.000*	12.0	15.2	.135	.053	.000*	.000*	.000*	.000*	.194	.024	.016*	.042	.000*	.812	.437	.671
Average On-Site	.329	.162	.014	.004	.003	.002*	13.3	13.8	.045	.037	.087	.025	.027	.011	.711	.115	.056	.046	.440	.089	.379	.168
PERIMETER																						
Byers Landing	.098	.283	.012	.008	.002*	.002*	17.0	17.9	.027	.090	.000*	.194	.080	.091	1.27	.274	.056	.063	.480	.000*	.106	.345
North Richland	.240	.047	.014	.002*	.004	.003*	15.8	13.1	.000*	.096	.000*	.000*	.000*	.000*	.418	.259	.000*	.000*	.038	.000*	.473	.000*
Ringold	.118	.995	.006	.008	.002*	.003*	16.5	13.1	.000*	.019*	.158	.000*	.013	.000*	.408	.032	.071	.000*	.134	.000*	.000*	.000*
ERC	.149	.102	.015	.005	.000*	.003*	11.9	11.9	.043	.000*	.158	.159	.009	.026*	.803	.064	.000*	.028*	.119	.000*	.907	.000*
Vernita	.080	.131	.007	.001*	.001*	.002*	14.9	16.9	.056	.000*	.000*	.222	.000*	.011*	.478	.081	.003	.165	.000*	.048*	.000*	.000*
Yakima Barr.	.159	.000*	.009	.003*	.004	.003*	14.2	14.6	.000*	.013*	.008	.261	.003	.020*	.174	.000*	.102	.106	.332	.385	.041	.411
Benton City	.450	.217	.018	.001*	.002*	.001*	14.5	11.7	.000*	.115	.000*	.000*	.038	.017*	.966	.006*	.046	.076	2.29	.000*	.000*	.494
Berg Ranch	.340	.084	.012	.003	.007	.003*	9.67	9.01	.000*	.047	.056	.000*	.030	.000*	.569	.000*	.084	.047	.096	.000*	.165	.227*
Riverview	.330	.196	.011	.010	.001*	.000*	13.3	11.2	.000*	.000*	.000*	.000*	.000*	.000*	.743	.299	.000*	.000*	.314*	.000*	1.20	.111*
Byers P.H.	.141	.126	.012	.001*	.003*	.001*	13.3	6.35	.000*	.070	.019*	.000*	.000*	.080	.603	.175	.000*	.113	.322*	.000*	.747	.630
Wahluke #2	.183	.092	.005	.004	.004	.003*	13.8	13.4	.118	.000*	.000*	.000*	.053	.079	.468	.256	.068	.000*	.330*	.000*	.000*	.000*
Rt. 240 CP 54	.161	.032	.002*	.018	.040*	.004	12.6	15.9	.097	.000*	.205	.000*	.000*	.000*	.329	.060	.000*	.000*	.627	.244	.274	.178*
Rattlesnake Springs	.433	.044	.018	.001*	.006	.000*	10.0	10.4	.000*	.000*	.000*	.000*	.000*	.000*	.969	.136	.000*	.000*	.318*	.489	.166*	.638
Average Perimeter (13)	.222	.173	.011	.005	.004	.002	13.7	12.7	.026	.035	.046	.064	.017	.026	.631	.126	.033	.046	.415	.090	.387	.233

* Less than the analytical limit.

TABLE 14: Concentration of Radionuclides in Perimeter Vegetation - 1971

Location	^{90}Sr	Pu	^{238}Pu	µgm/gm U	^{40}K	$^{95}ZrNb$	^{103}Ru	^{106}Ru	^{137}Cs	^{141}Ce	$^{144}CePr$	$^{228,232}Th$
Byers Landing	.783	.005	.002*	.08	7.63	2.37	0.589*	1.35*	.825	-.0592*	6.52	- -
North Richland	.265	.005	.001*	.13	5.43	2.45	0.702*	0.970*	.666	4.17*	7.53	.375
Ringold	.045	.006	.002*	.10	5.07	0.813	1.02	0.289	.154	3.40	1.79	.113
ERC	.137	.003	.004*	.05	6.27	1.05	0.862*	0.145*	.209	-2.13*	2.66	.103
Vernita	.204	.003	.000*	.30	5.16	1.63	0.887*	0.325*	.387	3.35*	3.72	.273
Yakima Barricade	.142	.004	.000*	.14	5.34	1.37	- -	1.90	.306	2.98*	3.23	.133
Benton City	.068	.001*	.000*	.08	5.78	0.859	- -	0.591*	.151	- -	1.40	.088
Berg Ranch	.182	.003*	.001*	.15	7.59	2.68	- -	2.71	.558	-0.241*	0.106	- -
Riverview	.143	.002*	.003*	.05	3.89	0.732	- -	0.099	.252	- -	3.98	- -
Byers P.H.	.117	.002*	.000*	.06	6.20	0.681	- -	0.339	.249	- -	1.12	- -
Wahluke #2	.217	.011	.004*	.07	8.37	2.36	- -	1.42	.598	- -	8.76	- -
Rt. 240 CP 54	.182	.006	.001*	.03	7.16	1.52	- -	1.18	.456	- -	3.98	- -
Rattlesnake	.230	.005	.000*	.07	7.50	2.18	- -	0.932*	.720	- -	5.90	- -
Avg. (13)	.209	.004	.001**	.10	6.26	1.59	0.812	0.942	.425	1.64	3.90	.181

* Less than the analytical limit

TABLE 15: CONCENTRATION OF RADIONUCLIDES IN ON-SITE VEGETATION - 1971

Units of 10^{-6} μCi/gm of Vegetation

Location	^{90}Sr	Pu	^{238}Pu	μgm/gm U	^{40}K	$^{95}ZrNb$	^{103}Ru	^{106}Ru	^{137}Cs	^{141}Ce	$^{144}CePr$	$^{228,232}Th$
FFTF SA	.085	.005*	.005*	0.00*	7.37	3.43	-.483*	0.837*	0.980	8.95	- -	- -
331 Building	.122	.001*	.002*	0.13	5.14	1.50	-.607*	0.812	0.487	0.367*	3.82	.139
W. 100-N	.054	.002	.002*	0.12	6.55	1.76	- -	1.83	0.409	- -	5.98	.146
200-E Hill	.076	.007	.002*	0.21	5.93	17.9	- -	1.13*	11.3	- -	8.63	.102
200 Fire Sta.	.189	.002*	.002*	0.11	3.36	3.96	- -	0.191	2.26	-0.128	7.31	.112
Rt. 4-11A	.726	.001*	.000*	0.05	7.28	12.5	- -	1.19	8.06	- -	5.77	- -
Redox P.S.	.216	.006	.000*	0.08	5.68	1.82	- -	0.588*	0.529	- -	4.62	- -
Y Barricade	.424	.004	.001*	0.04	7.46	3.88	- -	0.943	1.52	- -	9.24	- -
Hanford	.196	.002*	.000*	0.10	6.79	3.47	- -	1.30*	1.36	- -	6.75	- -
100-F	.228	.006	.000*	0.07	5.57	2.91	- -	1.32	0.840	- -	6.78	- -
Avg. (10)	.232	.004	.0014	0.09	6.11	5.31	-.545	1.01	2.77	3.06	5.69	.125

