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ENVIRONMENTAL STATUS OF THE HANFORD RESERVATION FOR JANUARY-JUNE, 1968

By

Environmental Evaluation
Radiation Protection
TECHNICAL SERVICES DIVISION

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ENVIRONMENTAL STATUS OF THE HANFORD RESERVATION FOR JANUARY- JUNE, 1968

By

Environmental Evaluations Staff
Radiation Protection Department
TECHNICAL SERVICES DIVISION

edited by C. B. Wooldridge

September, 1968

[redacted]

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ENVIRONMENTAL STATUS OF THE HANFORD RESERVATION FOR JANUARY-JUNE, 1968

I. INTRODUCTION

This report summarizes data collected during the first six months of 1968 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.

To show long-term trends and facilitate comparisons, the graphs in this report show 14 months of data - for the current half-year and the preceeding 8 months. However, the reader may also wish to refer to BNWL-CC-1197-6, "Environmental Status of the Hanford Reservation for November-December, 1967 (Annual Summary)" which contains a complete summary of 1967 data. Ground water data are not included in this report but will be presented in a BNWL report, "Radiological Status of the Ground Water Beneath the Hanford Project, January-June, 1968".

Data from off-site sampling locations is presented in the series of monthly reports, BNWL-778-__, "Environmental Surveillance in the Vicinity of Hanford for . . . , 1968".

The term "analytical limit", as used herein, is defined as the concentration at which the laboratory can measure a radionuclide with a precision of ± 100 per cent at the 90 per cent confidence level. The detection limit for a specific radionuclide varies with sample type, sample size, counting time, and the amounts of interfering radionuclides persent. The "analytical limits" were chosen to represent upper bounds to these fluctuating detection limits.

The majority of the data presented in this report was supplied by the U. S. Testing Co., Inc., which performed all routine radioassays of environmental samples.

II. SURVEILLANCE SUMMARY - JANUARY-JUNE, 1968

A summary of surveillance highlights for the period is given below with references to the page number(s) where more detail on the subject appears.

Liquid Waste Disposal

Three production reactors remained operational following the retirement of "B" reactor in mid-February. Dose rates and surface contamination measurements at shoreline locations downstream from the reactors, including Ringold, the Power Line Crossing, and Richland, showed significant increases between October of 1967 and May of 1968. Dose rate increases of up to 50% accompanied increased prevalence of particulates trapped in debris or in the rocks. The maximum shoreline exposure rate during the first six months of 1968, 1500 R/hr, was measured below 100-K. Particles found on the shoreline just below the plant boundary read as much as 75,000 c/m (GM). At the farthest downstream measurement location, sacajawea, patches of foam measuring 9,000 c/m (GM) were detected in May. (See p. 52).

Disposal of low-level radioactive wastes to open swamps, ponds, and trenches resulted in several unusual events. Total beta concentrations exceeded the limit for open waters (50,000 pCi/ℓ, Ref. AECM 0510) in T Swamp during May and June; the principal gamma emitters present were ^{137}Cs and ^{134}Cs. (See p. 10). Releases through the Purex Chemical Sewer resulted in several instances of high ^{131}I concentrations in B Swamp with a maximum of 47,000 pCi $^{131}I/ℓ$ occurring in April (p. 11). Total alpha concentrations temporarily exceeded 50,000 pCi/ℓ at the 200 West 222-S Swamp in April (p. 10). In addition, total alpha concentration in samples from the 231 Z Waste Pit exceeded the limit of 50,000 pCi/ℓ in February, with the maximum alpha activity of 420,000 pCi/ℓ in a sample collected February 23. The waste pit was retured on March 21, 1968.

Gaseous Waste Disposal

During the first six months of 1968, several transient increases in total beta, total alpha, and ^{131}I concentrations were observed. A general increase in the routine beta concentrations at most sample locations was attributed to fallout. (See p. 20-33).

In March, a particle filter from 200 West Redox indicating 3.4 pCiβ/m^3 and 0.91 pCiα/m^3 for the period 3-11 to 3-13 was analyzed by alpha spectrometry. The activity was radon-thoron and their respective daughters.

Other transient increases in atmospheric beta activity occurred at 100-N and 200 East Main Gate in early January, at 200-East East Center in early February and at 100-K in late May, with a maximum concentration of 2.5 pCiβ/m^3 at 200-East East Center.

Gaseous Waste Disposal (Continued)

Temporary increases in atmospheric ^{131}I concentrations were also observed at 100-F, 100-B, and 200-East East Center in March and April, with a maximum concentration of 0.24 pCi $^{131}I/m^3$ at 100-B.

Increases in ^{131}I at the 300 Area in January and March and at the 700 Area in March resulted from temporary increases in ^{131}I emission rates from laboratories in the 300 Area. The maximum concentration (0.54 pCi $^{131}I/m^3$) was noted in March at the 300 Area.

In early June, alpha spectrometry of the higher than usual activity (0.05 pCiα/m^3) on a 300 Area filter yielded the following results: ^{234}-^{235}U - 42%, ^{232}Th - 36%, ^{238}U - 20%, and ^{239}Pu - 1.8%.

Surface Contamination

Routine surveys of plant roads with a gamma spectrometer during the first six months of 1968 detected a total of 10 instances of particulate deposition, as compared to a total of seven such occurrences for all of 1967. Most of the increased road deposition appeared to be associated with radioactive material transport in the vicinity of the 100 Areas. Generally, contamination was either attached to the road surface or embedded in the sand and gravel beside the road. Follow-up surveys of adjacent off-road locations showed no additional contamination. Radiation levels of these particulates were as high as 100,000 c/m (GM) and 150 mrads/hr (Surface-Juno). (See p. 52).

No deposition of radioactive particulates on the routine control plots was detected during January-June, 1968.

Several retired waste burial grounds were surveyed and the appropriate custodians were notified of conditions at 100-F, the Wye, and the 300 Area North burial grounds which required attention. Radiation levels to 75,000 c/m (GM) were observed (p. 40).

Fallout from Nuclear Weapons Testing

In early January, atmospheric beta activity increases were attributed to fallout from an announced nuclear weapons test of December 24, 1967. An influx of fallout in May and June resulted in higher than normal beta concentrations. With these influxes of fallout, corresponding increases in external exposure rates were noted (p. 43).

III. COLUMBIA RIVER WATER

The locations from which raw and drinking water samples were obtained are shown in Map 1.

A. Raw Water

Weekly cumulative samples of raw Columbia River water from Priest Rapids Dam were analyzed for total alpha and total beta. In addition, a monthly composite was analyzed for ^{3}H, ^{90}Sr, ^{95}Zr-Nb, and ^{106}Ru. Results appear in Table I. The numbers in parentheses are the analytical limits for each analysis.

TABLE I

RADIONUCLIDE CONCENTRATIONS IN THE COLUMBIA RIVER AT PRIEST RAPIDS DAM (JAN.-MAR.) AND PRIEST RAPIDS GAUGE STATION (APRIL-JUNE)

Month	^{3}H (pCi/ℓ)	^{90}Sr (pCi/ℓ)	Total α (pCi/ℓ)	Total β (c/m/ml)
January	2300 (1000)	0.53 (0.50)	<1.2 (1.0)	<0.005
February	2500	<0.50	<1.1	<0.005
March	1500	<0.50	<1.0	<0.005
April	<1000	<0.50	<1.0	<0.006
May	*	*	<1.2	<0.005
June	*	<0.50	<1.0	<0.005

* No analysis made.

The total beta activity in river water at Ringold was obtained from analyses of weekly grab samples. Results of these analyses appear in Figure 1.

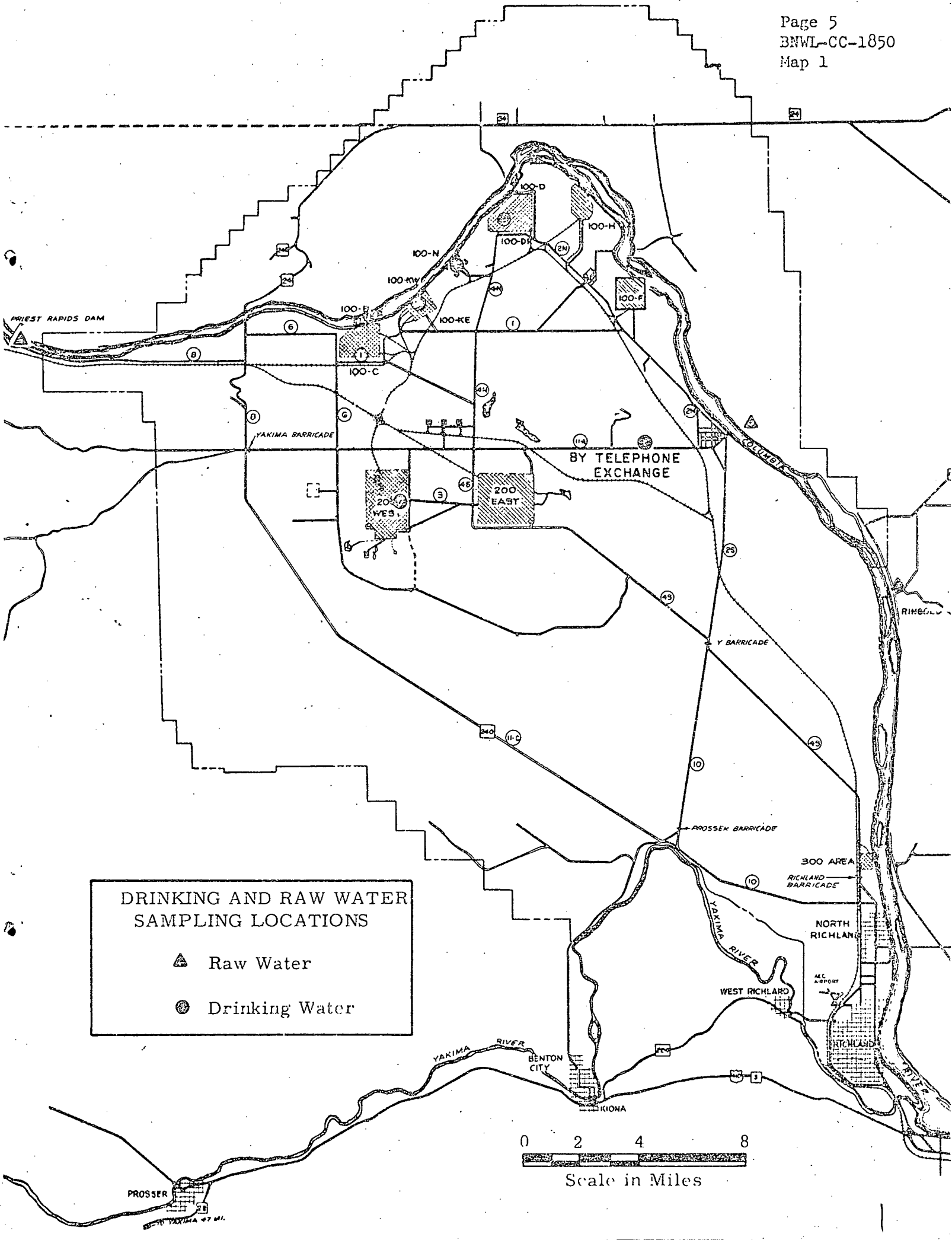
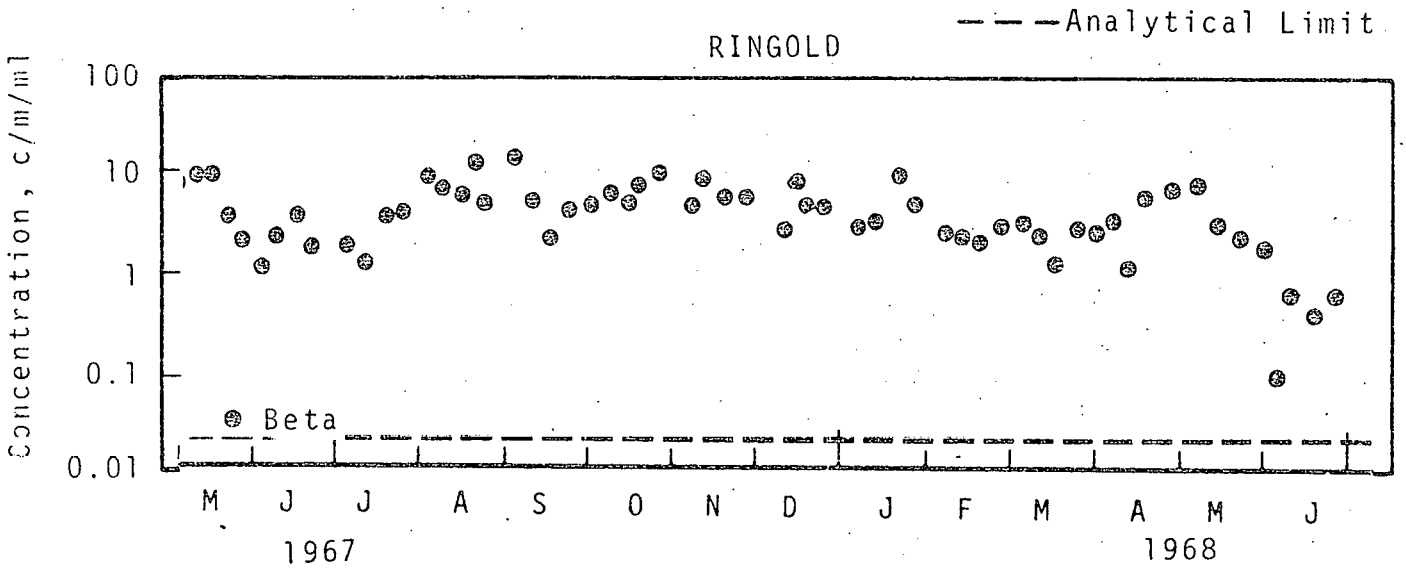

DRINKING AND RAW WATER
SAMPLING LOCATIONS
Raw Water
Drinking Water
PRIEST RAPIDS DAM
100-D
100-H
100-DR
100-N
100-KW
100-KE
100-F
100-B
100-C
YAKIMA BARRICADE
BY TELEPHONE
EXCHANGE
200
WEST
200
EAST
Y BARRICADE
PROSSER BARRICADE
300 AREA
RICHLAND
BARRICADE
NORTH
RICHLAND
YAKIMA
RIVER
WEST RICHLAND
BENTON
CITY
KIONA
PROSSER
0 2 4 8
Scale in Miles

