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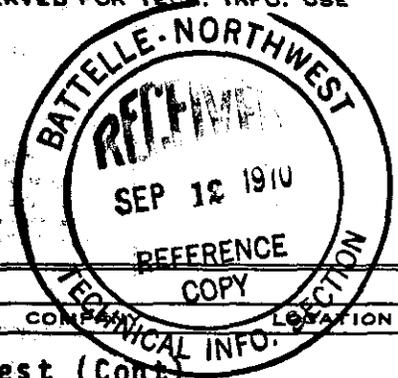
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HANFORD RESERVATION FOR JULY-DECEMBER, 1969

By

The Environmental Evaluations Staff
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TECHNICAL SERVICES DIVISION

C. B. Wilson and T. H. Essig, Editors

June 1970

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ENVIRONMENTAL STATUS OF THE
HANFORD RESERVATION FOR JULY-DECEMBER, 1969

I. INTRODUCTION

This report summarizes data collected during the last six months of 1969 from locations within the Hanford plant boundaries for the routine 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-CC-2478, "Environmental Status of the Hanford Reservation for January-June, 1969." However, to show long-term trends and facilitate comparisons, the graphs in this report show 14 months of data--the current six months and the preceding eight. The reader may also wish to refer to BNWL-CC-2026, "Environmental Status of the Hanford Reservation for July-December, 1968," which contains 1968 data. Groundwater data are not included in this report but are presented in BNWL-1392 "Radiological Status of the Groundwater Beneath the Hanford Project, July-December, 1969." Data from offsite sampling locations are no longer presented in a series of monthly reports, but are summarized in the series "Evaluation of Radiological Conditions in the Vicinity of Hanford for...." Some data from offsite locations are included in this report for comparison with similar measurements made onsite. 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.

II. SURVEILLANCE HIGHLIGHTS

Columbia River Water

During the last six months of 1969, average concentrations of coliform bacteria increased relative to the first six months by factors of 10 and 6 at locations both upstream and downstream respectively of the Hanford project. The increase was attributed to an unidentified source upstream of the project (p. 7). On November 9, approximately 2500 gallons of 25% ethylene glycol were inadvertently released to the river from 100-K. The maximum concentration of ethylene glycol at Richland was calculated to be <1 ppm, representing no health hazard (p. 7). All other results of river analyses were within their expected ranges of variation.

Swamps, Ditches and Ponds

Radionuclide concentrations in samples collected from open waters on the Hanford project were, in general, within their expected range of variation and were well below the recommended limit of 50,000 pCi/liter during the second half of 1969. The total beta activity in T Swamp increased during July and remained at levels which were above those measured during the first half of the year (p. 14). Results from radiological, chemical, and biological analyses of samples collected from the 300 Area ponds and trenches remained within the expected range.

On December 29, a duck containing unusually high concentrations of radionuclides (mostly ^{32}P) was collected from the 100-K trench. The analysis of this bird and subsequent birds collected in the vicinity of the 100 and 200 Areas will be discussed in the next report in this series (p. 16).

Airborne Radioactivity

Concentrations of ^{131}I in the atmosphere from July through December 1969 averaged about 0.01 pCi/m³ at most locations, which is less than the analytical limit. The highest six-month average (0.03 pCi/m³) was noted for the 300 Area which experienced a peak concentration of 0.7 pCi/m³ in July following an unusual release of ^{131}I from a laboratory building. No measurable increase in the calculated infant thyroid dose resulted (p. 26). For comparison, the maximum ^{131}I concentration noted during the first six months of 1969 was 0.1 pCi/m³, also at the 300 Area.

At most air sampling locations, total beta activity reached peak concentrations in July and August and then gradually decreased to less than 0.1 pCi/m^3 in December. Overall, six-month averages for the last half of 1969 were greater by about 0.1 pCi/m^3 than those for the first half of 1969 at nearly all locations.

Increased radionuclide releases associated with tank farm operations resulted in significant increases in total beta concentrations on the north side of 200-East Area. The highest beta concentration (12 pCi/m^3) measured in an environmental air sample since September 1965 occurred during November at 200-East North Center (p. 27).

Total alpha concentrations for this reporting period averaged 0.02 pCi/m^3 at 200-East North Center, and about one half that at all other locations. The highest total alpha concentration averaged over a one-week period during the last half of 1969, 0.06 pCi/m^3 , was observed at that location in November during a period of increased total beta activity (p. 37). The comparable maximum during the first six months of 1969 was 0.25 pCi/m^3 , on a filter from the east side of the 200-East Area.

Radiation Surveys

Only one instance of radioactive particulate contamination was found during road surveys. A particle ($50,000 \text{ c/m} - \text{GM}$) was detected on the entrance road to 100-K on October 20. The major gamma emitter was ^{60}Co . (p. 43).

Contamination was found on control plots in the vicinity of the 200 Areas on three occasions during the second half of 1969. Twice during October a small area 1000 cm^2 ($\sim 1 \text{ ft}^2$) on Control Plot #3 (near Redox Swamp) was found contaminated up to $2500 \text{ c/m} (\text{GM})$. The contaminant was ^{137}Cs . The third instance of control plot contamination involved Control Plot #10 (east of 200-East) in which a measureable radiation level ($1000 \text{ c/m} - \text{GM}$) was noted during October, but no particles were found (p. 45).

Increased exposure rates sustained at 200-East East Center averaged 3.6 mR/day compared to 1.9 mR/day during the previous six months. Both were significantly higher than averages for other measurement locations. The relatively higher exposure rates may have been associated with increased tank farm operations. Other locations where the average exposure rate during the last six months of 1969 was 1 mR/day or greater were 100-K, 200-East North Center, and the 300 Area (p. 49).

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 1969 was estimated to be 20 mrem (p. 51).

The exposure rates and surface contamination levels at shoreline locations downstream from the operating reactors during the fall of 1969 were generally somewhat less than in the fall of 1968. The maximum shoreline exposure rate during 1969, 310 μ R/hr, was detected near the Hanford Ferry (far shore) location on November 2. A few weeks earlier, the maximum shoreline contamination level encountered during 1969 (10 mrad/hr, uncorrected reading - Juno at 1") was observed at the same location. These have been discussed in a topical report, BNWL-CC-2363 (p. 61).

Radiation levels from shoreline contamination below the plant boundary were generally less than 2000 c/m (GM), with the exception of late July-early August and November measurements at Richland.

In July-August particulate contamination associated with a brownish scum, deposited as a band or in patches, was found at several locations in the vicinity of Richland. The maximum GM reading (15,000 c/m) was at the boat launch just below the Richland water plant intake. Gamma emitters associated with a sample from that location were ^{46}Sc , ^{54}Mn , ^{60}Co , ^{65}Zn , and $^{140}\text{Ba-La}$ (p. 66).

During November, the maximum radiation level associated with a brownish scum resting on stagnant water at the North Richland boat launch area was 18,000 c/m GM (P-11 probe). Gamma energy analysis of a sample detected ^{24}Na , ^{46}Sc , and ^{140}La (major), as well as ^{56}Mn , ^{58}Co , ^{59}Fe , ^{60}Co , ^{65}Zn , ^{140}Ba , ^{143}Ce , and ^{152}Eu (p. 66).

III. COLUMBIA RIVER WATER

Sampling locations for raw water and drinking water appear in Map 1.

A. Raw Water

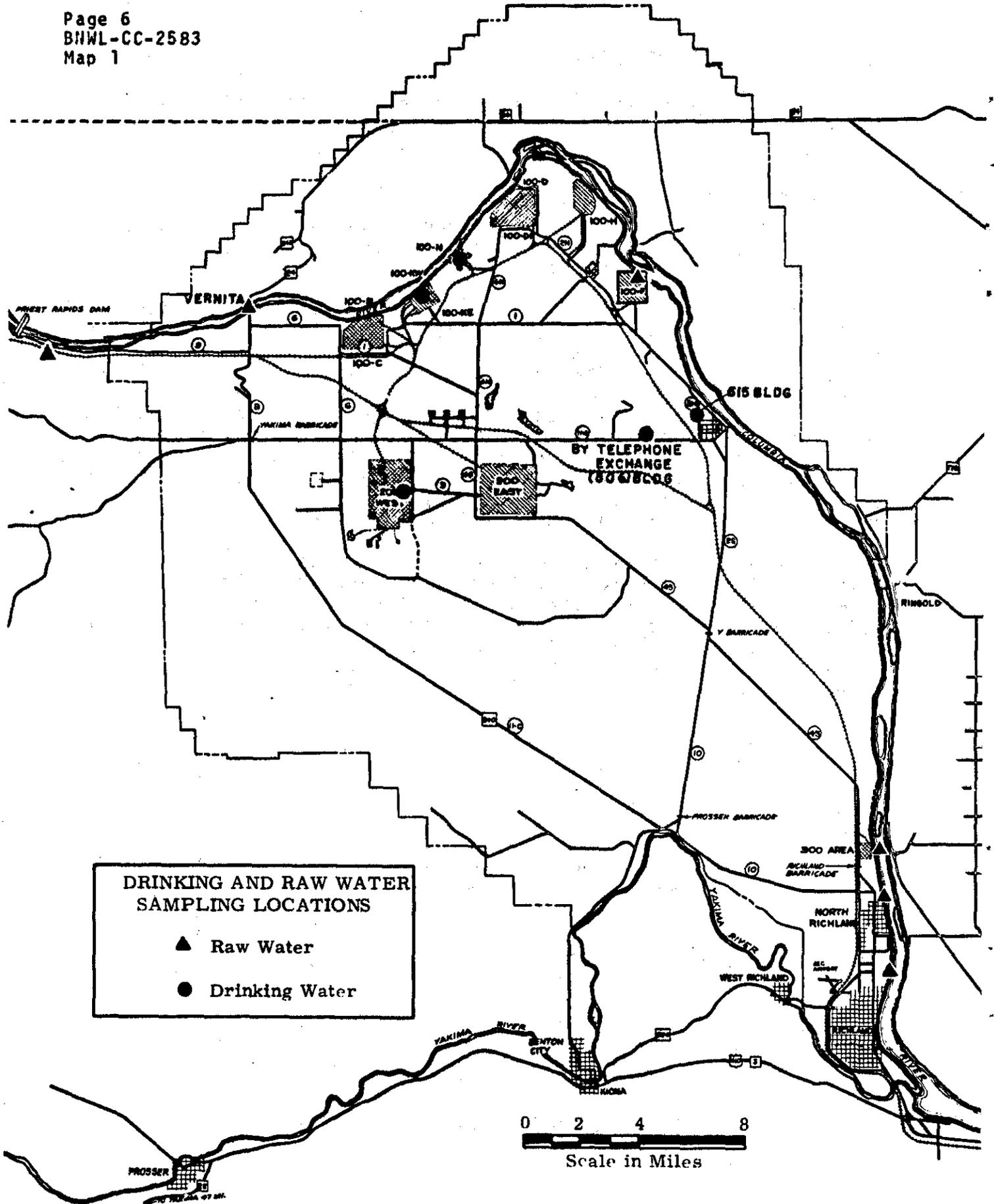
Columbia River water sampled above the Hanford project at Priest Rapids Gauge Station is analyzed for comparison with samples collected below the project.

Fallout radionuclides ^3H and ^{90}Sr , as well as total alpha activity were measured in monthly composites of weekly grab samples at Priest Rapids and in monthly composites of weekly integrated samples at Richland. Measurements of $^{95}\text{Zr-Nb}$, ^{99}Tc , and $^{106}\text{Ru-Rh}$ were discontinued at the Priest Rapids Gauge Station on July 1. Concentrations of $^{95}\text{Zr-Nb}$ and $^{106}\text{Ru-Rh}$ had been measured at this location since January 1967 and ^{99}Tc measurements had been made since August 1968. In all cases, no detectable activity was found. The Analytical Limit (A.L.) for each analysis is 5 pCi/liter. All total alpha concentrations during July-December at Priest Rapids were at or below the analytical limit of 1.0 pCi/liter.

Concentrations of these same radionuclides at Richland during this report period were as follows: $^{95}\text{Zr-Nb}$ and ^{99}Tc , no results were above the A.L. (5 pCi/liter); $^{106}\text{Ru-Rh}$, concentrations of 6.2 and 6.9 pCi/liter were detected in August and October, respectively, with all others below the A.L. (5 pCi/liter); and total alpha, all values were near or below the A.L. (1.0 pCi/liter), with the maximum being 1.2 pCi/liter in October.

TABLE 1. Concentrations of ^3H and ^{90}Sr at the Priest Rapids Gauge Station and at Richland (July-December, 1969) (Results in pCi/liter)

<u>Month</u>	^3H		^{90}Sr	
	<u>P.R.</u>	<u>Richland</u>	<u>P.R.</u>	<u>Richland</u>
July	4000	3300	<0.50	<0.50
August	2300	2800	<0.50	<0.50
September	1700	2800	0.59	<0.50
October	2400	1500	<0.50	1.1
November	<1000	2800	<0.50	<0.50
December	1300	1400	<0.50	<0.50
Average (7/69-12/69)	2100	2400	<0.52	<0.60
Average (1/69-6/69)	<1700	<1400	<0.50	<0.55



Biological measurements of Columbia River water samples collected semi-monthly from Vernita, 100-F, and North Richland appear in Table 2. The Columbia River from the Washington-Oregon border to Grand Coulee Dam is in Class A according to the Washington state water quality standards*. 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. Enterococci are measured in addition to coliform as an indication of contaminants of fecal origin.

Of interest in Table 2 is the fact that 6-month average coliform concentrations increased a factor of 10 at Vernita and a factor of 6 at 100-F and North Richland during the present report period. Coliform counts in samples at all locations were exceptionally high in December. The cause of the increase is not known, however, the data indicate a source upstream from Hanford.

DUN personnel reported that on November 9 they had inadvertently released ~2500 gallons of 25% ethylene glycol to the river near 100-K. The maximum concentration of ethylene glycol at Richland was calculated to be <1.0 ppm, based on a river flow rate of 2.8×10^4 m³/sec (1×10^5 cfs). This concentration represented no health hazard to local residents using the river for drinking water and/or irrigation, or to wildlife utilizing the river.

Results of chemical analyses of grab samples of river water collected at Vernita and 100-F (above and below the production reactors) as reported by Douglas-United Nuclear are shown in Tables 3 and 4. Chemical analyses (NO₃⁻ and Cr⁺⁶) are also performed on the weekly samples of river water from the Priest Rapids Gauge Station and from Richland. These data are shown in Table 5.

B. Drinking Water

Grab samples of drinking water are collected weekly from 100-N and 100-K, monthly from 200-W Area and the BY Telephone Exchange (506 Building), and quarterly from the Road Crew Headquarters (615 Building-Hanford 9 well). All were analyzed for total beta activity. Data from the 615 Building were less than the analytical limit (0.1 c/m/ml), during all of 1969. Data for other locations appear in Figures 1 and 2.

* "A Regulation Relating to Water Quality Standards for Interstate and Coastal Water of the State of Washington and a Plan for Implementation and Enforcement of Such Standards." Water Pollution Control Commission, State of Washington. December 4, 1967.

TABLE 2. Biological Measurements in the Columbia River (July-December 1969)

Date	Vernita			100-F			North Richland		
	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
7/8	92	NA*	3.2	105	NA	3.1	119	NA	2.7
7/22	15	64	1.6	10	53	1.8	120	62	0.6
8/6	52	95	1.4	130	85	0.95	197	96	1.4
8/19	285	107	1.6	61	5	2.0	101	36	2.4
9/9	81	86	2.2	90	41	1.4	96	43	1.3
9/23	61	27	1.6	130	24	1.2	190	33	1.6
10/14	51	2	2.6	85	9	3.0	64	6	2.9
10/22	100	30	2.7	130	53	2.1	160	38	2.9
11/11	132	22	2.6	180	27	2.2	160	64	2.8
11/18	123	2	3.6	128	1	3.2	156	10	3.2
12/2	42	6	2.6	70	3.5	2.4	90	18.5	2.7
12/9	280	2	2.2	275	1.25	3.4	345	8.5	2.9
<u>AVERAGE</u>									
Jan-June	11	11	4.6	20	26	4.2	25	35	3.8
July-Dec	110	40	2.3	116	28	2.2	150	38	2.3

* NA - No analysis made

TABLE 3. Chemical Characteristics of Columbia River at Vernita for July-December 1969 (Results in ppm)

<u>Date</u>	<u>Mg</u>	<u>Fe</u>	<u>Cu</u>	<u>Ca</u>	<u>SO₄</u>	<u>PO₄</u>	<u>Cl</u>	<u>Diss. O₂</u>	<u>Phth Alk.</u>	<u>M.O. Alk.</u>	<u>Hardness</u>	<u>Solids</u>
7/8	2.2	0.027	0.002	22	13	0.030	0.36	10.82	1	64	64	76
7/18	2.1	0.014	0.005	24	11.5	0.030	0.28	10.24	1	51	68	90
8/5	2.2	0.014	0.005	24	10	0.023	0.28	9.60	2	51	68	86
8/19	2.3	0.005	0.006	25	11	0.000	0.18	9.02	1	49	72	91
9/9	2.2	0.017	0.006	26	11	0.055	0.35	9.44	1	53	75	87
9/23	2.4	0.040	0.004	26	16	0.022	0.35	8.12	1	50	74	72
10/7	2.6	0.020	0.001	24	16	0.018	0.30	8.48	1	53	71	82
10/20	2.1	0.024	0.000	24	15	0.021	0.27	10.37	0	61	68	76
11/4	4.5	0.026	0.010	23	13	0.022	0.30	8.32	2	65	68	77
11/18	5.4	0.022	0.002	20	14	0.020	0.36	10.62	2	69	72	75
12/2	5.5	0.038	0.000	20	16	0.040	0.40	10.78	3	72	73	80
12/16	5.0	0.029	0.005	20	14	0.080	0.43	10.08	2	68	71	93
<u>AVERAGE</u>												
Jan-June	3.2	0.120	0.005	23	16	0.043	0.40	11.07	0.73	56	73	92
July-Dec	3.2	0.023	0.004	23	13	0.030	0.32	9.66	1.42	59	70	82
Annual	3.2	0.071	0.004	23	14	0.036	0.36	10.36	1.1	57	72	87

TABLE 4. Chemical Characteristics of Columbia River Water at 100-F for July-December 1969 (Results in ppm)

Date	Mg	Fe	Cu	Ca	SO ₄	PO ₄	Cl	Diss. O ₂	Phth Alk.	M.O. Alk.	Hardness	Solids
7/8	2.3	0.027	0.000	23	13.0	0.060	0.27	12.09	3	55	66	83
7/18	1.9	0.042	0.005	27	12.5	0.040	0.43	14.40	1	58	75	90
8/5	2.3	0.016	0.004	32	12	0.023	0.68	9.28	2	68	88	89
8/19	2.5	0.005	0.006	24	11	0.005	0.18	9.44	1	53	70	87
9/9	2.8	0.022	0.001	21	12	0.059	0.33	8.48	1	54	75	82
9/23	2.2	0.019	0.003	27	14	0.039	0.55	8.48	2	56	78	81
10/7	2.9	0.020	0.001	22	15	0.018	0.46	9.25	2	53	66	78
10/20	2.3	0.026	0.000	24	14	0.018	0.17	9.66	0	60	68	70
11/4	4.8	0.036	0.010	24	12	0.019	0.33	7.36	5	76	79	78
11/18	5.4	0.042	0.002	21	15	0.020	0.28	10.53	2	69	74	79
12/2	5.5	0.024	0.000	21	15	0.059	0.36	10.56	3	70	74	84
12/16	5.8	0.040	0.004	18	14	0.10	0.66	10.40	2	70	71	101
<u>AVERAGE</u>												
Jan-June	3.4	0.120	0.006	23	15	0.054	0.48	11.40	0.8	56	73	90
July-Dec	3.4	0.026	0.003	24	13	0.038	0.39	9.99	2.0	62	74	84
Annual	3.4	0.072	0.004	24	14	0.046	0.44	10.20	1.4	59	74	87

TABLE 5. NO_3^- and Cr^{+6} Analyses of River Water Samples--
Priest Rapids Gauge Station and Richland
(Results in ppm)

Month	NO_3^-		Cr^{+6}	
	P.R.(a)	Richland(b)	P.R.(a)	Richland(c)
July	0.24	0.13	<0.003	0.001
August	<0.05	<0.05	<0.003	0.002
September	0.15	0.18	<0.003	0.002
October	<0.14	0.26	<0.003	0.002
November	0.18	0.29	<0.003	0.002
December	0.21	0.33	<0.003	0.001
<u>AVERAGE</u>				
Jan-June 1969	0.30	0.26	<0.003	0.001
July-Dec 1969	0.16	0.21	<0.003	0.002

(a) Based on cumulative samples until the end of April and on grab samples after that.

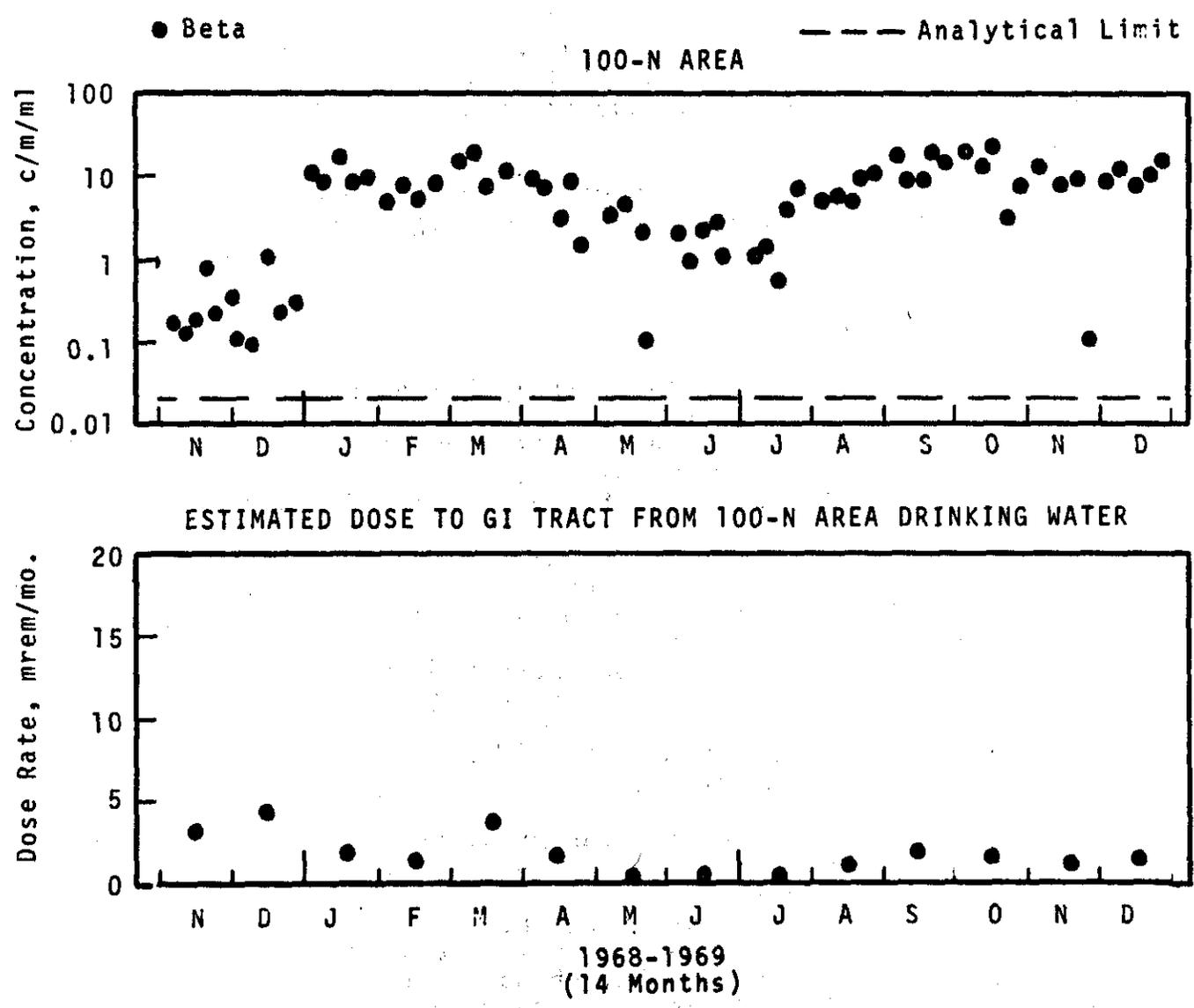
(b) Based on cumulative samples throughout the year at Richland.

(c) Data collected at the 300 Area. A continuous monitor for hexavalent chromium was operated during 1969 at the 300 Area ACRMS location. The monitor has a detection level of 1 ppb of Cr^{+6} , but trends below this concentration can be followed by comparing Cr^{+6} and ^{51}Cr concentrations.

The monthly GI-tract dose from drinking 100-N water (Figure 2) was estimated from monthly isotopic and thrice weekly total beta analyses. The assumed water intake rate was 0.93 liters/day for 5 days/week--50 weeks/yr, as reported previously*. The GI-tract dose from drinking 100-N water was about 8 mrem for the last six months of 1969 and 17 mrem for the entire year, compared with 40 mrem for 1968. The GI-tract doses from drinking 100-N sanitary water for 1969 and 1968 represented 1.1 and 2.7%, respectively, of the dose standard for non-occupationally exposed individuals.

* BNWL-CC-2478, "Environmental Status of the Hanford Reservation for January-June 1969," edited by C. B. Wilson and T. H. Essig.