* Less than the analytical limit

X. RADIATION SURVEYS

A. Surface Contamination

1. Hanford Roads Survey

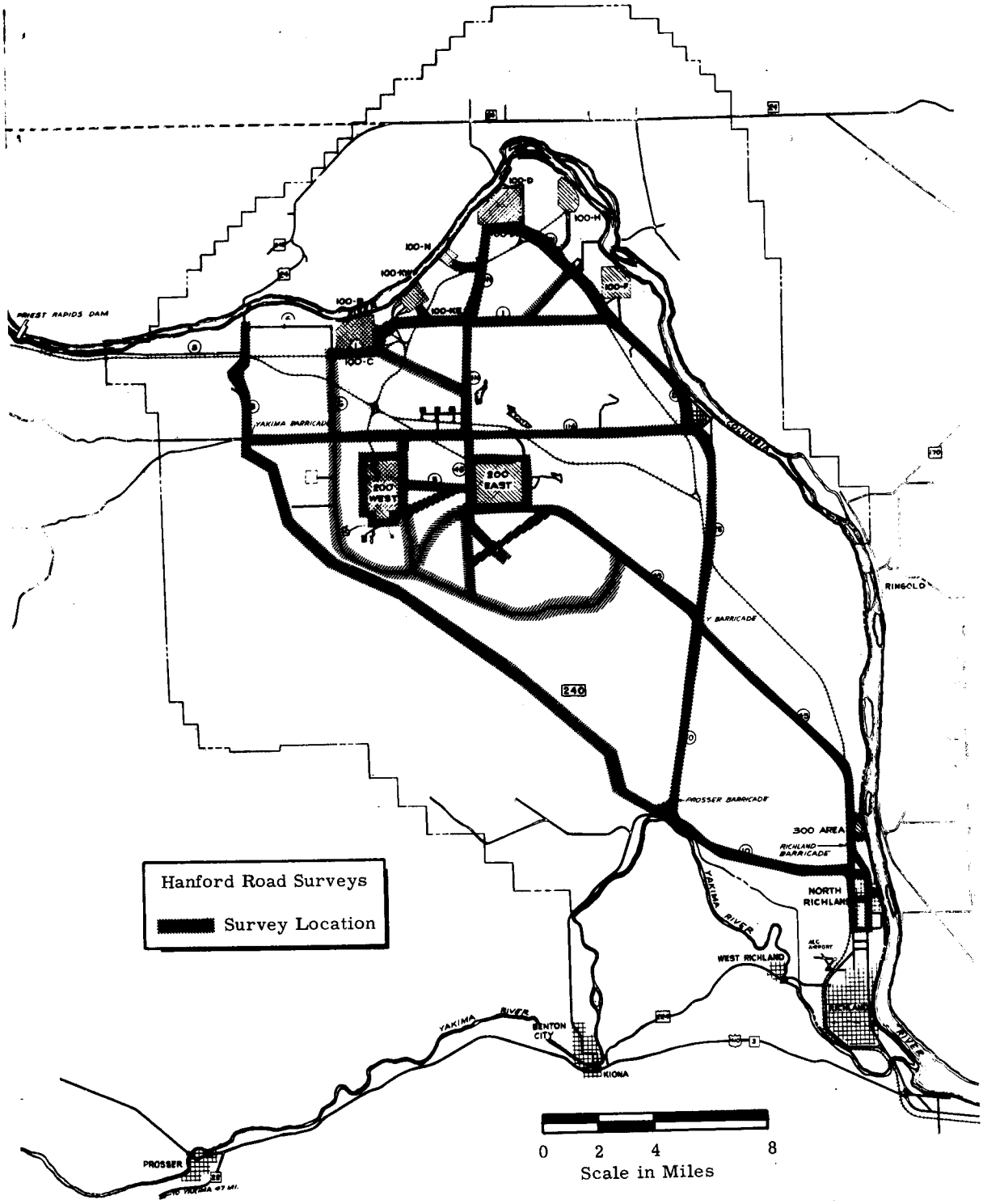
Hanford roads are routinely surveyed (Map 7) with a bioplastic scintillation detector attached to the front end of a truck and positioned about 0.6 meters (2 ft.) above the road surface. This road monitor has been described in BNWL-62. Most roads were surveyed monthly.

During the year, several radioactive particles or contaminated areas were found on or near Hanford roadways. These appear to have resulted from the transport (truck) of radioactive waste. The most significant of these particles was found on May 23 on the roadway 0.4 miles north of the Fire Station at the intersection of Routes 1 and 4. An uncorrected beta dose rate of 10 rad/hr was observed at the roadway surface. The particle could not be picked up and was chipped out of the surface later by road maintenance personnel.

Other contamination detected by road surveys follows. All of these were removed.

January 12-13: Four particles were found and picked up from the roadway between D-DR Reactor entrance road and the intersection of Routes 1 and 4. Each read greater than 100,000 cpm (GM). Highest dose rate reading from a single particle was 38 mrad/hr, 1 mR/hr at contact. Radioanalysis revealed the radionuclide composition as follows:

Nuclide	μCi/Sample
Ru-106	1.8
Sb-125	0.04
Cs-134	0.34
Cs-137	0.88
Ce-144	1.4


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

MAP 7

X. RADIATION SURVEYS (Continued)

February 3: General contamination was found near the south end of the SE perimeter fence of 200-East Area with particles up to 100,000 cpm (GM). A thistle from the area read 3000 cpm (GM). A weed recovered from the NE corner of the 200-East Area read 8000 cpm (GM).

February 10: One particle reading > 100,000 cpm (GM) was found and picked up about 10 feet from the site where two particles were picked up near the D-DR Reactor entrance in January.

July 31: A small piece of contaminated metal reading 100 mR/hr at contact and a second unidentified particle reading 3000 cpm (GM) were found on the shoulder of the road about 0.2 miles from the 100-N gate.

2. Railroad Survey

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

On October 13 a contaminated spot reading 600 cpm (GM) was detected along the tracks leading into the 300 Area. Investigation revealed that a rail car which was later found to be leaking fluid had previously been parked nearby for some time. Radioanalysis of a sample of the contamination revealed the following:

Nuclide	μCi/Sample
Cs-136	0.005
Cs-137	0.02

On October 14 four spots that appeared to be contaminated and ranging from 1000 to 50,000 cpm (GM) were found near the 200 Area.