Figure 1

RADIOACTIVITY OF COLUMBIA RIVER RAW WATER (GRAB) SAMPLES

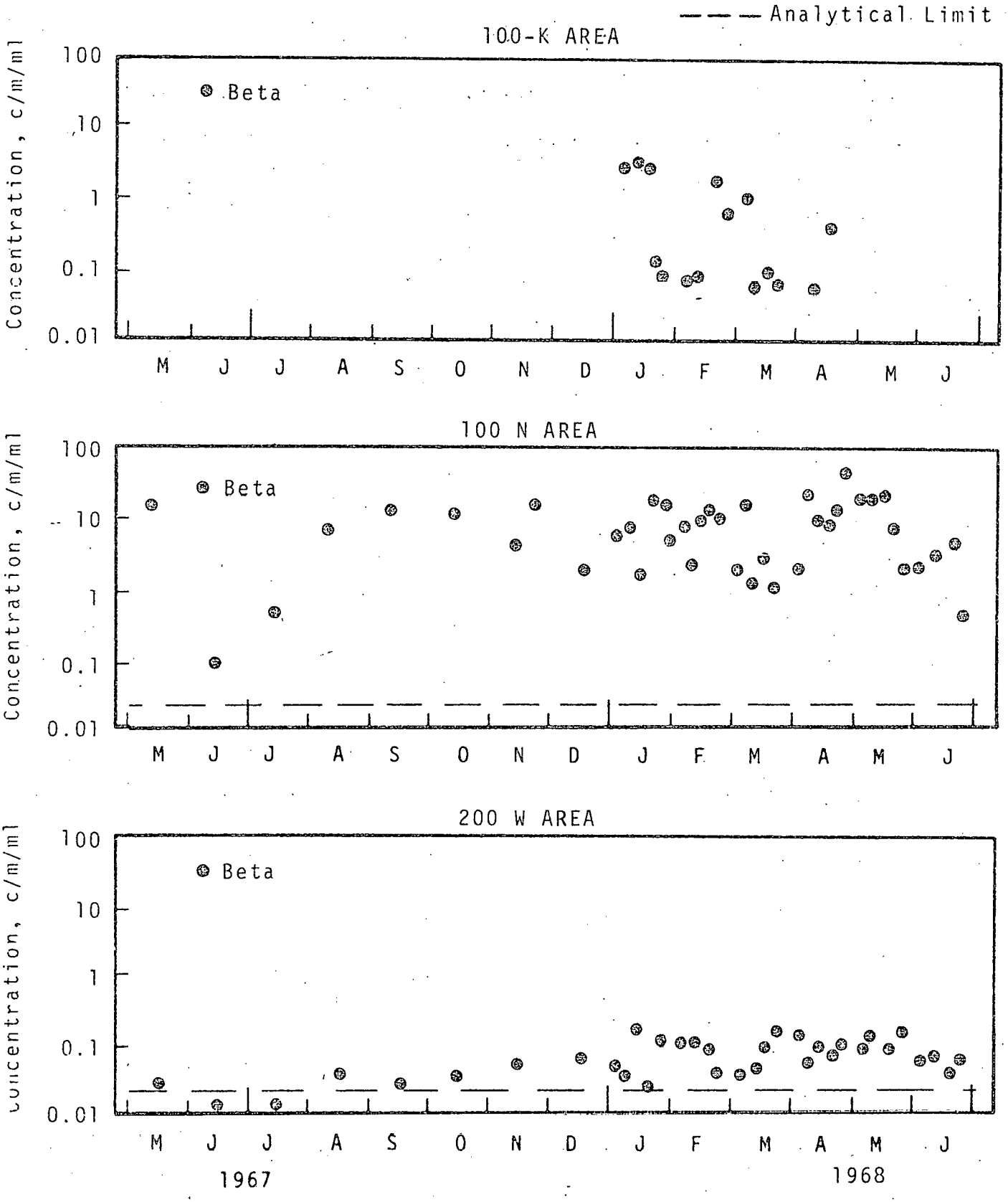


B. Drinking Water

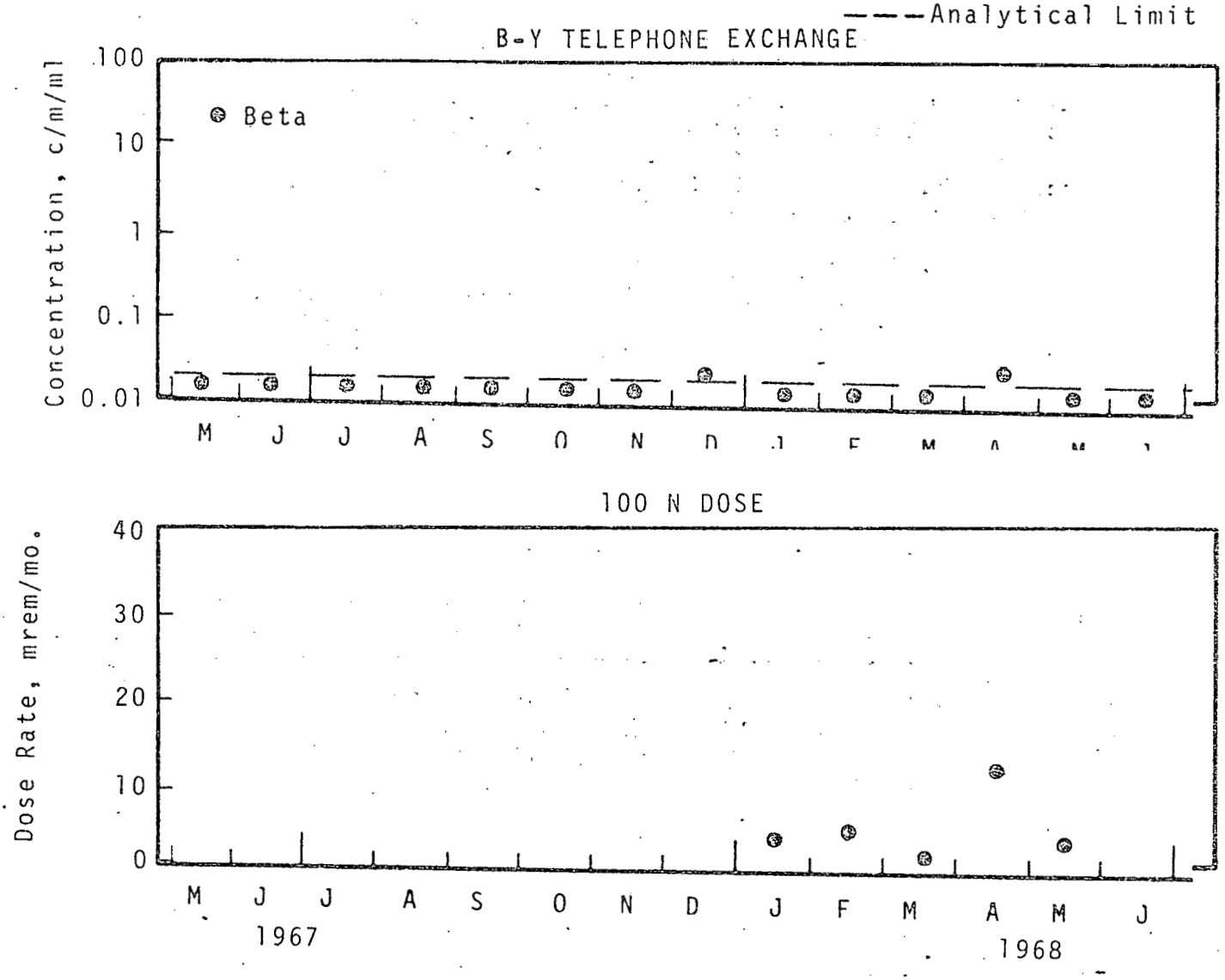
Total beta analyses of drinking water samples taken from 100-K, 100-N, 200-W, and the B-Y Telephone exchange are shown in Figures 2 and 3. The 100-K sampling location was added on January 1, 1968. As expected, total beta concentrations at 100-K have been significantly lower than those observed at 100-N. The 100-N and 200-W locations were switched to a weekly sampling frequency on January 1, 1968, in order to more closely follow the short-term changes in total beta concentrations. The monthly GI tract dose shown in Figure 3 is estimated from isotopic analyses of drinking water samples collected at 100-N. This estimate is based on an assumed intake of 1.2 liters per day, 5 days per week.

Figure 2

RADIOACTIVITY OF DRINKING WATER (GRAB) SAMPLES



RADIOACTIVITY OF DRINKING WATER (GRAB) SAMPLES



IV. SWAMPS, DITCHES, AND PONDS

A. Water

Open waters which may be used by migratory waterfowl are routinely sampled at the locations shown in Map 2. The sampling frequencies for all locations were changed to monthly on January 1, 1968. Figures 4-6 show data collected from swamps and ditches located within or near the 200 West Area. Figure 7 shows data collected from swamps and ditches located within and near the 200 East Area, and Figure 8 shows data collected from the 300 Area pond.

All swamp samples collected between January and June were quantitatively analyzed for significant radionuclides. These results appear in Table 2. Increases in radionuclide concentrations beyond the expected range of variation were noted at the following locations during January-June: U Swamp North (beta), T Swamp North (beta), 222-S Swamp (alpha), Gable Swamp North (alpha) and Purex Chemical Sewer (alpha).

TABLE 2

RADIONUCLIDE CONCENTRATIONS IN WASTE WATER SAMPLES

(pCi/ℓ)

	Date	^{51}Cr	^{95}Zr-Nb	^{103}Ru	^{106}Ru	^{134}Cs	^{137}Cs	^{144}Ce-Pr	^{239}Np
T Swamp North	1-19	640	ND*	ND	<440	ND	960	<530	ND
	3-22	1100	ND	ND	<440	660	2300	<530	ND
	4-19	2000	ND	<57	2700	<150	430	ND	ND
	5-24	750	<52	ND	ND	930	3700	ND	ND
	6-21	<470	ND	ND	ND	240	720	ND	200

	Date	^{51}Cr	^{131}I	^{137}Cs	^{144}Ce-Pr
U Swamp North	1-19	1900	ND	68	ND
	2-23	2200	ND	90	<520
	3-22	1400	ND	79	ND
	4-19	1300	ND	55	<520
	5-24	1100	ND	160	<530
	6-21	700	<49	350	ND

	Date	^{51}Cr	^{65}Zn	^{137}Cs	^{144}Ce-Pr
222-S Swamp	1-19	1400	<96	<51	ND
	2-23	1600	ND	<51	<520
	3-22	1700	ND	<51	ND
	4-19	1300	ND	<51	<520
	5-24	1000	ND	<51	ND
	6-21	<480	<96	<51	ND

* ND - Not detected.

A. Water (Continued)

TABLE 2 (Continued)

	Date	^{51}Cr	^{65}Zn	^{137}Cs	^{144}Ce-Pr
Redox North East	1-19	2500	<96	<51	ND
	2-23	2200	ND	<51	ND
	3-22	2000	ND	<51	ND
	4-19	1700	ND	ND	<520
	5-24	880	<96	<51	ND
	6-21	<480	ND	<51	ND

	Date	^{51}Cr	^{103}Ru	^{106}Ru	^{131}I	^{137}Cs	^{144}Ce-Pr
Purex Chemical Sewer	1-19	4300	160	6200	ND	<51	ND
	2-23	3500	ND	<440	ND	<51	<520
	3-22	ND	ND	ND	2,800	<51	ND
	4-19	ND	ND	ND	72,000	<51	ND
	5-24	1300	ND	ND	ND	<51	<520
	6-21	ND	ND	ND	64,000	<51	ND

	Date	^{51}Cr	^{65}Zn	^{106}Ru	^{131}I	^{137}Cs	^{144}Ce-Pr
B Swamp North	1-19	150	ND	1400	ND	<51	<530
	2-23	150	<96	<440	ND	ND	ND
	3-22	ND	ND	ND	860	<51	ND
	4-19	ND	ND	ND	47,000	<51	ND
	5-24	ND	ND	ND	790	<51	ND
	6-21	ND	ND	ND	3,100	<51	ND

	Date	^{51}Cr	^{65}Zn	^{137}Cs	^{144}Ce-Pr
Gable Swamp North	1-19	2100	<96	56	<1200
	2-23	2000	ND	280	<520
	3-22	1600	ND	100	ND
	4-19	1400	ND	150	<520
	5-24	740	<96	96	ND
	6-21	<480	<96	86	ND

Results for the 231-Z Waste Pit (a temporary sampling location) are shown below. The waste pit was retired on March 21, 1968.

TABLE 3

231-Z WASTE PIT

Date	Total Alpha (pCi/ℓ)	Total Beta (pCi/ℓ)
1-5-68	1,300	270
1-12-68	220	210
1-19-68	500	330
1-26-68	1,100	95

A. Water (Continued)

TABLE 3 (Continued)

Date	Total Alpha (pCi/ℓ)	Total Beta (pCi/ℓ)
2-2-68	220,000	5,100
2-9-68	3,600	320
2-16-68	6,200	550
2-23-68	420,000	7,600
3-1-68	19,000	930
3-8-68	12,000	580
3-15-68	27,000	1,100

300 Area Leach Trench - Samples were periodically collected from the 300 Area sanitary waste disposal site for coliform, enterococci (a fecal organism) and BOD (biochemical oxygen demand) analyses.

TABLE 4

	300 Area Leach Trench		
Date	Coliform/100 ml	Enterococci/100 ml	BOD mg/ℓ
3-19	180,000	20,000	-
6-18	200,000	350,000	18

	River Shoreline Seepage Area		
Date	Coliform/100 ml	Enterococci/100 ml	BOD mg/ℓ
3-19	38	31	-
6-18	32	59	1.5

300 Area Process Pond - Weekly cumulative samples were collected from the 300 Area process pond throughout this report period. Results for total beta, uranium, nitrate, and hexavalent chromium appear in Figure 8. Monthly averages of the fluoride concentrations appear below.

TABLE 5

300 AREA PROCESS POND - FLUORIDE CONCENTRATIONS

Month	Average Concentrations (ppm)
January	3.7
February	3.0
March	2.5
April	3.3
May	2.7
June	3.5

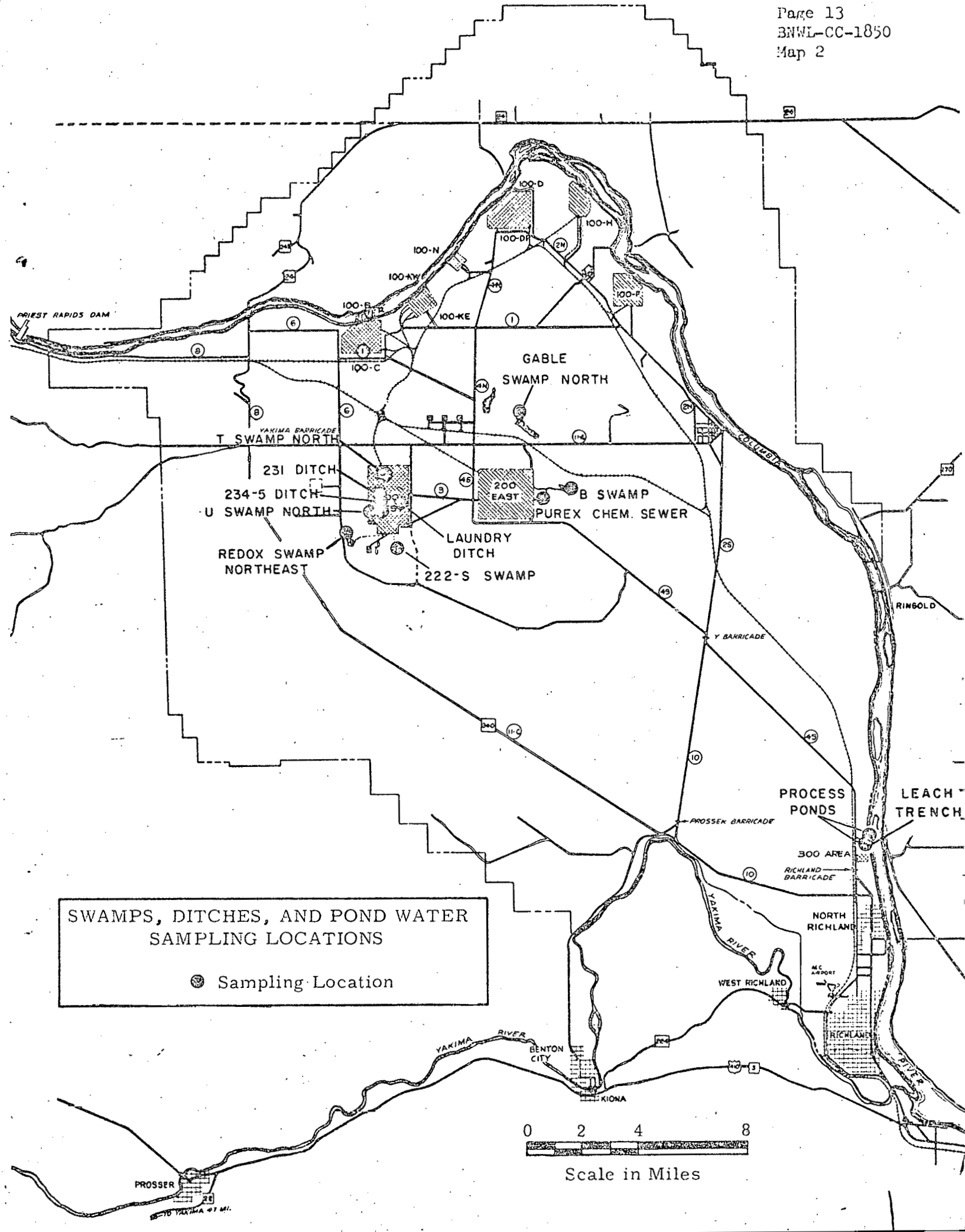

PRIEST RAPIDS DAM
100-D
100-H
100-DR
100-N
100-KW
100-KE
100-B
100-C
100-F
GABLE
SWAMP NORTH
YAKIMA BARRICADE
T SWAMP NORTH
231 DITCH
234-5 DITCH
U SWAMP NORTH
REDOX SWAMP
NORTHEAST
LAUNDRY
DITCH
222-S SWAMP
200
EAST
B SWAMP
PUREX CHEM. SEWER
COLUMBIA
RINGOLD
Y BARRICADE
PROCESS
PONDS
LEACH
TRENCH
PROSSER BARRICADE
300 AREA
RICHLAND
BARRICADE
YAKIMA RIVER
NORTH
RICHLAND
WEST RICHLAND
RICHLAND
BENTON
CITY
KIONA
YAKIMA RIVER
PROSSER
TO YAKIMA 47 MI.
SWAMPS, DITCHES, AND POND WATER
SAMPLING LOCATIONS
Sampling Location
0 2 4 8
Scale in Miles