TOTAL BETA ACTIVITY OF DRINKING WATER (GRAB) SAMPLES AND ESTIMATED GI TRACT DOSE



IV. SWAMPS, DITCHES, AND PONDS

A. Water

Open waters near the 200 and 300 Areas which may be used by migratory waterfowl are routinely sampled at the locations shown in Map 2. Grab samples were collected monthly with the exceptions of the 300 Area Process Pond Inlet (a weekly cumulative sample) and the 231 Ditch Outlet (a weekly grab sample). Total alpha and total beta concentrations in samples collected during July-December, 1969 were below 50,000 pCi/liter, the limit for open waters (AECM, Chapter 0510).

Radiochemical results for the 200 Area surface waste water samples are shown in Figures 3-4. Data for the 300 Area Process Pond include both radiochemical and chemical analyses (Figure 5 and Table 6).

Biological measurements of samples from the 300 Area Leach Trench and its associated river shoreline seepage area are summarized in Table 7.

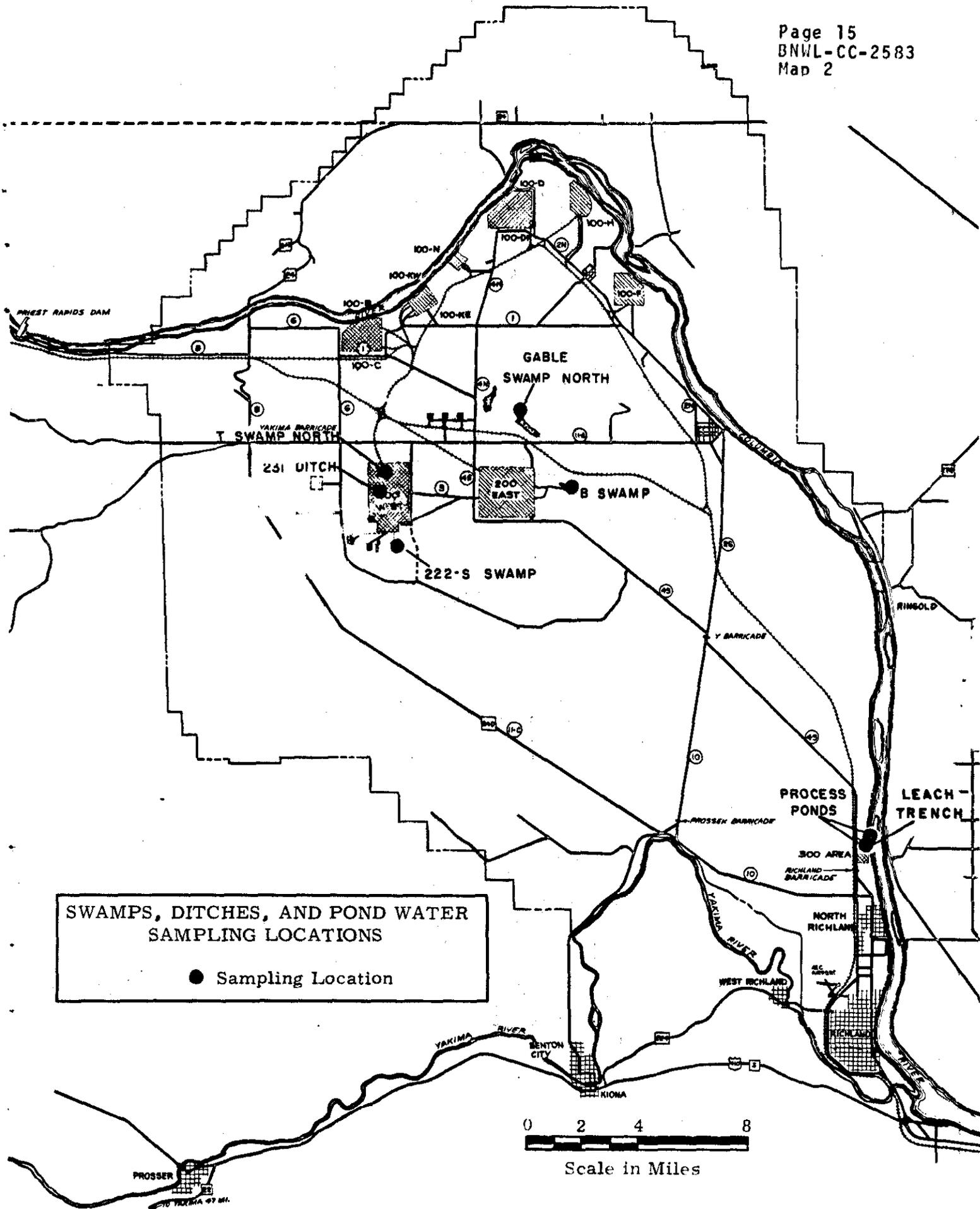
1. 200 Area Waste Waters

Routine sampling of the Laundry Ditch (216-U-14), U Swamp (216-U-10), and Redox Swamp (216-S-16) was discontinued on July 1, 1969. Open disposal sites remaining in the sampling program were 222-S Swamp (216-S-19), T Swamp (216-T-4), Gable Swamp (216-A-25), B Swamp (216-B-3) and 231-Z Ditch (216-Z-11).

The total beta activity in all swamps was, for the most part, within the normal range of variation. The total beta activity in T Swamp increased to 14,000 pCi/liter during July. The principal gamma emitter was ^{137}Cs - ^{137m}Ba (7900 pCi/liter). Total beta concentrations soon decreased, but were still at higher levels than those observed during January-June.

The total alpha activity in all swamps was within the normal range of fluctuation.

The frequency of gamma scan analyses on swamp samples was changed for all swamps (except 216-B-3) from monthly to quarterly, effective July 1, 1969. ^{137}Cs - ^{137m}Ba was detected in samples collected from 222-S Swamp in October (370 pCi/liter), from T Swamp in July and October (32 pCi/liter), and from B Swamp in December (27 pCi/liter). ^{95}Zr -Nb was detected in samples collected from 222-S Swamp in October (30 pCi/liter) and from B Swamp in October, November, and December (67, 55, and 110 pCi/liter). ^{106}Ru -Rh was detected in a sample collected from T Swamp in October (250 pCi/liter).



2. 300 Area Process Pond

Total beta, uranium, nitrate ion, and hexavalent chromium ion concentrations measured in weekly cumulative samples, collected near the inlet of the 300 Area process pond, appear in Figure 5. The concentration of uranium is based on a measurement of total alpha. Monthly average fluoride ion measurements appear in Table 6.

TABLE 6. Fluoride Ion Concentrations in the 300 Area Process Pond (July-December, 1969)

<u>Month</u>	<u>F⁻ ppm</u>
July	4.3
August	2.4
September	1.5
October	3.9
November	2.4
December	NS*

*NS - Not Sampled (sampler out of service)

3. 300 Area Sanitary Waste

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 7.

B. Game Birds

There were no game birds collected from open liquid waste disposal sites near the 200 Areas during the last half of 1969. However, on December 29, 1969, a bird containing unusually high concentrations of radionuclides was collected from the 100-K trench. The radionuclide present in the greatest concentration was ³²P (14.3 day half-life) at about 110,000 pCi/g. A complete discussion of the results from the radiochemical analysis of this bird and of birds subsequently collected in the vicinity of the 100 and 200 Areas will be made in the next report in this series.

TABLE 7. Biological Measurements of Samples Collected From the 300 Area Leach Trench and Its Associated River Shoreline Seepage Area

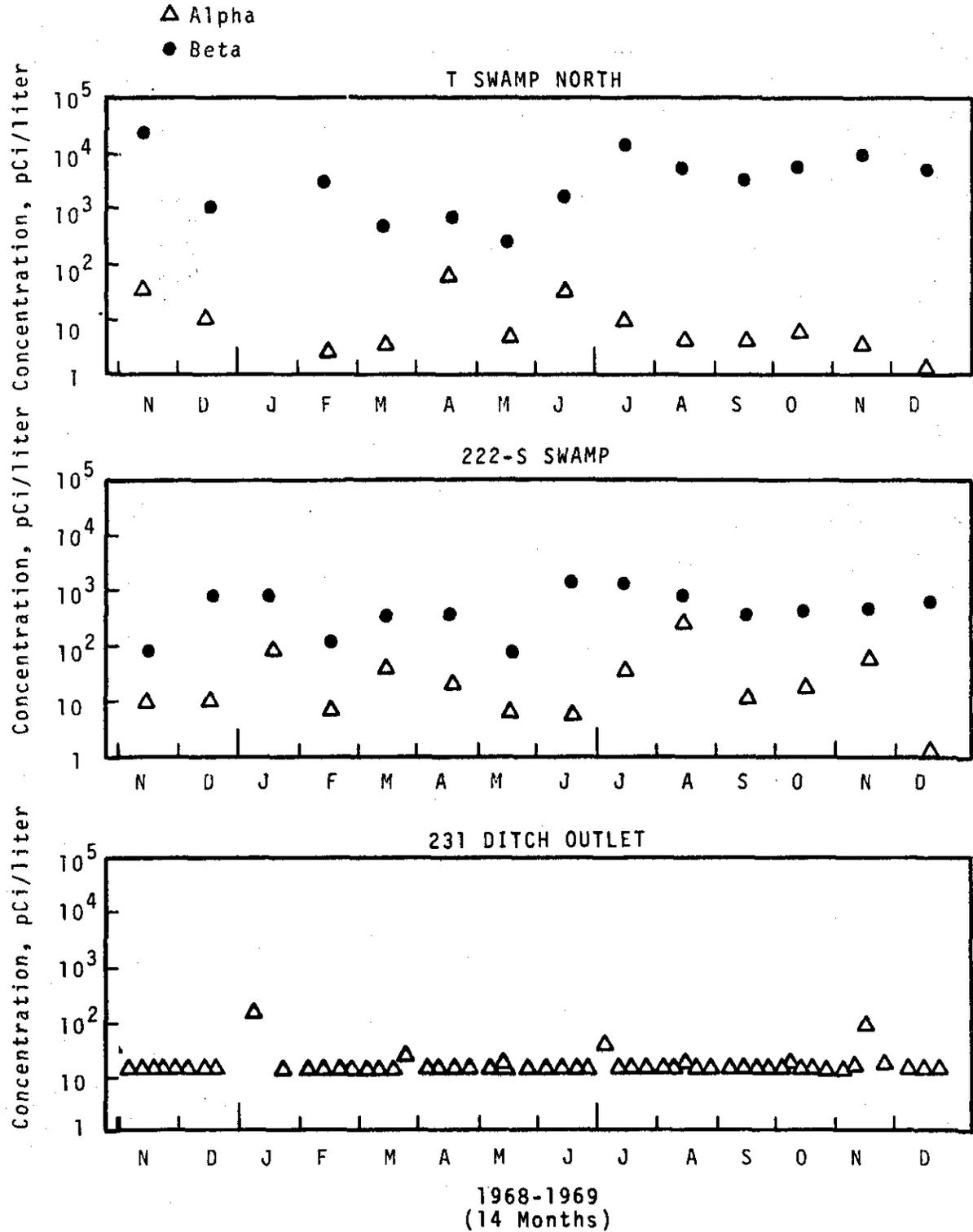
300 Area Leach Trench

<u>Date</u>	<u>Coliform/100 ml</u>	<u>Enterococci/100 ml</u>	<u>BOD mg/l</u>
7/22 /69	53,000	2,200	2.8
8/19	70,000	20,000	4.8
9/23	77,000	3,000	4.8
10/22	220,000	24,000	3.6
11/18	290,000	71,000	6.4
12/9	350,000	5,300	7.4

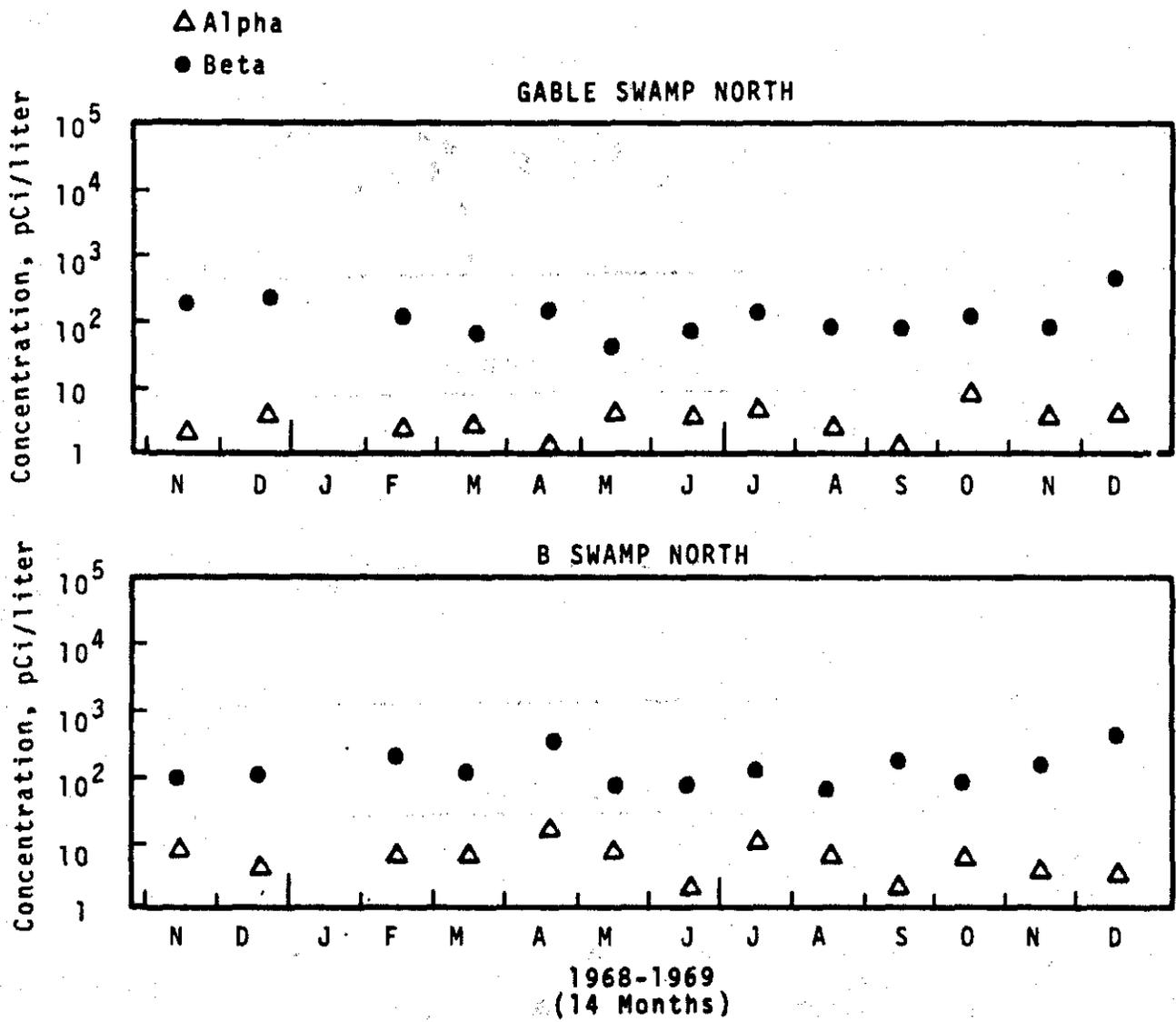
River Shoreline Seepage Area

<u>Date</u>	<u>Coliform/100 ml</u>	<u>Enterococci/100 ml</u>	<u>BOD mg/l</u>
7/22 /69	11	54	1.6
8/19	90	8	1.6
9/23	180	44	1.6
10/22	220	80	2.8
11/18	100	8	3.0
12/9	340	12	2.8

RADIOACTIVITY OF WASTE WATER SAMPLES 200-WEST AREA

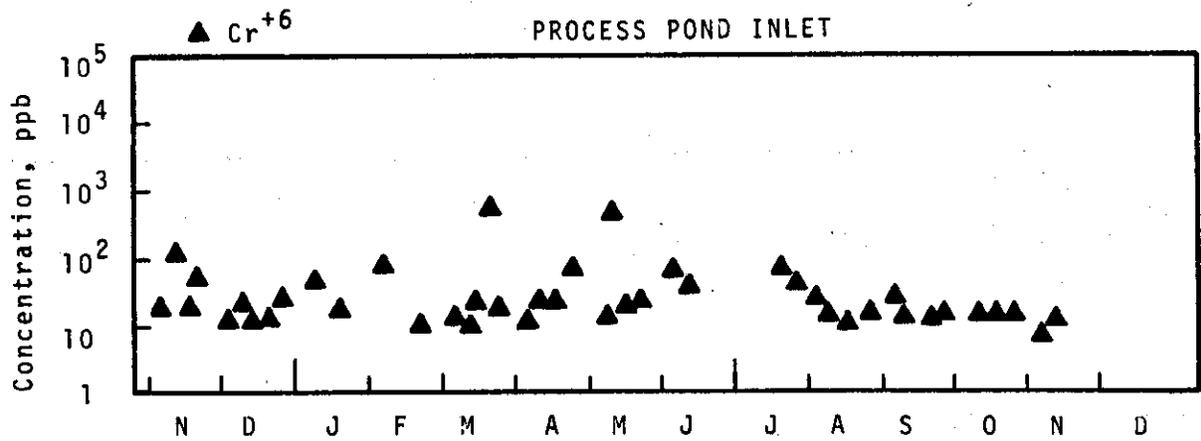
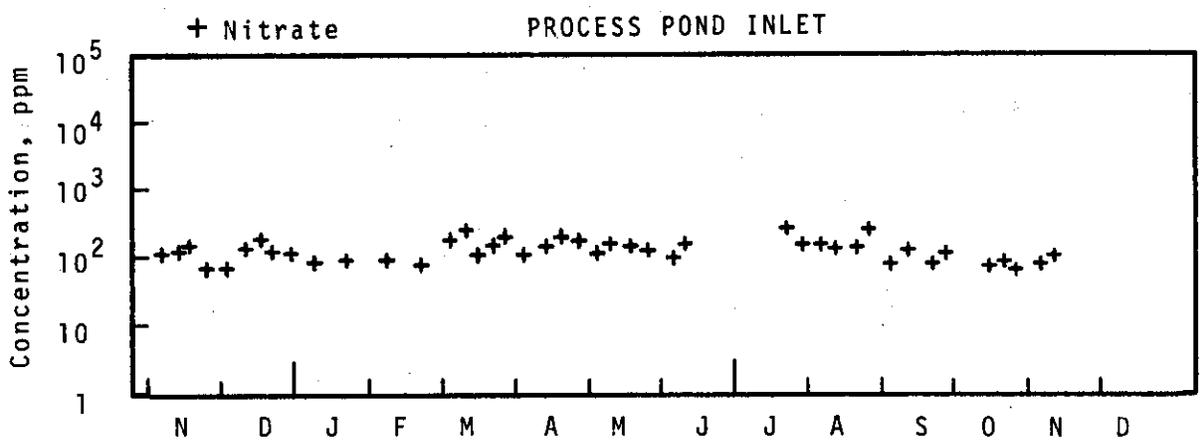
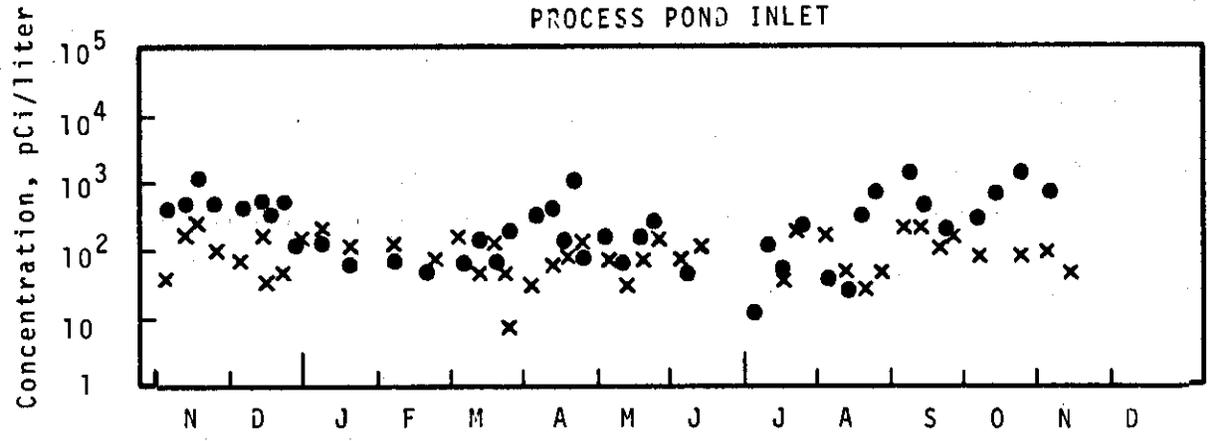


RADIOACTIVITY OF WASTE WATER SAMPLES 200-EAST AREA



WASTE WATER ANALYSES 300 AREA

× Uranium
● Beta



1968-1969
(14 Months)

V. AIRBORNE RADIOACTIVITY

Results of routine sampling of the atmosphere for radioactivity at 20 locations within the Hanford Reservation (Map 3) are shown in Figures 6-17. For comparison, data from some offsite locations (May 4) are included in the following discussion. (Sampling for chemical pollutants in the atmosphere is conducted and reported by the Hanford Environmental Health Foundation.)

The sampling equipment sheltered in small buildings designated "614," draws air at a flow rate of 2.5 m³/hr (1.5 cfm) through HV-70 filter paper and then through a solution of NaOH for radioiodine collection. The normal sampling period is one week. Total beta represents the gross beta activity (⁹⁰Sr-Y calibration) and total alpha represents the gross alpha activity (²³⁹Pu calibration) of particulates collected on the filter paper during the sampling period.

Table 8 shows Concentration Guides for selected radionuclides in air. Table 9 shows the average ¹³¹I and particulate total beta activity in air at various locations, and Table 10 contains results of gamma scans, gross alpha, and gross beta analyses on selected environmental air filters.

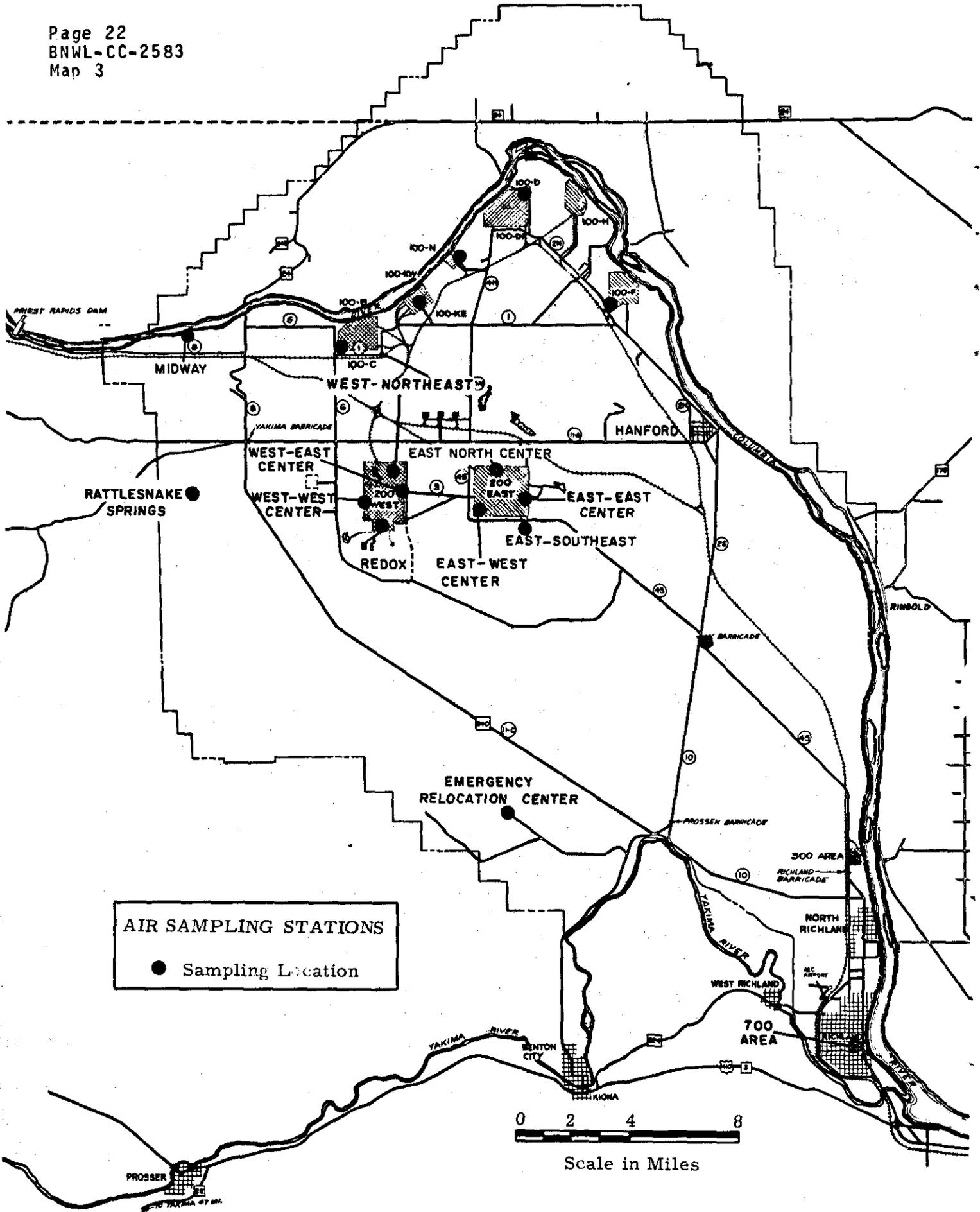
A. Iodine-131

Concentrations of ¹³¹I in the atmosphere during this reporting period averaged about 0.01 pCi/m³ at nearly every onsite and offsite sampling location. Exceptions were the 300 Area with an average of 0.03 pCi¹³¹I/m³, and three locations with averages of 0.02 pCi/m³ (200-East East Center, 100-N Area, and Ringold).