Location	Nuclide	μCi/Sample
Susie Yard - Main Susie Yard - NW Leg	Cs-137	0.2
Susie Yard - NE Leg	Co-60	5.0
Helen Yard - E. Leg	Cs-134	0.01
	Cs-137	4.0

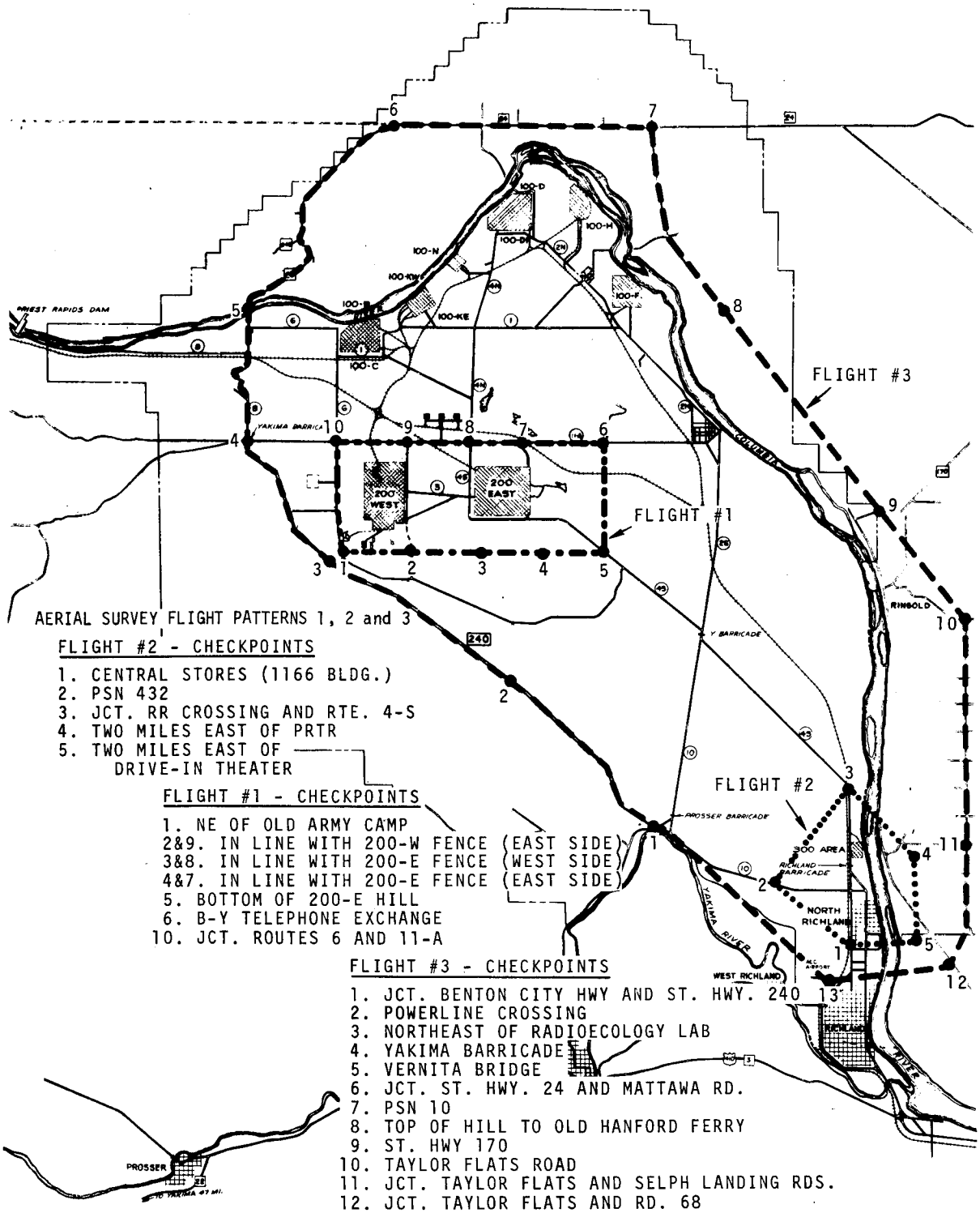
X. RADIATION SURVEYS (Continued)

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 1971 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 only once during 1971. No unusual radioactivity conditions were detected.

4. Control Plots

Small areas, called control plots, are located within the Hanford boundaries (Map 10). These plots, measuring 3.05 m by 3.05 m (10' x 10'), 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. Contamination was found on a control plot on only one occasion during 1971. On March 16 a particle reading 2500 cpm (GM) was detected on control plot number 10 on the southeast side of 200-East Area. No radioanalysis was performed as the particle was believed to be related to the contamination along the area fence detected by road surveys in February.