Figure 4

RADIOACTIVITY OF WASTE WATER SAMPLES

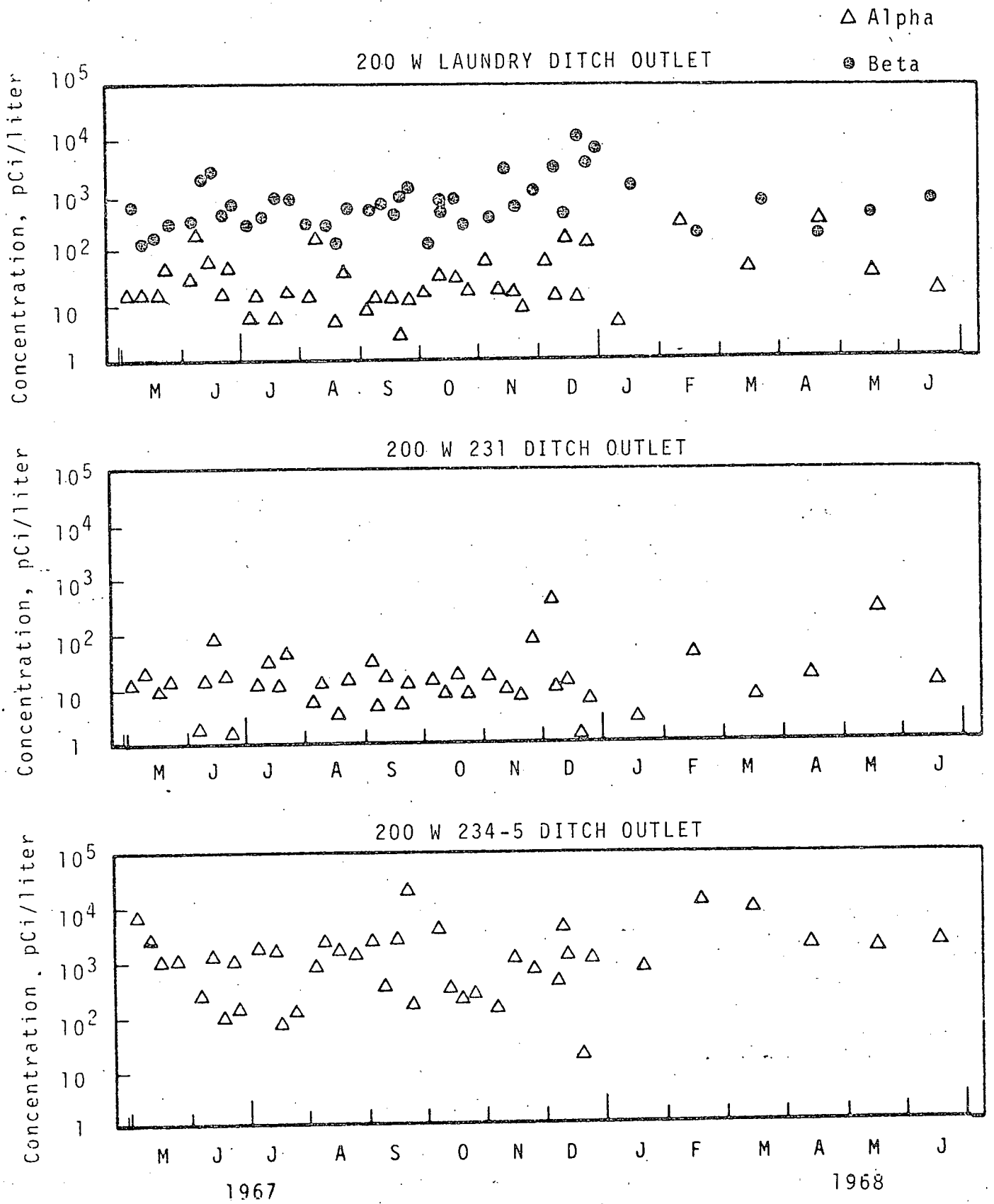


Figure 5

RADIOACTIVITY OF WASTE WATER SAMPLES

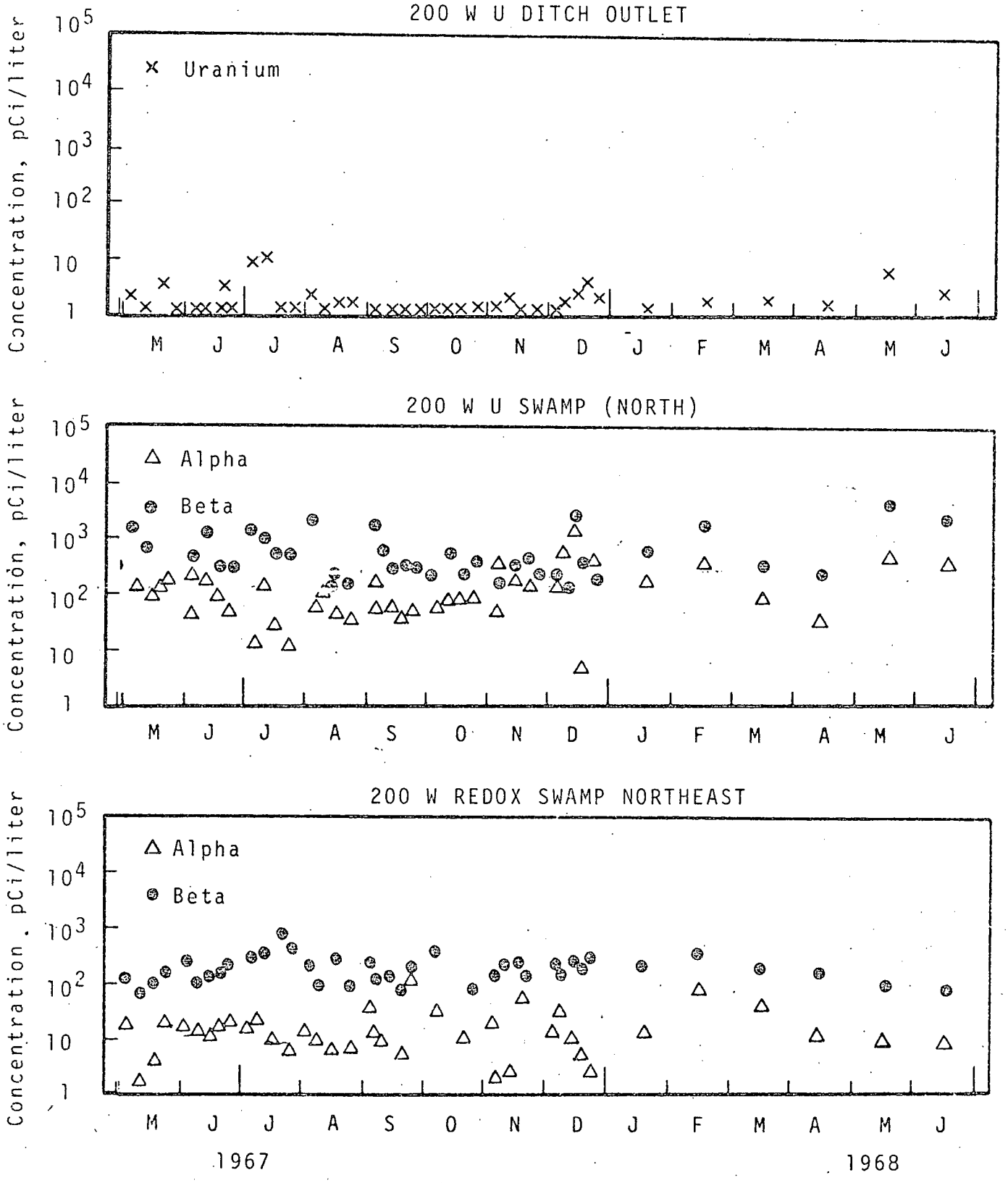
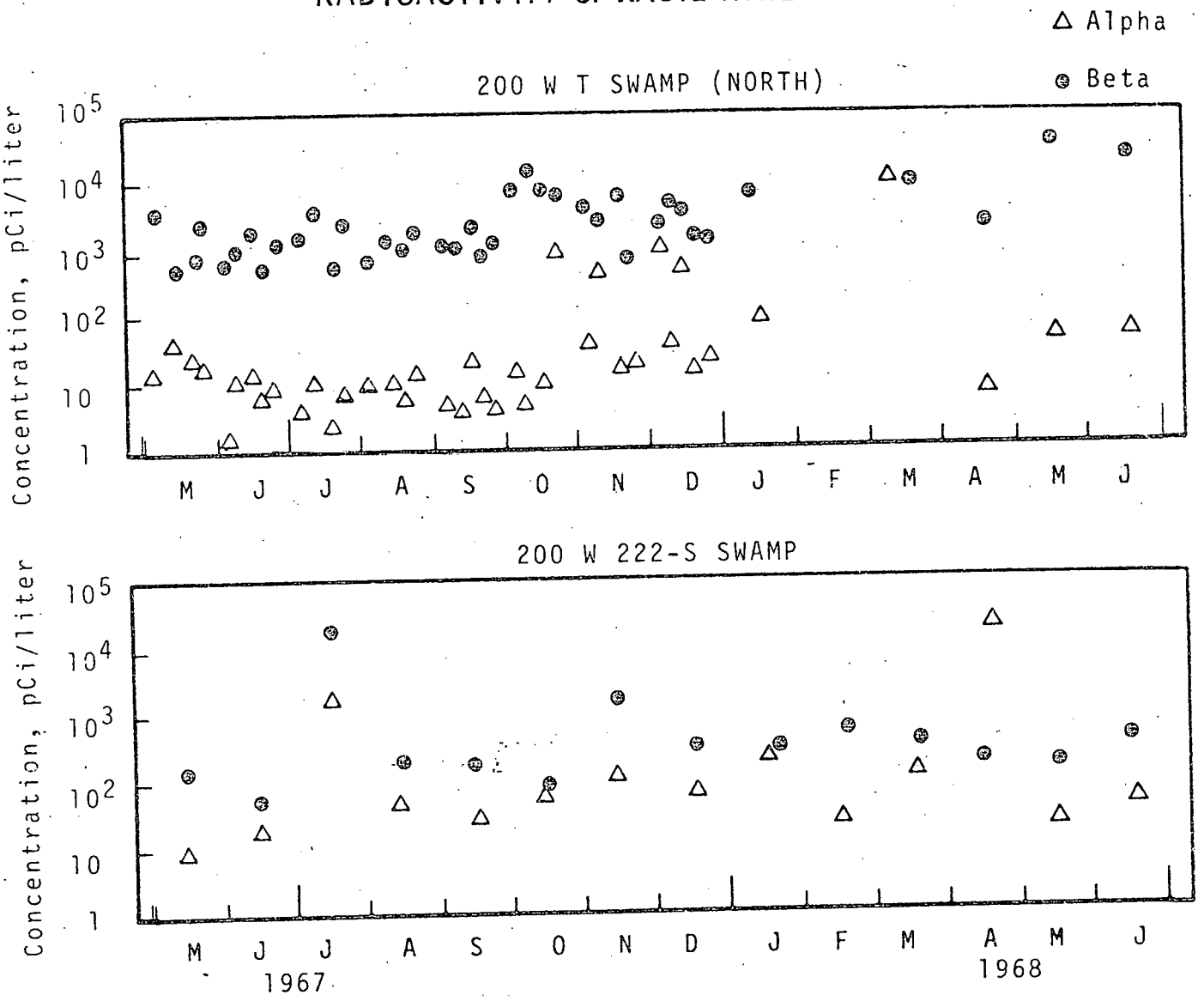


Figure 6

RADIOACTIVITY OF WASTE WATER SAMPLES



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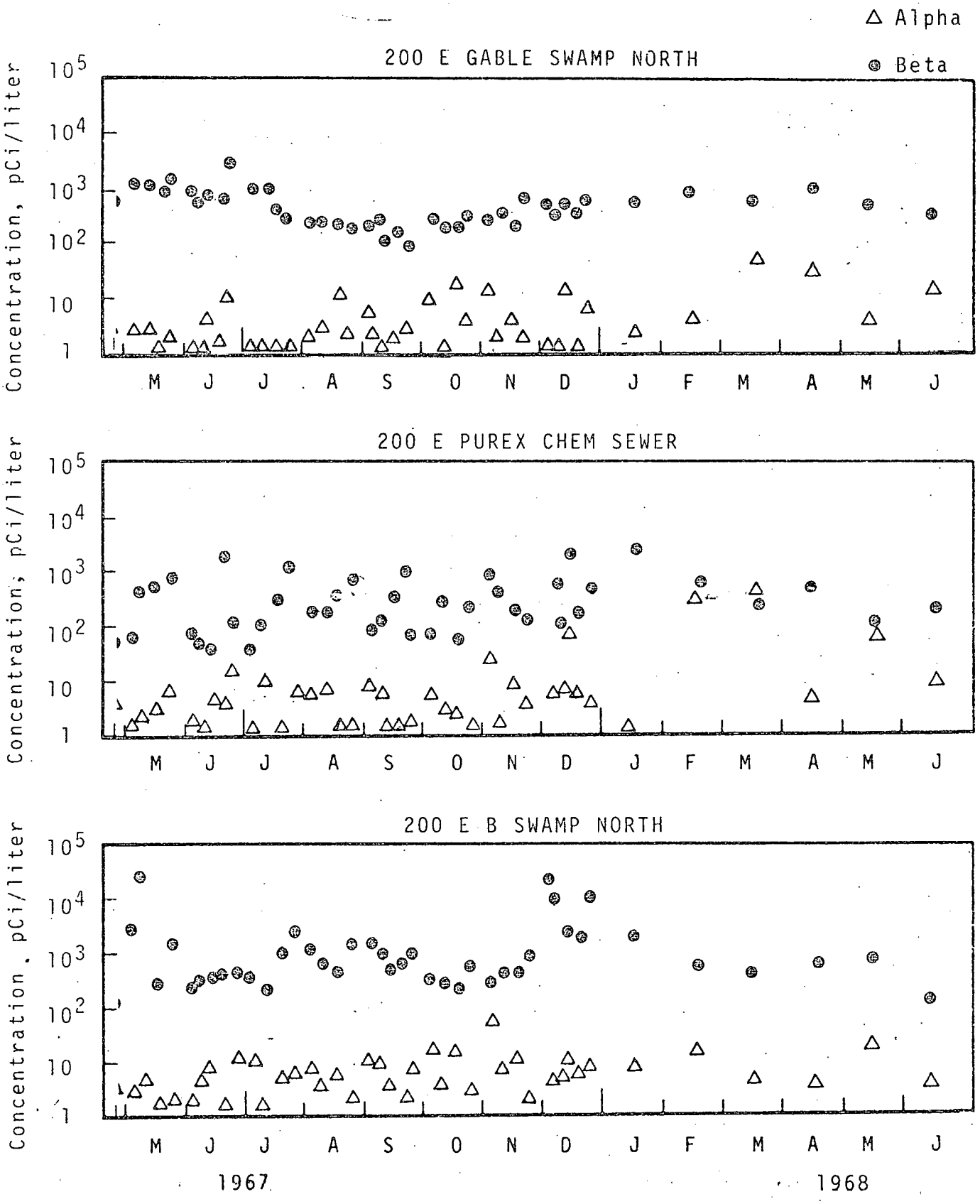
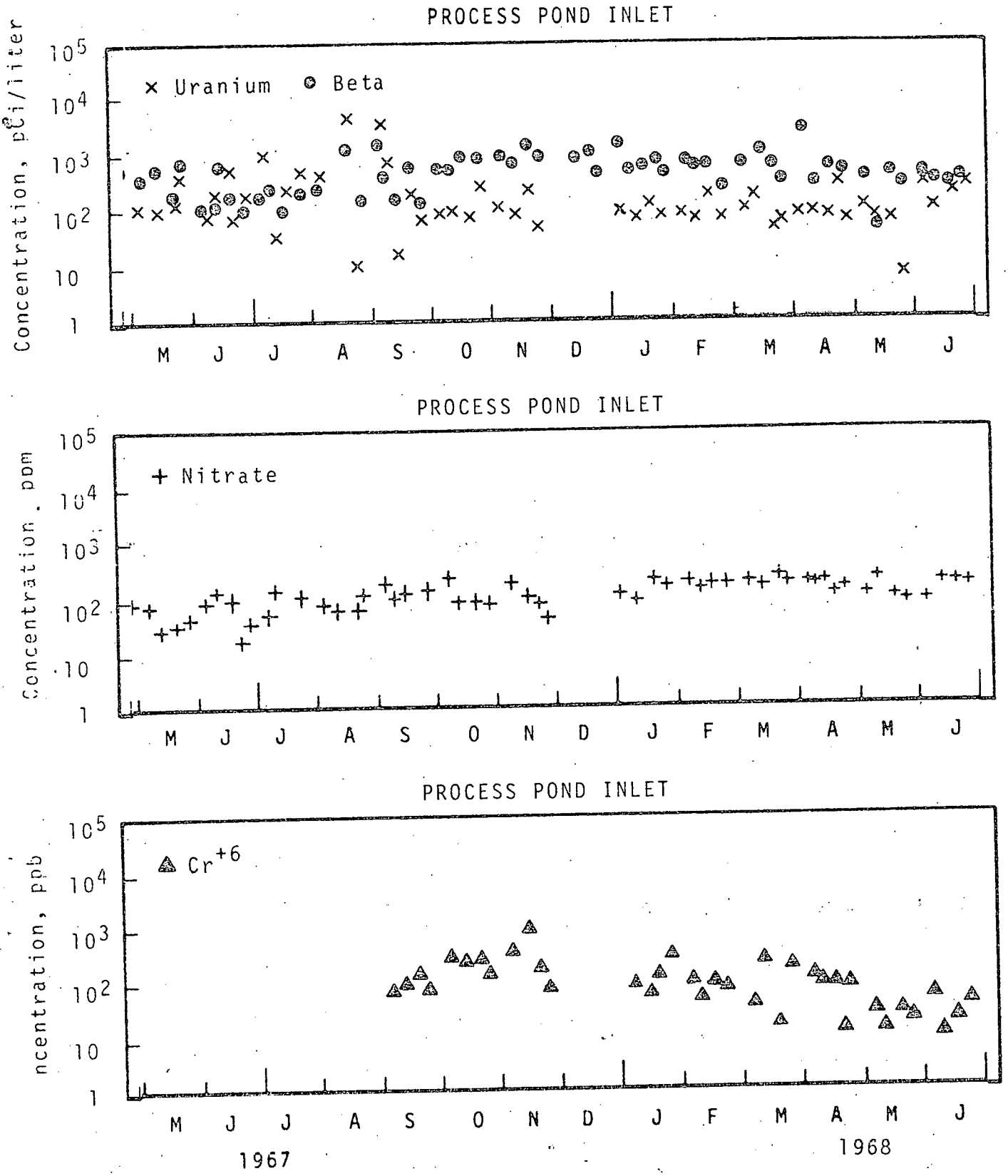


Figure 8

WASTE WATER SAMPLE ANALYSES - 300 AREA



IV. SWAMPS, DITCHES, AND PONDS (Continued)

B. Game Birds

No game bird samples were collected near liquid waste disposal sites during this report period.

V. THE ATMOSPHERE

A. Iodine-131 and Total Beta Activity

Results of routine sampling of the atmosphere at 19 locations within the Hanford Reservation (Map 3) are shown in Figures 9-15. At most locations the sampling equipment was contained within a small building designated "614". The sample is taken at a flow rate of 1.5 cfm through HV-70 filter paper and then passed through a solution of NaOH for ^{131}I collection. The normal sampling period is one week. "Total Beta" represents the activity of particulates collected on filter paper during the sampling period. During the first six months of 1968 several transient increases in total beta and/or ^{131}I concentrations were observed, as well as a general increase in the routine beta concentration at most sample locations. This increase was attributed to fallout. A month-by-month summary of each change in concentration follows.

January-February - Increased atmospheric beta activity starting early in January was attributed to fallout following an announced nuclear weapons test on December 24, 1967.

In January, increases were noted in ^{131}I concentrations at the 300 Area following above normal ^{131}I emissions from laboratory buildings.

Increased beta concentrations were noted at 100-N and 200-East Main Gate in early January and 200-East East Center in early February but could not be explained on the basis of known plant releases.

Air sampling was initiated at 200-West Northeast during the latter part of February.

March-April - A particle filter removed after running from 3-11 to 3-13 at 200-West Redox indicated a beta concentration of 3.4 pCi/m^3. This sample was analyzed by alpha spectrometry which indicated the activity was radon-thoron and their respective daughters. Investigation failed to indicate a source for this activity.

During the last part of March, increases in ^{131}I concentrations were noted at the 300 and 700 Areas due to a temporary increase in the emission rate from laboratory buildings.

^{131}I concentrations increased during March and April at 100-F, 100-B, and 200-East East Center due to temporary increases in the emission rate of ^{131}I from a chemical separations facility.

May-June - The average beta concentration at most sampling stations increased in May with the spring influx of fallout, and continued higher than normal through June.

During the latter part of May, the total beta activity at 100-K reached 1.6 pCi/m^3. A gamma spectrometer analysis of the 100-K air filter indicated ^{144}Ce-Pr - 0.41 pCi/m^3, ^{106}Ru-Rh - 0.47 pCi/m^3, and ^{95}Zr-Nb - 0.16 pCi/m^3. A beta decay curve on this same filter indicated two primary decaying isotopes; one with a half life of about 2.5

V. THE ATMOSPHERE (Continued)

A. Iodine-131 and Total Beta Activity (Continued)

days, corresponding closely to radon-thoron daughters, the other with a half life of about 52 days, corresponding closely to 50.4 day ^{89}Sr. Subsequent separation for ^{32}P gave a result of 0.027 pCi/m^3.

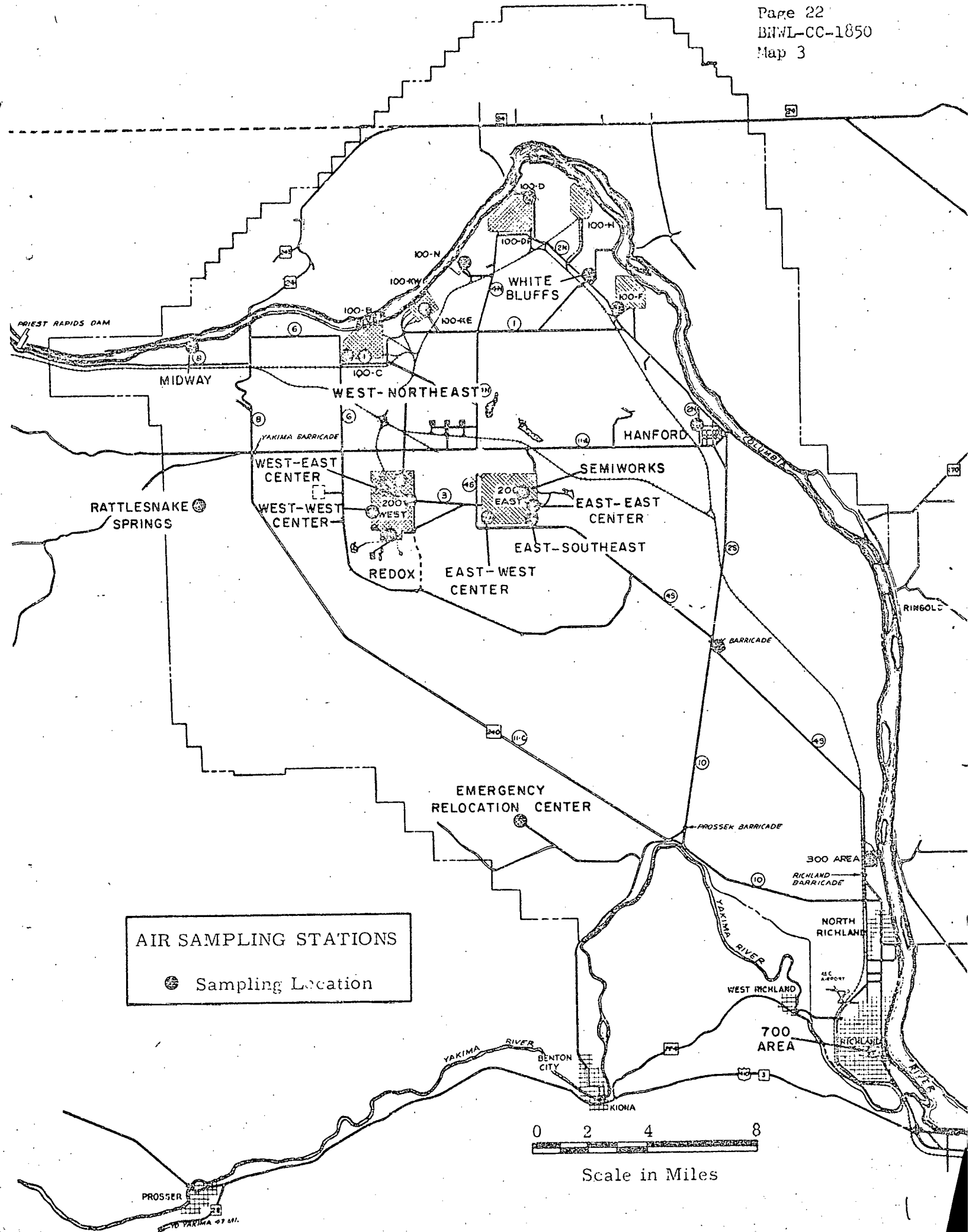
The average ^{131}I and total beta concentrations for the first half of 1968 are shown below in Table 6, and for comparison the averages for 1965, 1966, and 1967 are also shown.