The maximum individual concentration measured during this reporting period 0.7 pCi/m³, was noted in July at the 300 Area following an above average release of ¹³¹I from a laboratory building, but caused no measurable increase in the calculated infant thyroid dose. For comparison the maximum ¹³¹I concentration measured during the first six months of 1969 was 0.1 pCi/m³, also at the 300 Area.

Routine measurements of ¹³¹I in the air were discontinued at the old Hanford townsite and at Redox in July, and at 100-B, 100-K, 100-F, Rattlesnake Springs, and the Emergency Relocation Center in August.

A monthly summary of changes in ¹³¹I concentrations in air appears below.



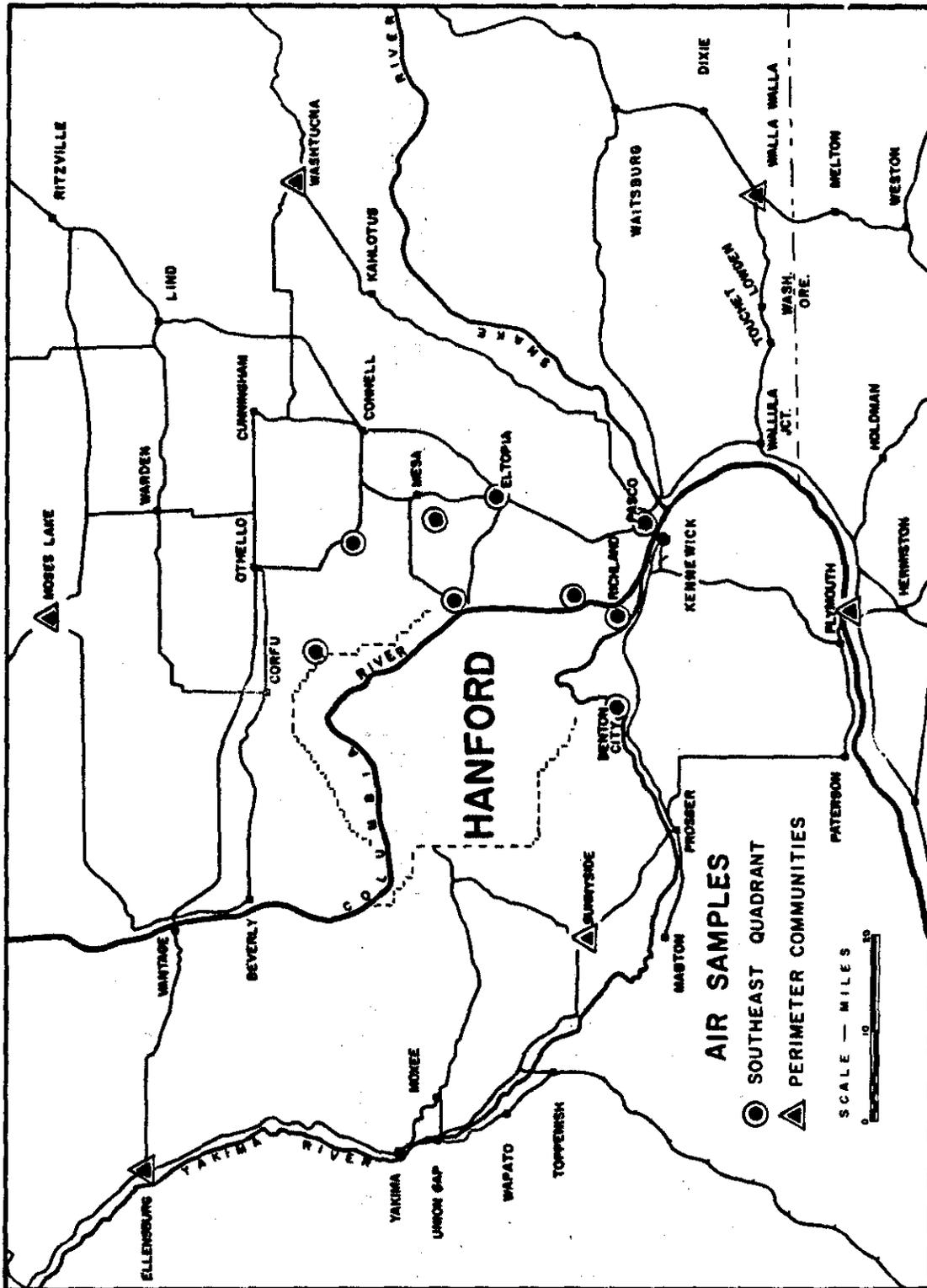


FIGURE 6. Offsite Air Sampling Locations

TABLE 8. Concentration Guides for Selected Radionuclides in Air for Individuals in Uncontrolled Areas*

Radionuclide---	<u>90Sr</u>	<u>95Zr</u>	<u>106Ru</u>	<u>131I</u>	<u>134Cs</u>	<u>137Cs</u>	<u>140Ba</u>	<u>144Ce</u>	<u>238Pu</u>	<u>239Pu</u>	<u>240Pu</u>	<u>241Am</u>	<u>U-Nat.</u>
Most Restrictive CG (pCi/m ³)---	30	1000	200	100	400	500	1000	200	0.07	0.06	0.06	0.2	2
Insoluble or Soluble---	(S)	(I)	(I)	(S)	(I)	(I)	(I)	(I)	(S)	(S)	(S)	(S)	(I)

* AEC Appendix 0524, Annex A, Table II, Column 1, (approved November 8, 1968). These Concentration Guides are for individuals. For the general population, the appropriate Concentration Guide would be one-third of the listed values.

July:

^{131}I concentrations in the atmosphere at the 300 Area increased temporarily to 0.7 pCi/m^3 (July 21-23) following an above average release from a laboratory building. A small increase was noted in Richland at the 700 Area. No measurable contribution to the calculated infant thyroid dose resulted.

August:

A slightly increased ^{131}I concentration in air was noted at an offsite location near Mesa during the first week of August (0.08 pCi/m^3 at New Moon). In late August at Ringold, an unexplained temporary increase to 0.06 pCi/m^3 during August 21 to 28, was observed. Iodine concentrations at the 300 Area also were slightly higher than usual, 0.04 pCi/m^3 during August 25 to September 2.

September:

During the third week of September, iodine-131 concentrations temporarily increased to 0.06 pCi/m^3 in the 200-West Area at the East Center location.

October:

Slight increases in ^{131}I in air were noted at 100-N Area during the first two weeks of October ($0.04\text{-}0.05 \text{ pCi/m}^3$).

At 200-East East Center, an above average ^{131}I concentration 0.07 pCi/m^3 , occurred during the second week of October. A similar concentration occurred offsite at the McNary sampling location during October 10-17.

November:

See below.

December:

^{131}I concentrations observed in December were generally less than 0.03 pCi/m^3 . Exceptions were 0.04 pCi/m^3 for the Wahluke Slope and Benton City samples in late November early December.

B. Total Beta

Twenty environmental air filters from onsite locations and thirteen from offsite are examined weekly for total beta activity. Table 8 presents Concentration Guides for comparison.

Table 9 shows the average ^{131}I and particulate total beta activity in air at various locations and Table 10 shows results of gamma energy analyses of selected filters.

With the exception of unusual concentrations at 200-East Area, atmospheric total beta activity was highest during July and August as a result of increased fallout (0.5 to 2 pCi/m^3), but had decreased to less than 0.1 pCi/m^3 by the end of December. The highest total beta concentration at an offsite location during 1969 (2.1 pCi/m^3) was measured on a filter from Washtucna during July. The major gamma emitters present were ^{106}Ru , $^{144}\text{Ce-Pr}$, and $^{95}\text{Zr-Nb}$. Six-month averages for the last half of 1969, about 0.1 pCi/m^3 , were greater than those recorded for the first half of the year at most sampling locations. However, an increase from about 0.9 to 2.5 pCi/m^3 for the six-month average was noted at 200-East North Center as a result of increased radionuclide releases associated with tank farm operations. As measured by monthly composites of weekly filters, the average concentrations of $^{137}\text{Cs-}^{137\text{m}}\text{Ba}$ and $^{144}\text{Ce-Pr}$ at the 200-East North Center location were about 2.2 pCi/m^3 and 1.1 pCi/m^3 , respectively, during this reporting period.

The peak total beta activity at that location, 12 pCi/m^3 , occurred during November 4 to 11 and was the highest measured in an environmental air sample since September 1965. The principal gamma emitters present were $^{137}\text{Cs-}^{137\text{m}}\text{Ba}$ and $^{144}\text{Ce-Pr}$ at concentrations of 6.3 and 4.3 pCi/m^3 , respectively, although $^{95}\text{Zr-Nb}$ and ^{134}Cs were also detected (Table 10). Analysis for ^{89}Sr and ^{90}Sr indicated concentrations of 0.14 and 0.29 pCi/m^3 , respectively. It was thought that removal of a heater from a waste tank caused the increased airborne radioactivity.

Increases in total beta activity were observed at a few other onsite locations during November, notably at 200-East East Center. At offsite locations in the direction of the prevailing wind (SE Quadrant), total beta concentrations were generally less than 0.4 pCi/m^3 , in November. At the more remote offsite locations, concentrations were generally less than 0.2 pCi/m^3 .

There were foreign nuclear weapons tests on September 22 and 29, 1969. However, no increases in environmental concentrations of radionuclides were apparent as a result of these events.

TABLE 10. Gamma Emitting Radionuclides on Selected Air Filters (July-December 1969)
(pCi/m³)

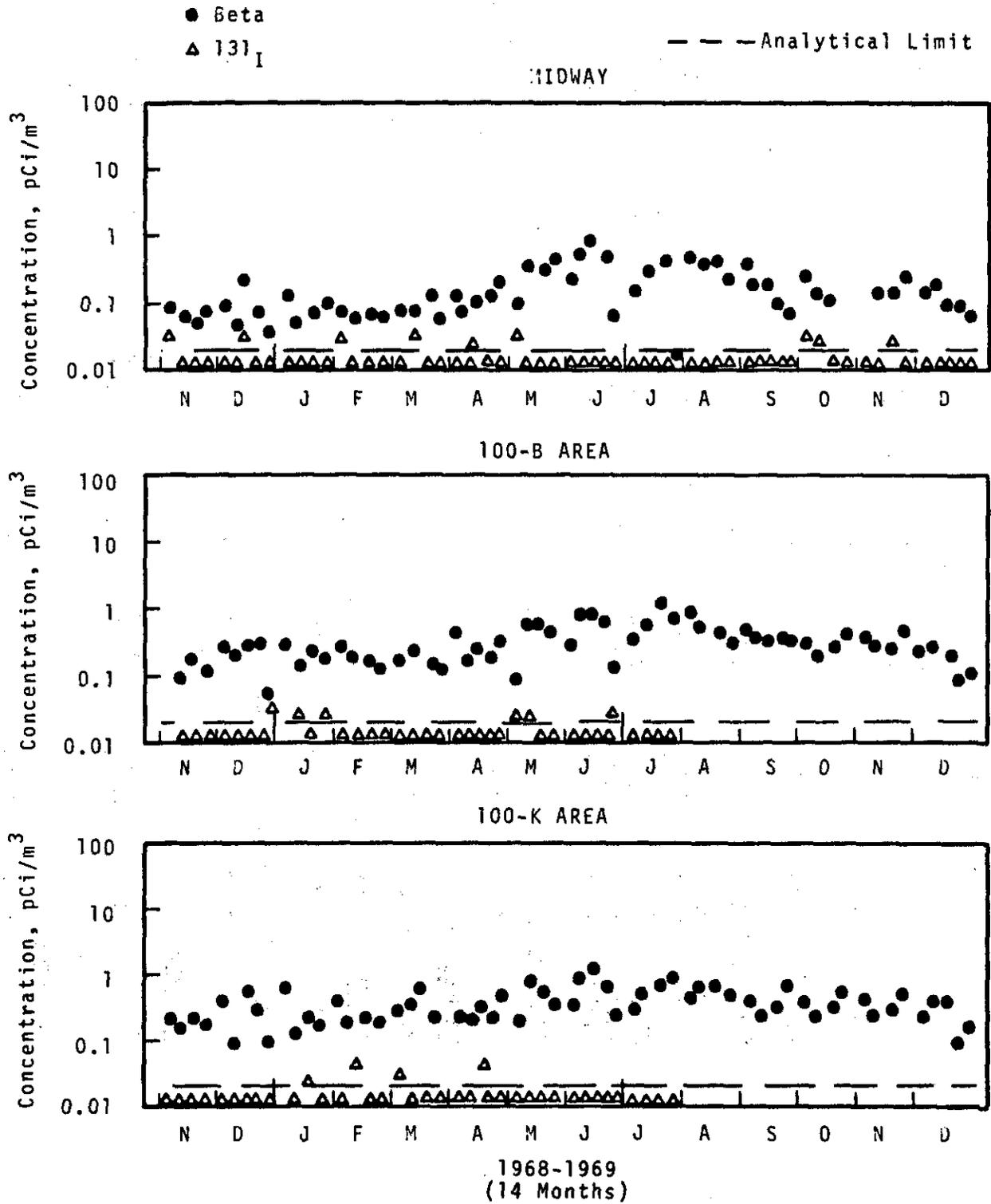
Inclusive Dates	⁹⁵ Zr-Nb	¹⁰⁶ Ru-Rh	¹³⁴ Cs	¹³⁷ Cs- ^{137m} Ba	¹⁴⁰ Ba-La	¹⁴⁴ Ce-Pr	Total Alpha	Total Beta
<u>100-K</u>								
6/23	0.18	0.26		0.01	-	0.18	0.014	0.58
7/28	0.17	0.23		0.01	-	0.18	0.011	0.55
8/25	0.09	0.18		0.02	-	0.09	0.011	0.53
9/29	0.05	0.13	0.21	-	-	-	0.005	0.34
10/27	0.06	-		0.15	0.52	-	0.004	0.34
11/24	0.01	0.07		0.01	-	-	0.002	0.25
12/29								
<u>200-East East Center</u>								
6/23	0.19			0.05	-	0.22	0.021	0.78
7/29	0.39			0.16	-	0.50	0.018	0.87
8/26	0.08			0.14	-	0.12	0.011	0.69
9/30	0.03			0.09	-	-	0.012	0.32
10/3	0.12			0.40	-	-	0.008	0.58
9/30	0.28			0.33	-	0.17	0.008	1.0
10/28	0.08			0.12	-	0.03	0.004	0.39
11/25	0.01				-			
12/30					-			
<u>200-East North Center</u>								
7/15	0.45			2.4	-	1.3	0.054	3.4
7/29	0.22			1.4	-	0.75	0.027	1.7
8/26	0.10		0.02	1.0	-	0.09	0.022	1.5
9/30	0.17			1.7	-	-	0.028	1.4
10/3	0.12			1.9	-	-	0.013	1.2
10/28	0.60		0.25	6.3	-	4.3	0.060	12.
11/4	0.66			5.2	1.7	4.4	0.031	8.6
11/25		0.20		1.4	-	0.13	0.009	1.8
12/30					-			
<u>Rattlesnake Springs</u>								
6/25	0.21	0.31		0.01	-	0.17	0.014	0.50
7/30	0.17	0.27		0.01	-	0.18	0.009	0.40
8/27	0.08	0.12		0.01	-	0.11	0.005	0.25
9/24	0.08	0.11		-	-	-	0.007	0.27
10/29	0.02	0.07		0.02	-	-	0.003	0.24
11/26	0.01			0.03	-	-	0.004	0.12
12/31					-			

TABLE 10. (Continued)

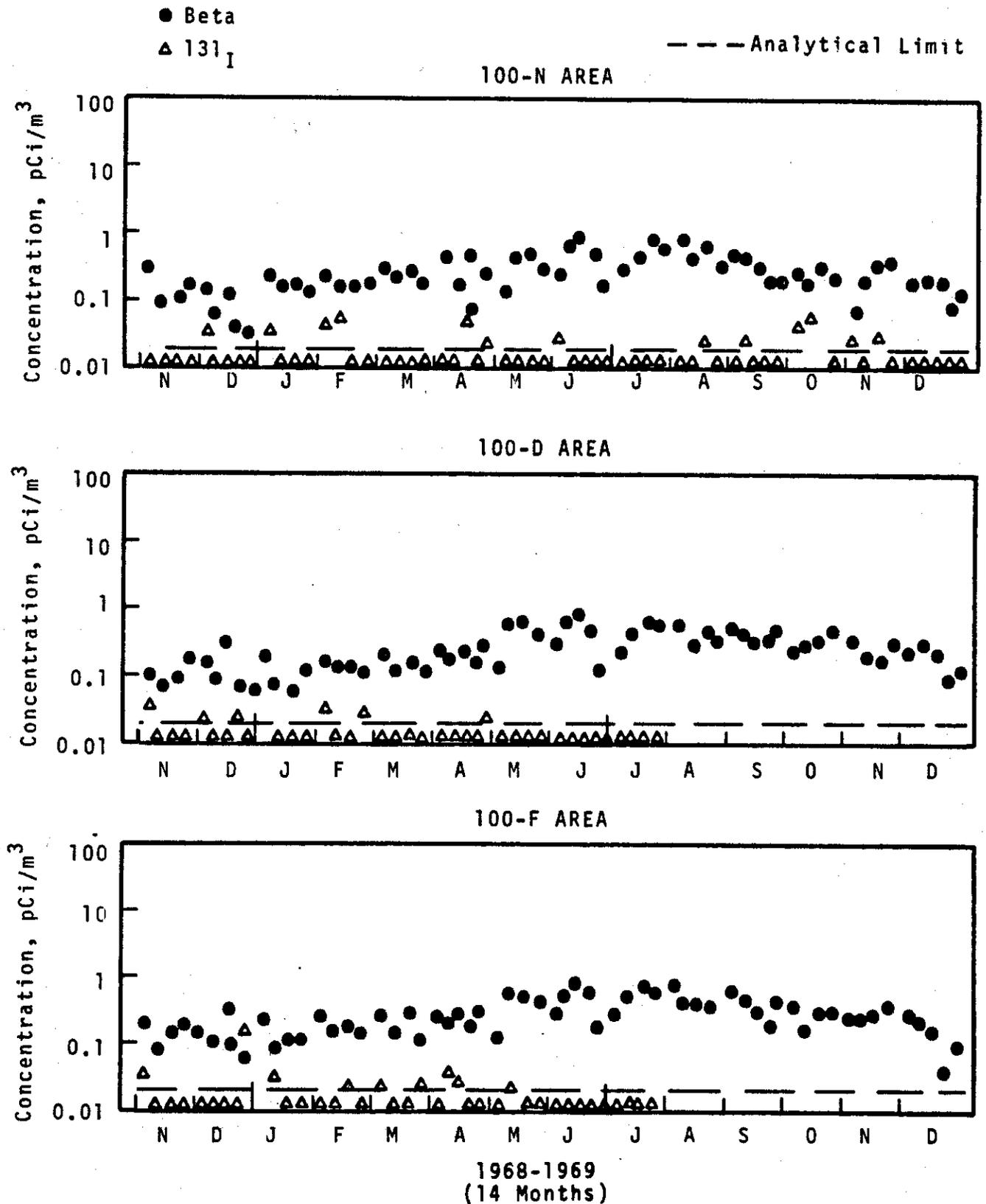
<u>Inclusive Dates</u>	<u>95Zr-Nb</u>	<u>106Ru-Rh</u>	<u>134Cs</u>	<u>137Cs-137mBa</u>	<u>140Ba-La</u>	<u>144Ce-Pr</u>	<u>Total Alpha</u>	<u>Total Beta</u>
<u>Ringold</u>								
6/24	7/31	0.14	-	0.01	-	0.13	0.007	0.32
7/31	8/28	0.13	-	0.01	-	0.12	0.008	0.24
8/28	9/25	0.05	-	-	-	-	0.004	0.26
9/25	10/30	0.04	-	-	-	-	0.003	0.08
10/30	11/26	0.01	-	-	-	-	0.003	0.10
11/26	12/31	0.01	-	-	-	-	0.002	0.08
<u>Byers Landing</u>								
6/23	7/28	0.19	-	-	-	0.21	0.016	0.44
7/28	8/25	0.20	-	0.01	-	0.21	0.009	0.48
8/25	9/29	0.07	-	0.01	-	0.10	0.008	0.27
9/29	10/27	0.07	-	-	-	-	0.007	0.18
10/27	11/24	0.01	-	-	-	-	0.004	0.19
11/24	12/29	0.01	-	0.01	-	-	0.003	0.12
<u>Moses Lake</u>								
7/20	7/25	0.76	-	-	-	1.0	NA*	1.3
<u>Wash tucna</u>								
7/20	7/28	0.92	-	-	-	1.1	NA	2.1
<u>200-West East Center</u>								
7/15	7/22	0.46	-	-	-	0.38	0.026	0.72
<u>Emergency Relocation Center</u>								
7/16	7/23	0.46	-	-	-	0.48	NA	0.84
<u>300 Area</u>								
7/14	7/21	0.41	-	0.03	-	0.20	0.023	1.3
9/29	10/6	0.11	0.08	0.08	-	-	0.011	0.41
<u>700 Area</u>								
9/29	10/6	0.03	-	-	-	-	0.008	0.34

* NA - No analysis made

IODINE-131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE 100 AREAS AND VICINITY

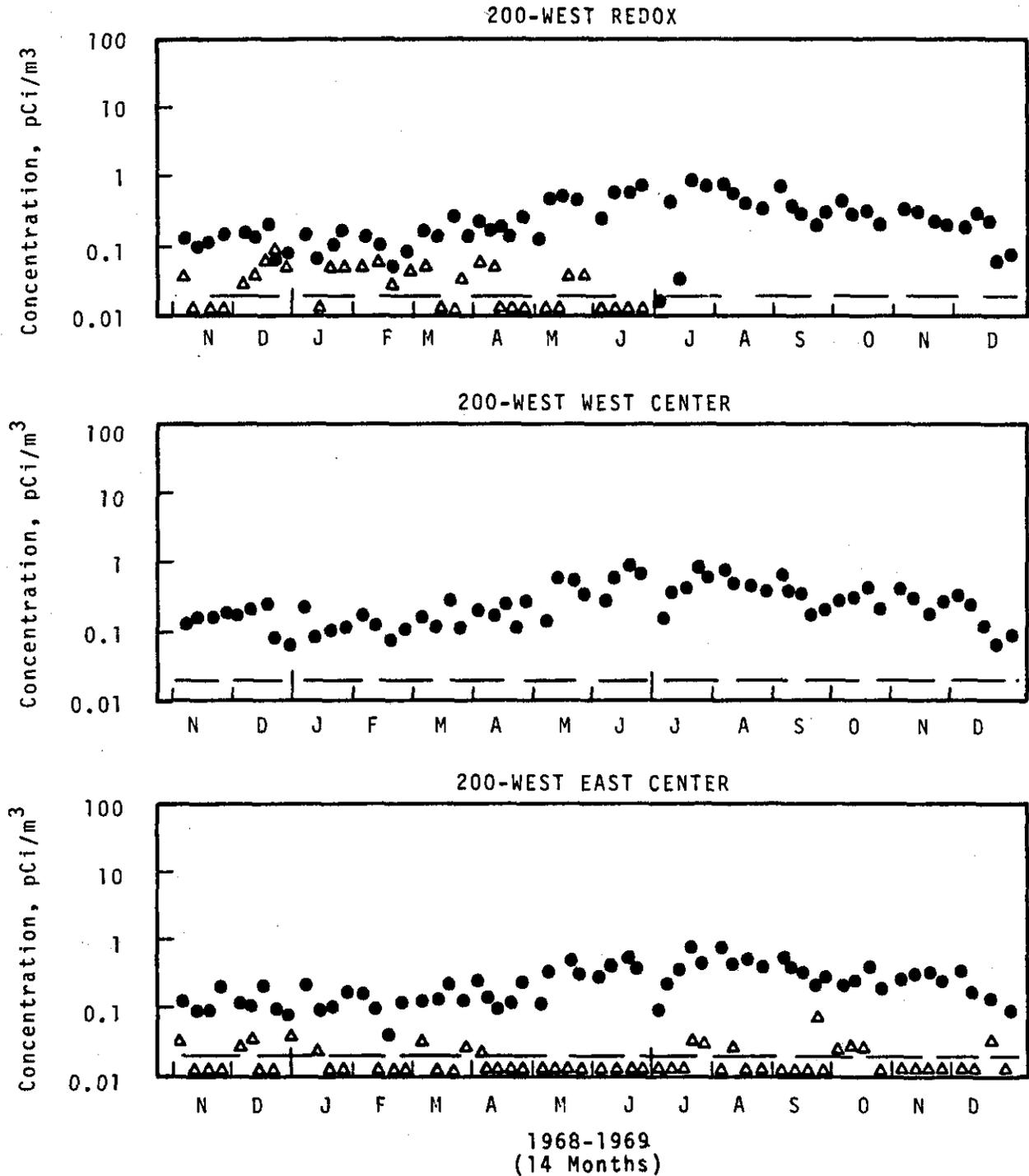


IODINE-131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE 100-AREAS AND VICINITY