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

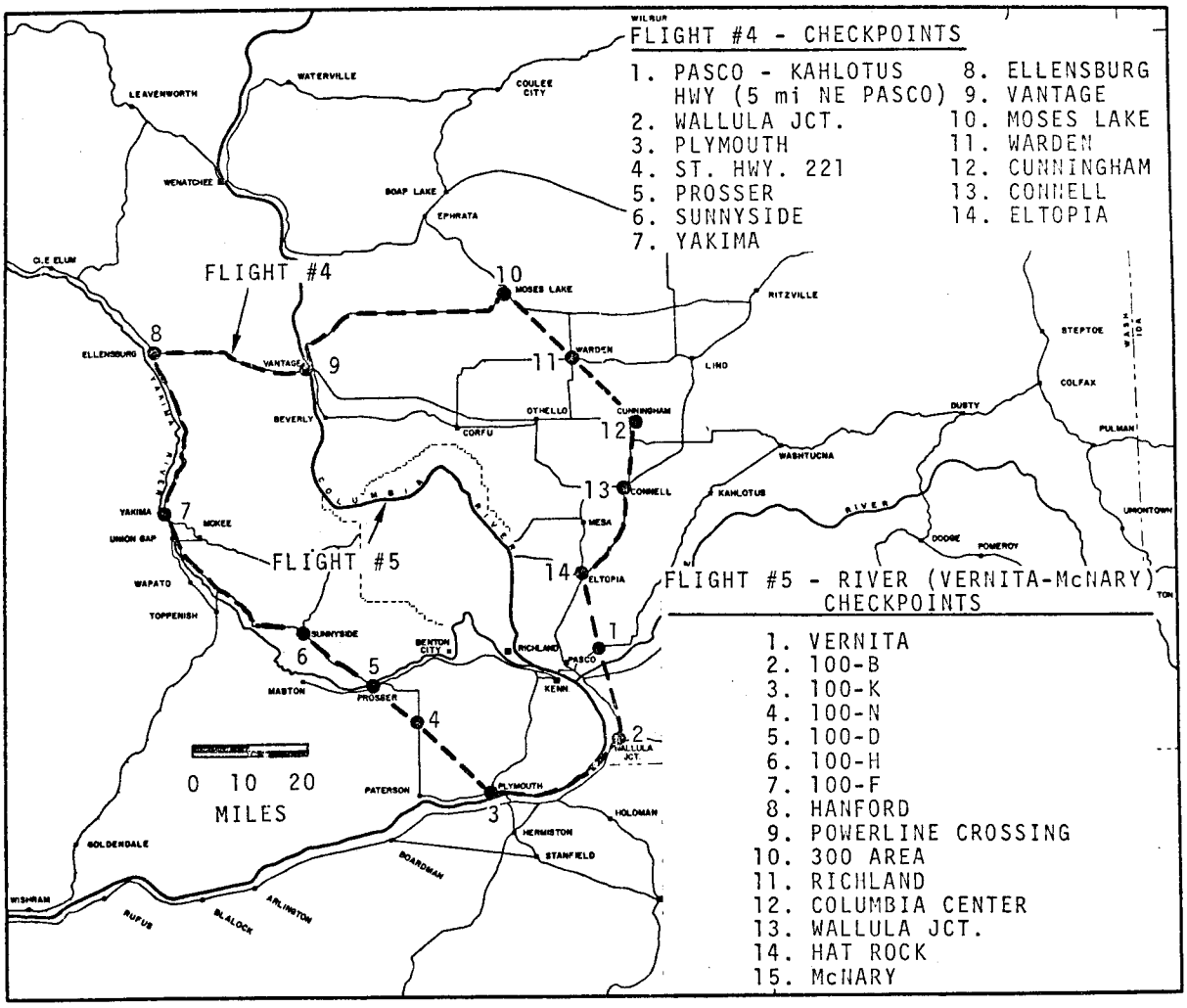
FLIGHT #1 - CHECKPOINTS

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

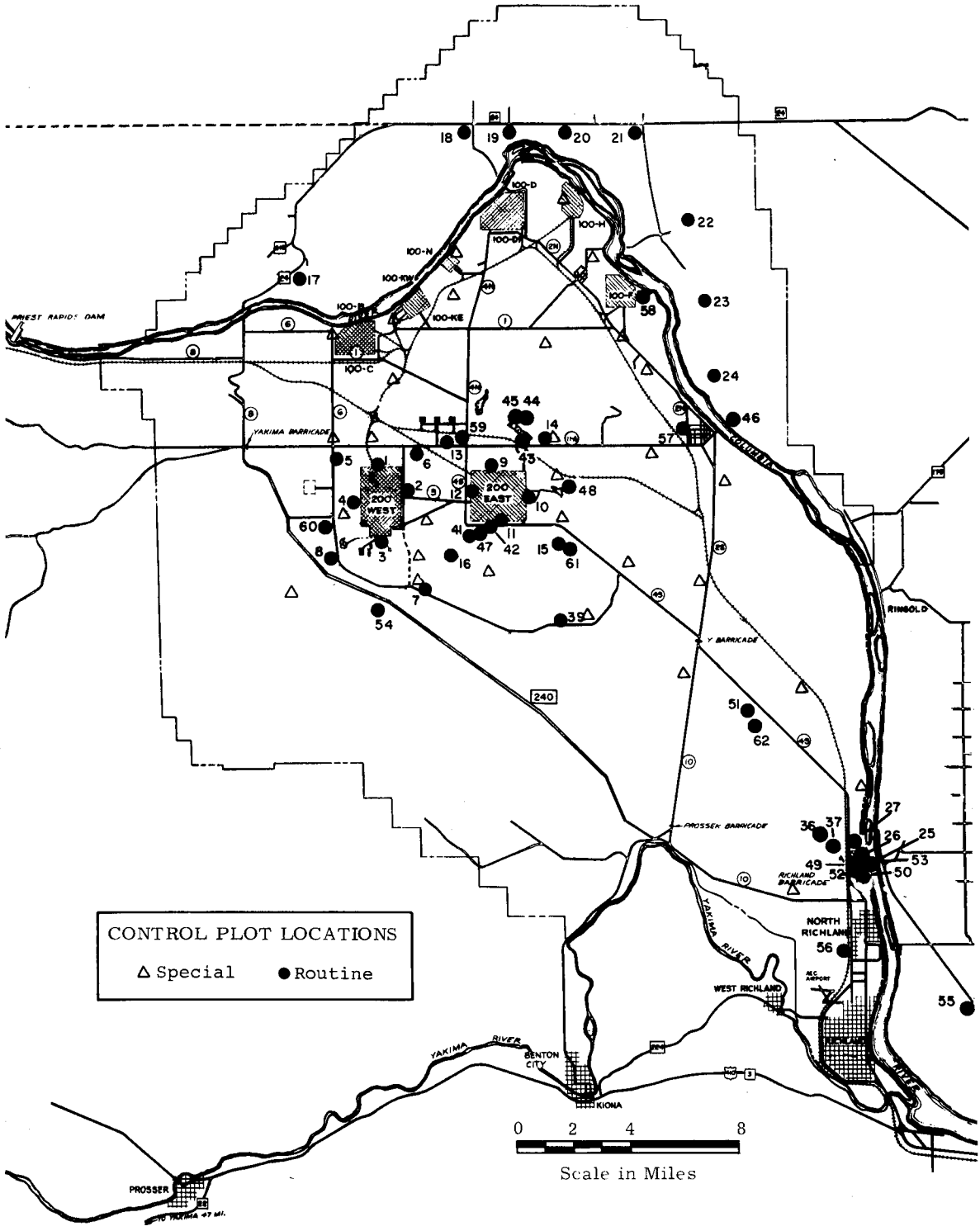
1. JCT. BENTON CITY HWY AND ST. HWY. 240
2. POWERLINE CROSSING
3. NORTHEAST OF RADIOECOLOGY LAB
4. YAKIMA BARRICADE
5. VERNITA BRIDGE
6. JCT. ST. HWY. 24 AND MATTAWA RD.
7. PSN 10
8. TOP OF HILL TO OLD HANFORD FERRY
9. ST. HWY 170
10. TAYLOR FLATS ROAD
11. JCT. TAYLOR FLATS AND SELPH LANDING RDS.
12.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

MAP 8



AERIAL SURVEY FLIGHT PATTERNS 4 and 5

MAP 9


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

MAP 10

X. RADIATION SURVEYS (Continued)

5. Waste Disposal Sites

Retired waste burial grounds and areas where surface contamination is known to exist are inspected periodically for general physical condition and evidence of disturbance. The locations of such sites outside plant areas are shown in Map 11. During 1971, inspections were made at most of the indicated areas on a quarterly schedule. Waste disposal site conditions were generally good during 1971. The most recurrent problem was contaminated material outside of the burial pit. Unusual radiation levels or conditions were noted as follows and were reported to responsible contractor representatives for corrective action:

January:

a) 100-B - Waste carton in pit broken open. Picked up glove outside pit, 3000 cpm (GM).

b) 100-F - Animal waste burial ground signs and fences down in places.

March:

a) 300 - Papers blowing from the burial trench at 300 West burial ground into the uncontrolled area. Contamination levels on the papers ranged from 300 to 1500 cpm (GM).