TABLE 6

ATMOSPHERIC ^{131}I AND TOTAL BETA CONCENTRATIONS - AVERAGES

(Results in pCi/m^3)

Location	Total Beta				^{131}I			
	1/2 1968	1967	1966	1965	1/2 1968	1967	1966	1965
100 Areas	0.40	0.34	0.29	0.44	0.02	0.02	0.20	<0.03
200 Areas	0.31	0.41	0.58	0.80	0.02	0.09	0.10	0.14
Other On-Plant Locations	0.25	0.26	0.24	0.34	0.03	0.04	0.20	0.05


100-D
100-H
100-DR
100-N
100-KW
WHITE BLUFFS
100-F
100-KE
100-B
PRIEST RAPIDS DAM
100-C
MIDWAY
WEST-NORTHEAST
YAKIMA BARRICADE
HANFORD
COLUMBIA
WEST-EAST CENTER
SEMIWORKS
RATTLESNAKE SPRINGS
WEST-WEST CENTER
200 WEST
200 EAST
EAST-EAST CENTER
EAST-SOUTHEAST
REDOX
EAST-WEST CENTER
RINGOLD
BARRICADE
EMERGENCY RELOCATION CENTER
PROSSER BARRICADE
300 AREA
RICHLAND BARRICADE
NORTH RICHLAND
YAKIMA RIVER
WEST RICHLAND
700 AREA
BENTON CITY
KIONA
PROSSER
AIR SAMPLING STATIONS
Sampling Location
0 2 4 8
Scale in Miles

IODINE-131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE

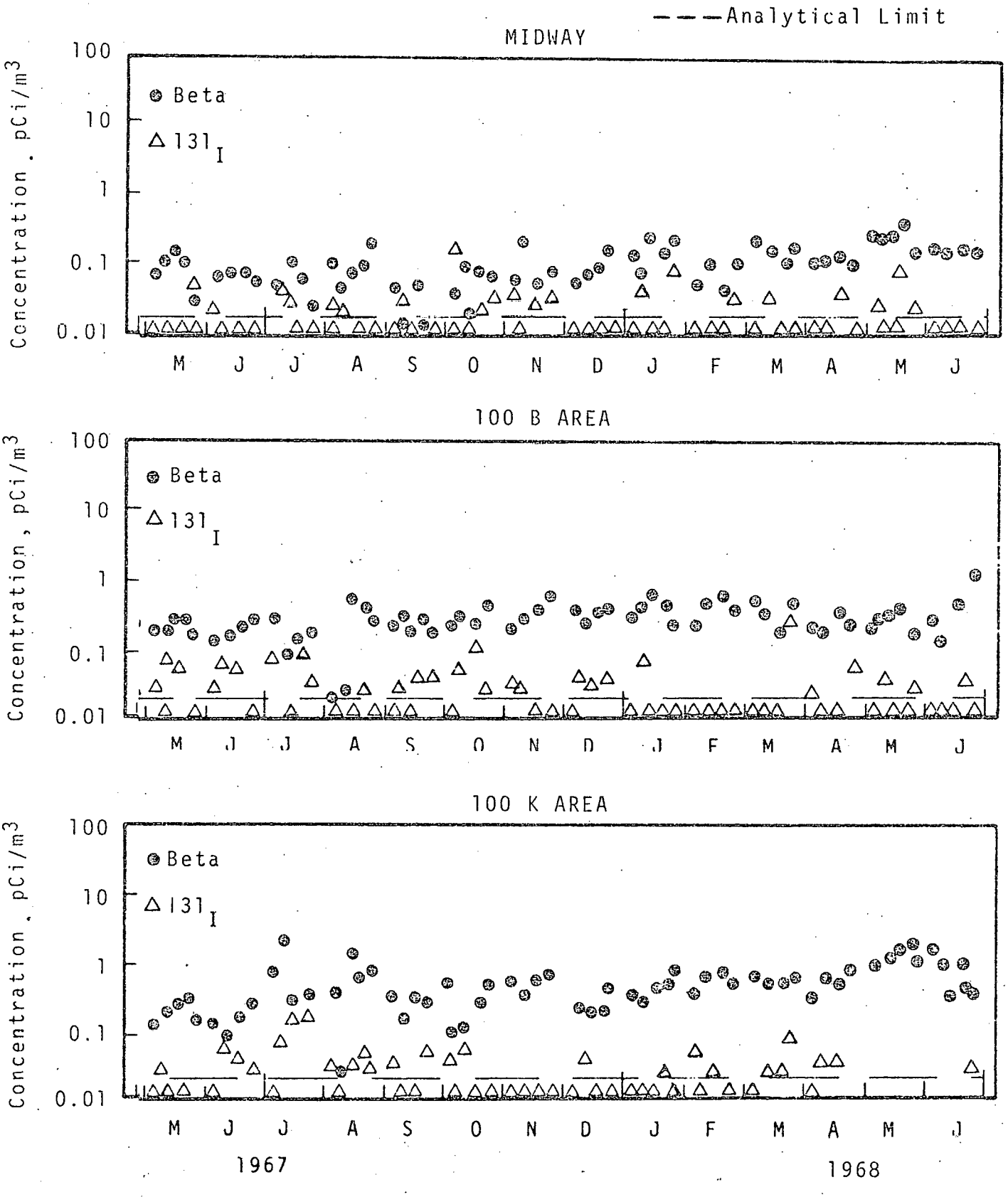
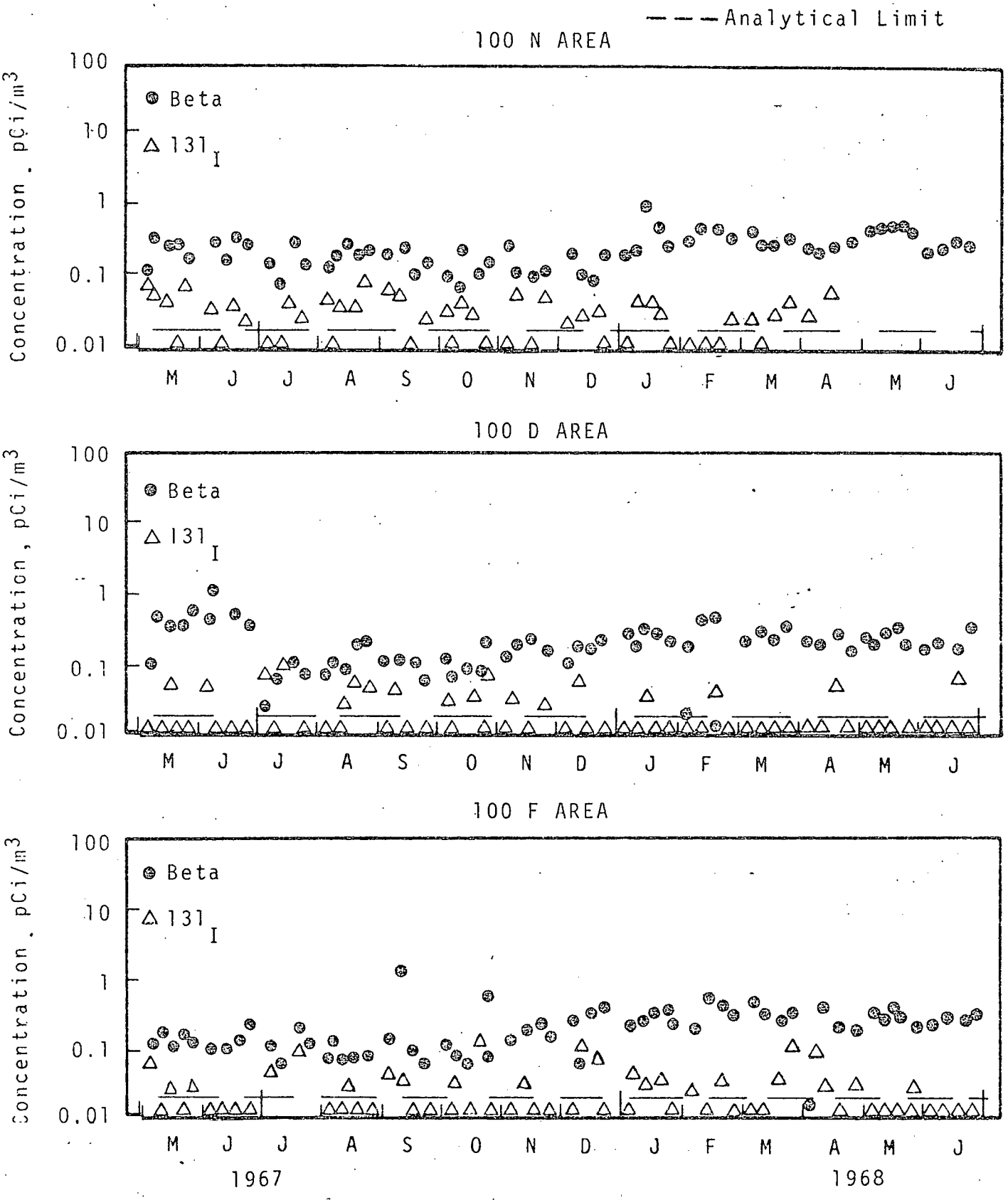
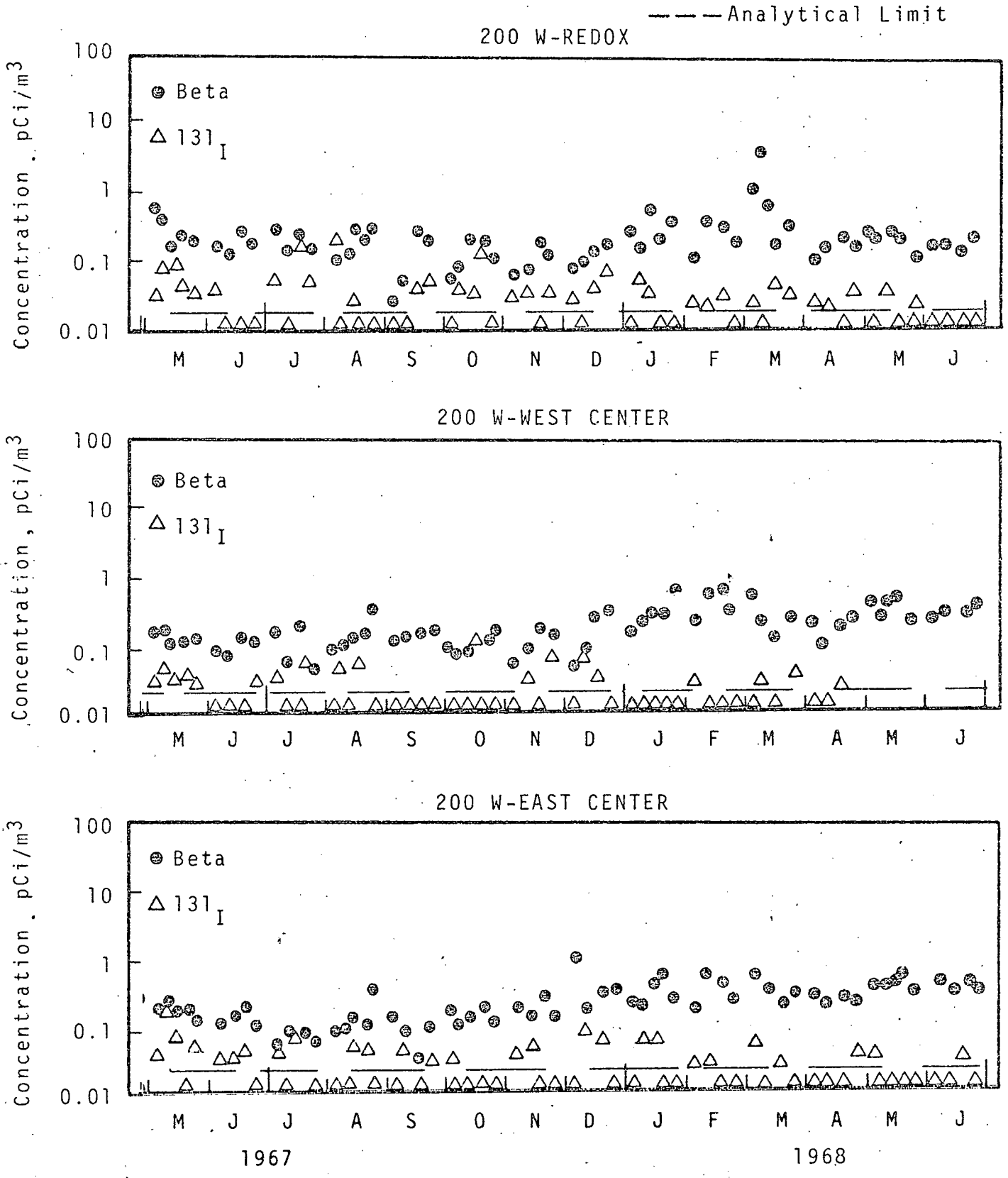


Figure 10

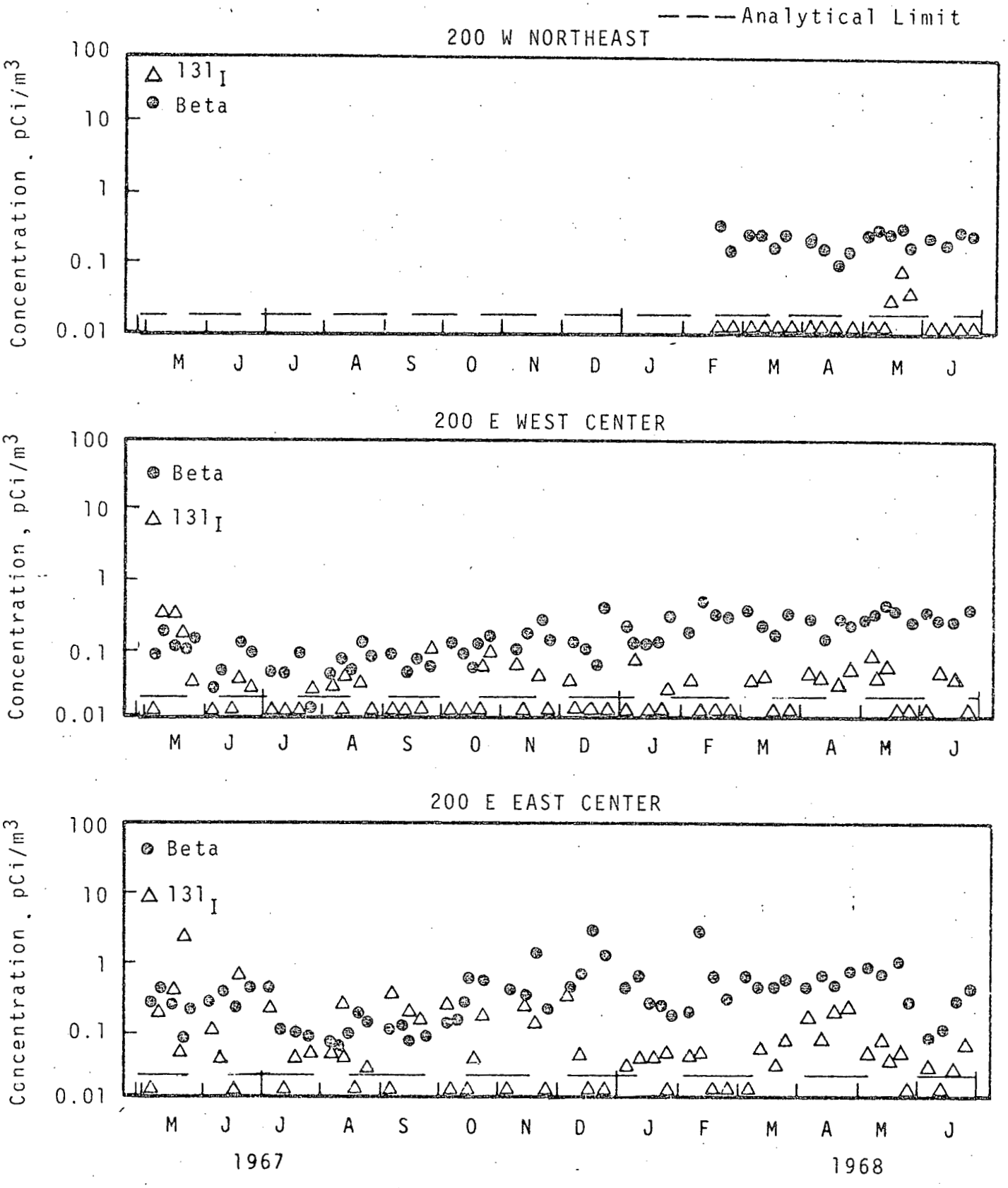
IODINE-131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE



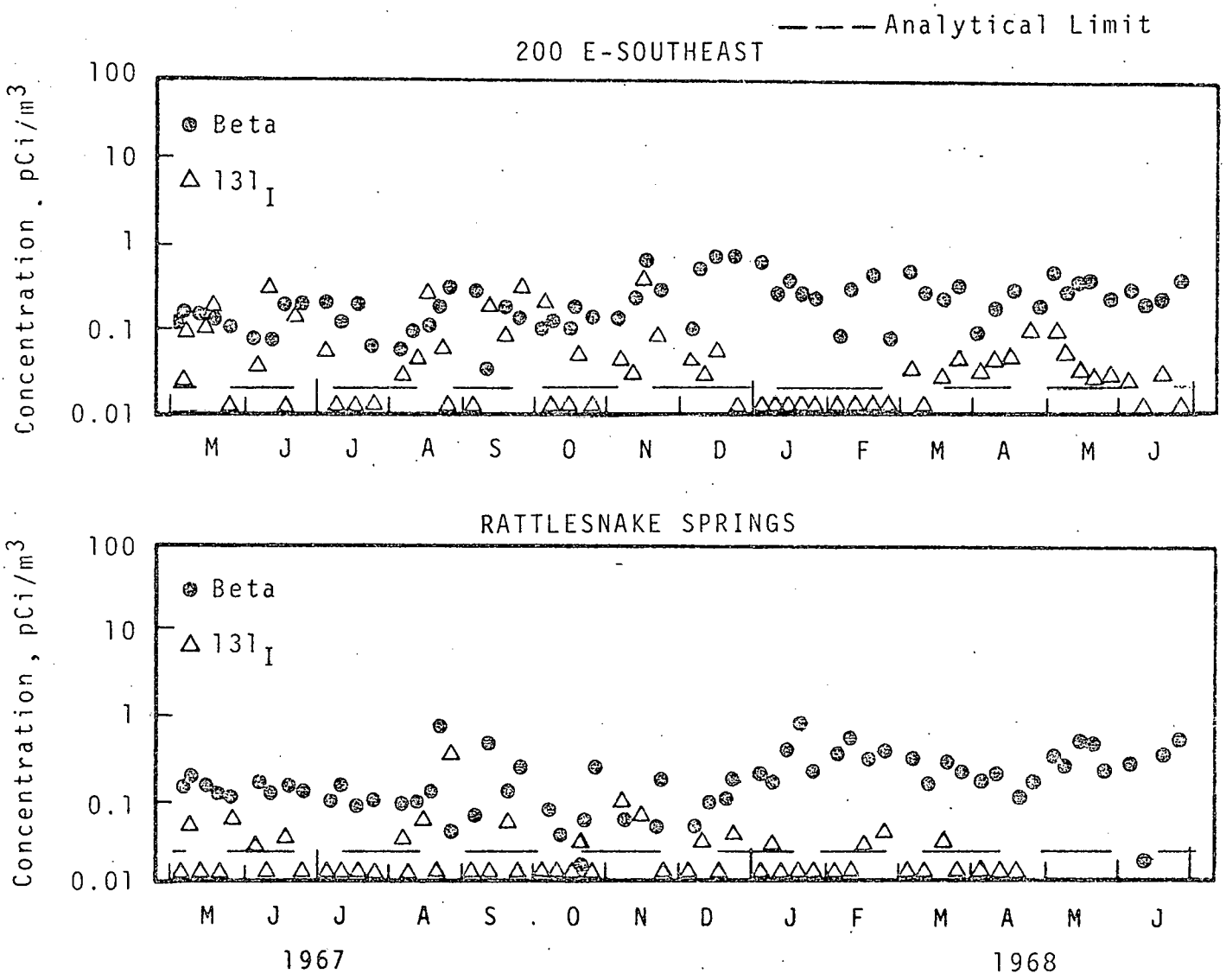
IODINE-131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE