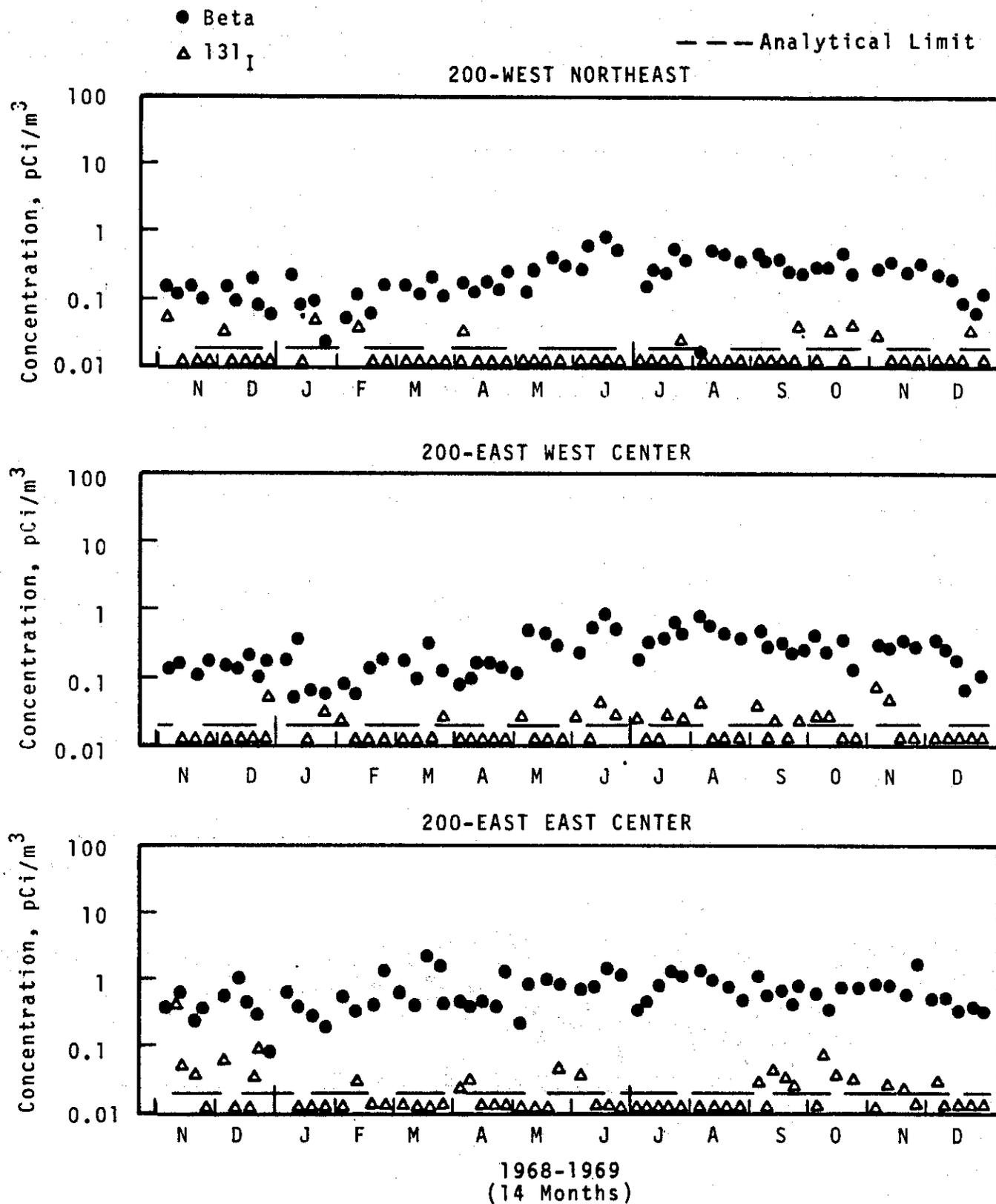


IODINE-131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE 200 AREAS

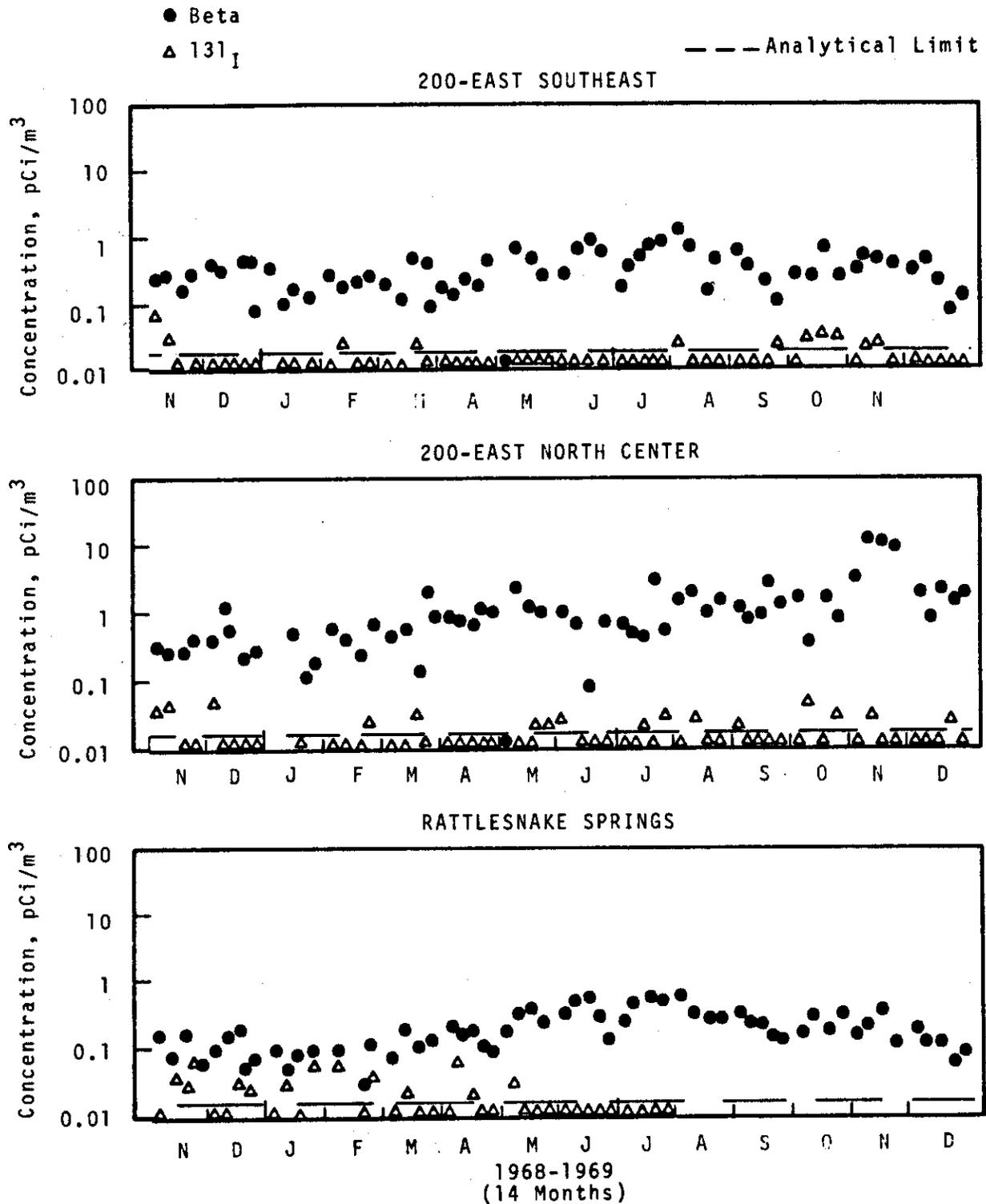
● Beta
 ▲ ^{131}I
 --- Analytical Limit



IODINE-131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE 200 AREAS



IODINE-131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE 200 AREAS AND INTERMEDIATE AREAS

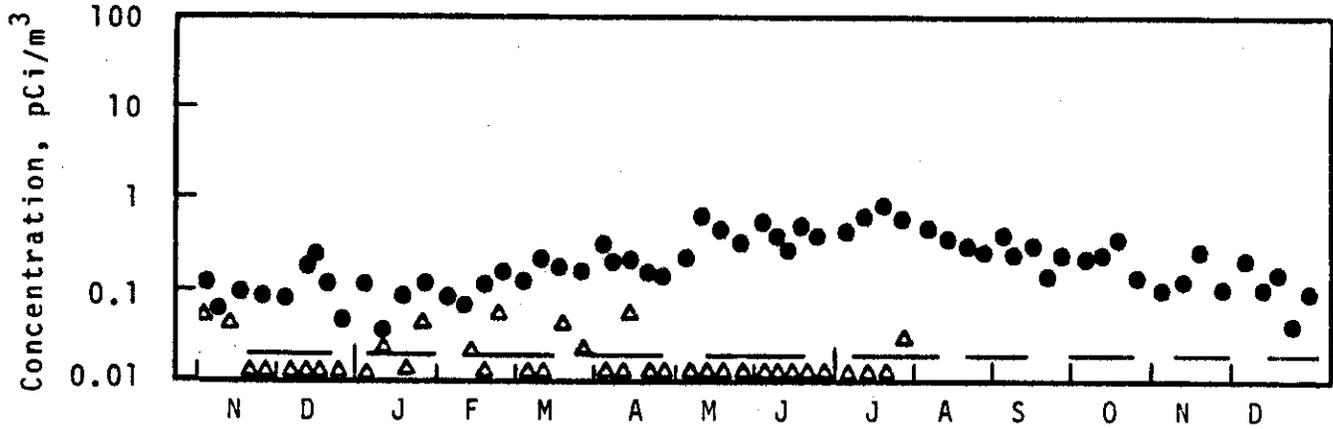


IODINE-131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE INTERMEDIATE AREAS

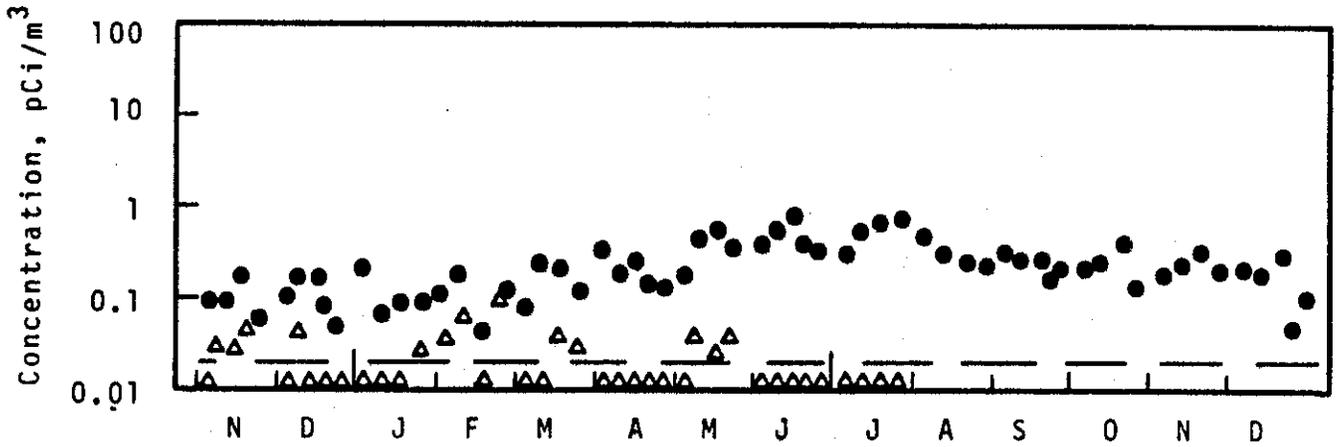
● Beta
△ ¹³¹I

— — — Analytical Limit

EMERGENCY RELOCATION CENTER

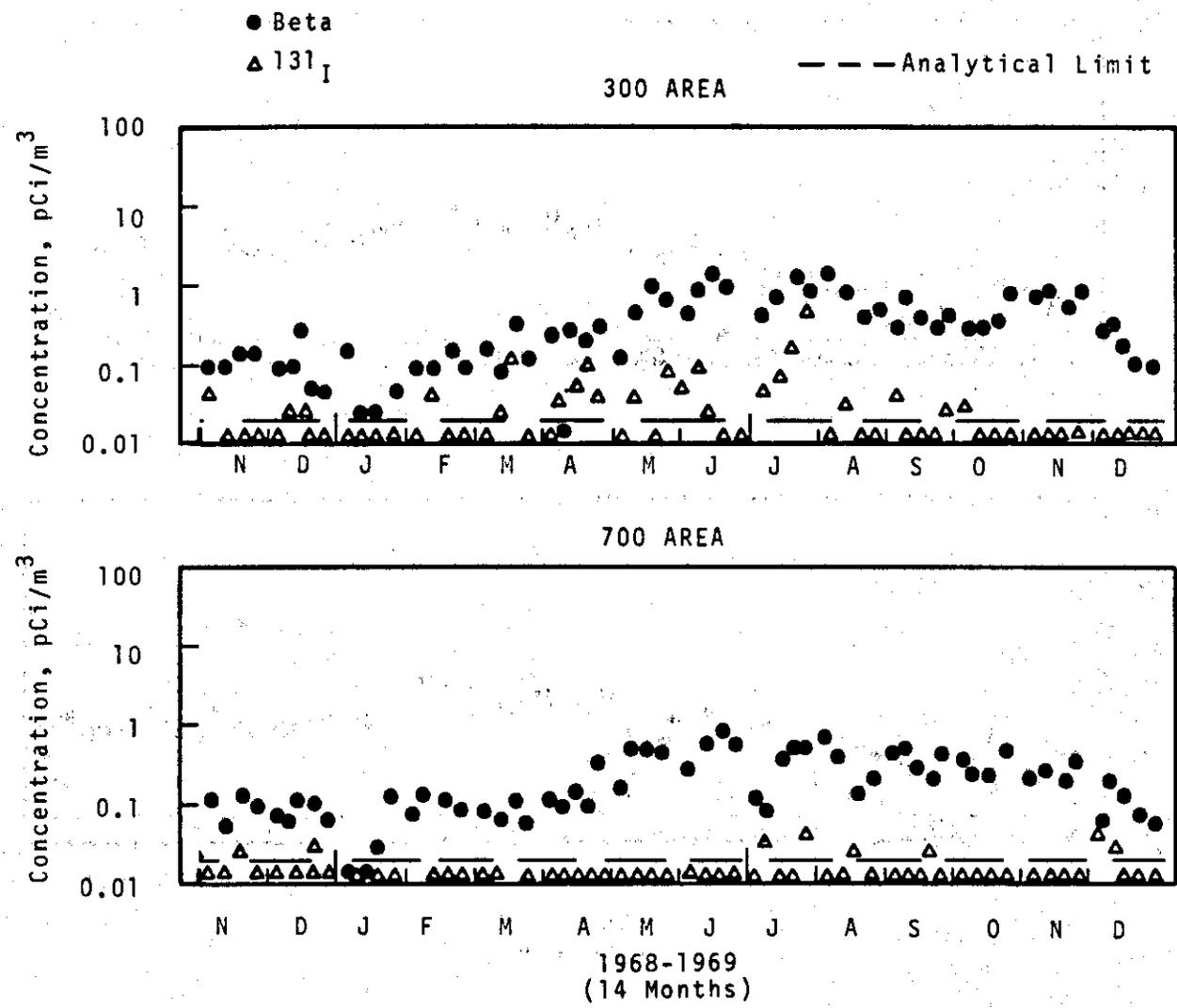


WYE BARRICADE



1968-1969
(14 Months)

IODINE-131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE 300 AND 700 AREAS



C. Total Alpha

Fifteen of the weekly filters that are analyzed for beta-gamma emitting radionuclides are also analyzed for alpha activity with most such sampling sites located in the 200 Areas. These data are presented in Figures 13-17. Routine measurements of atmospheric alpha activity at 100-B and 100-F were discontinued at mid-year.

Alpha counting of the filters was normally done after 48 hours to allow for the decay of short-lived activity from naturally-occurring daughters of radon-thoron.

A summary of transient increases during the last half of 1969 appears below. Because the analytical limit for total alpha concentrations (0.01 pCi/m³) is a significant fraction of the Concentration Guide for ²³⁹Pu in air for individuals in uncontrolled areas (0.06 pCi/m³), results only slightly above the analytical limit are of considerable interest.

Average total alpha concentrations for the last six months of 1969 were at or below 0.01 pCi/m³ for all locations with the exception of the 200-East North Center location (0.02 pCi/m³). The highest total alpha concentration measured in the last six months of 1969 was 0.060 pCi/m³, on a sample from the north side of the 200-East Area during November 4 through 11. For comparison, the maximum alpha concentration during the first six months of 1969 was 0.25 pCi/m³.

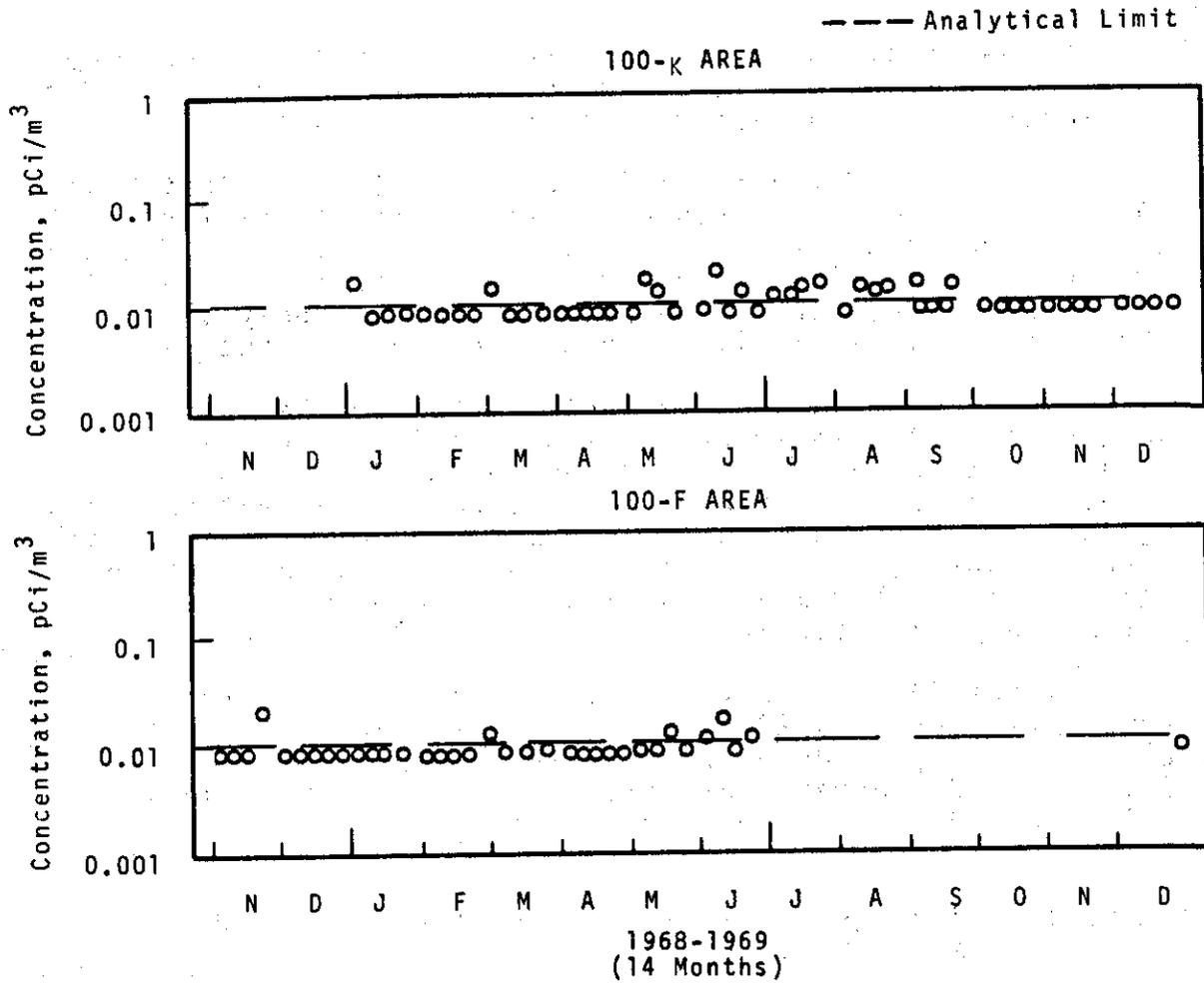
At the 200-East North Center location, the air filter sample removed on 9/23 indicated higher than usual total alpha activity (0.05 pCi/m³) as well as increased total beta activity. Subsequent analysis for plutonium indicated 0.007 pCi/m³ of ^{239,240}Pu and 0.004 pCi/m³ of ²³⁸Pu.

TABLE 11. Average Total Alpha Concentrations in the Atmosphere (pCi/m³)

<u>Location</u>	<u>1965</u>	<u>1966</u>	<u>1967</u>	<u>1968</u>	<u>Jan- June 1969</u>	<u>July- Dec 1969</u>
100K Area	-	-	-	-	0.008	0.008
200 Areas	<0.03	0.01	0.02	0.006	0.010	0.011
300 Area	<0.08	0.02	0.01	0.011	0.009	0.011
700 Area	<0.02	0.02	0.01	0.006	0.005	0.008

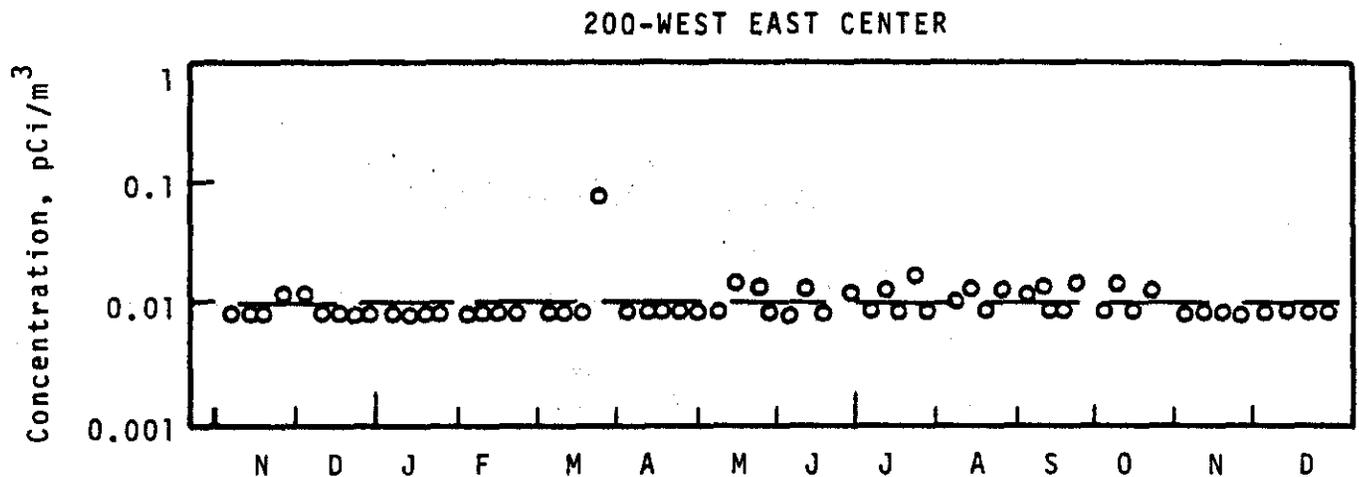
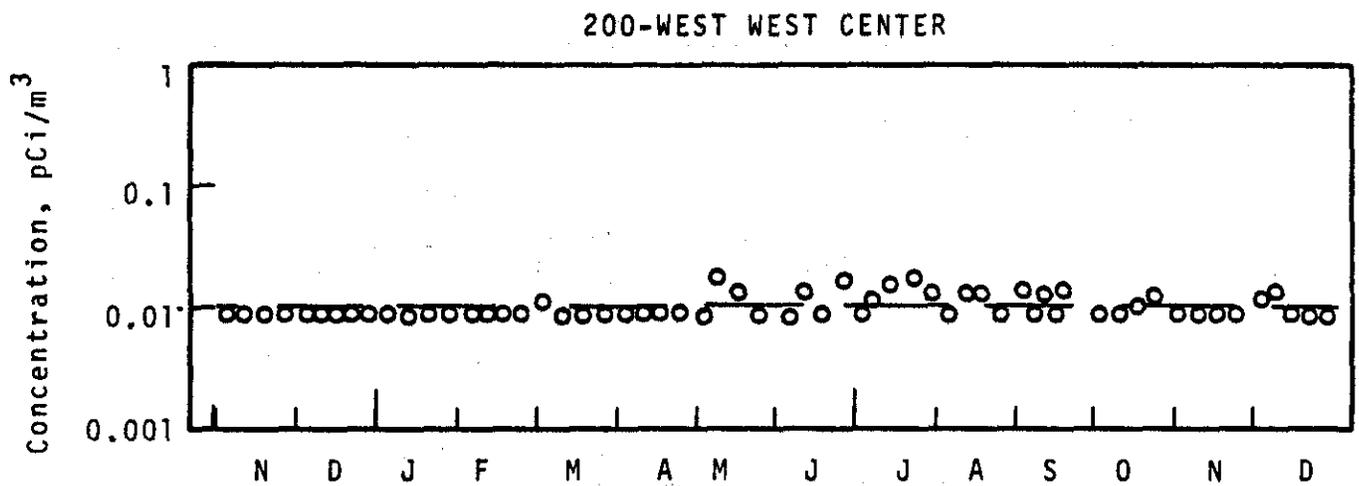
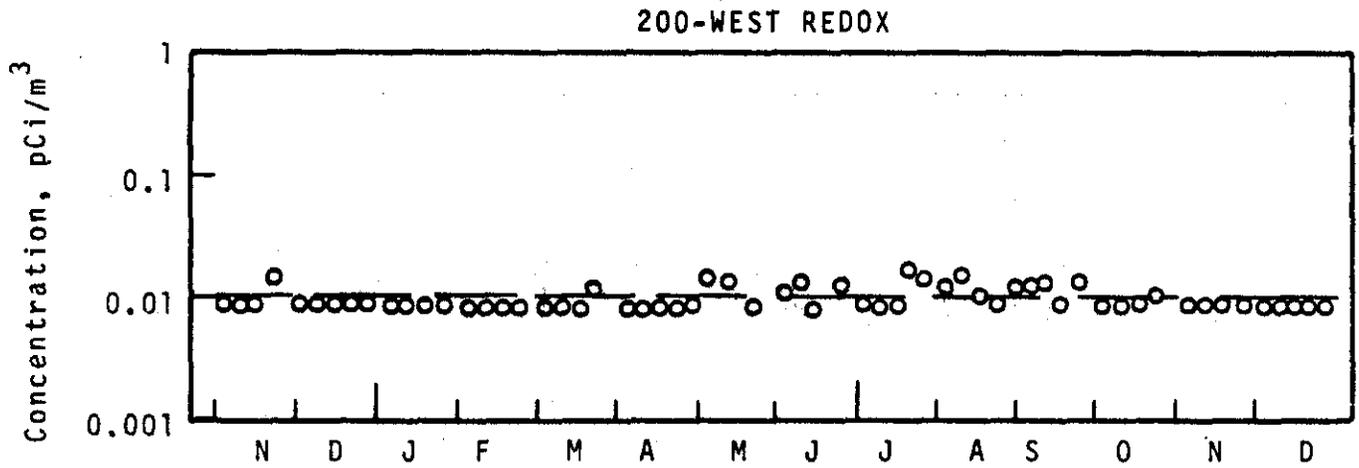
Note: During 1969, the 200 Area sampling locations included in the average were: 200-West (Northeast, West Center, Redox, and East Center) and 200-East (West Center, Southeast, East Center, and North Center).