April:

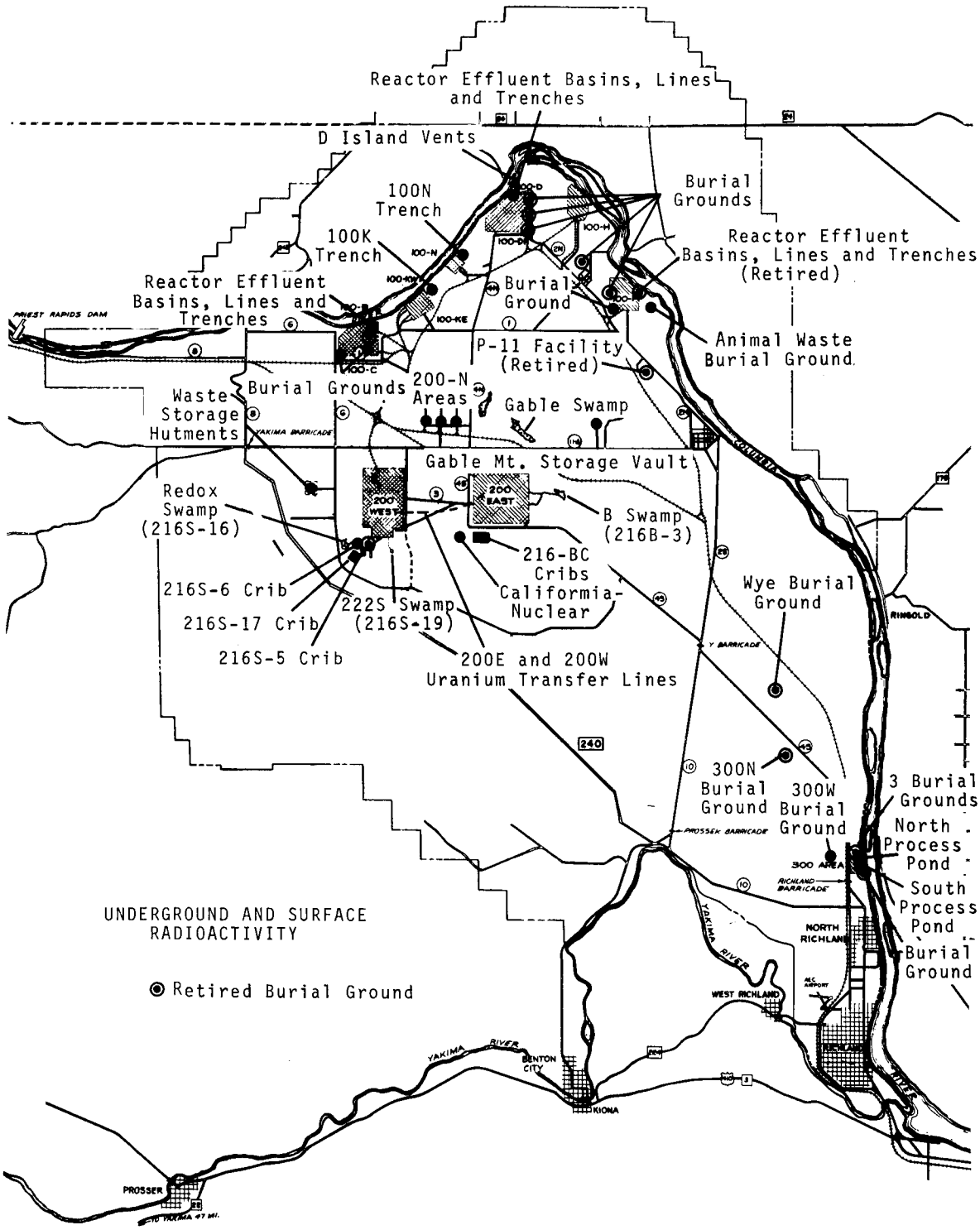
a) 300 - Lots of paper still blowing out of 300-West burial trench.

July:

a) White Bluffs - Signs faded and falling down. (In December, the burial site had been excavated and the contents removed.)

December:

a) 300 - Cave-in in northeast corner of 300 Area burial ground number 2. Unidentified metal visible, 6000 cpm (GM) at contact.


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)
200 WEST
200 EAST
B Swamp (216B-3)
216-BC Cribs California-Nuclear
216S-6 Crib
216S-17 Crib
216S-5 Crib
222S Swamp (216S-19)
200E and 200W Uranium Transfer Lines
Wye Burial Ground
300N Burial Ground
300W Burial Ground
3 Burial Grounds
North Process Pond
South Process Pond
Burial Ground
UNDERGROUND AND SURFACE RADIOACTIVITY
Retired Burial Ground
PRIEST RAPIDS DAM
YAKIMA BARRICADE
Y BARRICADE
PROSSER BARRICADE
RICHLAND BARRICADE
300 AREA
NORTH RICHLAND
WEST RICHLAND
YAKIMA RIVER
BENTON CITY
KIONA
PROSSER
RINGOLD
240

MAP 11

X. RADIATION SURVEYS (Continued)

B. External Exposure Rates

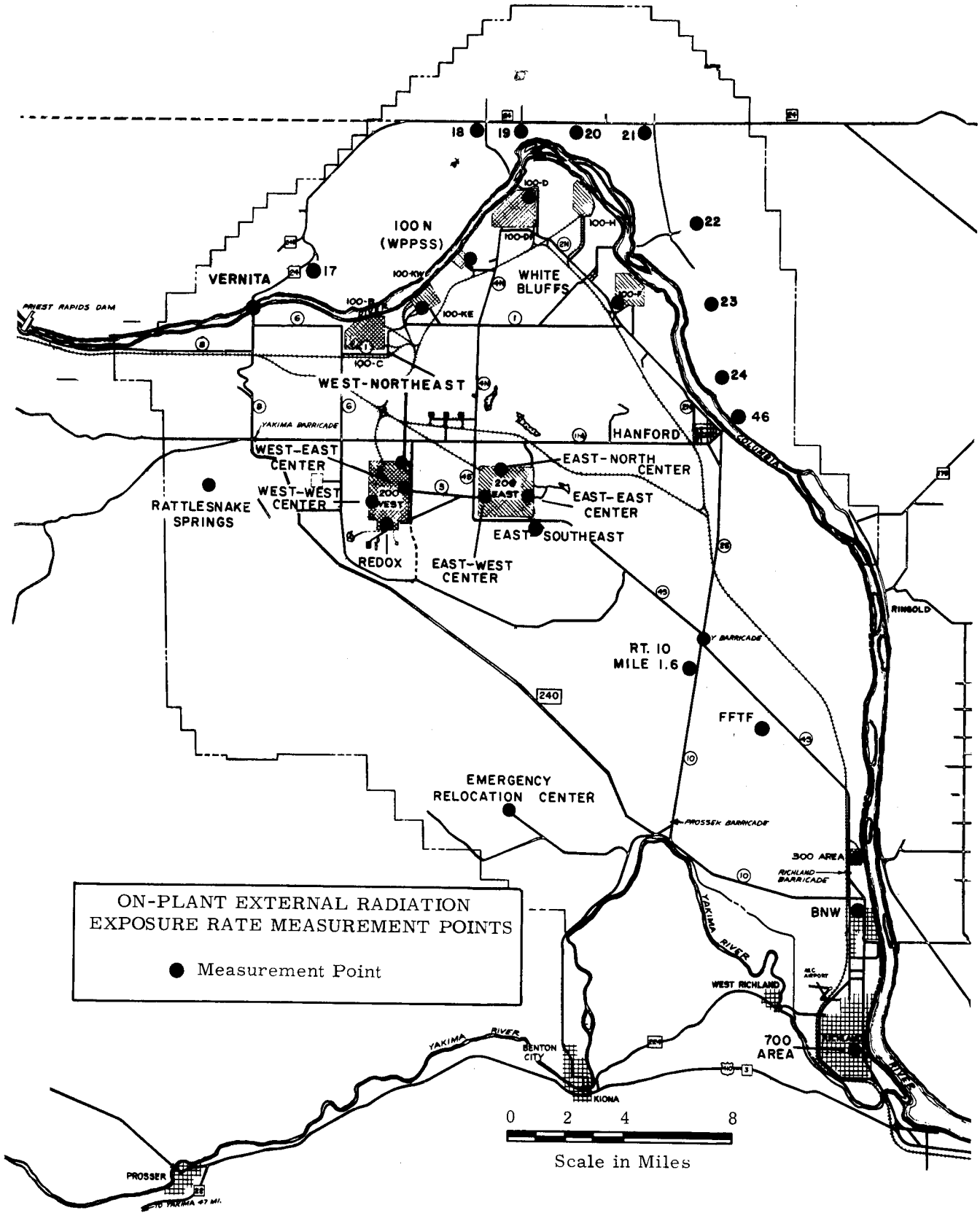
1. Exposure Rates On-Plant

During 1971 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 1970 and 1971. Off-site locations are not included in the table.