IODINE-131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE



IODINE-131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE



IODINE-131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE

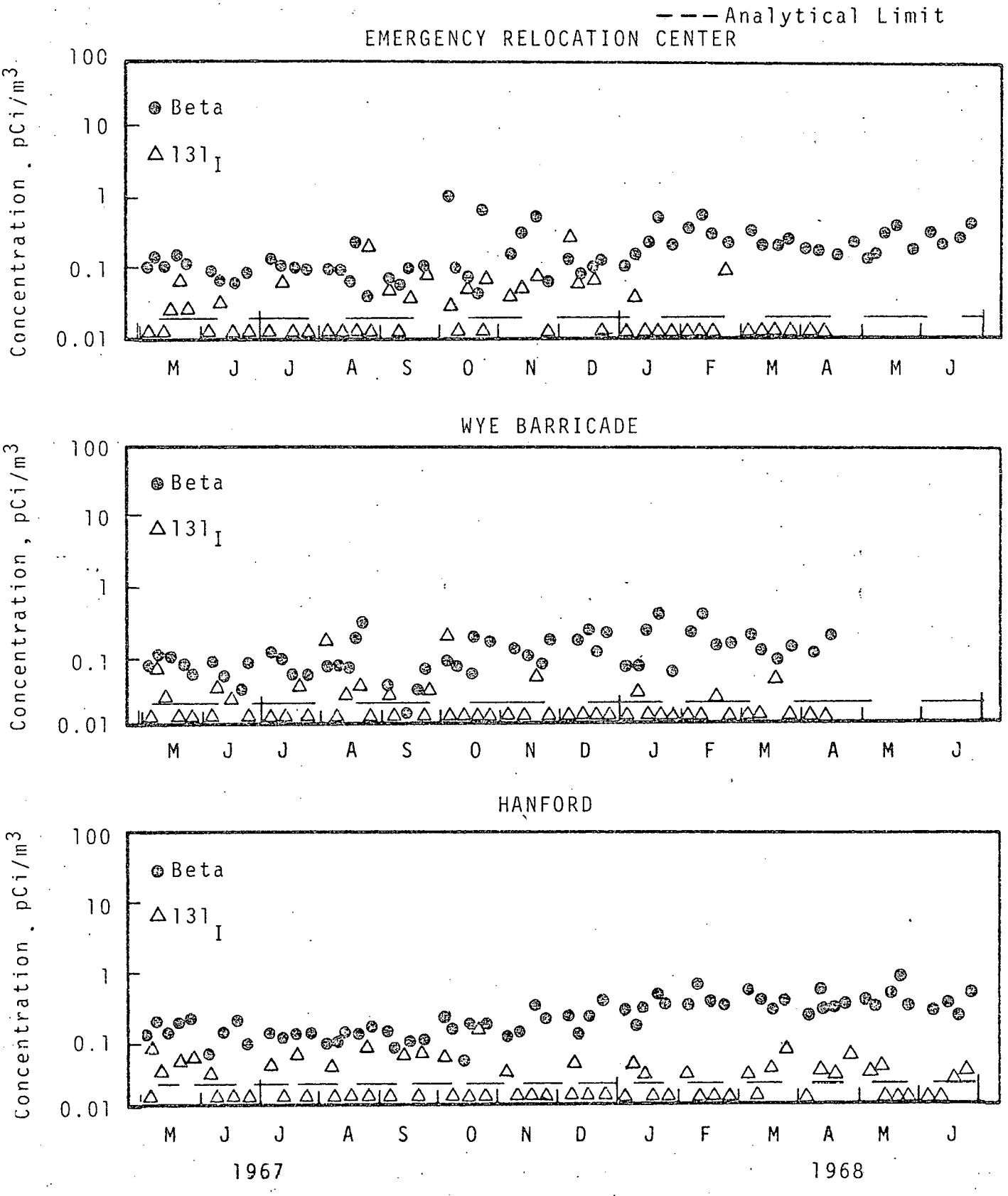
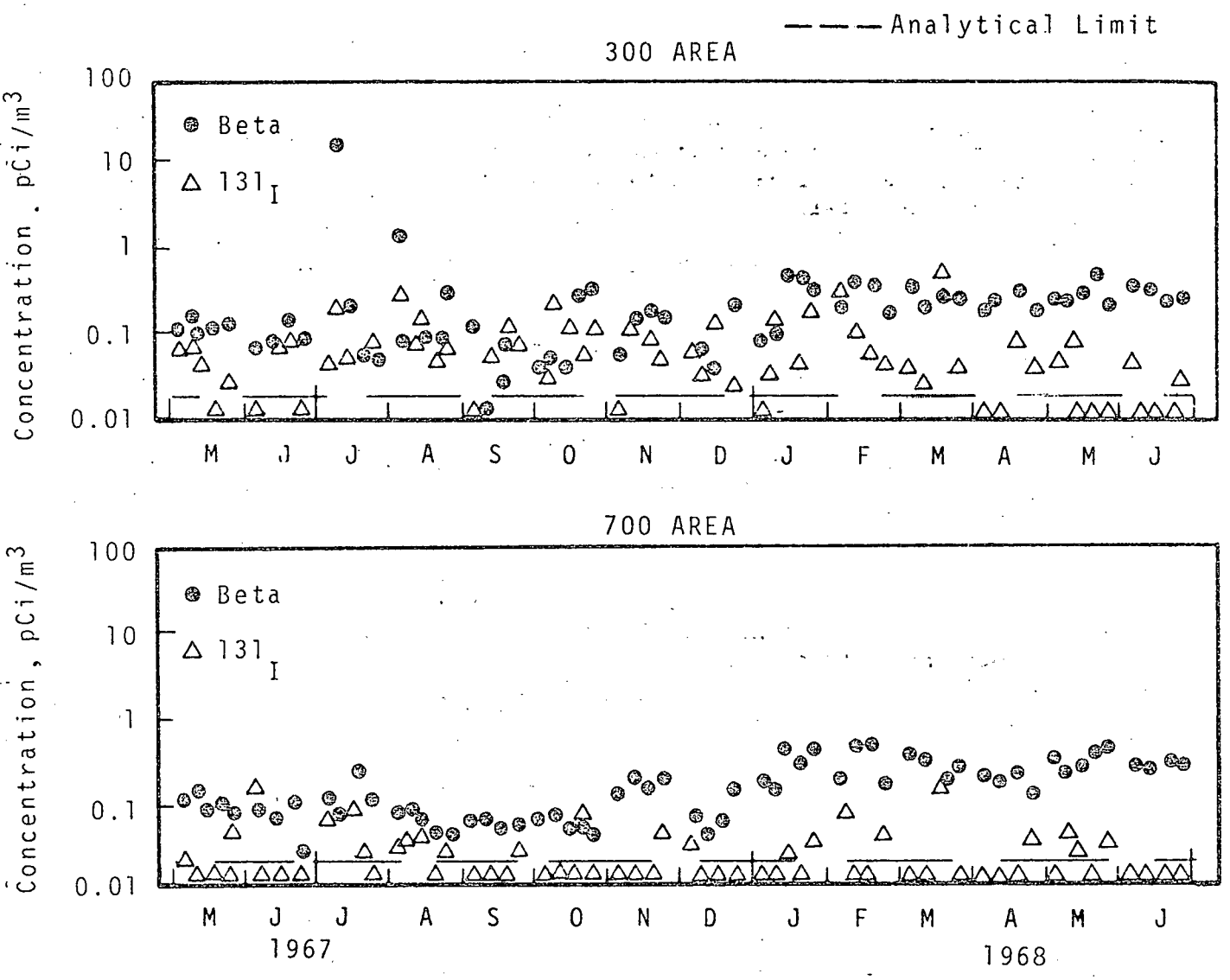


Figure 15

IODINE-131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE



V. THE ATMOSPHERE (Continued)

B. Total Alpha Activity

Eleven of the 19 weekly filters which collect beta-gamma emitting radionuclides are also analyzed for alpha activity, with most of the sampling sites located in the 200 Areas. These data are presented in Figures 16-19.

For most sampling locations, results were generally at or below the analytical limit of 0.01 pCiα/m^3 during the first half of 1968. However, in early March the alpha concentration reached 0.913 pCi/m^3 at 200-West Redox. Analysis by alpha spectrometry indicated activity was radon-thoron. An isolated temporary increases in total alpha concentration at 100-F occurred during the first week of March.

During the first part of June an alpha concentration of 0.05 pCi/m^3 was reached on the 300 Area filter. Subsequent analysis by alpha spectrometry yielded the following results: ^{232}Th - 36%, ^{238}U - 20%, ^{234}-^{235}U - 42%, and ^{239}Pu - 1.8%.

The six month average total alpha concentrations in the atmosphere for 1968 are presented in Table 7. For comparison, averages for 1965, 1966, and 1967 are also shown.

TABLE 7

ATMOSPHERIC TOTAL ALPHA CONCENTRATIONS - AVERAGES

(Results in pCi/m^3)

Location	1/2 1968	1967	1966	1965
100 Areas	.01	.01	.01	<0.02
200 Areas	.01	.01	.01	<0.03
300 Area	.01	.02	.02	0.08
700 Area	.01	.02	.02	<0.02

Figure 16

TOTAL ALPHA ACTIVITY IN THE ATMOSPHERE

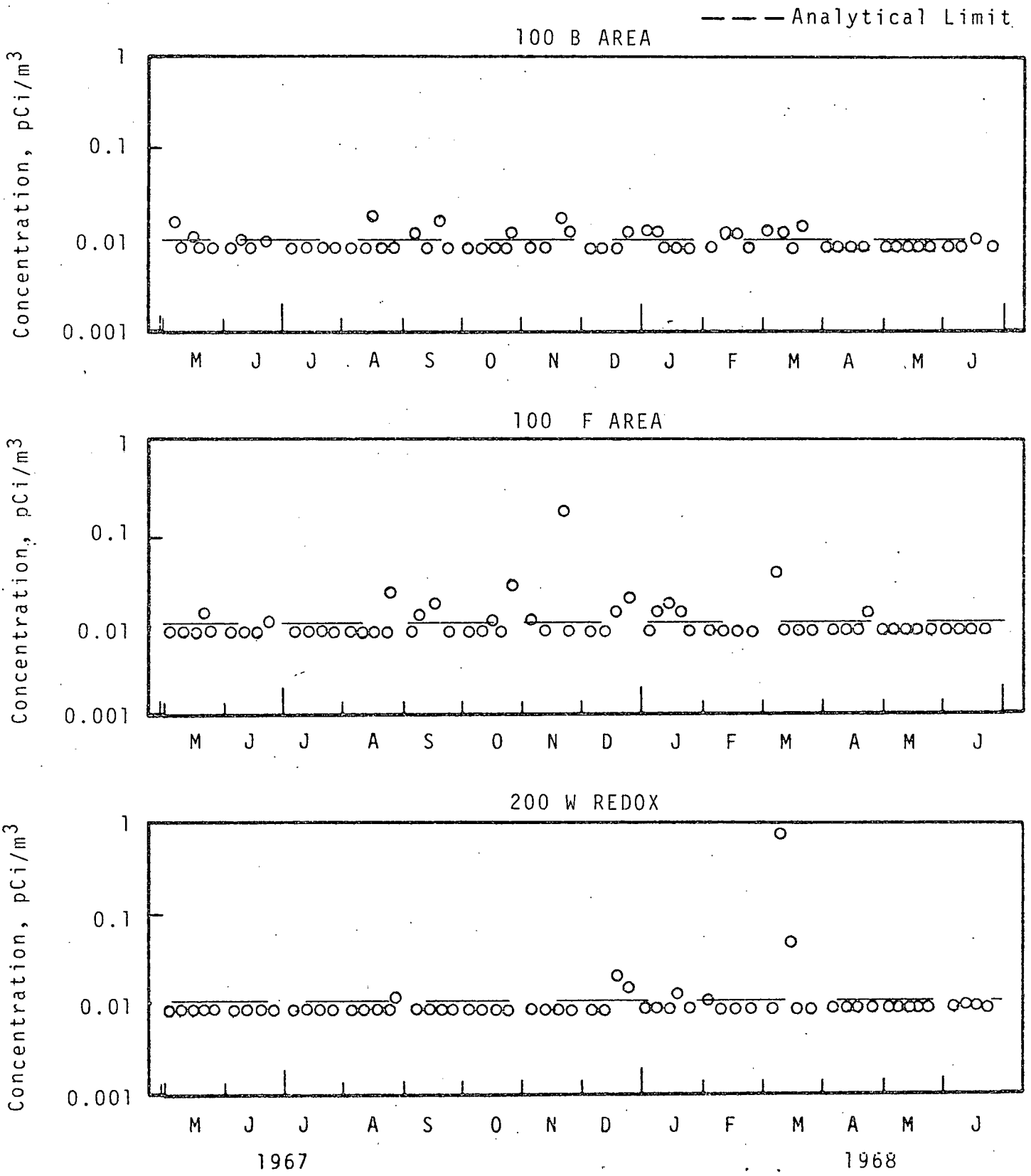
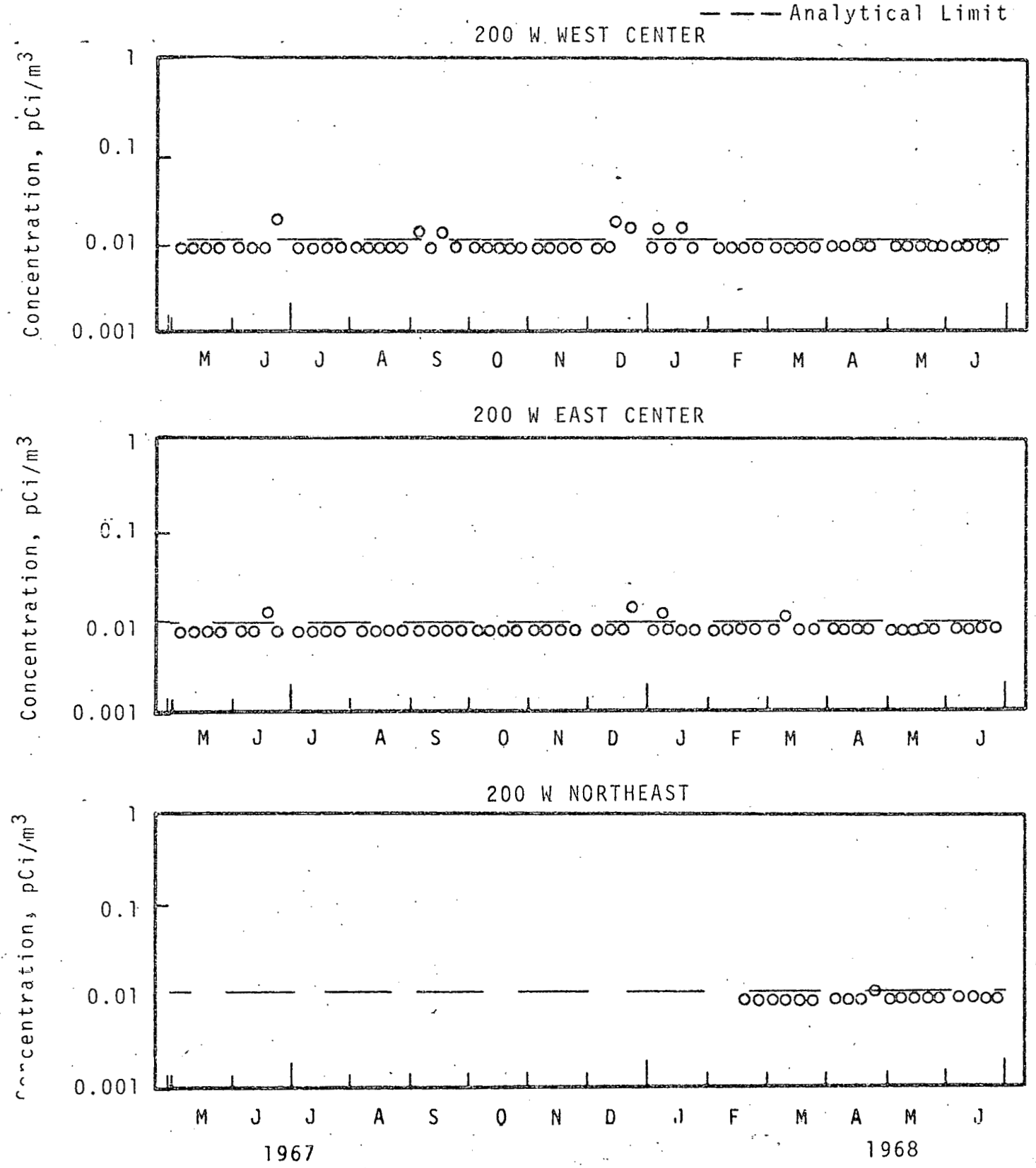