TOTAL ALPHA ACTIVITY IN THE ATMOSPHERE 100 AREAS



TOTAL ALPHA ACTIVITY IN THE ATMOSPHERE 200 AREAS

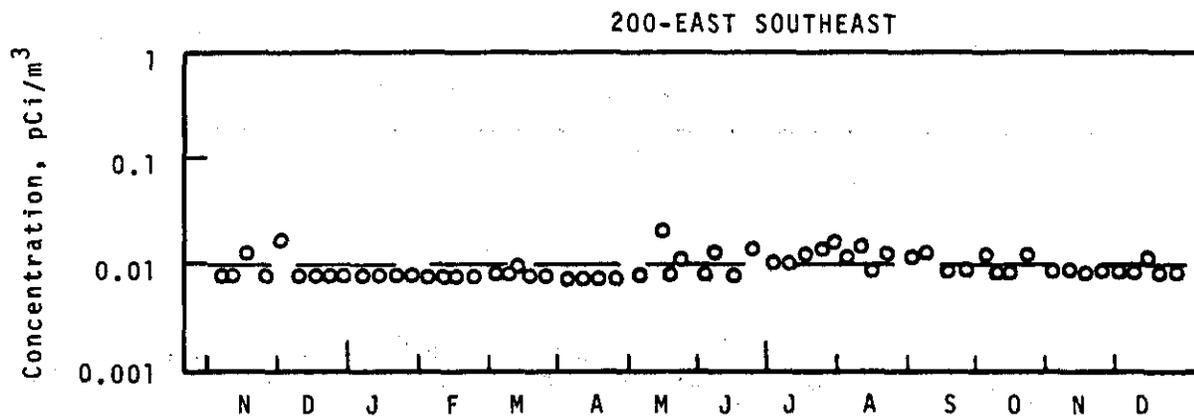
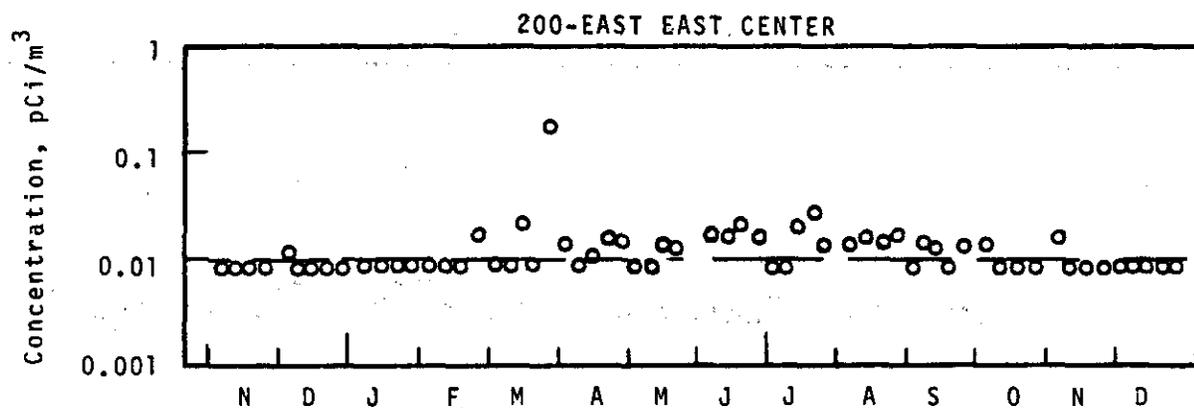
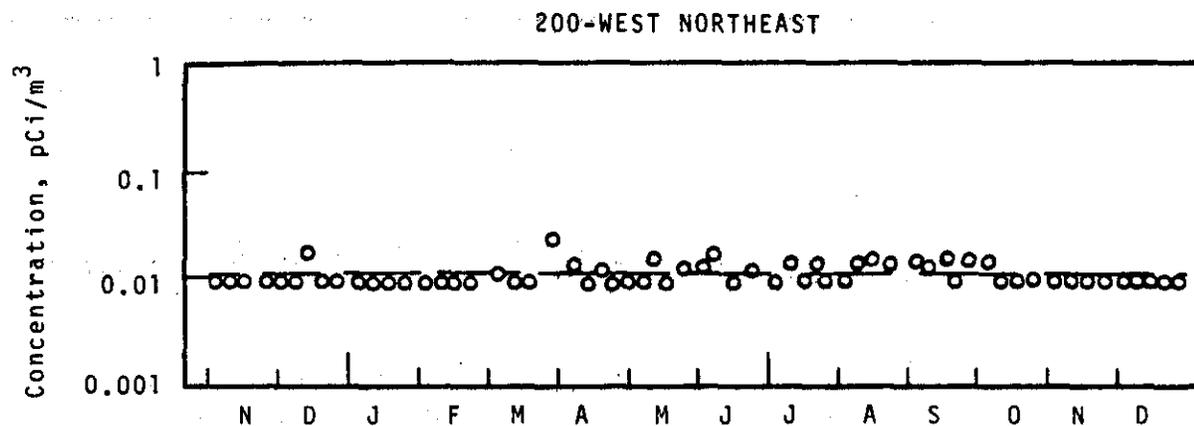
— — — Analytical Limit



1968-1969
(14 Months)

TOTAL ALPHA ACTIVITY IN THE ATMOSPHERE 200 AREAS

— — — Analytical Limit

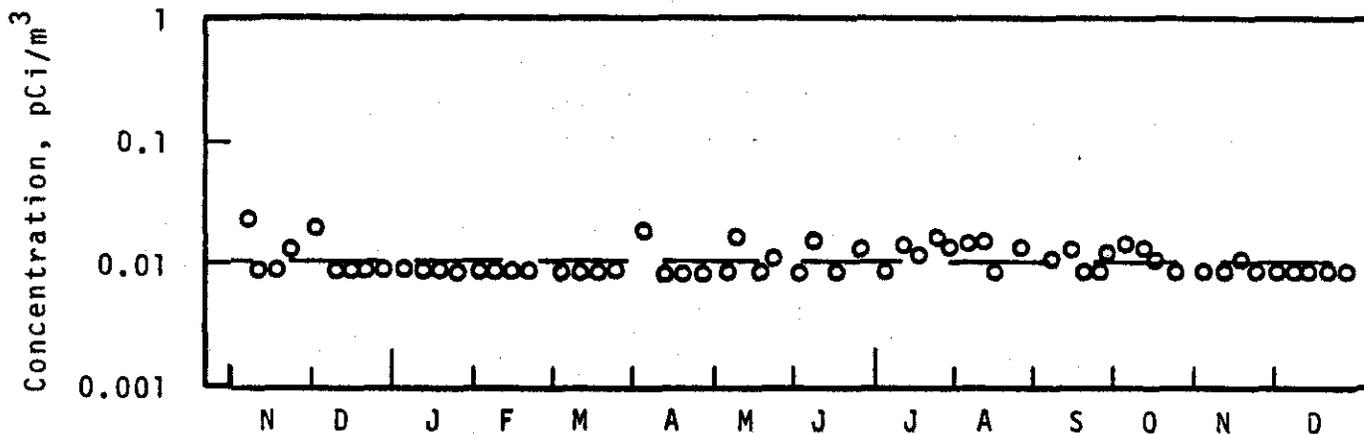


1968-1969
(14 Months)

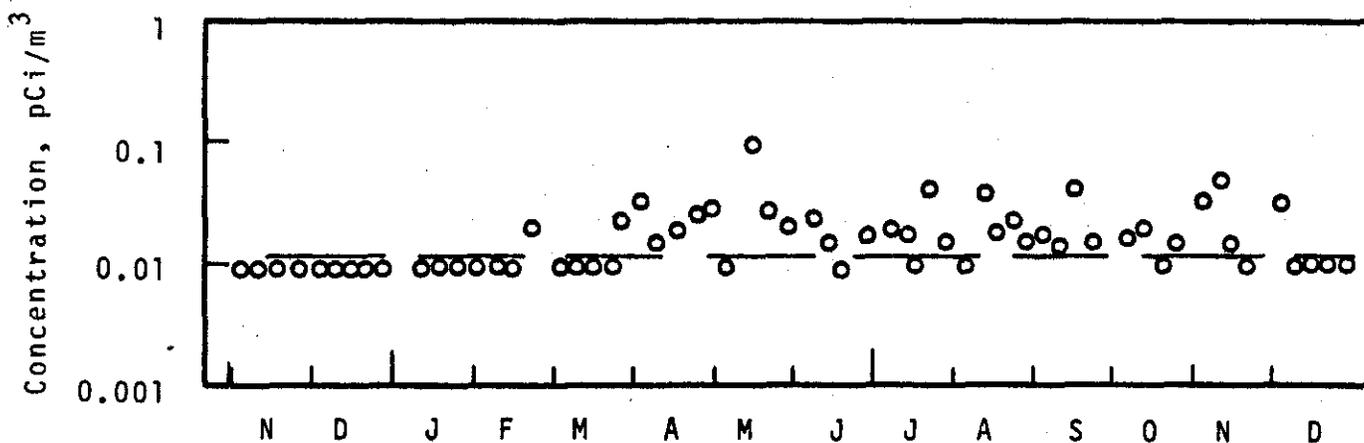
TOTAL ALPHA ACTIVITY IN THE ATMOSPHERE 200 AREAS AND RATTLESNAKE SPRINGS

— — — Analytical Limit

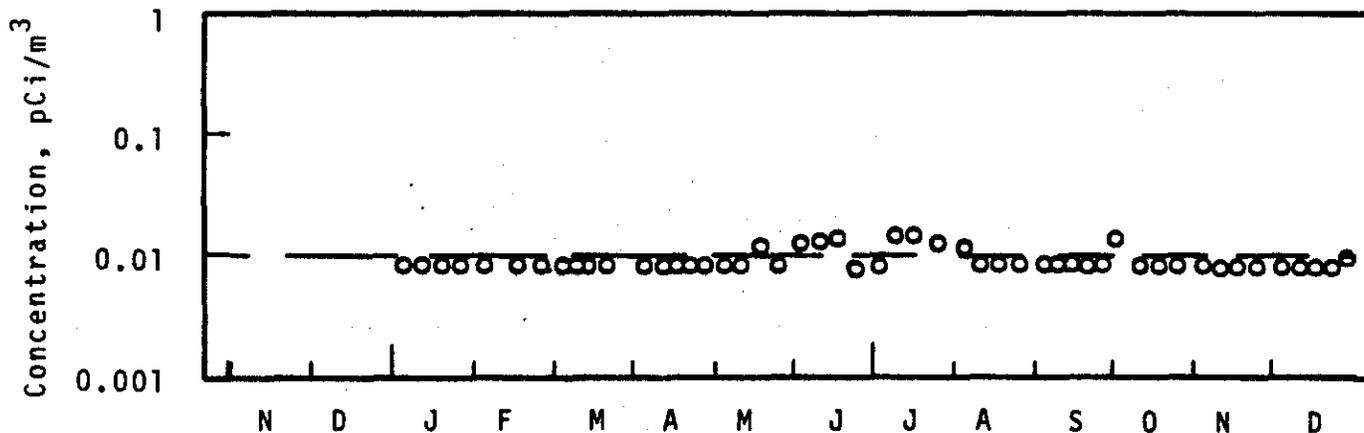
200-EAST WEST CENTER



200-EAST NORTH CENTER

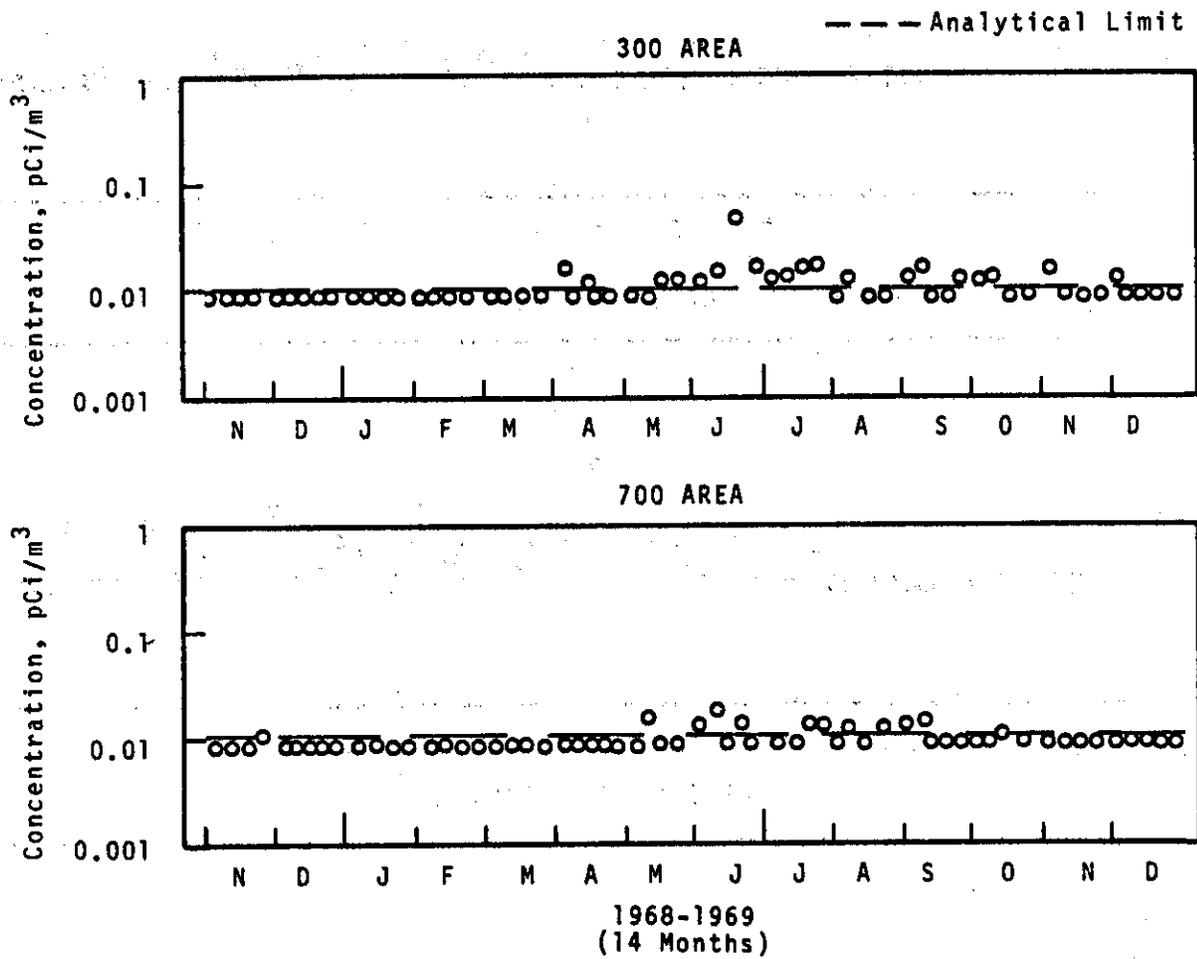


RATTLESNAKE SPRINGS



1968-1969
(14 Months)

TOTAL ALPHA ACTIVITY IN THE ATMOSPHERE 300 AREA AND 700 AREA



VI. RADIATION SURVEYS

A. Surface Contamination

1. Hanford Roads

Hanford roads are routinely surveyed (see Map 5) with a bioplastic scintillation detector attached to the front end of a truck and positioned about 0.6 meter (2 ft) above the road surface. This road monitor has been described in BNWL-62. Beginning July 1, all roads were surveyed monthly.

The only instance of radioactive particulate contamination found on road surveys during the second half of 1969 was on the entrance road to 100-K, approximately 100 yards from its junction with Route 1. The particle was found on October 20 and had a surface radiation level of 50,000 c/m (GM). The major gamma emitter was ^{60}Co . Unusual responses noted on surveys are summarized below:

July:

On July 10, a response of 2-3 times background was noted on route 4-S on the slope of 200-E hill. A GM survey revealed a radiation level of 100-150 c/m above a 100 c/m background. No particulate contamination was found. On July 28, a response of 2-3 times background was noted near the old Hanford town-site. A GM survey revealed no activity above background.

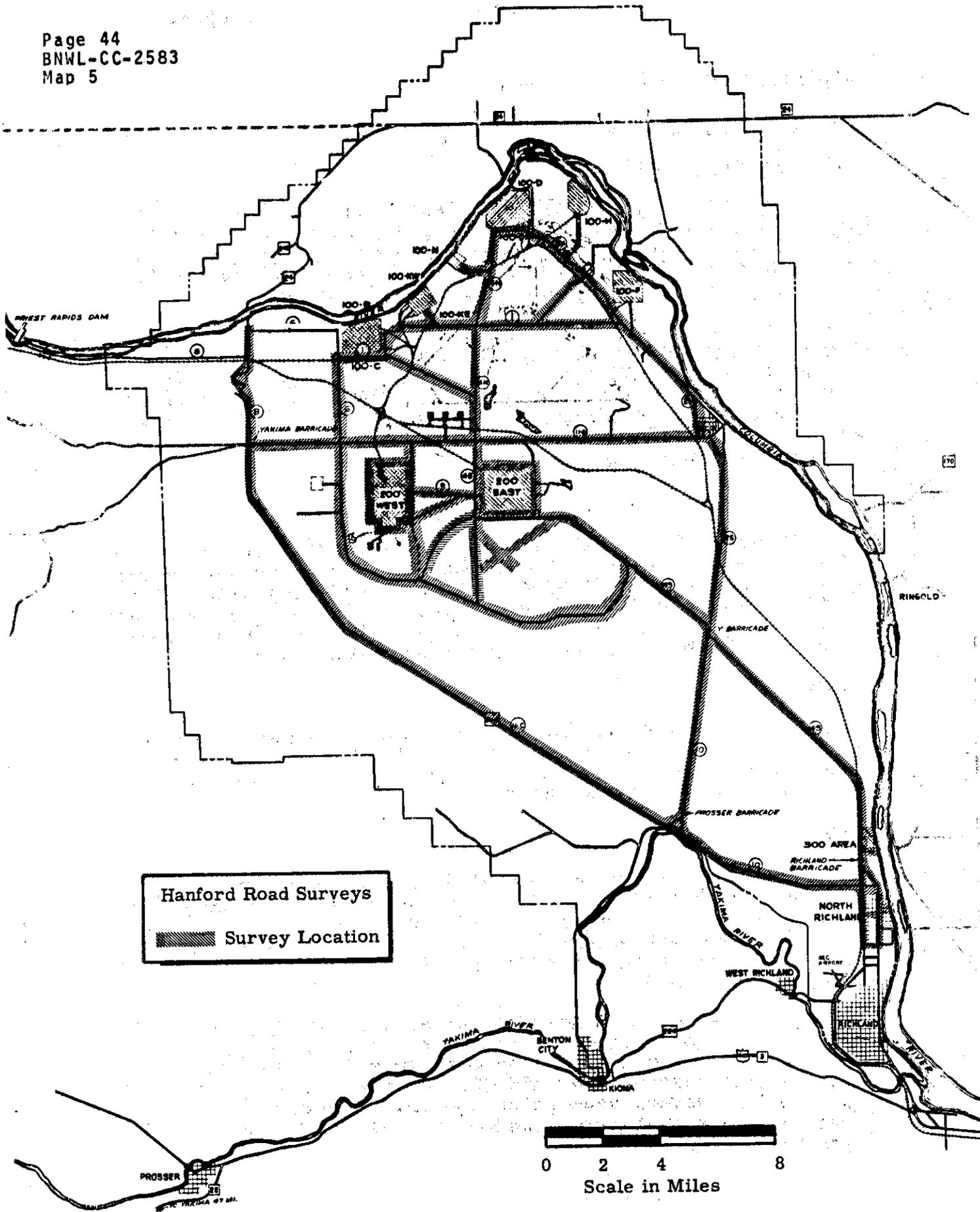
October:

A radioactive particle [50,000 c/m (GM)] was found on October 20 on the entrance road to 100-K, about 100 meters from its junction with Route 1. The major gamma emitter was ^{60}Co . DUN personnel were notified.

November:

A special survey was conducted in November after it was learned that the cask which had been shipped from 100-N to the 300 Area had leaked and contaminated the truck bed. The entrance roads to 100-N and 300 Area and several points in between were surveyed with the road monitor. No detectable activity was found.

On November 24, a special survey was made between Route 11-A and the north boundary of 200-E Area. This survey was made as a followup to the high air concentrations noted after a heater was removed from ITS #2. No particulate contamination was found; however, vegetation samples collected from three locations near the north boundary of 200-E Area all showed traces of ^{137}Cs .



2. Control Plots

Thirty-nine small areas, called control plots, are located within the Hanford boundaries (see Map 6). These plots, measuring 3.3 m by 3.3 m (10' by 10'), are periodically surveyed with a GM survey meter for deposited radioactive material. In addition, 32 special control plots located near test wells are surveyed on a semiannual basis: All special control plots were surveyed in September and no contamination was found.

Contamination was found on control plots on three occasions during the second half of 1969. On October 7, a small area of about 1000 cm² (1 ft²) on Control Plot #3 (near Redox Swamp - 216-S-16) was found to have a radiation level of 600-2500 c/m (GM). The major gamma activity on a soil sample was ¹³⁷Cs-¹³⁷Ba. Also on October 7, Control Plot #10 (east perimeter of 200-East) was found to have a radiation level of 1000 c/m (GM). No discrete particles were found. Another survey of Control Plot #3 on October 28 detected the same conditions as on the October 7 survey.