External exposure rates for 1971 were about the same as for 1970 for most locations. The maximum six-month average exposure rate noted during 1971 was 0.8 mR/day at 200 East-East-Center (EEC) location. Average of the locations in Table 16 was 0.22 mR/day compared with 0.17 mR/day for a number of off-site locations. At most locations, the external exposure rate was relatively constant. Three 200-Area locations which showed some variations through the year are shown in graphic form in Figure 19.

2. 100-N Area

Victoreen stray radiation chambers are used at 100-N Area in order to estimate the potential exposure of WPPSS personnel. Based on measurements with stray radiation chambers during 1971, the average exposure rate was 0.42 mR/day at 100-N compared to 0.35 mR/day at Richland. Based on the net exposure rate of 0.07 mR/day (0.42 mR/day minus 0.35 mR/day) and assuming exposure for 40 hours per week (50 weeks per year), the whole-body dose to WPPSS personnel from Hanford sources of external radiation at 100-N during 1969 would be 5 mrem/yr (1% of the standard for individuals non-occupationally exposed or 0.1% of the standard for individuals occupationally exposed). The comparable exposure for 1970 was 9 mrem/yr (2% of the respective standards).


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

MAP 12

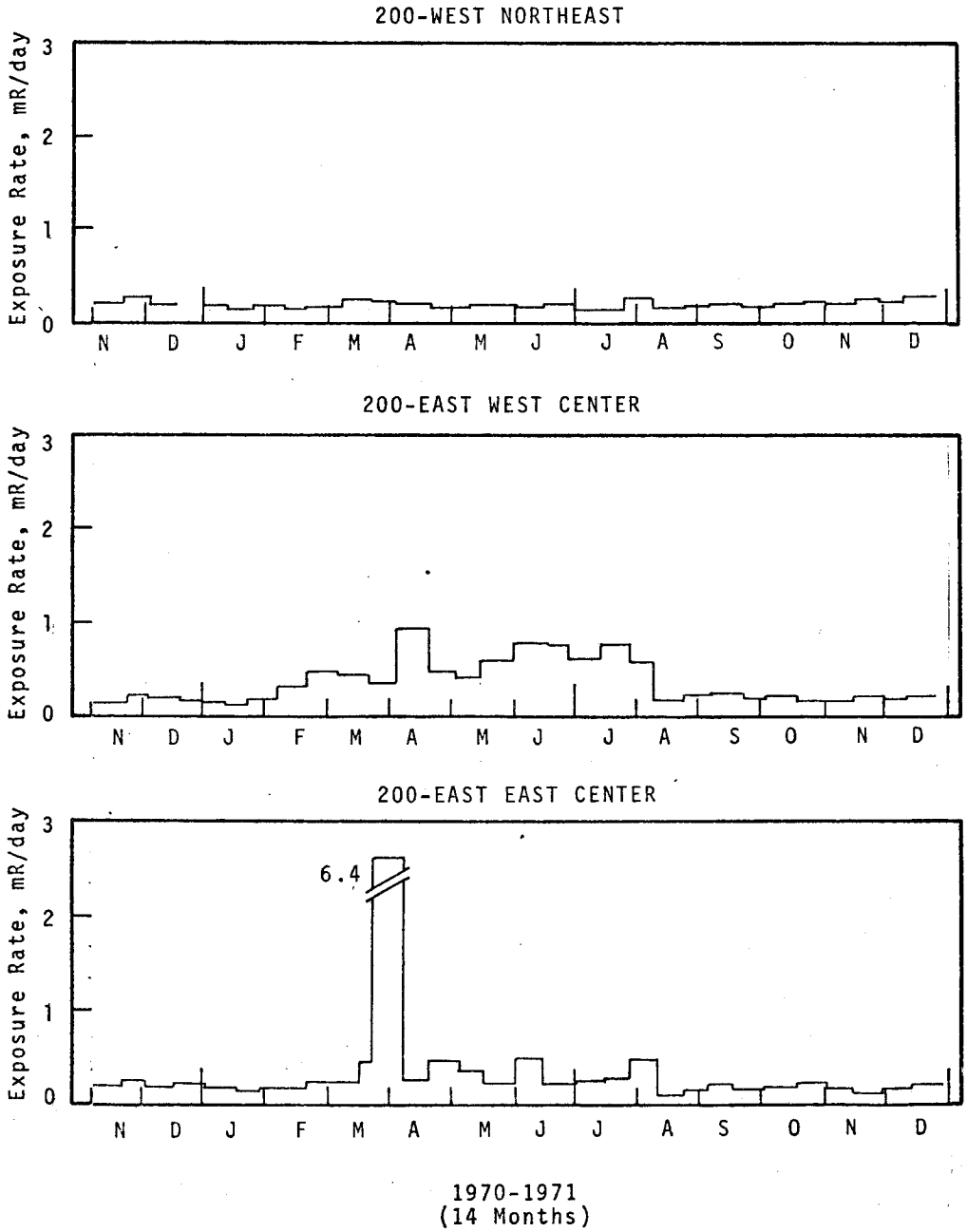
TABLE 16: AVERAGE EXTERNAL GAMMA EXPOSURE RATES (mR/day)

Location	1970 July-Dec	1971 Jan-June	1971 July-Dec
100 Areas			
Vernita	0.22	0.22	0.20
Midway			
100-B			
100-K	0.27	0.21	0.21
100-N			
*100-N (WPPSS)	0.46*	0.42*	0.41*
100-N (WPPSS)	0.23	0.20	0.20
100-D	0.17	0.16	0.25
100-F	0.17	0.22	0.15
Hanford	0.16	0.16	0.16
200-West Area			
Redox	0.18	0.31	0.23
West-Center	0.24	0.22	0.23
East-Center	0.17	0.16	0.16
West-Northeast	0.21	0.18	0.19
200-East Area			
North-Center	0.35	0.36	0.36
West-Center	0.18	0.45	0.29
Southeast	0.23	0.22	0.22
East-Center	0.24	0.80	0.22
Wahluke Slope			
C.P. 17	0.20	0.20	0.24
C.P. 18	0.20	0.20	0.20
C.P. 19	0.19	0.19	0.19
C.P. 20	0.19	0.20	0.20
C.P. 21	0.19	0.19	0.18
C.P. 22	0.19	0.20	0.18
C.P. 23	0.20	0.19	0.19
C.P. 24	0.20	0.20	0.20
C.P. 46	0.19	0.19	0.19
Other On-Site			
Yakima Barricade	0.18	0.18	0.20
Rattlesnake Springs	0.18	0.20	0.16
Emergency Relocation Center	0.18	0.21	0.21
FFTF Site	0.19	0.20	0.18
WYE Barricade	0.16	0.16	0.15
*Rt. 10 Mile 1.6	0.42*	0.41*	0.39*
Rt. 10 Mile 1.6	0.18	0.18	0.17
300 Area (3705 Bldg)	0.20	0.22	0.21
300 Area (320 Bldg)	0.20	0.20	0.16
300 Area (331 Bldg)		0.23	0.17
300 Pond	0.33	0.26	0.22
ACRMS	0.18	0.18	0.16

* Measurements with stray radiation chambers.