Figure 17

TOTAL ALPHA ACTIVITY IN THE ATMOSPHERE



TOTAL ALPHA ACTIVITY IN THE ATMOSPHERE

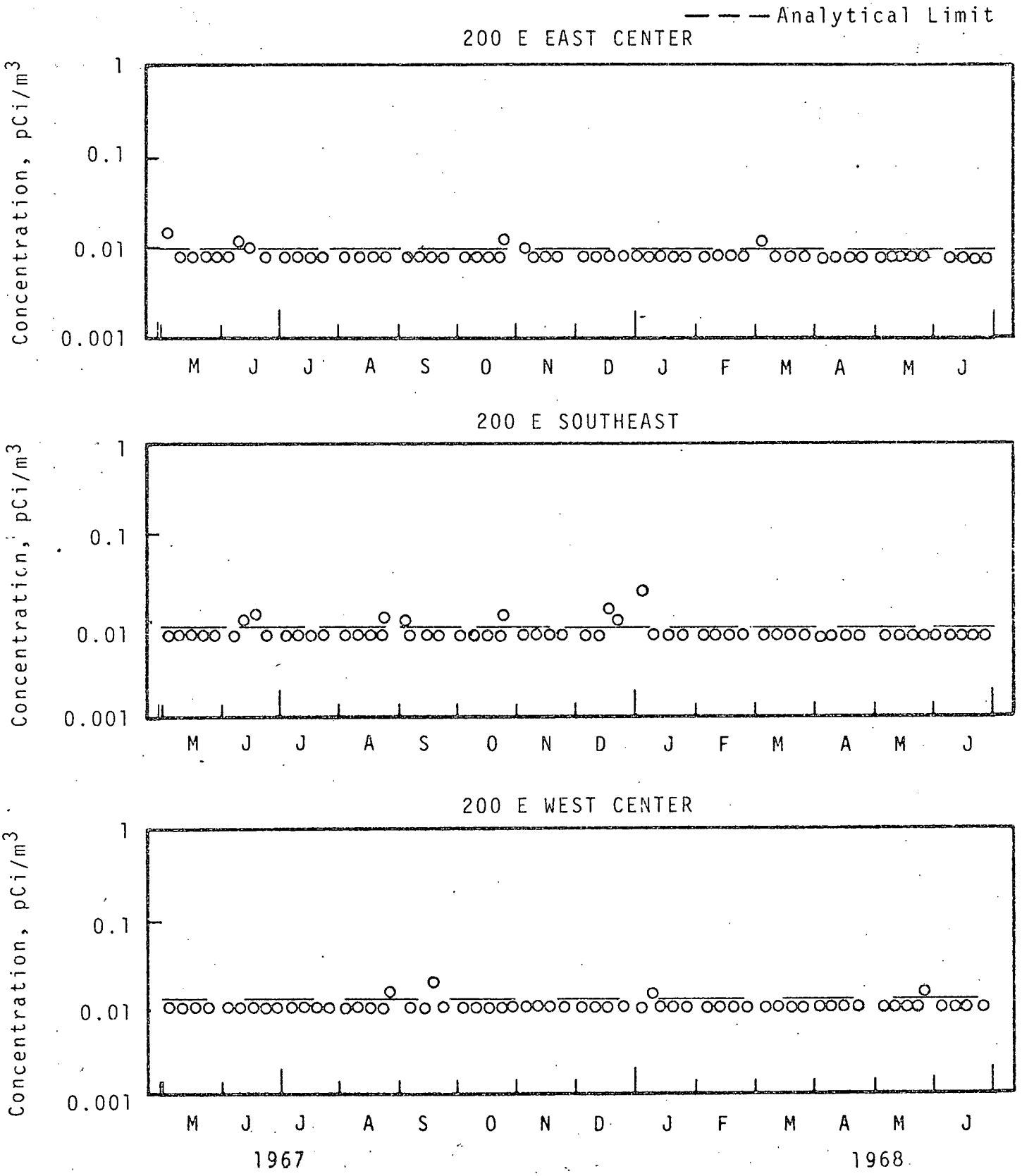
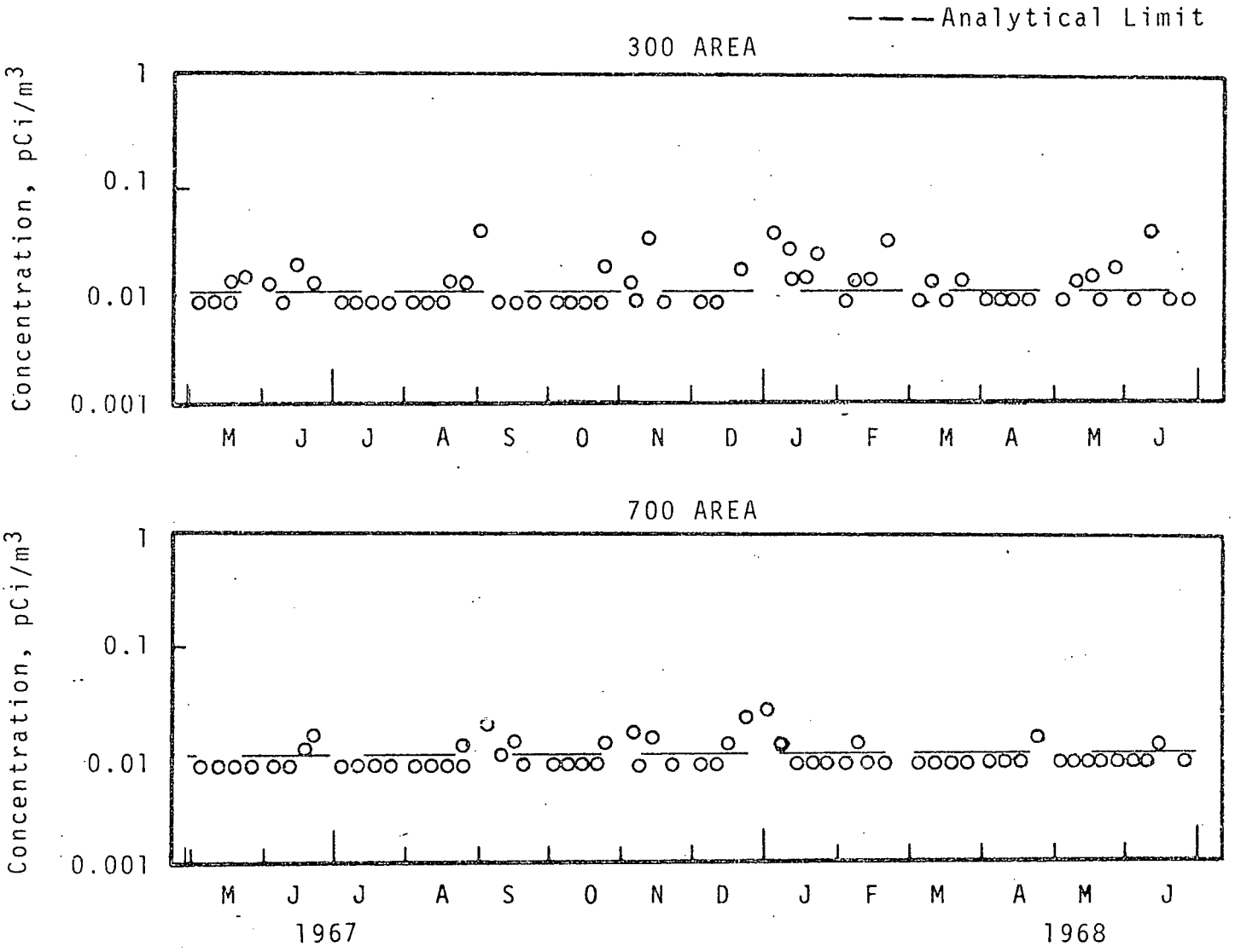


Figure 19

TOTAL ALPHA ACTIVITY IN THE ATMOSPHERE



VI. RADIATION SURVEYS

A. Surface Contamination

1. Hanford Roads

Hanford roads are routinely surveyed (see Map 4) with a bio-plastic scintillation detector which is attached to the front end of a truck and is positioned about two feet above the surface of the road. The minimum level of contamination that can be detected by the road monitor corresponds to a portable GM meter response of approximately 1000 c/m per probe area. The routes between the 300 Area and the 300 Areas were surveyed bi-weekly during the report period; the remainder were surveyed monthly.

Routine surveys detected a total of ten instances of particulate contaminates during the first half of 1968, as compared to a total of seven such instances during all of 1967. Most of the increased road deposition appeared to be associated with radioactive material transport in the vicinity of the 100 Areas.

A month-by-month summary of significant findings follows:

January - Two radioactive particles were detected on Rt. 3 between 200 East and West Areas. The one with the highest reading of 100,000 c/m (GM) was recovered; the activity was found to be primarily ^{137}Cs.

February - A special survey of the road between 100-N and 100-D Areas was made on February 1 on notification that contaminated liquid dripping was suspected during waste hauling operations. A total of eight particles, including a small piece of metal, were found along the route, but no apparent liquid drops. The maximum radiation level was 150 mrads/hr (S-Juno). Laboratory analysis of the more active particles showed the activity to be a mixture of fission products and ^{60}Co. Additional surveys of road shoulders and nearby ground control plots gave negative results.

March - A maximum reading of 15,000 c/m (GM) was obtained on a particle in gravel along Rt. 2N east of 100-H Area.

Contaminated weeds at the southwest fence corner of 200 West Area read 400 c/m.

May - A particle detected along Rt. 2N at White Bluffs, reading 100,000 c/m, had ^{60}Co as the predominant radioisotope.

Two additional particles between 100-D and 100-N Area access roads were found, with the higher reading 100,000 c/m.

Numerous particulate materials associated with weeds and other organic debris were found along the dirt road south of the 200 B-C Crib Area. Several of these particles had GM readings greater than 100,000 c/m. Follow-up surveys of nearby control plots and other roads in the vicinity showed no contamination. Although more

VI. RADIATION SURVEYS (Continued)

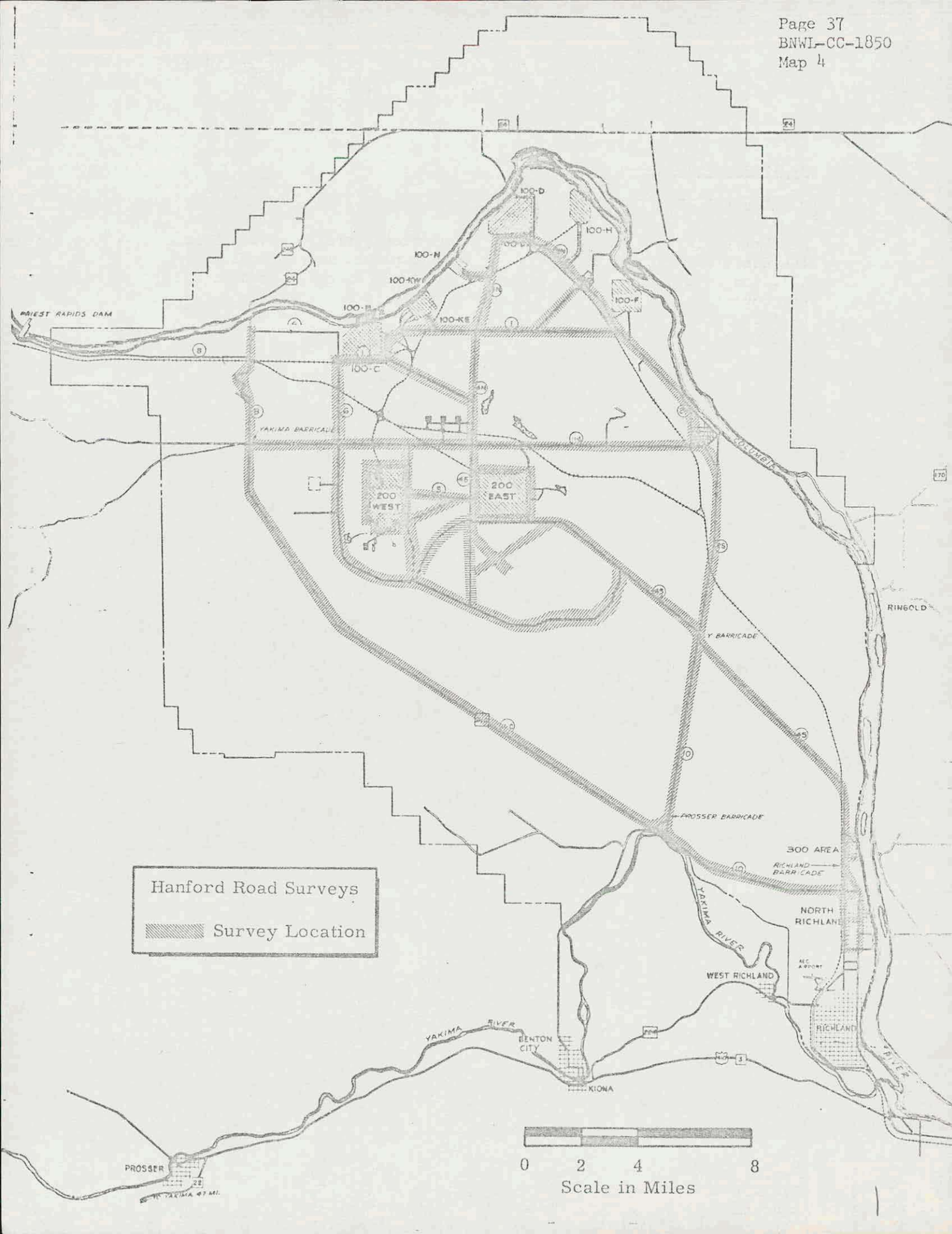
A. Surface Contamination (Continued)

1. Hanford Roads (Continued)

numerous than previously reported, the contamination levels and extent of the spread of this material from the 200 B-C Crib Area is not believed to be significantly different from a year ago.

June - Radiation levels of 200 to 400 c/m were found on sands and gravels used for fill along George Washington Way in North Richland. Radioanalysis showed the activity to be predominantly ^{65}Zn, ^{54}Mn, and ^{137}Cs. These levels and the radionuclide spectrum are typical of the river shoreline in the vicinity of Richland. On subsequent surveys no radiation was detected.

Radioactive weeds inside the fence at the northeast corner of 200 East Area were detected, with a maximum radiation level of 150 mrads/hr (Juno).

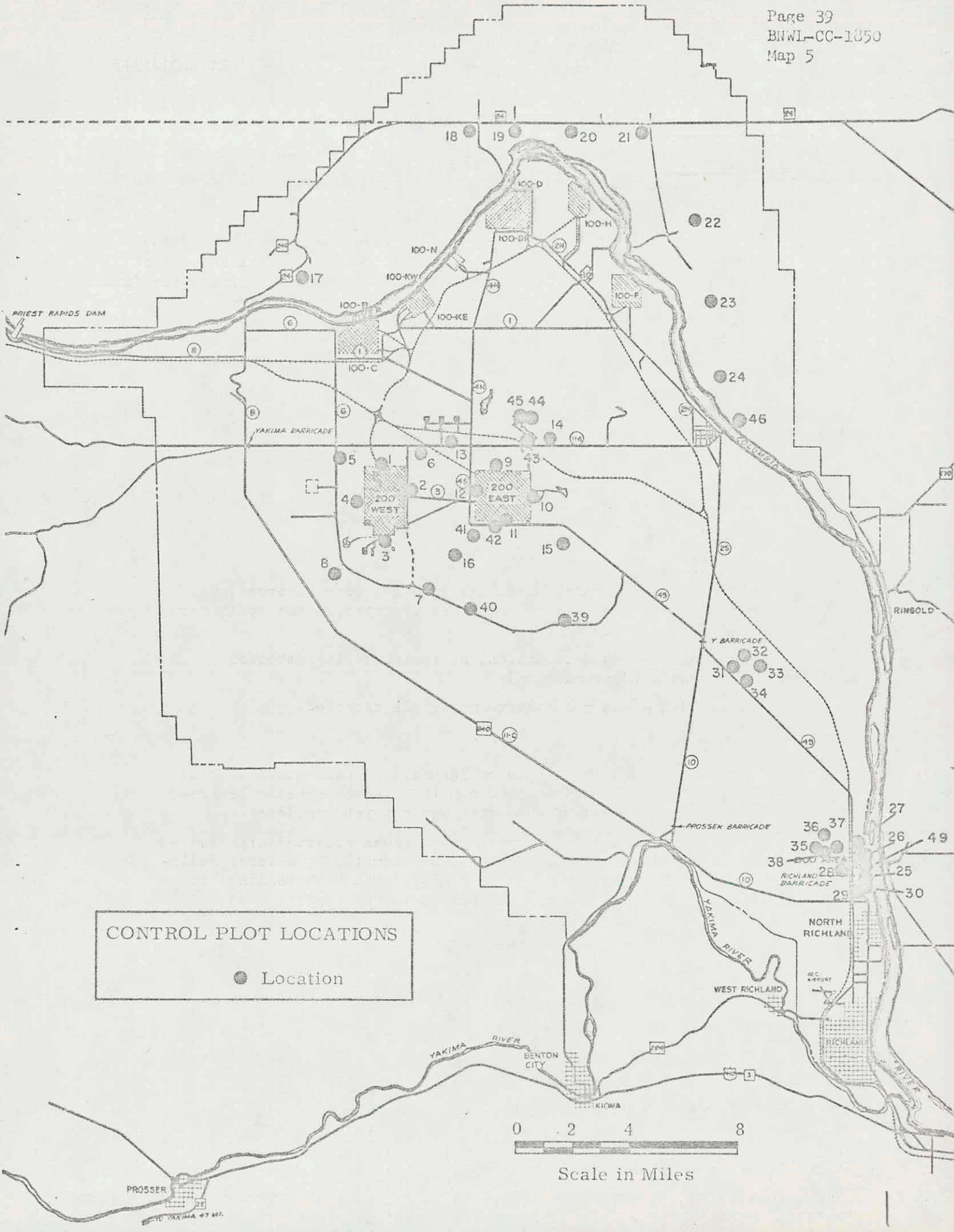

100-D
100-H
100-N
100-KW
100-KE
100-F
100-C
PRIEST RAPIDS DAM
YAKIMA BARRICADE
200 WEST
200 EAST
COLUMBIA
RINGOLD
Y BARRICADE
PROSSER BARRICADE
300 AREA
RICHLAND BARRICADE
NORTH RICHLAND
YAKIMA RIVER
WEST RICHLAND
RICHLAND
YAKIMA RIVER
BENTON CITY
KIONA
PROSSER
Hanford Road Surveys
Survey Location
0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

VI. RADIATION SURVEYS (Continued)

A. Surface Contamination (Continued)

2. Control Plots

Forty-six land areas, called control plots, are located within the Hanford boundaries (see Map 5). These plots, measuring 10' by 10', are periodically surveyed with a GM meter in order to detect any deposition of radioactive material. During the period covered by this report, no radioactivity was detected on the routine control plots.


CONTROL PLOT LOCATIONS
Location
0 2 4 8
Scale in Miles
PRIEST RAPIDS DAM
YAKIMA BARRICADE
100-D
100-H
100-DR
100-N
100-KW
100-F
100-KE
100-B
100-C
200 WEST
200 EAST
Y BARRICADE
PROSSER BARRICADE
RICHLAND BARRICADE
RINGOLD
NORTH RICHLAND
WEST RICHLAND
RICHLAND
YAKIMA RIVER
BENTON CITY
KIONA
PROSSER

VI. RADIATION SURVEYS (Continued)

A. Surface Contamination (Continued)

3. Waste Disposal Sites

Retired waste burial grounds are inspected periodically for general condition and evidence of disturbance. The locations of such sites outside plant areas are shown in Map 6. During the first half of 1968, inspections were made of the burial sites listed below with the findings. Where unsatisfactory conditions were found, the appropriate custodian was notified.

January

P-11 - Good condition, no radioactivity detected.

100-F - Gate chain was down. This site appeared to be still active, as many waste containers were exposed within an open trench.

100-H - No signs posted, no radioactive materials detected.

April

P-11 - Several small animal holes were observed, but no radioactivity was detected on the spoil from these holes.