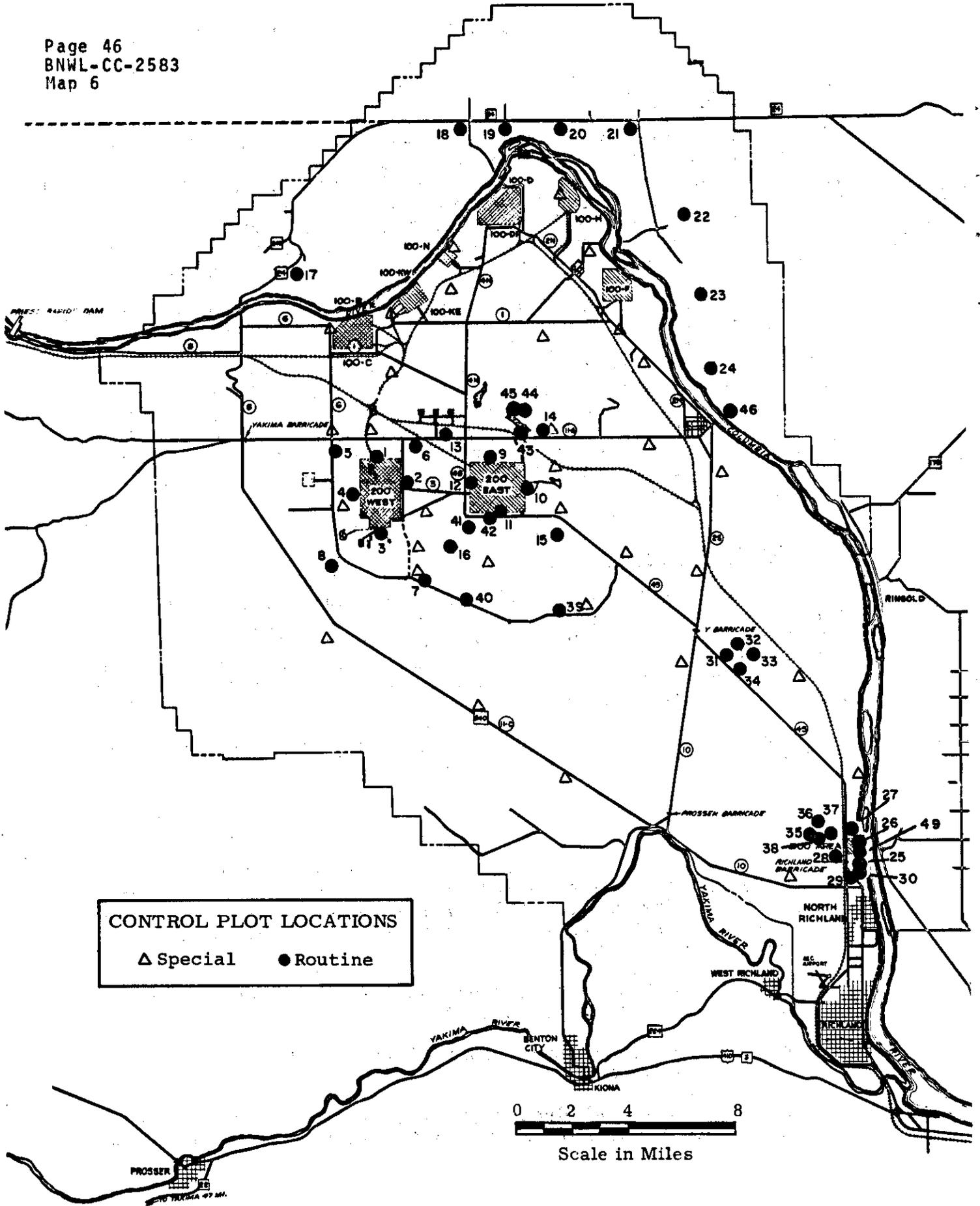
3. Waste Disposal Sites

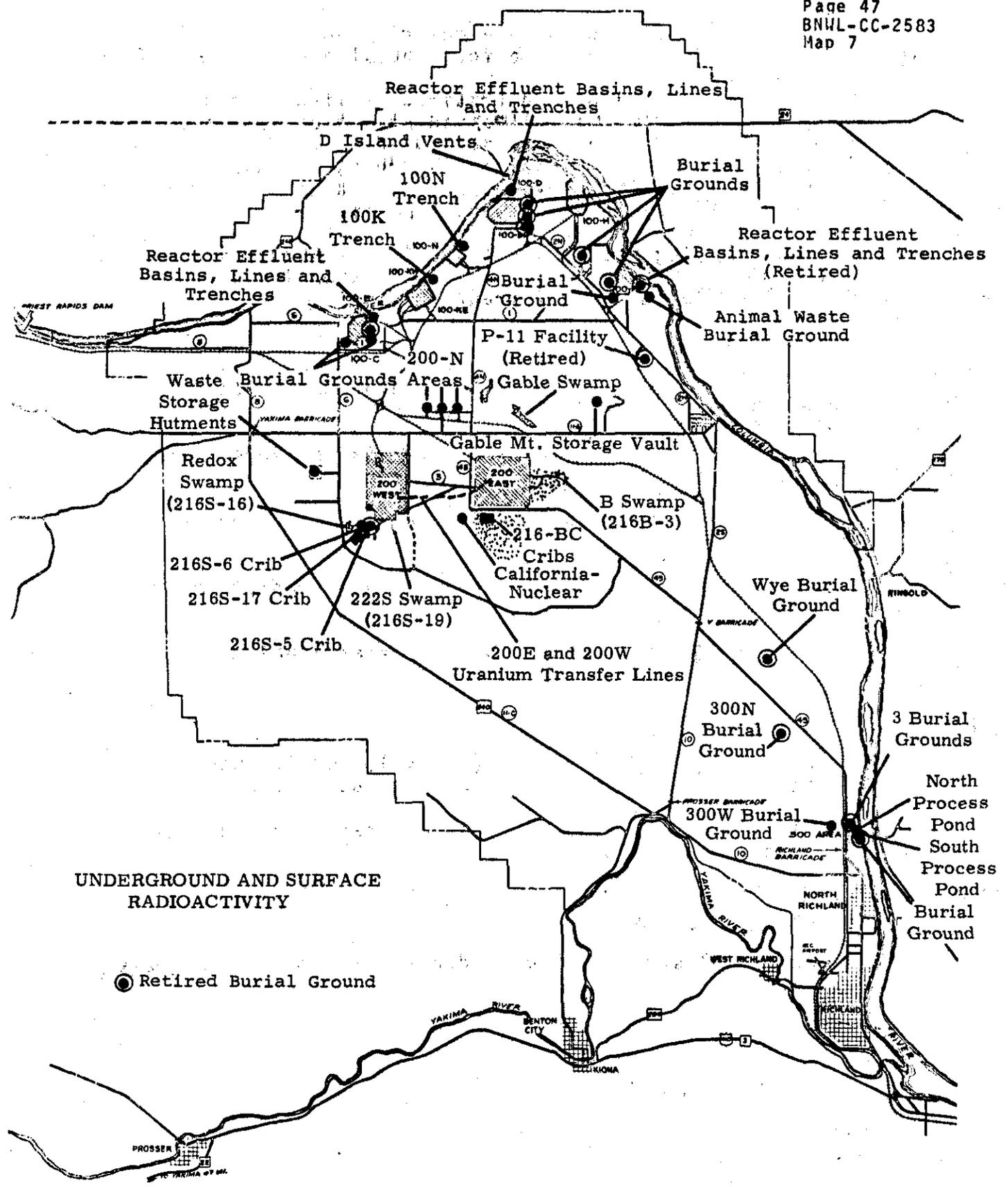
Retired waste burial grounds and areas where surface contamination is known to exist are inspected periodically for general physical condition and evidence of disturbance. The locations of such sites outside plant areas are shown in Map 7. During the second half of 1969, inspections were made at all the indicated areas.

No unusual radiation levels were observed; however, the following conditions were noted and appropriate personnel were notified.

August:

- a) 100-F - solid waste dumped on side of hill adjacent to active burial ground. Leach trench not well marked. Sawdust and solid waste piles inside of fenced area not marked as a radiation zone yielded readings up to 10,000 c/m (GM)
- b) Gable Mountain Storage Vault - wind erosion was again noted in the southwest corner
- c) 216-BC Crib Area - contaminated rabbit droppings were again noted
- d) 300-W Burial Ground (active) - cardboard cartons and other waste not in pit, but were inside fenced area





- e) 300-W Storage Area - material and equipment labeled radioactive were found outside of area
- f) Wye Burial Ground (retired) - sign regarding entry by RWP was still posted at entrance. Several (6-8) oil drums were found around perimeter. No contamination was apparent on drums, but they should be removed. Chained-off area was larger than the area delineated by concrete marker posts.
- g) Burning Pit north of 300 Area - burned metal turnings were found having a radiation level of 15,000 c/m (GM) and 4 mrad/hr (Juno)

October:

- a) 222-S Crib (216-S-14) - chain was up but no radiation zone signs were apparent
- b) 222-S Swamp (216-S-19) - radiation zone signs were faded
- c) Redox Swamp (216-S-16) - needs radiation zone signs
- d) Storage Igloos (T101-107) - need radiation zone signs
- e) 216-BC Crib Area - contaminated rabbit droppings were again noted

December:

- a) 100-F Burial Ground (active) - waste uncovered in a few spots having GM readings up to 6000 c/m
- b) 216-BC Crib Area - contaminated rabbit droppings were again noted

4. Aerial Surveys

No aerial surveys were conducted during the last half of 1969.

B. External Exposure Rates

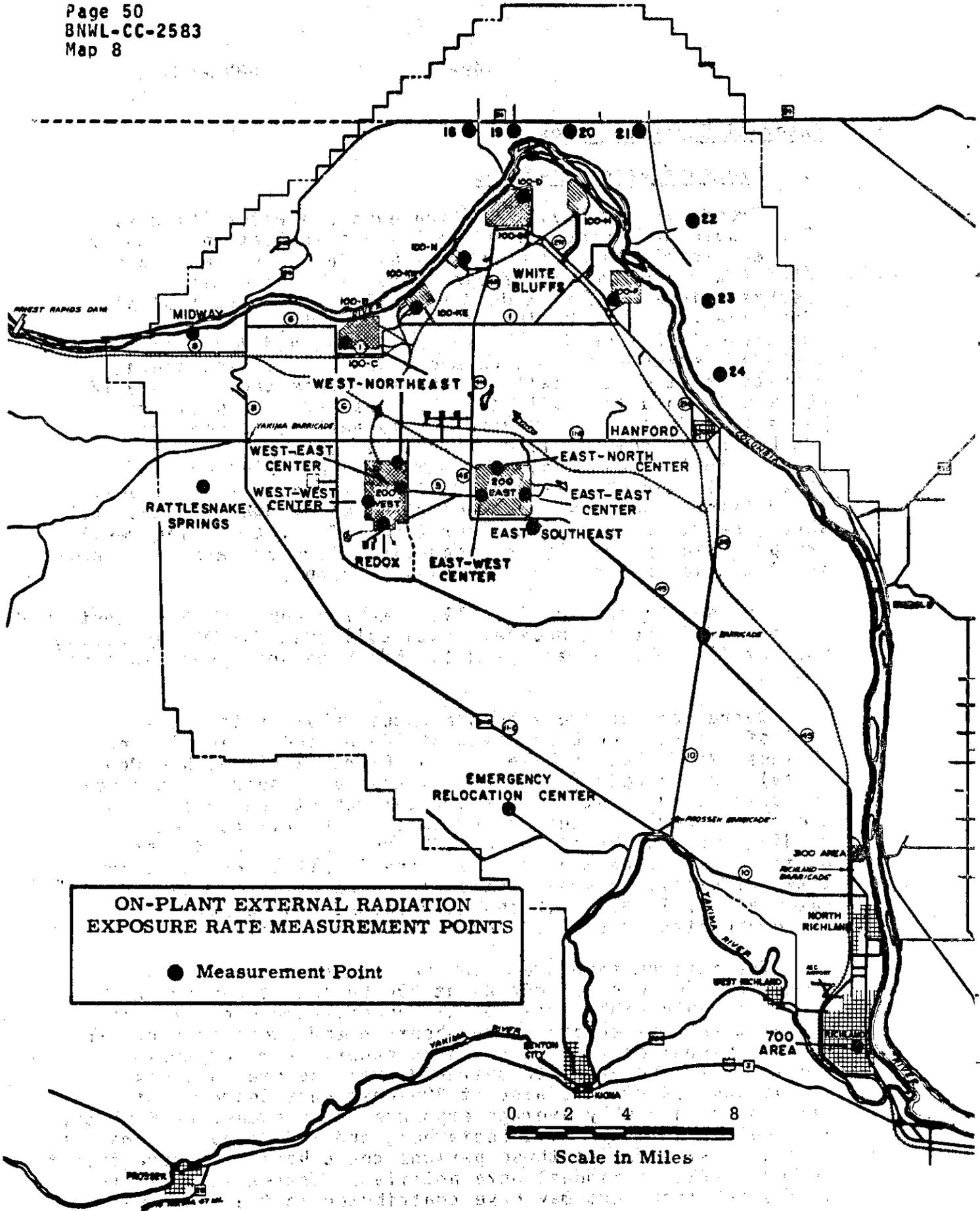
1. Exposure Rates On-Plant

Trends in external radiation exposure rates (Figures 19-24) were determined from pencil-type ionization chambers located (in clusters of three) within buildings designated "614" (Map 8) where air samples were also collected. Measurements were also made during 1969 at the control plots (Nos. 17-24) on the Wahluke slope (Table 12). At three locations (100-N WPPSS, Rt. 10, Mile 1.6, and 700 Area), Victoreen stray radiation chambers were used. The average results for the last half of 1969 are presented in Table 12 below with data from offsite locations and from previous years for comparison. However, data early this year may not be wholly comparable to past data due to dosimeter reader problems and consequent changes in equipment, procedures, and calibrations during the first half of 1969. In addition, "pencils" are subject to error due to mechanical shock, heat, humidity and other types of leakage. The results are presented primarily as trend indicators and are only semi-quantitative measurements of exposure rates.

During the last half of 1969, measurements were discontinued at the old Hanford townsite. Data collected for Midway during most of 1969 were invalid and therefore do not appear in this report.

Decreased average exposure rates relative to the first half of the year were observed at 100-B, 100-D, 100-F, and 200-West Northeast (onsite) and at Pasco, Wahluke, New Moon (Mesa), and Eltopia (offsite). Increased exposure rates were measured at 200-East East Center throughout the majority of the report period. Lesser increases in pencil dosimeter readings were noted at 200-East North Center, 100-K, and Control Plot 17 on the Wahluke Slope (onsite) and at Benton City (offsite). A small increase in the external exposure rates at Rt. 10 Mile 1.6 and at Richland was measured by Victoreen stray radiation chambers was also noted.

The maximum exposure rate averaged over the last six months of 1969 was 3.6 mR/day at 200-East East Center, a location where higher than usual concentrations of airborne radioactive particulates were observed and where exposure to radiation sources is also known to occur. For comparison, the maximum exposure rate averaged over the previous six months was 1.9 mR/day, also at 200-East East Center. At that location weekly average exposure rates exceeding 6 mR/day were noted in early July, September, and mid-October. Transient exposure rates during those periods could have been significantly higher. ARHCO personnel were notified. Increased activity at the "A" tank farm may have contributed to the increased exposure rates in early July.



Other locations where the average exposure rate during the last half of 1969 was 1 mR/day or greater were 100-K, 200-East North Center, and the 300 Area.

At 100-K Area, weekly average exposure rates of about 3 mR/day were noted in early August, September, and October. Although exposure rates were also above average in early December, a decreasing trend followed.

With the exception of one week in early September, the exposure rate at 200-East North Center increased from early August to a mid-September peak of >2.8 mR/day. A decreasing trend followed with the exception of a single week in mid-October when measurements indicated 2.5 mR/day.

At the 300 Area, generally higher exposure rates were noted during July and August with a maximum of >2.8 mR/day observed in August. Generally lower exposure rates were observed during the remainder of the year with transient increases noted late in November and also in December. Average exposure rates at onsite locations, other than the four mentioned above, were in the range 0.4-0.6 mR/day during the last half of 1969. At offsite locations, comparable average exposure rates were generally in the range 0.5-0.7 mR/day with the exception of the Benton City data (0.8 mR/day). For comparison, exposure rates at all offsite locations averaged 0.3 to 0.7 mR/day during the last half of 1968.

2. 100-N Area

Victoreen stray radiation chambers were substituted for the pocket-type dosimeters at 100-N area at the end of March and the sampling location was moved in order to obtain data suitable for estimating the potential exposure of WPPSS personnel. The appropriate radiation dose standards for this group are those for members of the general public. Based on measurements with stray radiation chambers during the last six months of 1969, the average exposure rate was 0.54 mR/day at 100-N compared to 0.32 mR/day at Richland. Averages at these locations during the first half of the year were 0.54 and 0.26 mR/day, respectively. Thus, the average exposure during 1969 was 0.54 mR/day at 100-N (based on nine months of data) compared to 0.30 mR/day at Richland. Based on the net exposure rate of 0.24 mR/day and assuming exposure for 40 hours per week (50 weeks/year), the whole-body dose to WPPSS personnel from Hanford sources of external radiation at 100-N during 1969 would be 20 mrem/yr (4% of the standard for individuals non-occupationally exposed).

TABLE 12. Average External Gamma Exposure Rates (mR/day)

Location	1967		1968		1968		1969	
	Jan-June	July-Dec	Jan-June	July-Dec	Jan-June	July-Dec	Jan-June	July-Dec
100 Areas								
Midway	0.53	0.67	0.57	0.60	-- (1)	--	--	--
100-B	0.56	0.89	0.72	0.69	1.0	0.49	0.49	0.49
100-K	1.4	1.7	1.9	1.6	1.4	1.6	1.6	1.6
100-N	0.73	0.92	1.20	0.91	1.0 (2)	--	--	--
100-N(WPPSS)	--	--	--	--	0.54(3)	0.54*	0.54*	0.54*
100-D	0.65	0.51	0.48	0.41	0.95	0.37	0.37	0.37
100-F	0.35	0.42	0.42	0.43	1.1	0.55	0.55	0.55
200-West Area								
Redox	0.62	0.56	0.56	0.61	0.53	0.56	0.56	0.56
West-Center	0.40	0.51	0.41	0.43	0.60	0.52	0.52	0.52
East-Center	0.42	0.49	0.41	0.41	0.56	0.59	0.59	0.59
West-Northeast	--	--	--	0.48	0.84	0.54	0.54	0.54
200-East Area								
North-Center	--	--	--	0.58	0.94	1.2	1.2	1.2
West-Center	0.34	0.45	0.52	0.42	0.44	0.39	0.39	0.39
Southeast	0.35	0.50	0.50	0.46	0.56	0.53	0.53	0.53
East-Center	0.56	0.58	0.46	0.53	1.9	3.6	3.6	3.6
Wahluke Slope								
C.P. 17	--	--	--	--	0.41	0.60	0.60	0.60
C.P. 18	--	--	--	--	0.44	0.52	0.52	0.52
C.P. 19	--	--	--	--	0.45	0.36	0.36	0.36
C.P. 20	--	--	--	--	0.44	0.39	0.39	0.39
C.P. 21	--	--	--	--	0.38	0.38	0.38	0.38
C.P. 22	--	--	--	--	0.41	0.28	0.28	0.28
C.P. 23	--	--	--	--	0.42	0.46	0.46	0.46
C.P. 24	--	--	--	--	0.41	0.34	0.34	0.34

TABLE 12. (Continued)

Location	1967		1968		1969	
	Jan-June	July-Dec	Jan-June	July-Dec	Jan-June	July-Dec
Other Onsite						
Rattlesnake Springs Emergency Relocation Center	0.40	0.46	0.40	0.42	0.56	0.63
Wye Barricade *Rt. 10 Mile 1.6	0.33	0.43	0.40	0.41	0.65	0.57
300 Area	0.55	0.65	0.62	0.62	0.51	0.40
700 Area	0.36*	0.34*	0.38*	0.34*	0.31*	0.42*
*700 Area	0.44	0.54	0.55	0.63	0.92(4)	1.0
	0.52	0.75	0.31	0.62	0.53	0.55
	0.26*	0.27*	0.28*	0.29*	0.26*	0.32*
Offsite						
Berg Ranch	--	--	--	0.74	0.59	0.52
Wahlake	--	--	0.46	0.48	0.82	0.55
New Moon (Mesa)	--	--	0.40	0.64	0.75	0.50
Eltopia	--	--	0.54	0.62	0.91	0.48
Ringold Fish Station	--	--	0.42	0.55	0.70	0.66
Byers Landing	--	--	0.27	0.33	0.49	0.60
Pasco	--	--	0.38	0.46	0.89	0.73
Benton City	--	--	0.38	0.57	0.62	0.81
McNary	--	--	0.47	0.61	0.62	0.74

* Average measurements with stray radiation chambers.

(1) Midway data were probably invalid.

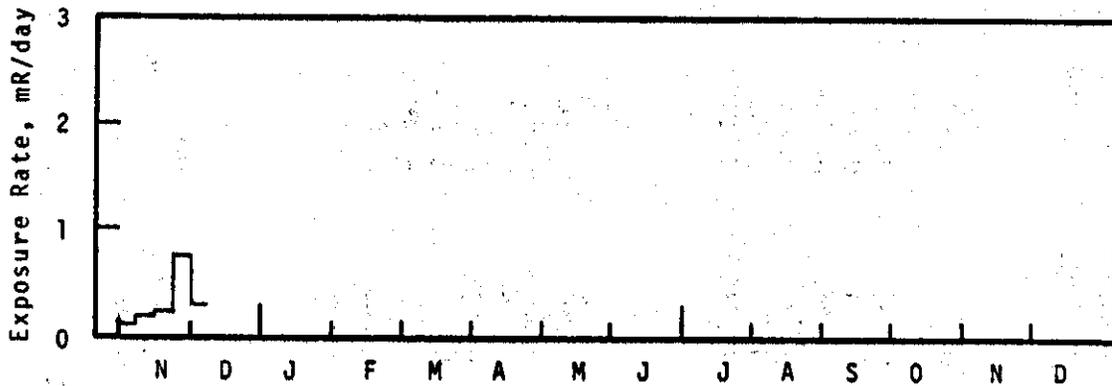
(2) This represents only data for January-March because the 100-N location was moved at the end of March and stray radiation chambers substituted for the pocket dosimeters.

(3) Measurements with stray radiation chambers at the WPPSS location within 100-N include April-June only.

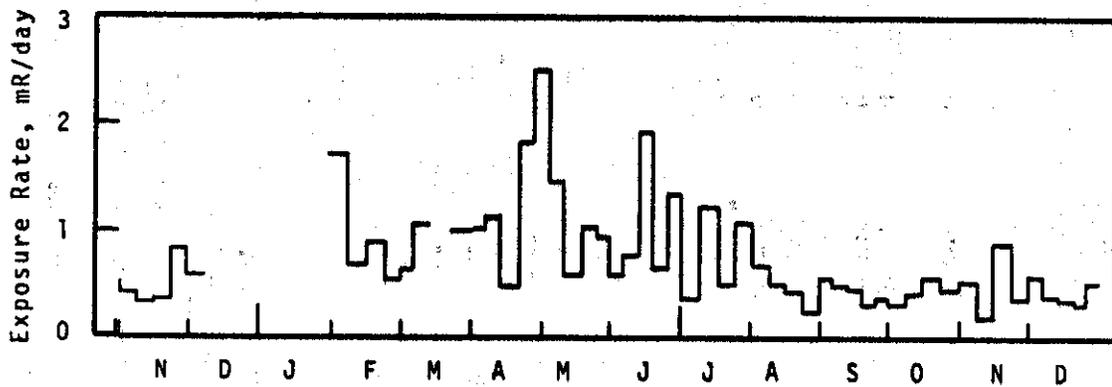
(4) The 300 Area sampling location was moved from the south-central location to a west-central location in late March.

EXTERNAL RADIATION ON PLANT 100 AREAS AND VICINITY

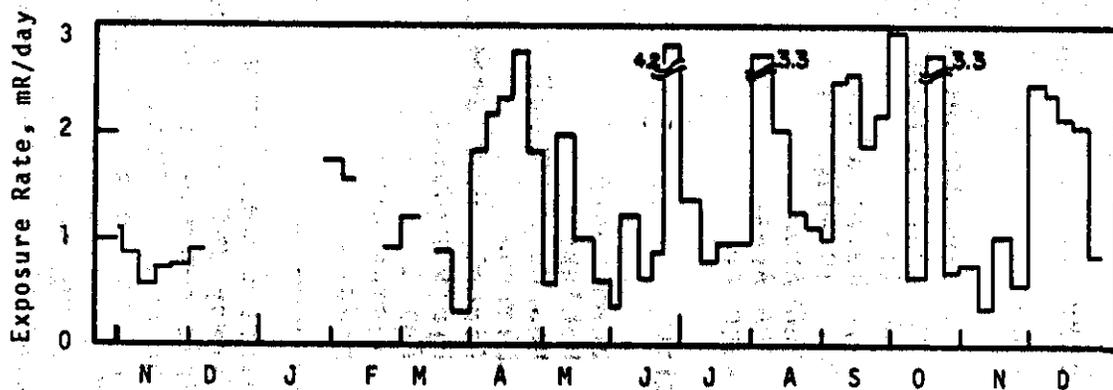
MIDWAY



100-B AREA

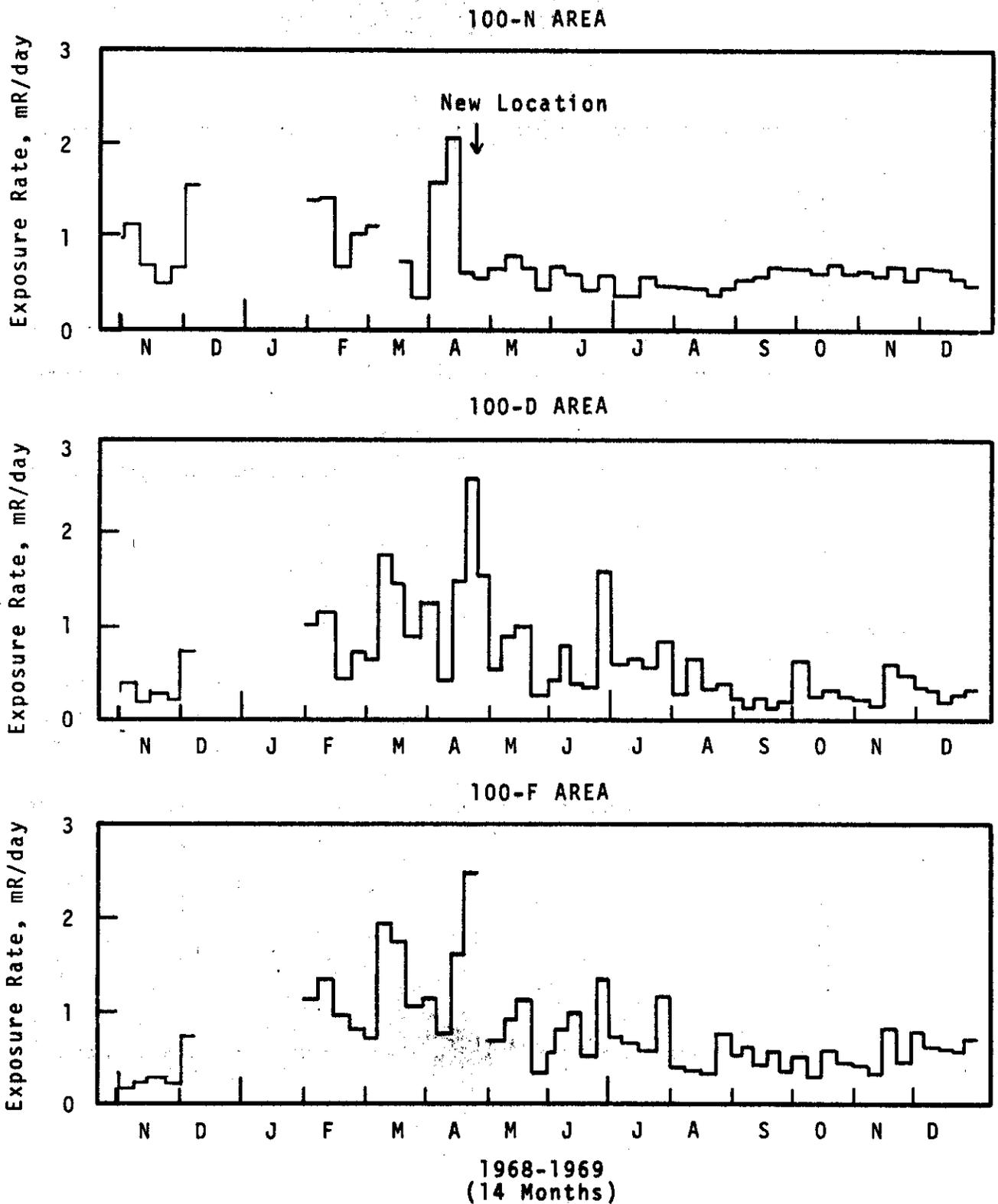


100-K AREA



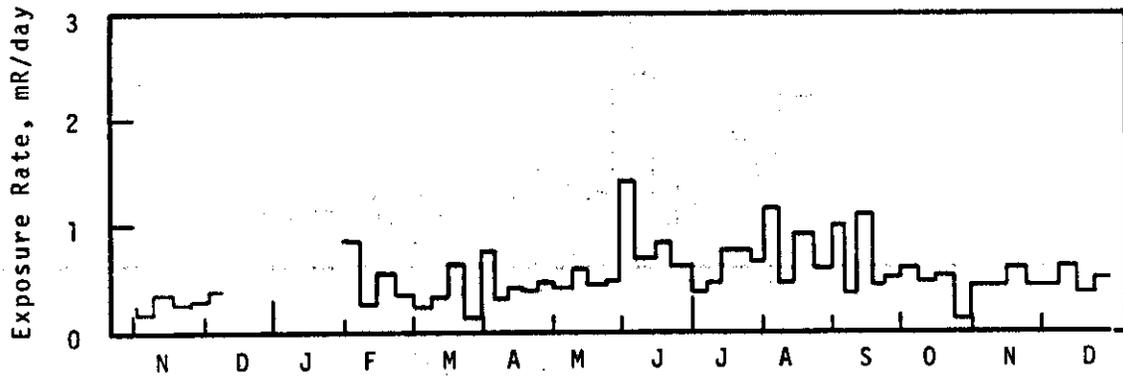
1968-1969
(14 Months)