No entry indicates no measurement was performed.

EXTERNAL RADIATION ON PLANT
200 AREAS



1970-1971
(14 Months)

FIGURE 19

X. RADIATION SURVEYS (Continued)

3. Exposure Rates at the Columbia River Shoreline

Radiation exposure rates are measured at 1 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. During the first half of 1971, shoreline exposure rate measurements were made with a 40-liter ionization chamber (40-L) whose measurement is calibrated in μR/hr (radium gamma). During the latter half of the year, shoreline exposure was measured with a low level dose rate monitor (LLM)* similarly calibrated. Contamination level was measured with a GM survey instrument.

Monthly measurements of exposure rates made at 23 shoreline locations covering the reach of the river from the reactors to Richland include both the exposure rate at 1 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 biweekly at Sacajawea Park, ten miles downstream from Richland.

During 1971, exposure rates on the Columbia River shoreline were generally lower than during 1970. The maximum shoreline exposure rate found during routine surveys in 1971 was 86 μR/hr, measured in January at 3 locations, above 181 KE, 100-F slough and Hanford (Table 17). For comparison, the maximum shoreline exposure rate measured during 1970 was 250 μR/hr on D Island.

The maximum level of surface shoreline contamination encountered during 1971, 750 cpm (GM), was detected at the 100-F slough location in January.

---

* Manufactured by Nuclear Enterprises Limited, Canada.

TABLE 17: MAXIMUM READINGS[a] FROM MONTHLY SHORELINE SURVEYS FOR 1971

(μR/hr with c/m in parentheses)

A. COLUMBIA RIVER PLANT SHORE

Date	382.5 P[b] Above 181 KW		381.5 P Above 181 KE		379.4 P 100-N Trench		379.0 P White Bluff Ferry		369.7 P White Bluff Ferry		368.3 P 100-F Slough		362.0 P Hanford		350.4 P Powerline Cross.		340.5 P Richland	
	40-L or LLM	(GM)	40-L or LLM	(GM)	40-L or LLM	(GM)	40-L or LLM	(GM)	40-L or LLM	(GM)	40-L or LLM	(GM)	40-L or LLM	(GM)	40-L or LLM	(GM)	40-L or LLM	(GM)
1/27	45	(200)	86	(600)	23	(200)	22	(200)	26	(300)	86	(750)	86	(500)	53	(350)	20	(100)
2/18	14	(<100)	33	(100)	20	(150)	20	(100)	40	(250)	40	(200)	27	(100)	17	(<100)	17	(<100)
3/29	8	(200)	14	(300)	8	(200)	8	(200)	8	(200)	17	(250)	12	(200)	20	(250)	14	(250)
4/20	8	(150)	17	(150)	8	(150)	8	(150)	18	(150)	23	(200)	18	(150)	18	(150)	21	(150)
5/20	10	(200)	14	(300)	17	(300)	10	(300)	14	(300)	14	(300)	14	(300)	14	(300)	14	(250)
6/24	20	(150)	20	(150)	18	(150)	15	(150)	20	(150)	15	(150)	13	(150)	15	(150)	12	(150)
7/7	10	(250)	20	(250)	13	(500)	10	(300)	10	(200)	10	(175)	12	(275)	15	(200)	20	(200)
8/9	10	(100)	11	(100)	17	(150)	12	(100)	17	(100)	11	(100)	11	(100)	20	(200)	10	(100)
9/14	12	(150)	9	(200)	14	(200)	11	(200)	15	(150)	14	(200)	12	(200)	12	(150)	9	(150)
10/28	5	(100)	13	(200)	14	(200)	12	(150)	13	(200)	14	(250)	23	(200)	14	(150)	8	(100)
11/18	7	(100)	8	(150)	15	(150)	12	(150)	12	(100)	10	(150)	12	(150)	8	(100)	10	(150)
12/10	10	(200)	12	(250)	15	(200)	12	(250)	17	(250)	16	(250)	23	(300)	13	(150)	12	(150)

B. COLUMBIA RIVER - ISLAND LOCATIONS

Date	377.4 I D-Island		375.8 IF E-Island		373.4 IP Locke Island		371.1 P Locke Island		367.0 IF 100-F Slough		355.7 I[d] Near Ringold	
	40-L or LLM	(GM)	40-L or LLM	(GM)	40-L or LLM	(GM)	40-L or LLM	(GM)	40-L or LLM	(GM)	40-L or LLM	(GM)
1/27	48	(250)	42	(250)	64	(400)	32	(200)	24	(300)	82	(750)
2/18	24	(100)	24	(<100)	46	(250)	17	(<100)	24	(100)	24	(<100)
3/29	8	(200)	8	(200)	8	(200)	8	(200)	8	(200)	20	(250)
4/20	8	(150)	8	(150)	23	(200)	14	(150)	21	(200)	29	(250)
5/20	10	(250)	12	(300)			14	(350)	10	(250)	10	(250)
6/24	15	(150)	20	(150)			13	(150)	18	(200)	23	(200)
7/7	8	(200)	15	(200)	15	(200)	15	(200)	15	(200)	12	(300)
8/9	13	(100)	20	(100)	13	(100)	12	(100)	13	(<100)	13	(<100)
9/14	14	(250)	10	(200)	10	(200)	8	(200)	15	(150)	16	(250)
10/28	20	(250)	10	(150)	13	(200)	10	(200)	14	(150)	12	(100)
11/18	13	(150)	8	(100)	15	(150)	10	(100)	10	(150)	10	(150)
12/10	18	(250)	13	(200)	15	(300)	12	(200)	15	(200)	18	(250)

TABLE 17 (Continued): MAXIMUM READINGS[a] FROM MONTHLY SHORELINE SURVEYS FOR 1971
(μR/hr with c/m in parentheses)