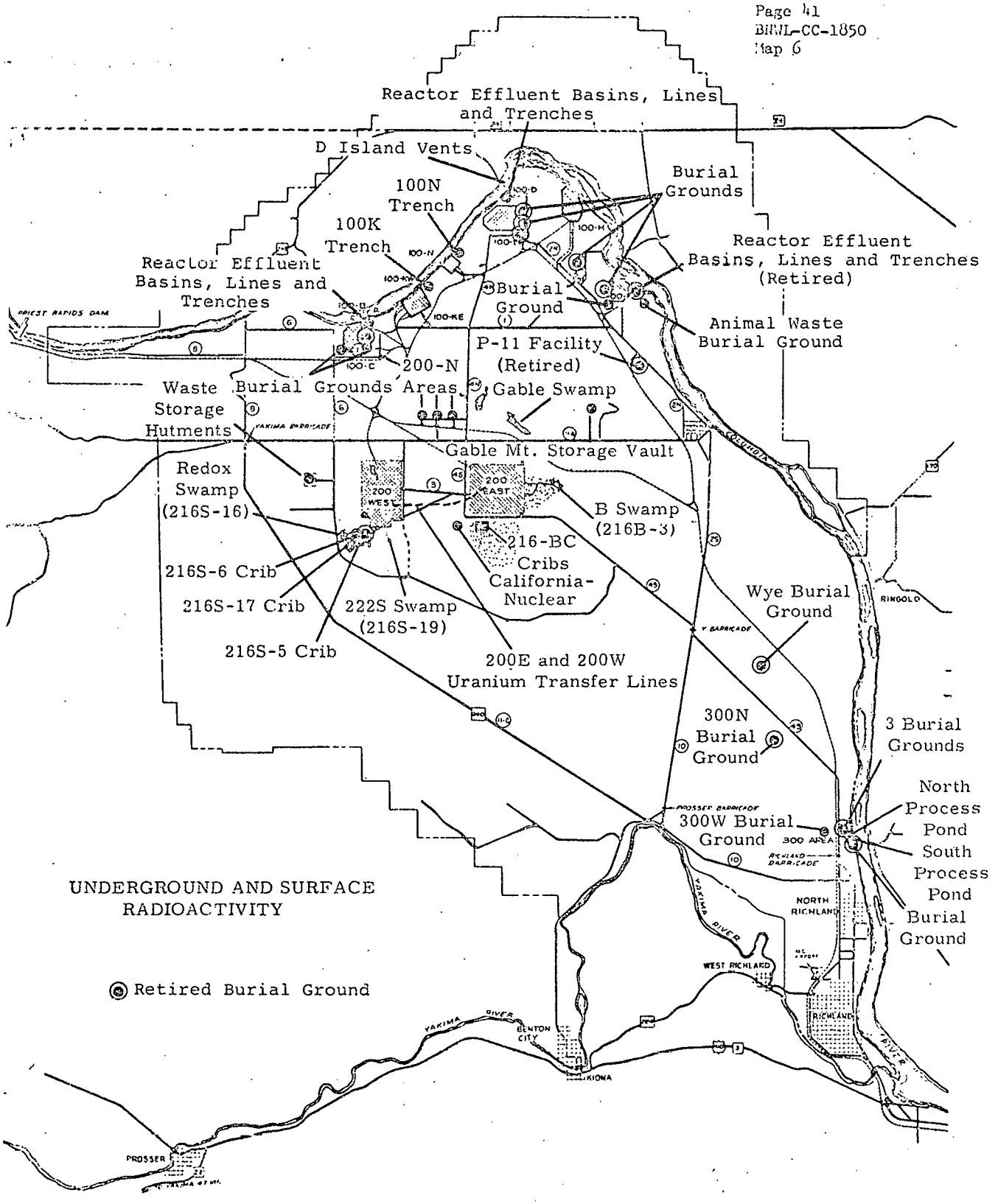
White Bluffs (Construction) - Good condition, no radioactivity detected.

100-H - No radioactive materials detected.

June

Wye - A small pile of lead bricks with contamination levels to 3000 c/m (GM) was observed. Retirement of this site was not yet complete.

300 Area North - Exposed vertical piping was observed with radiation levels to 75,000 c/m (GM). Several radioactive weeds were also found with readings to 10,000 c/m. A bucket on the surface read 8000 c/m.


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

VI. RADIATION SURVEYS (Continued)

A. Surface Contamination (Continued)

4. Aerial Surveys

No aerial survey flights were made during the period January-June 1968.

VI. RADIATION SURVEYS (Continued)

B. External Radiation Exposure Rates

1. Exposure Rates on-Plant

External radiation exposure rates (in units of mR/day) were determined from pencil-type gamma dosimeters located within buildings designated "614" (Map 7). The average results for the first half of 1968 are presented in Table 8 below.

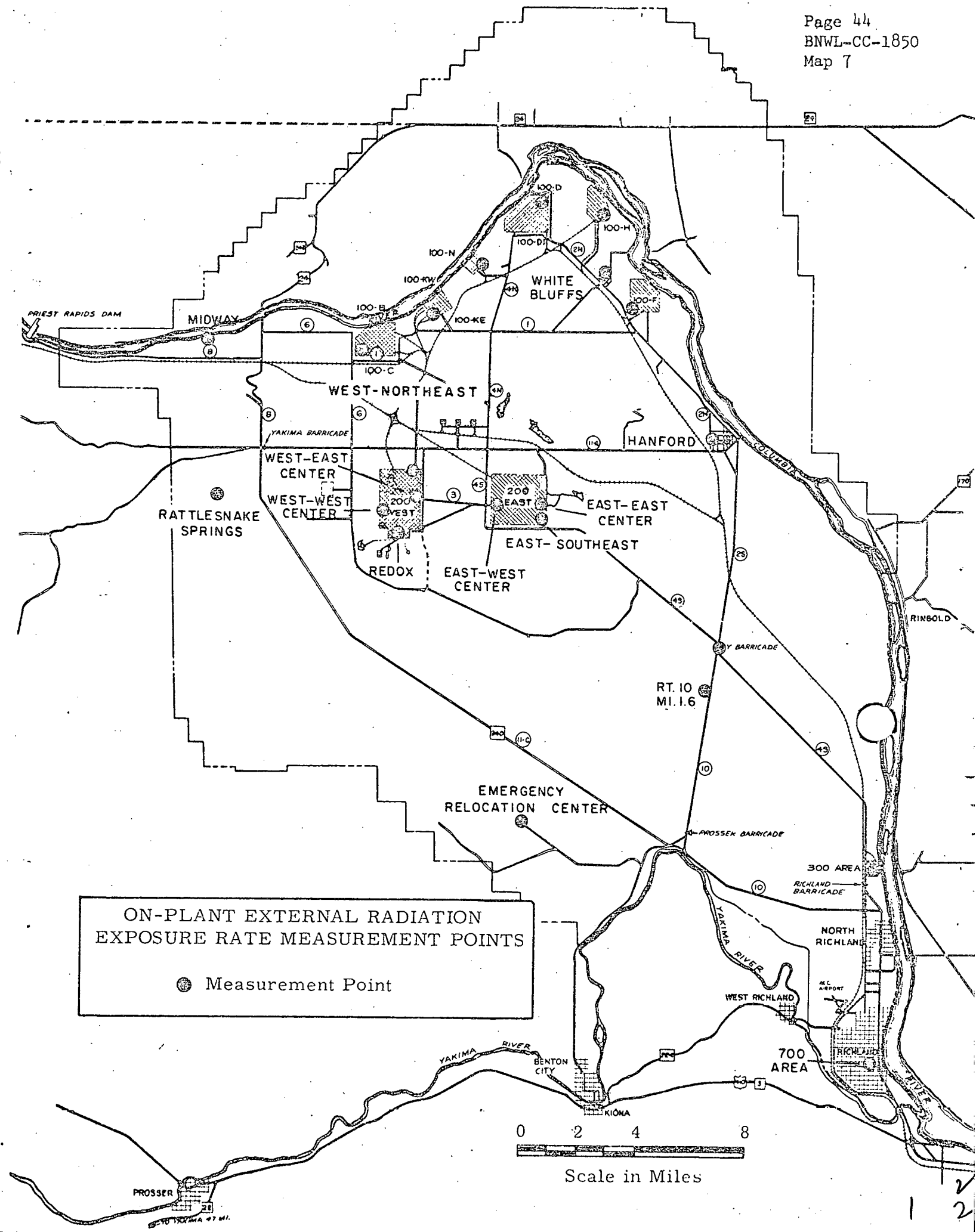
Measured exposure rates were about the same in 1968 as in 1967 at most locations, although significantly higher at 100-K and 100-N Areas. Generally, the peak exposure rate during the first half of 1968 occurred during the last half of January and the first half of February (Figures 20-26), and was primarily due to regional fallout from weapons testing, although augmented by plant releases. A second peak occurred at most stations during the last half of May and the month of June which correlated with an increased influx of fallout at that time.

TABLE 8

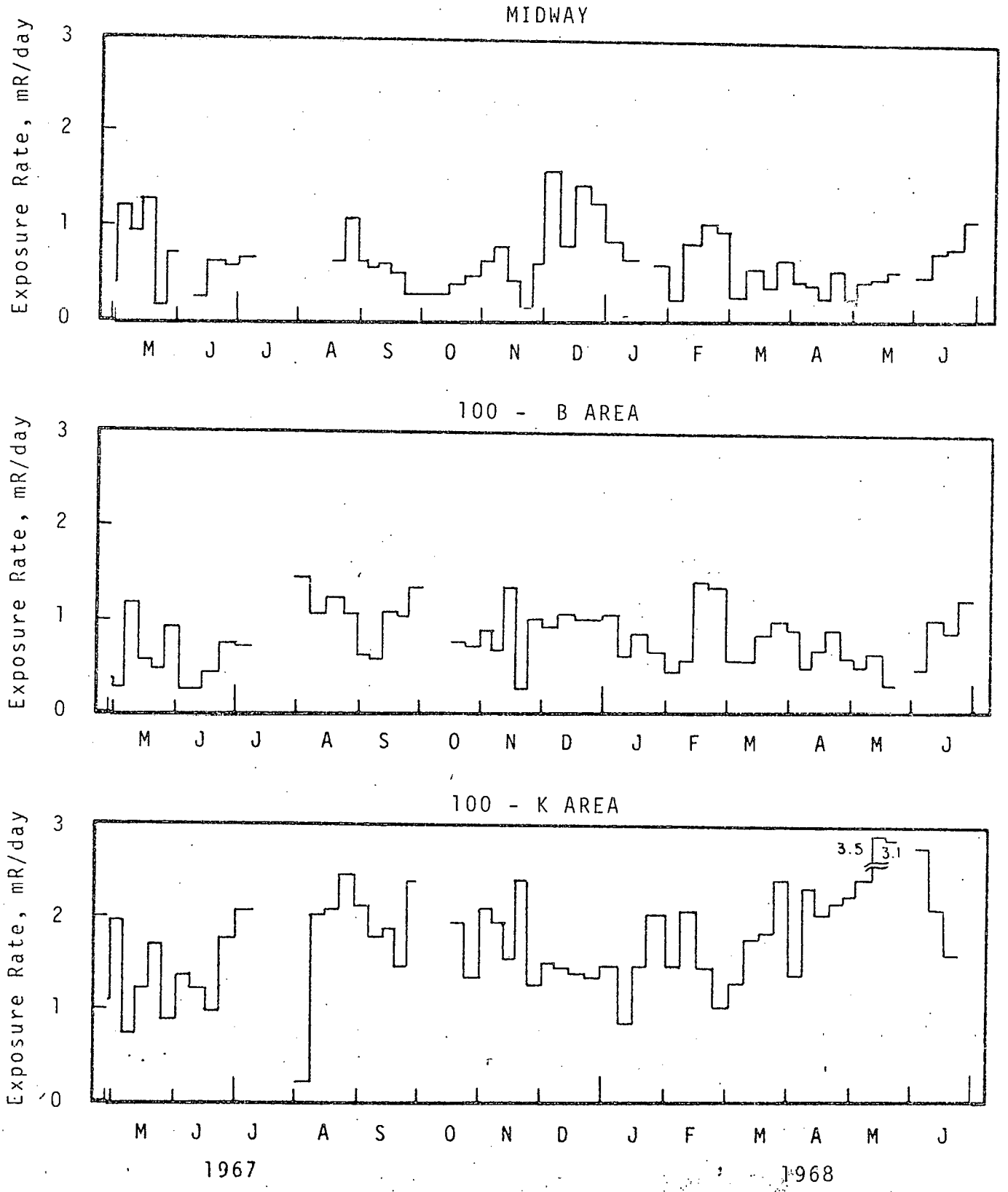
AVERAGE EXPOSURE RATES
(Results in mR/day)

	Location	January-June 1968	January-December 1967
100 Areas	Midway	0.57	0.58
	100-B	0.82	0.72
	100-K	2.13	1.5
	100-N	1.38	0.83
	100-D	0.73	0.56
	100-F	0.68	0.39
	Hanford	0.92	0.59
200 West Area	Redox	0.56	0.59
	West Center	0.41	0.43
	East Center	0.41	0.44
200 East Area	West Center	0.52	0.37
	East Center	0.50	0.55
	Southeast	0.46	0.39
Other	Rattlesnake Springs	0.40	0.45
	Emergency Relocation Center	0.40	0.38
	*Wye Barricade	0.62	0.58
	Rt. 10 Mile 1.6	0.38	0.35
	300 Area	0.55	0.48
	700 Area	0.31	0.59

* Data for January-April only.


PRIEST RAPIDS DAM
MIDWAY
100-B
100-C
100-D
100-H
100-N
100-KW
100-KE
100-F
WHITE BLUFFS
WEST-NORTHEAST
YAKIMA BARRICADE
HANFORD
COLUMBIA
WEST-EAST CENTER
WEST-WEST CENTER
200 WEST
200 EAST
EAST-EAST CENTER
EAST-SOUTHEAST
RATTLESNAKE SPRINGS
REDOX
EAST-WEST CENTER
RINGOLD
Y BARRICADE
RT. 10 MI. 1.6
EMERGENCY RELOCATION CENTER
PROSSER BARRICADE
300 AREA
RICHLAND BARRICADE
YAKIMA RIVER
NORTH RICHLAND
WEST RICHLAND
700 AREA
BENTON CITY
KIONA
PROSSER
ON-PLANT EXTERNAL RADIATION
EXPOSURE RATE MEASUREMENT POINTS
Measurement Point
0 2 4 8
Scale in Miles