EXTERNAL RADIATION ON PLANT 100 AREAS AND VICINITY

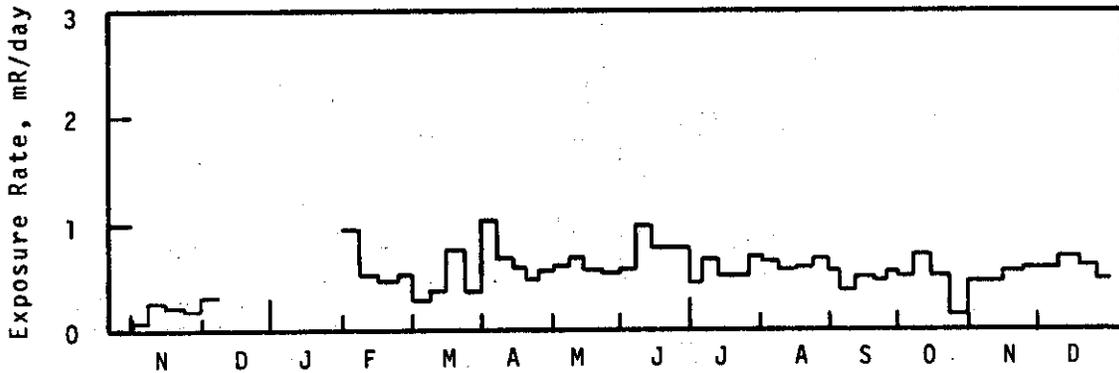


EXTERNAL RADIATION ON PLANT 200 AREAS

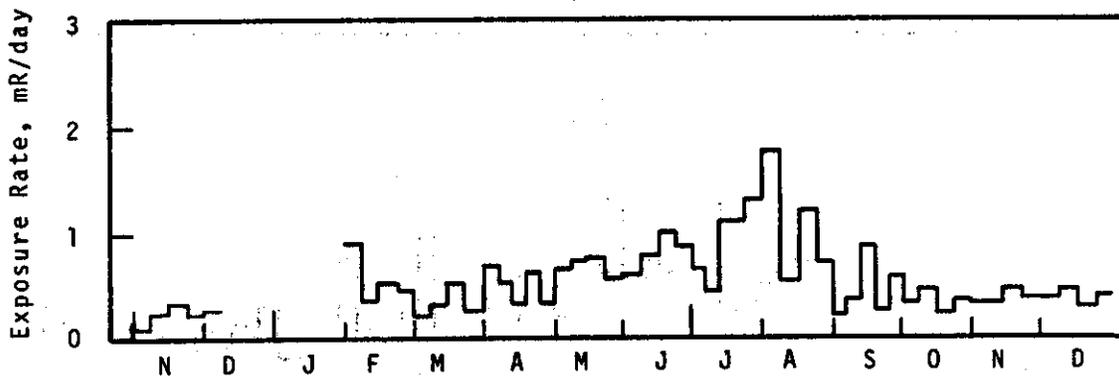
200-WEST REDOX



200-WEST WEST CENTER



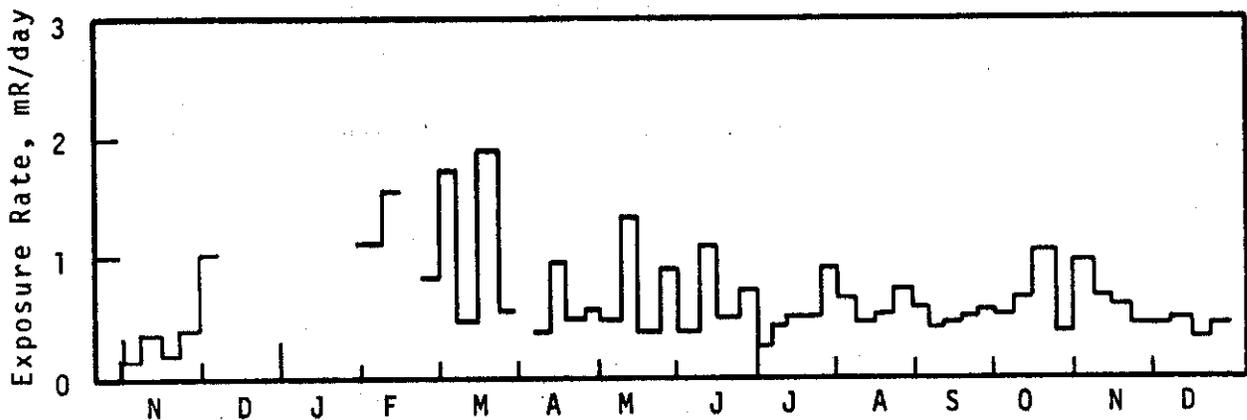
200-WEST EAST CENTER



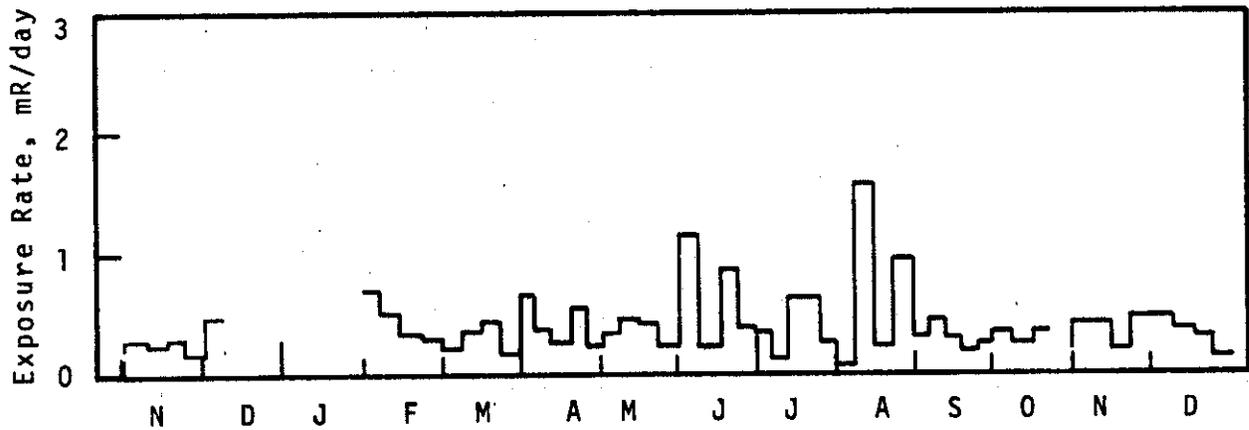
1968-1969
(14 Months)

EXTERNAL RADIATION ON PLANT 200 AREAS

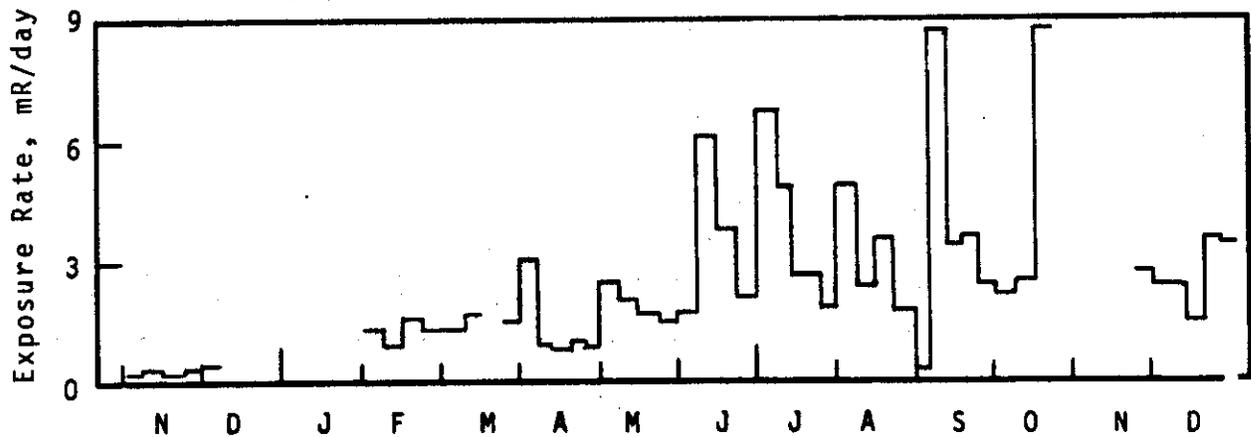
200-WEST NORTHEAST



200-EAST WEST CENTER



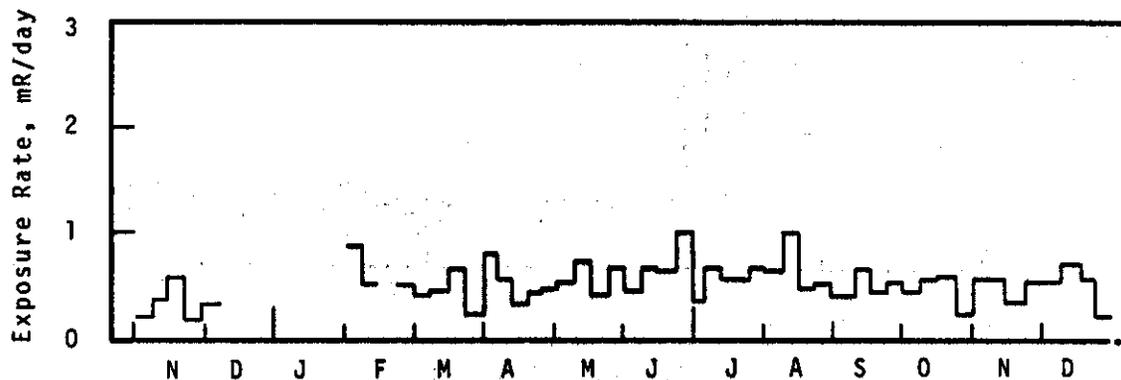
200-EAST EAST CENTER (NOTE CHANGE OF SCALE)



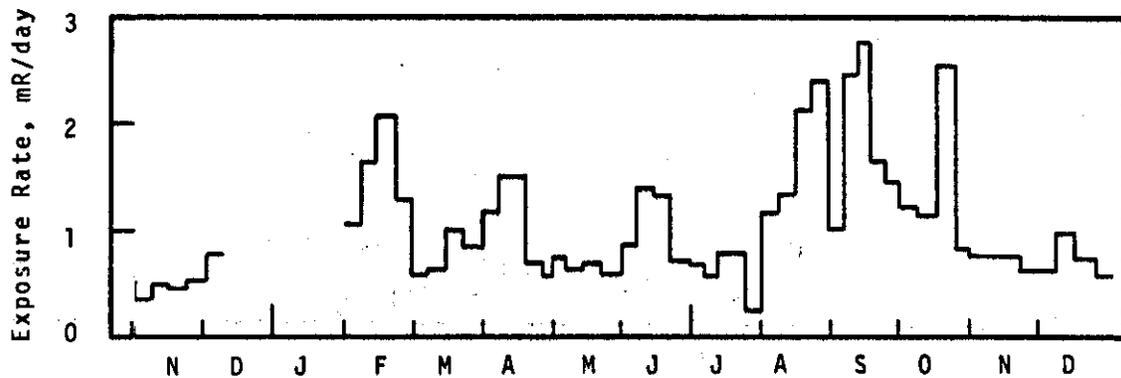
1968-1969
(14 Months)

EXTERNAL RADIATION ON PLANT
200 AREAS AND INTERMEDIATE AREAS

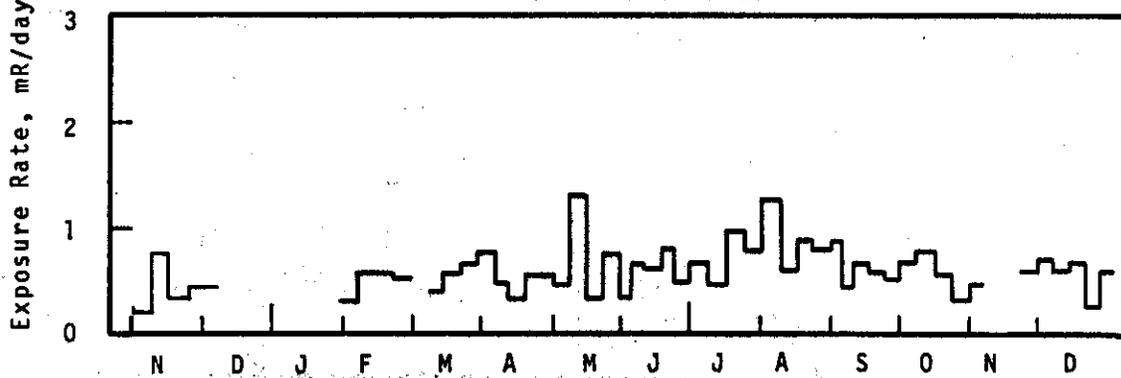
200-EAST SOUTHEAST



200-EAST NORTH CENTER



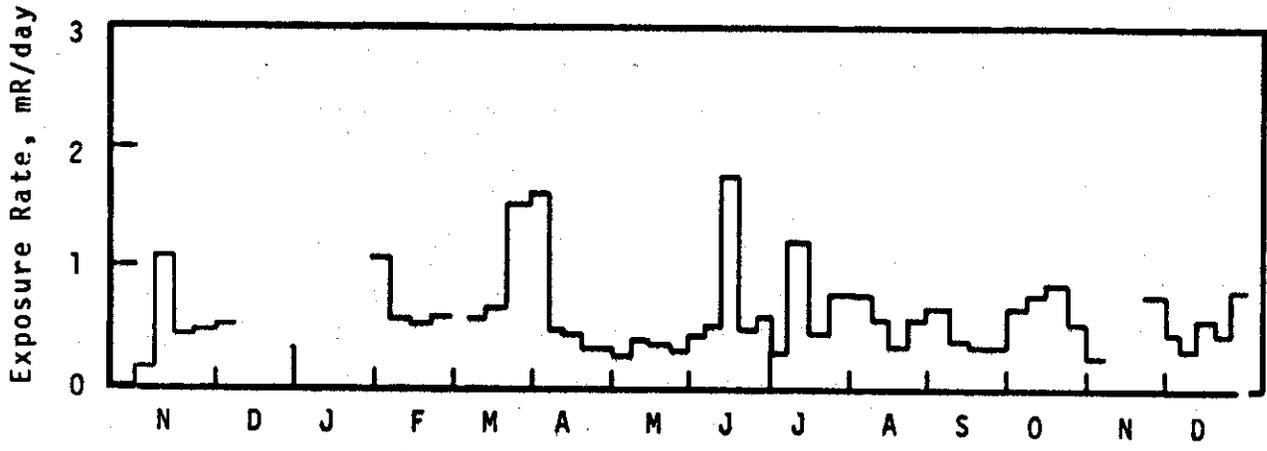
RATTLESNAKE SPRINGS



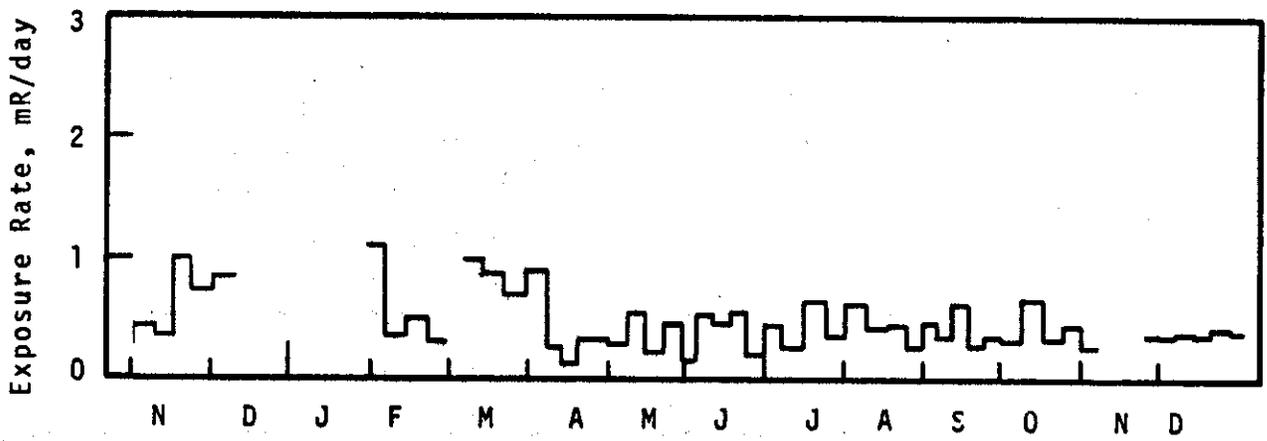
1968-1969
(14 Months)

EXTERNAL RADIATION ON PLANT INTERMEDIATE AREAS

EMERGENCY RELOCATION CENTER

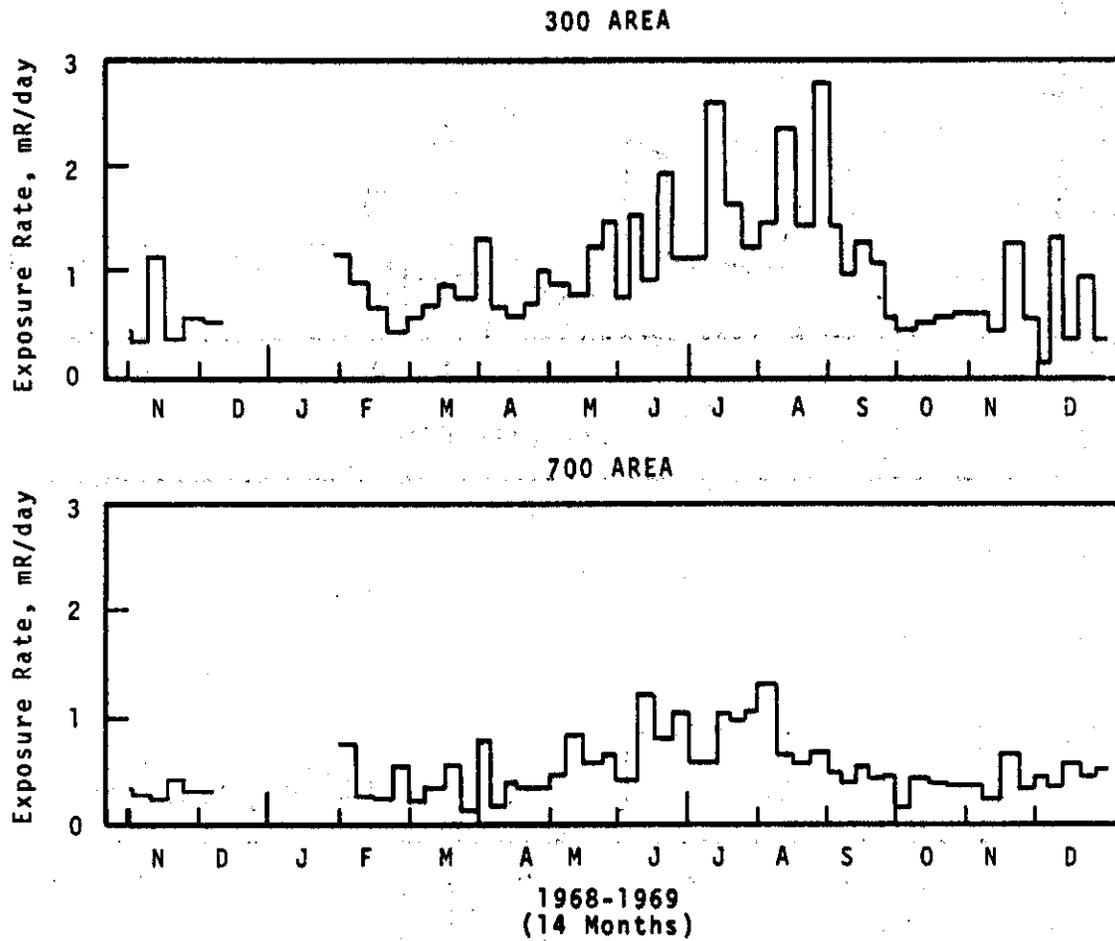


WYE BARRICADE



1968-1969
(14 Months)

EXTERNAL RADIATION ON PLANT 300 AREA AND 700 AREA



3. Exposure Rates at the Columbia River Shoreline

Radiation exposure rates are measured at 1 meter (about 3 feet) above the river shoreline with a 40-liter ionization chamber whose response is calibrated in $\mu\text{R/hr}$ (radium gamma). Measurements at 1 meter approximate the exposure rate to the gonads of a person standing on the riverbank.

The weekly measurements of exposure rates at four sampling locations shown in Map 9 and at Sacajawea Park and McNary Dam (Washington shore) appear in Figures 25-26. Additional monthly shoreline surveys 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 as measured with a portable GM survey meter. These data appear in Table 13. Changes in monthly survey points were made in December.

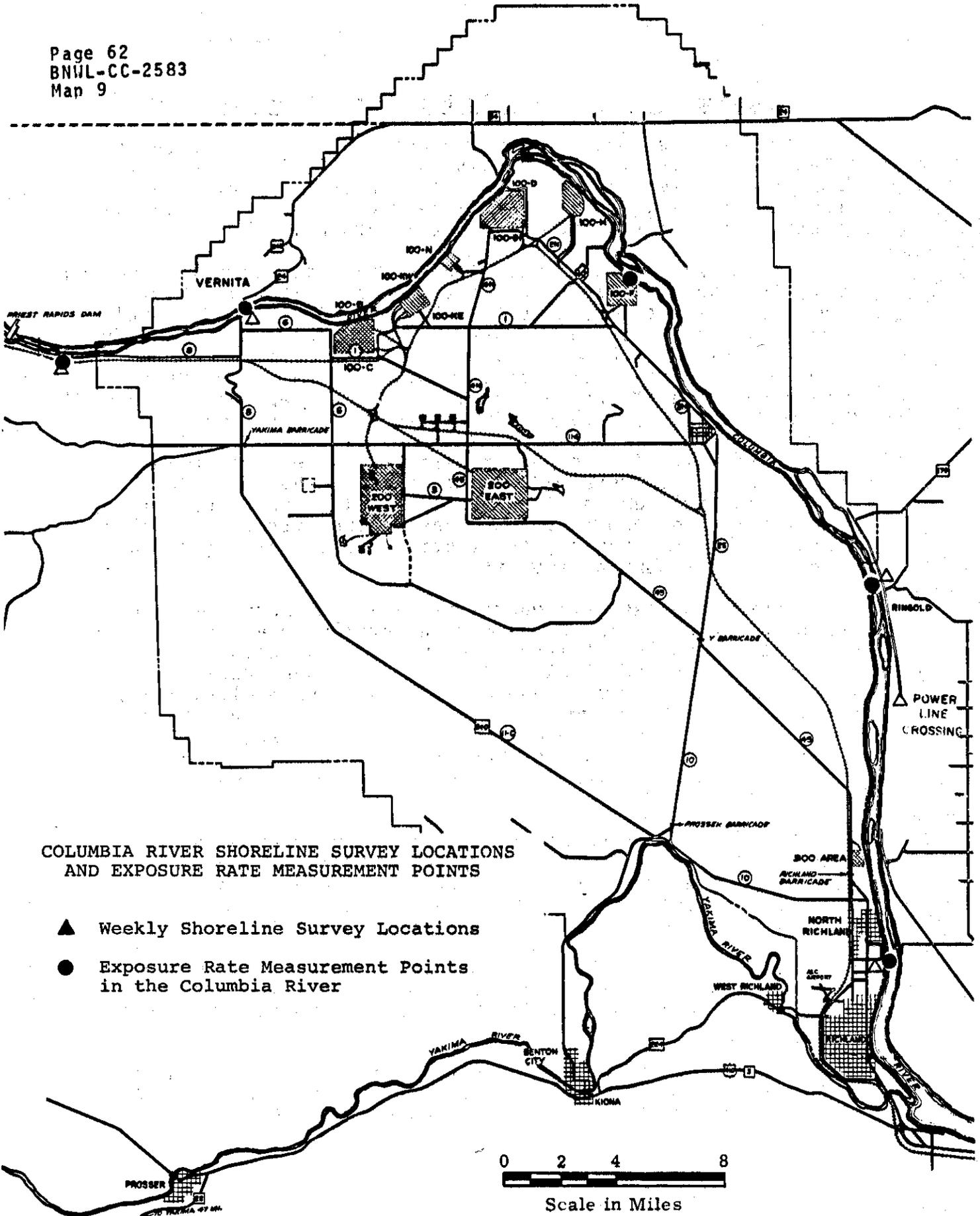
In addition to the routine surveys, several special shoreline surveys were made during the last half of 1969 which also included locations not normally inspected. With the exception of two investigations of the Richland shoreline discussed in this report, the special surveys are discussed in detail in a topical report*.