C. COLUMBIA RIVER - FAR SHORE

Date	381.0 F 100-K Trench		378.4 F Above 181 D		369.8 F White Bluffs Ferry		362.0 F[d] Hanford		359.1 F Savage Island		354.7 F[c] Ringold		350.4 F Powerline Cross.		345.2 F Byers Landing		Sacajawea Park	
	40-L or LLM	(GM)	40-L or LLM	(GM)	40-L or LLM	(GM)	40-L or LLM	(GM)	40-L or LLM	(GM)	40-L or LLM	(GM)	40-L or LLM	(GM)	40-L or LLM	(GM)	40-L or LLM	(GM)
1/27	33	(150)	14	(150)	16	(150)	30	(250)	42	(250)	40	(350)	24	(300)	23	(250)	22	(150)
2/18	14	(<100)	17	(<100)	17	(<100)	24	(100)	17	(<100)	17	(<100)	20	(100)	36	(200)	15	(150)
3/29	8	(200)	8	(200)	8	(200)	24	(300)	12	(200)	12	(250)	14	(250)	20	(250)	17	(150)
4/20	8	(150)	8	(150)	21	(150)	36	(250)	18	(150)	18	(150)	14	(150)	23	(200)		
5/20	10	(250)	12	(250)	10	(250)	10	(250)	14	(300)	7	(200)	10	(250)	12	(300)	12	(100)
6/24	17	(150)	13	(100)	15	(150)	20	(200)	15	(150)	14	(150)	17	(200)	19	(150)	13	(100)
7/7	10	(100)	10	(250)	10	(225)	15	(225)	12	(300)	10	(300)			12	(225)	11	(160)
8/9	13	(100)			12	(100)	24	(150)	16	(100)	20	(100)	12	(<100)	14	(100)	5	(100)
9/14	10	(150)	12	(200)	6	(200)	14	(200)	10	(200)	12	(200)	16	(150)	22	(350)	10	(110)
10/28	5	(100)			12	(150)	38	(250)	12	(150)	13	(150)	12	(150)	25	(250)	8	(125)
11/18	6	(100)	6	(100)	8	(100)	9	(200)	6	(100)	8	(100)			12	(200)	12	(100)
12/10	5	(100)			11	(200)	22	(300)	11	(150)	12	(150)	17	(250)	22	(200)	11	(175)

(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.

(e) Average of bi-weekly measurements

No entry indicates no measurement was performed

X. RADIATION SURVEYS (Continued)

4. Exposure Rates Below the Surface of the Columbia River

During 1971, 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 1971 are shown in Table 18 with data from 1970 for comparison.

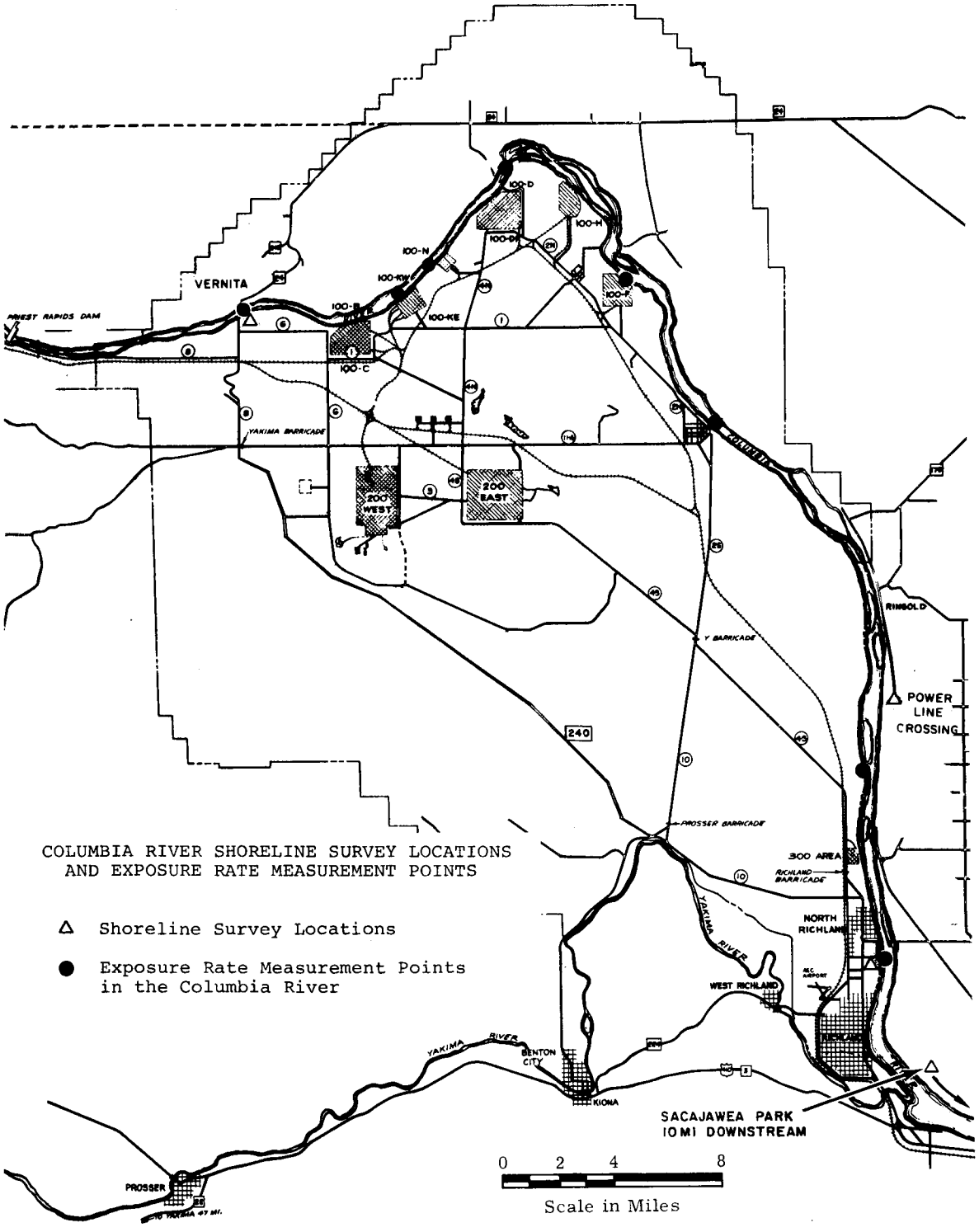
Exposure rates in the river for 1971 were, for the most part, reduced compared to the latter half of 1970. Prior to July, 1970, exposure rates in the river were determined from a cluster of five pencil ionization chambers.

TABLE 18: AVERAGE EXPOSURE RATES BELOW THE SURFACE OF THE COLUMBIA RIVER (1970 - 1971)

	(mR/day)		
	1970	1971	
	July-Dec	Jan-June	July-Dec
Vernita	0.1(b)	0.10(a)	
100-K Barge		1.9(a)	0.13
D-Island		1.4(a)	0.68
100-F Area	0.7(c)	0.45(a)	
S. Wooded Island	0.6(d)	0.49	0.14
Richland Pumphouse	0.6(d)	0.30	0.13

(a) January, February
(b) July, November, December
(c) October-December
(d) May-June

No entry indicates no measurement was performed.



COLUMBIA RIVER SHORELINE SURVEY LOCATIONS
AND EXPOSURE RATE MEASUREMENT POINTS

△ Shoreline Survey Locations

● Exposure Rate Measurement Points in the Columbia River

MAP 13

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