During the last six months of 1969, exposure rates on the Columbia River shoreline were generally lower than during the last six months of 1968. The maximum shoreline exposure rate measured during 1969, 310 $\mu\text{R/hr}$, was found during a special survey in October and has been discussed elsewhere*. However, the maximum shoreline exposure rate found during routine surveys during 1969 was 250 $\mu\text{R/hr}$, measured in October on the plant shore above 181-NE (Table 13). For comparison, the maximum shoreline exposure rate measured during 1968 was 1550 $\mu\text{R/hr}$ below 181-KE.

The maximum level of surface shoreline contamination encountered during 1969 (10 mrad/hr, uncorrected reading - Juno at 1") was detected about 100 meters downstream from the routine Hanford Far shore location during a special shoreline survey in October (see BNWL-CC-2363 for details).

Levels of shoreline surface contamination at sampling locations below the plant boundary during the last six months of 1969 were greater than in the first six months, but were

* D. H. Denham and W. L. Fisher. "Radiological Considerations of Opening the Columbia River for Recreational Purposes--Ringold to 100-F Area," BNWL-CC-2363. December 22, 1969.



**COLUMBIA RIVER SHORELINE SURVEY LOCATIONS
 AND EXPOSURE RATE MEASUREMENT POINTS**

- ▲ Weekly Shoreline Survey Locations
- Exposure Rate Measurement Points in the Columbia River

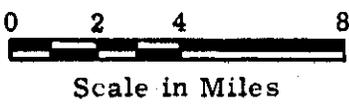


TABLE 13. Maximum Readings (1) From Monthly Shoreline Surveys - July-December, 1969
(μ R/hr with c/m in parentheses)

A. COLUMBIA RIVER - PLANT SHORE

Date	382.5P(2) #10 Above 181 KW	381.5 P #13 Above 181 KE	380.5 P #17 Above 181 NE	379.0 P #25 Below 181 NE	369.7 P #44 White Bluffs Ferry	362.0 P Hanford	350.4 P. Powerline Crossing	344.5 P PRR	340.9 P Richland(3) Ferry
July 11	17(300)	36(400)	18(1000)	23(400)	36(600)	56(800)	34(600)	24(600)	20(400)
Aug. 7	15(100)	85(700)	48(550)	90(1500)	115(1000)	91(700)	85(700)	45(400)	33(200)
Sept. 26	-(150)	-(4000)	-(5000)	-(3000)	-(3000)	-(800)	-(1000)	-(2000)	-(500)
Oct. 30	15(150)	140(900)	250(200)	-(2000)	-(2000)	-(800)	-(1000)	-(1500)	-(150)
Dec. 30	30(150)	140(650)	100(400)	110(650)	56(250)	160(1000)	-	-	-

B. COLUMBIA RIVER - FAR SHORE

Date	381.0 F #8 Below 181 KE	378.6 F #13 Above 181 D	377.4 I #1 D Island	377.0 F #16 Below DR Outfall	369.8 F #25 White Bluffs Ferry	362.0 F Hanford(3)	354.7 F Ringold(4)	350.4 Powerline Crossing(3)	345.0 Byers Landing
July 11	10(200)	15(200)	-	10(300)	22(400)	56(300)	15(300)	26(800)	28(200)
Aug. 7	16(125)	19(125)	-	24(200)	59(550)	91(500)	20(150)	69(550)	70(350)
Sept. 26	-(250)	-(400)	-	-(4000)	-(1500)	-(800)	-(200)	-(800)	-(400)
Oct. 30	24(100)	-(100)	-	-(150)	-(600)	-(750)	-(600)	-(800)	-(300)
Dec. 30	13(150)	11(100)	110(650)	17(250)	38(200)	74(350)	50(200)	-	-

C. NEW SURVEY LOCATIONS SURVEYED DECEMBER 30

375.8 F E Island	373.0 F Locke Island	372.1 P Below 1904-H	371.1 P Locke Island	373.3 F Locke Island	368.4 P Below 100F	367.0 P 100F Slough	364.4 P Between 100F and Hanford	359.1 F Savage Island(4)	355.7 I Near Ringold(4)	345.2 F Above 300 Area(3)
80(350)	55(250)	40(200)	52(250)	60(300)	46(150)	110(450)	44(200)	65(250)	90(700)	72(250)

(1) Measurements reported in μ R/hr are taken with a 40-liter ionization chamber, the center of the chamber 1 meter above 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 area of the water's edge.

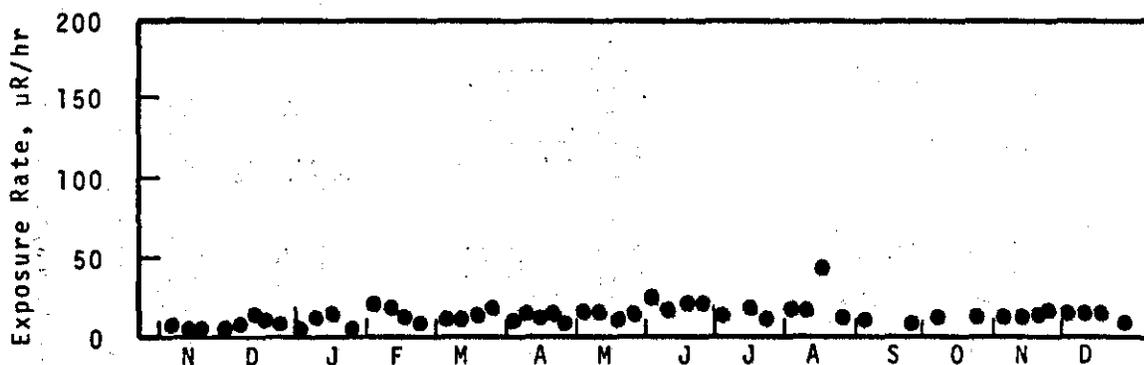
(2) River Miles measured from the mouth of the Columbia. Plant shore, far shore, and island are designated by P, F, and I, respectively.

(3) Point open to the general public during the entire year.

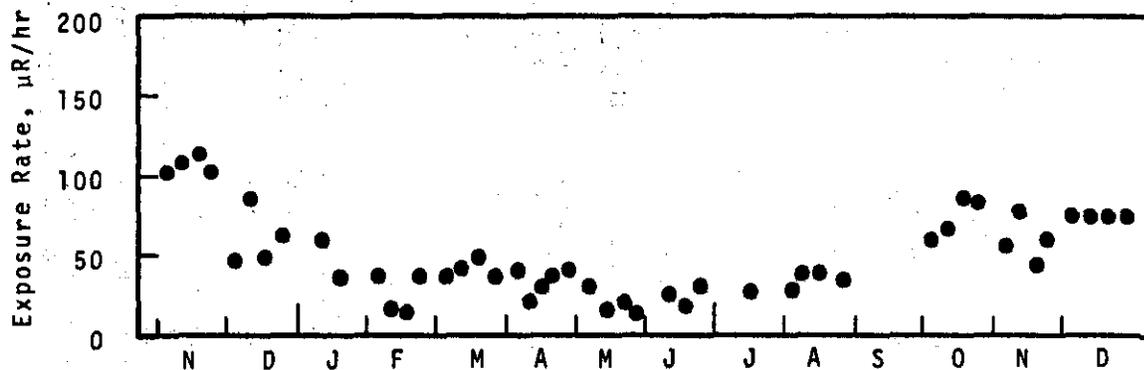
(4) Point only open to the general public on Wednesdays, Saturdays, and Sundays, during the hunting season.

EXTERNAL RADIATION AT THE COLUMBIA RIVER SHORELINE

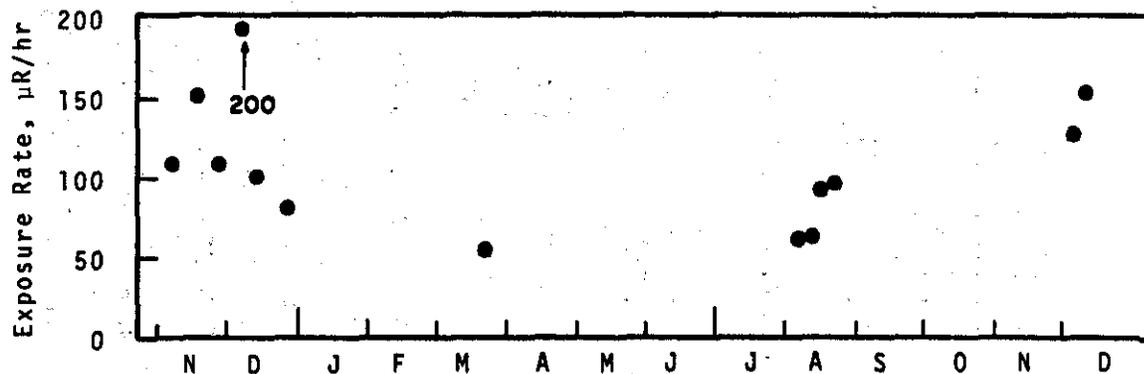
PRIEST RAPIDS GAUGE STATION



RINGOLD FAR SHORE

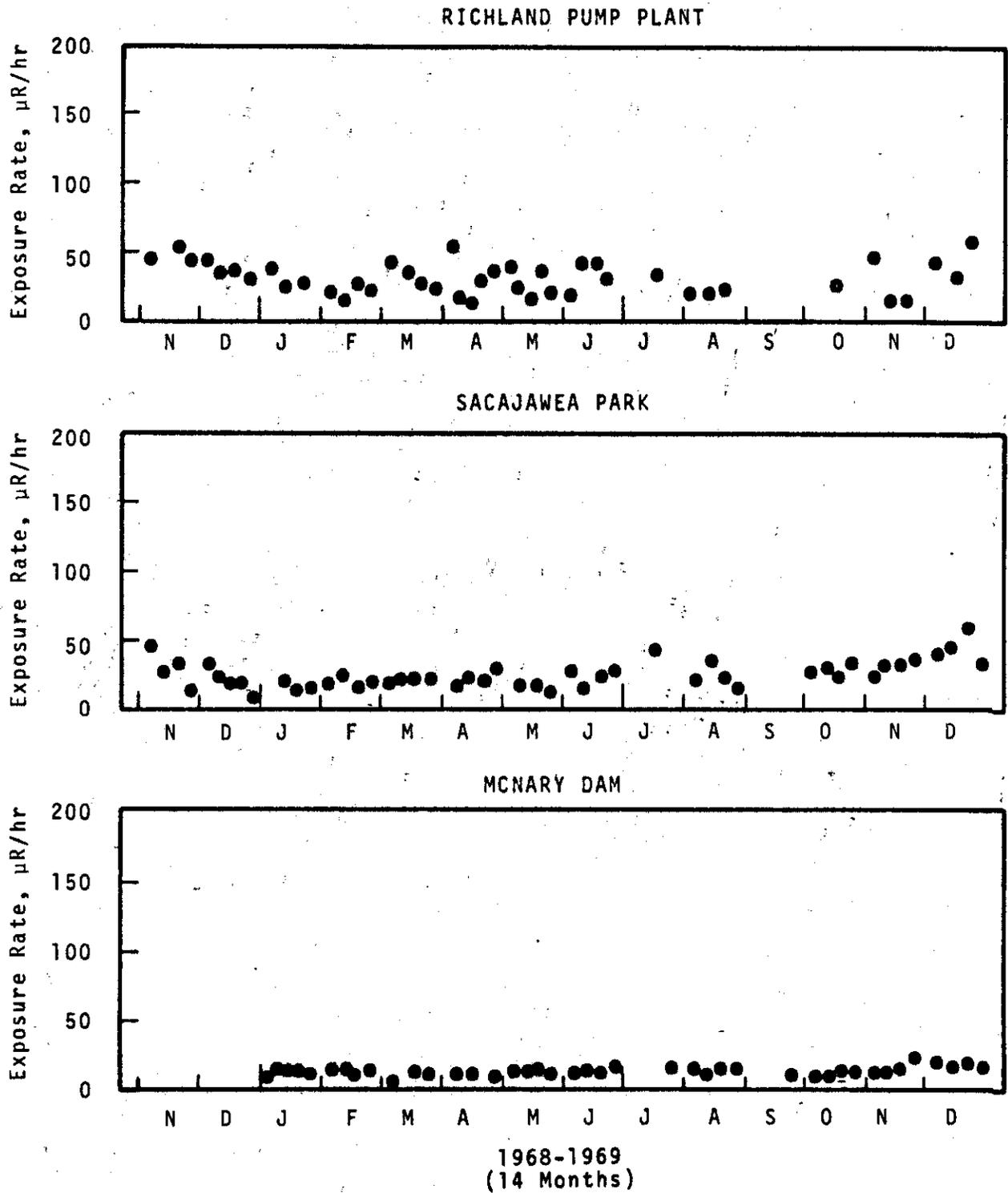


POWERLINE CROSSING FAR SHORE



1968-1969
(14 Months)

EXTERNAL RADIATION AT THE COLUMBIA RIVER SHORELINE



generally somewhat less than in the fall of 1968. With the exceptions of late July-early August and November measurements in the vicinity of Richland, most measurements were less than 2000 c/m (GM).

Unusual shoreline contamination (10,000 c/m-surface) was observed on a routine weekly survey at the Richland water plant intake boat launch area on July 21, a week after 800 c/m had been detected at the same location. Later investigations on July 31 and August 1 detected maximum surface radiation levels of 15,000 c/m at that location, 5,000 c/m at the Amon Park boat launch, and 3,000 c/m at a private launch area in between. No measurements of external exposure rates were made because of instrument difficulties. In all instances, the higher radiation levels were associated with a visible brownish scum deposited as a band or in patches along the shoreline as the river receded. Gamma emitters associated with a scum sample collected from the Richland water plant boat launch were ^{46}Sc , ^{54}Mn , ^{65}Zn , ^{60}Co , and $^{140}\text{Ba-La}$.

Re-survey of the Richland water plant intake boat launch area a week later detected no unusual radioactivity.

On November 11, an unusual accumulation of a brownish scum was found at the North Richland boat launch area. The scum was resting on a stagnant section of water near the shoreline and covered an area about 1 meter wide and 10 meters long. The general radiation level was 10,000-15,000 c/m-GM (P-11 probe) and the maximum was 18,000 c/m. Gamma energy analysis of a sample of the scum detected ^{24}Na , ^{46}Sc , and ^{140}La (major) and ^{65}Zn , ^{60}Co , ^{58}Co , ^{56}Mn , ^{140}Ba , ^{143}Ce , ^{152}Eu , and ^{59}Fe . The concentration of ^{65}Zn and ^{46}Sc combined was estimated to be about 27,000 pCi/g.

The maximum shoreline exposure rate in the vicinity of the scum was 110 $\mu\text{R/hr}$ at 1 meter above the shoreline. At the routine Richland location (boat launch below the water plant intake), the exposure rate on the same day was 42 $\mu\text{R/hr}$ and the general surface contamination was 200-400 c/m.

4. Exposure Rates Below the Surface of the Columbia River

Exposure rates in the river (Figures 28-29) were determined from a cluster of five pocket dosimeters contained within submerged plastic bottles at the locations shown in Map 8. Missing data were the result of lost containers or equipment malfunction.

Six-month averages for 1969 are shown in Table 14 with data from 1968 for comparison.

The exposure rates in the river during the fall of 1969 were slightly higher than comparable data for the spring of 1969 at 100-F and at the Richland Pumphouse and slightly lower at Pasco and Ringold. Increases were probably due to increased concentrations of ^{46}Sc in the river mentioned in the previous section. During November 7 to 14, the maximum immersion exposure rate measured in 1969 (7.4 mR/day) occurred at 100-F Area.

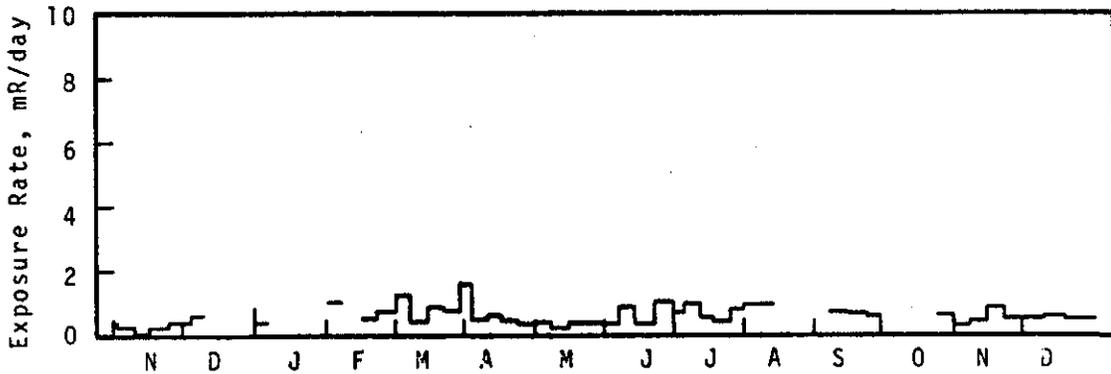
TABLE 14. Average Exposure Rates Below the Surface of the Columbia River (1968-1969)

	(mR/day)			
	1968		1969	
	<u>Jan-June</u>	<u>July-Dec</u>	<u>Jan-June</u>	<u>July-Dec</u>
Priest Rapids	0.6(1)	0.4	0.6	0.6
100-F Area	-	5.9	5.5	7.4
Ringold	1.7(2)	1.8(3)	2.7(4)	1.8(5)
Richland Pumphouse	1.4(6)	1.8	2.2	3.0
Pasco Pumphouse	-	2.3	2.4	1.7

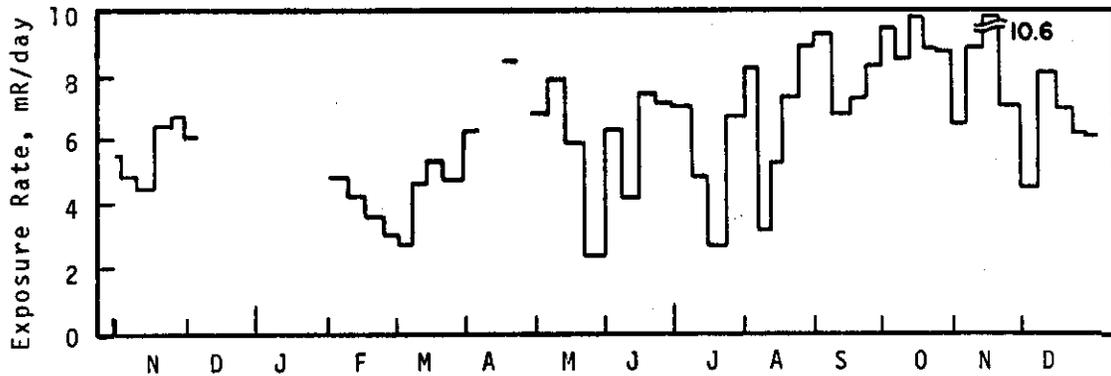
-
- (1) Upstream location was Vernita during this period
 (2) January through May only
 (3) October through December only
 (4) January through March only
 (5) September through December only
 (6) May through June only

EXTERNAL RADIATION BELOW THE SURFACE OF THE COLUMBIA RIVER

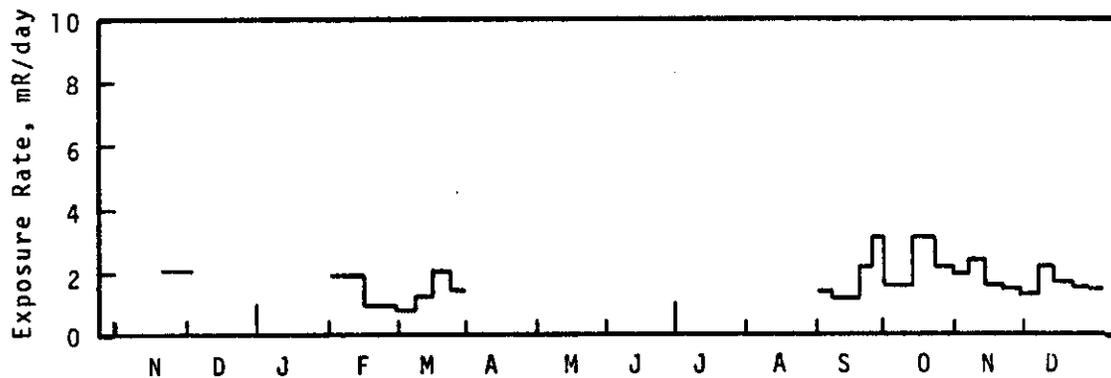
PRIEST RAPIDS GAUGE STATION



100-F



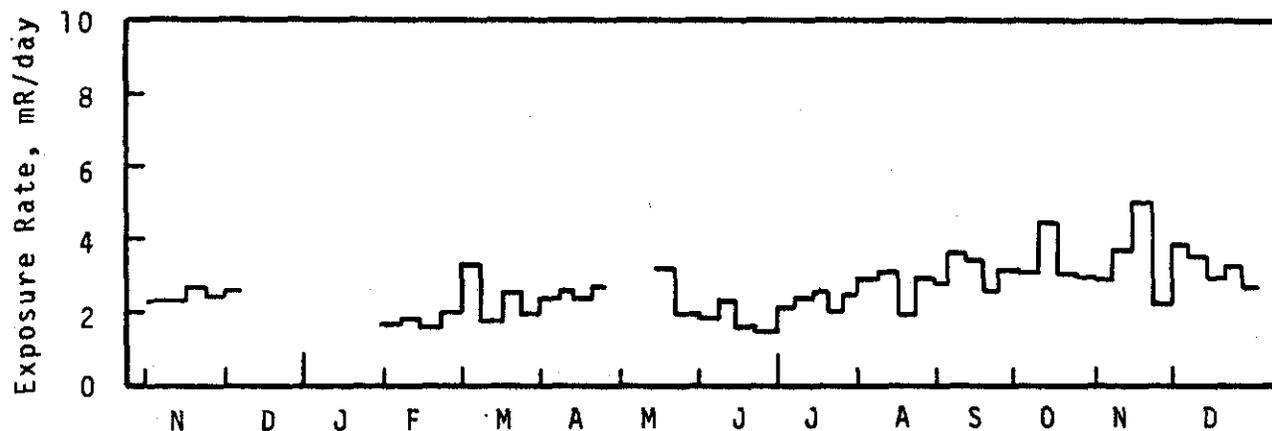
RINGOLD FAR SHORE



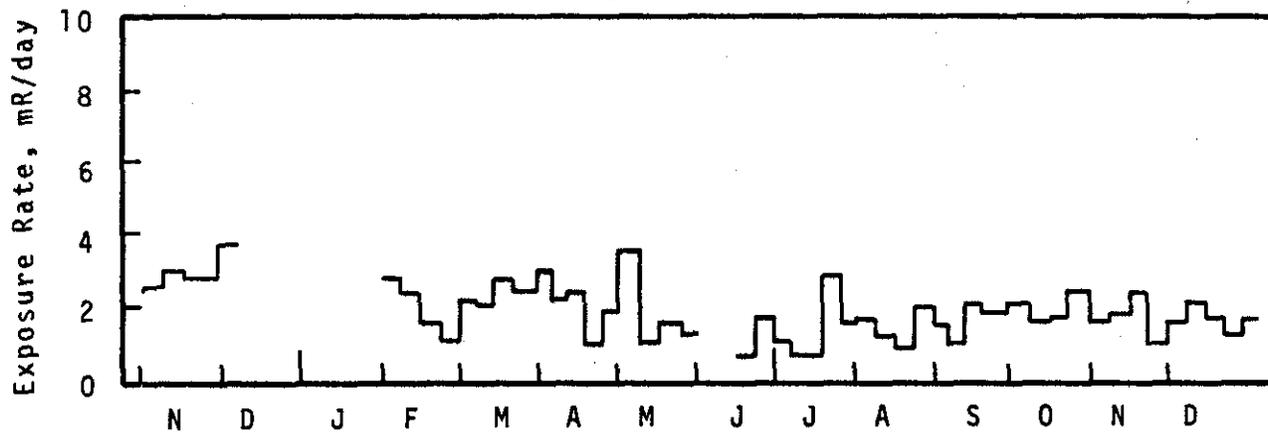
1968-1969
(14 Months)

EXTERNAL RADIATION BELOW THE SURFACE OF THE COLUMBIA RIVER

RICHLAND PUMPHOUSE



PASCO PUMPHOUSE



1968-1969
(14 Months)