EXTERNAL RADIATION ON PLANT



EXTERNAL RADIATION ON PLANT

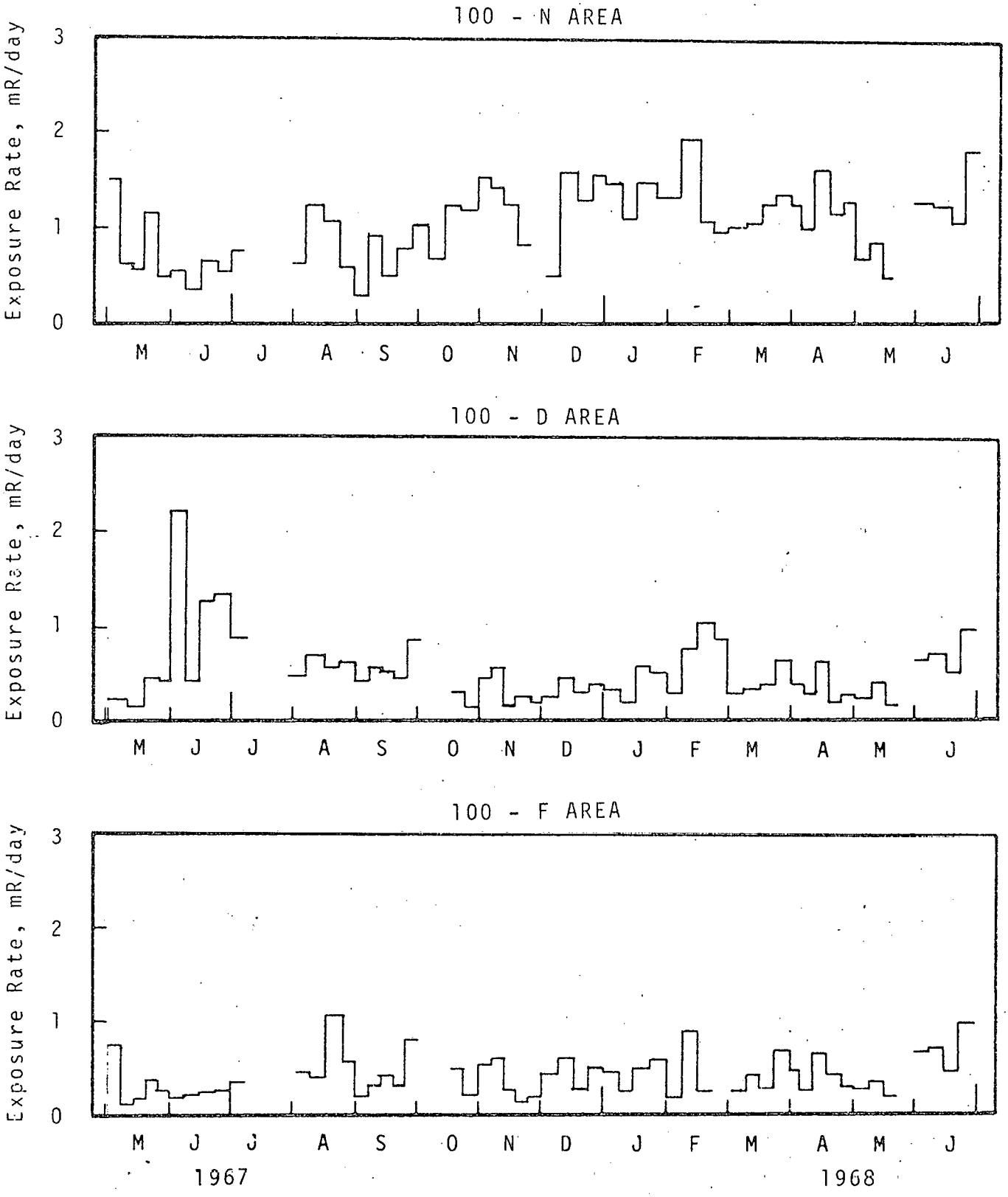


Figure 22

EXTERNAL RADIATION ON PLANT

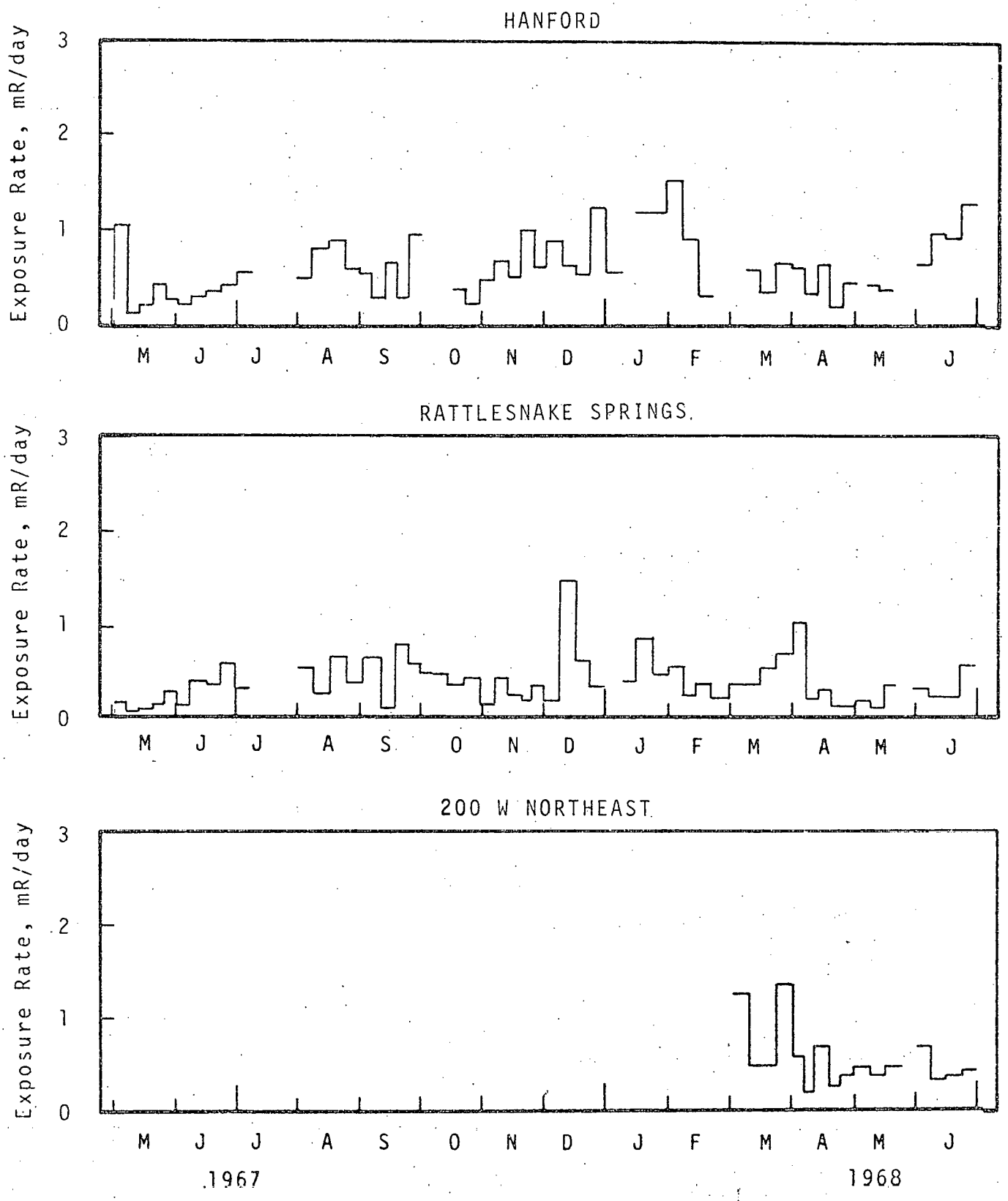
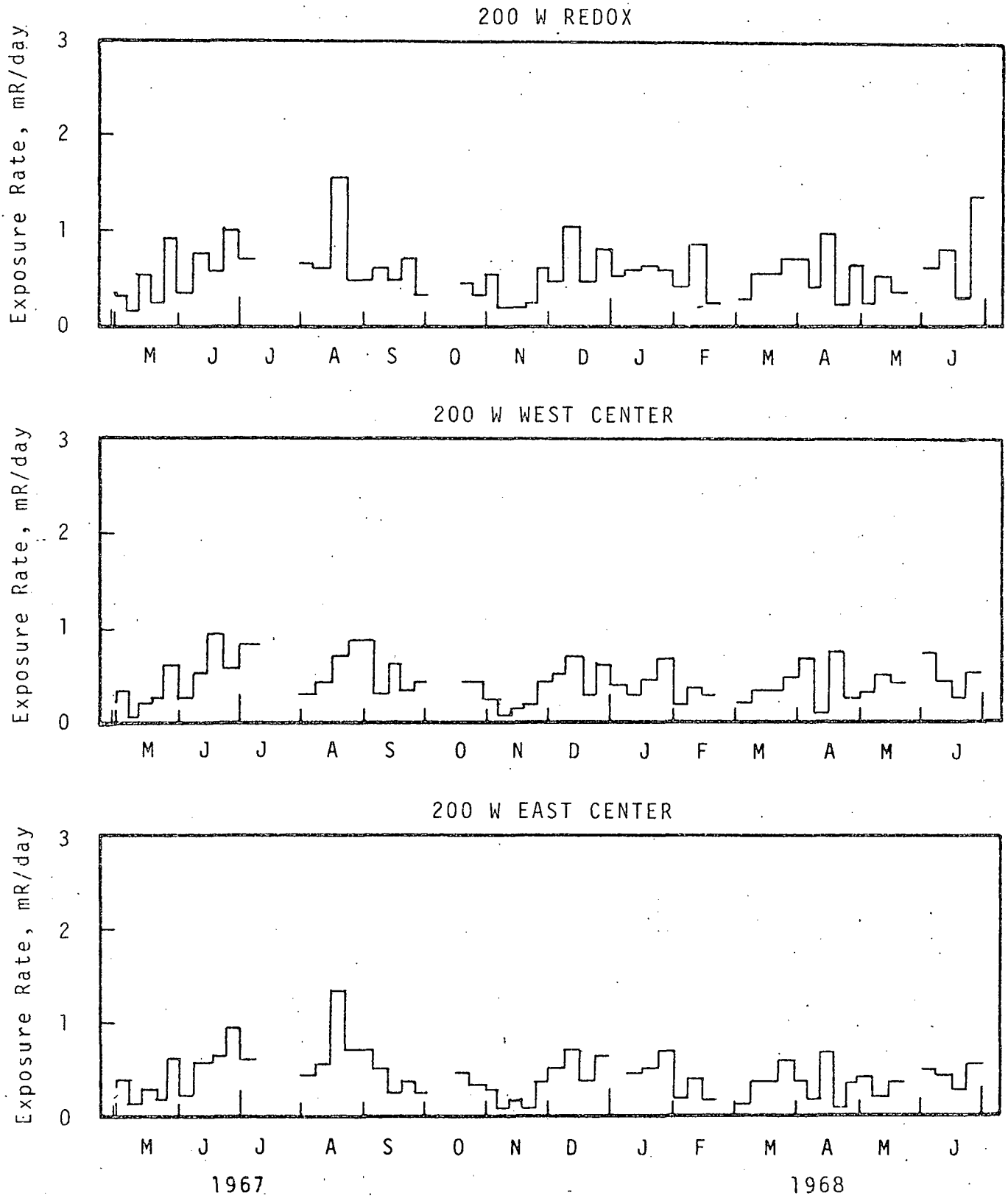


Figure 23

EXTERNAL RADIATION ON PLANT



EXTERNAL RADIATION ON PLANT

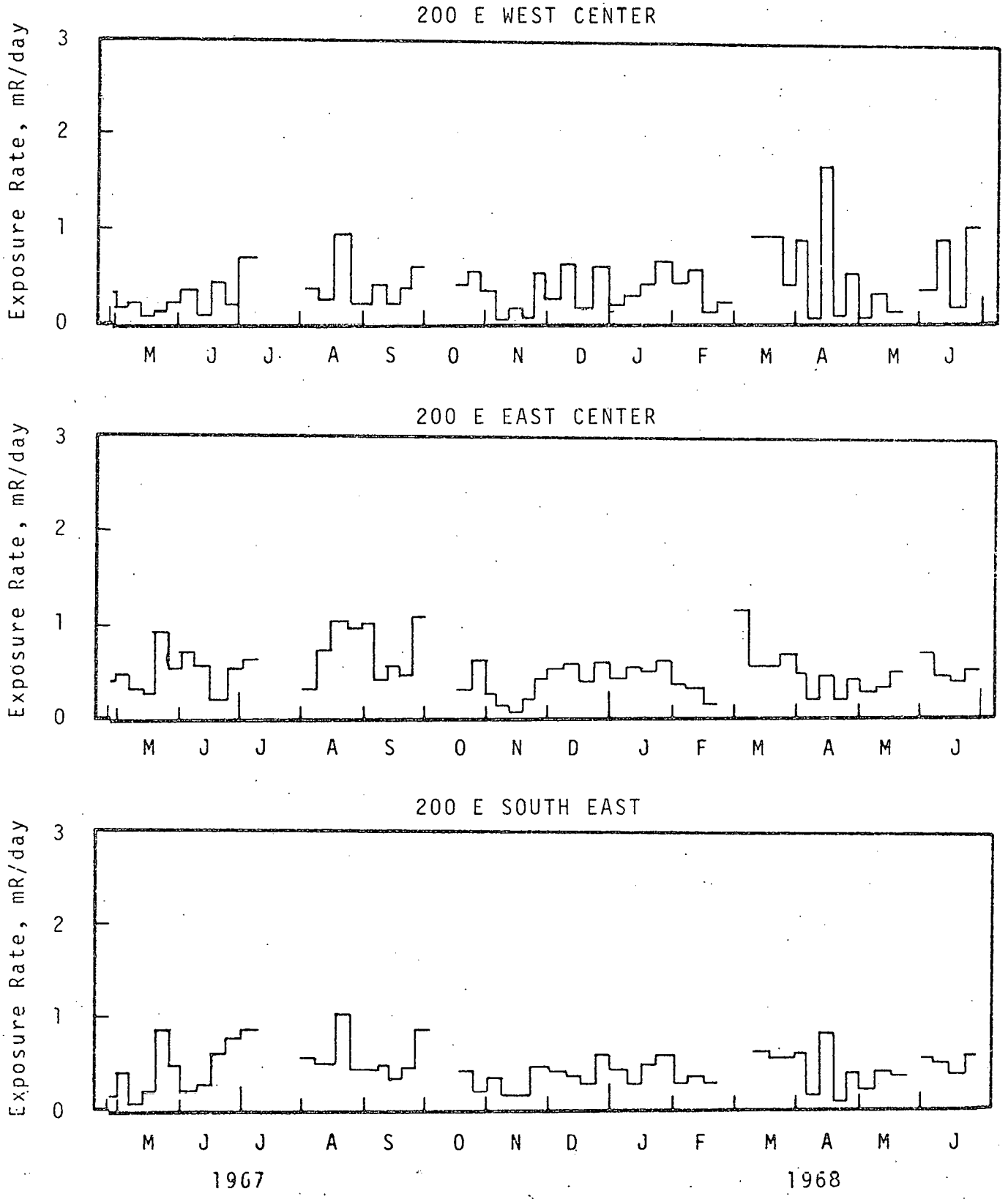


Figure 25

EXTERNAL RADIATION ON PLANT

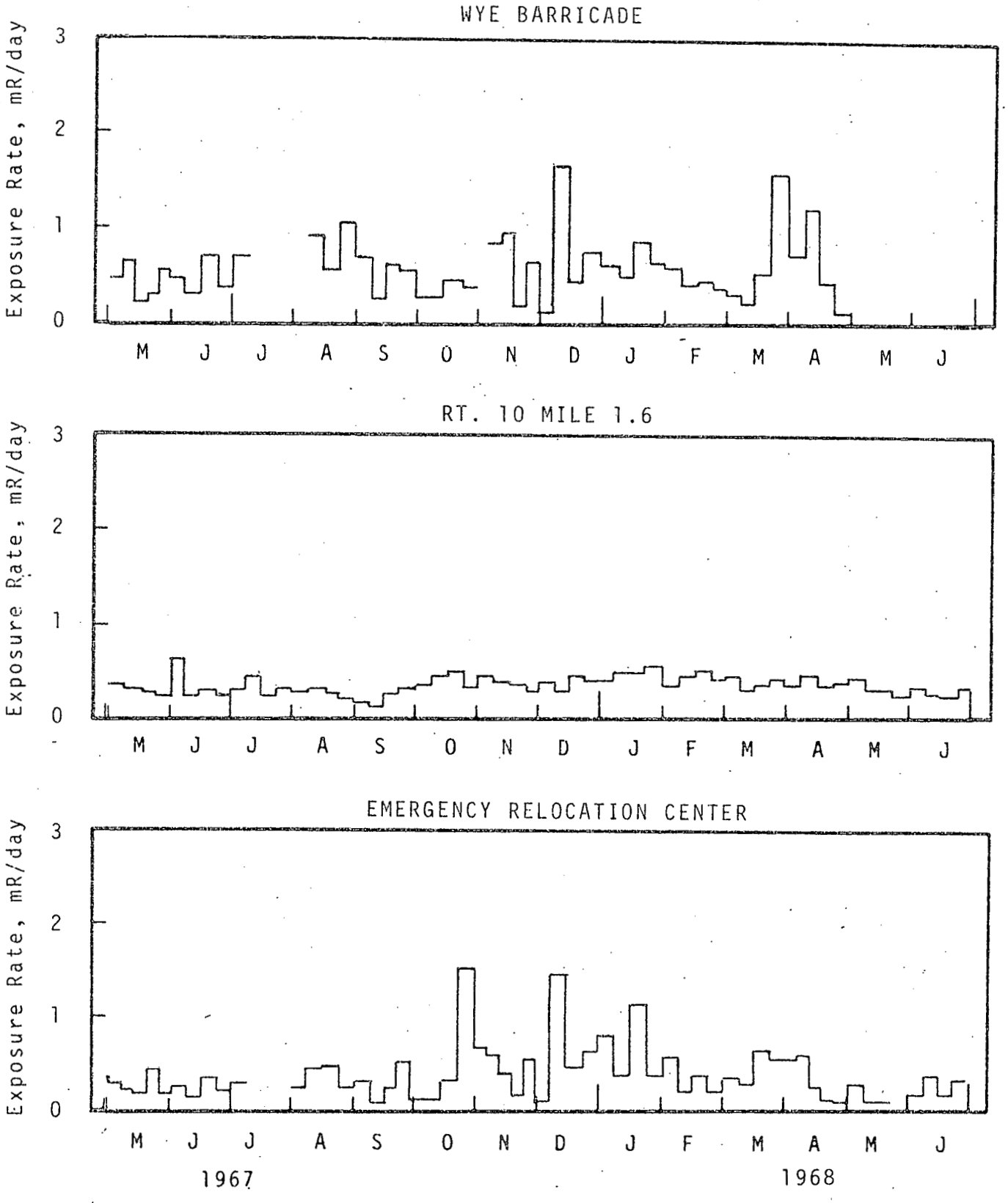
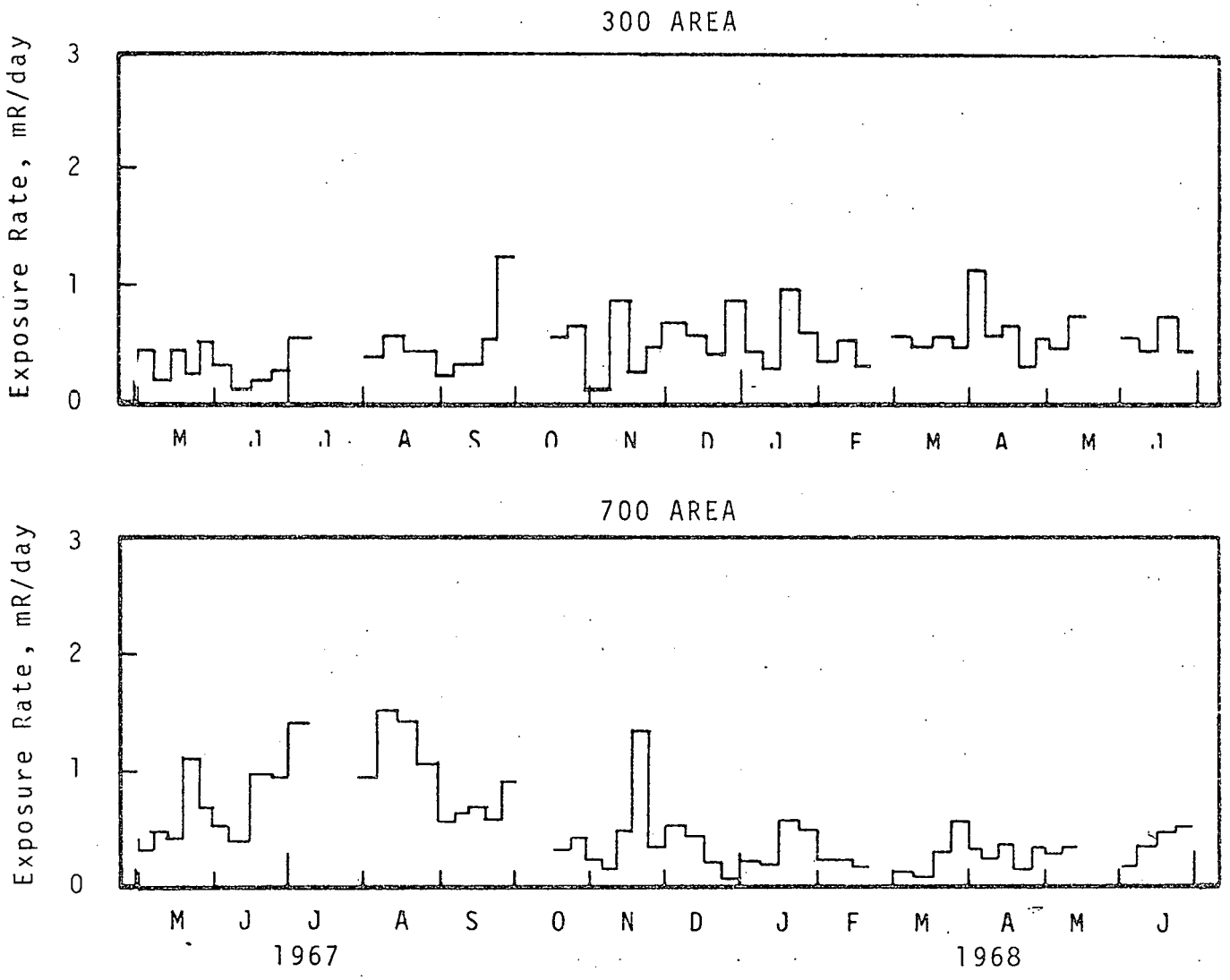


Figure 26

EXTERNAL RADIATION ON PLANT



VI. RADIATION SURVEYS (Continued)

B. External Radiation Exposure Rates (Continued)

2. Exposure Rates at the Columbia River Shoreline

Shoreline exposure rates (Map 8 and Figures 27 and 28) are measured weekly at 3 feet above the ground with a 40-liter ionization chamber whose response is interpreted in terms of μR/hr (radium gamma calibration). This approximates the exposure rate to the gonads of a person standing on the riverbank. Additional monthly shoreline surveys, covering the reach of the river from the reactor outfalls to Richland, include both the exposure rate at 3 feet and the levels of surface contamination as measured with a portable GM meter. The data are presented in Table 9.

In addition to the effect of the annual river flow cycle, seasonal increases in shoreline exposure rates are normally expected in March and April when increased concentrations in the Columbia River of stable ^{55}Mn due to spring run-off result in increased concentrations of ^{56}Mn.

During the first half of 1968, shoreline exposure rates and particulate frequency at locations below the plant boundary continued to show increases compared to 1966-1967. These increases were observed during the latter half of 1967 and were attributed to a combination of reactor area events and river behavior. The effects of rapidly changing river flow rates were also seen in late June when particulate contamination was detected on a previously-flooded area of the plant shore near PRTR. As usual, the exposure rates decreased in late May when the river flow rate increased.

Unusual results during the period included the following.

January - A shoreline exposure rate of 1500 μR/hr was measured below 100-K. Exposure rates of 50% higher than in 1967 were observed downstream as far as Ringold.

February - Particles of 60,000 c/m were found at both Ringold and the Power Line Crossing during low water following large river fluctuations. Analysis showed predominantly ^{46}Sc, but a number of other radionuclides were detectable.

March - A particle reading 50,000 c/m was found at the Hanford Far Shore location. Analysis showed ^{65}Zn predominating with ^{46}Sc, ^{144}Ce-Pr, ^{51}Cr, and ^{155}Eu also present.

A maximum reading of 4,000 c/m was obtained on mud at the Richland Pump Plant.

May - Several particles with a maximum reading of 75,000 c/m were detected at Ringold and the Power Line Crossing. Patches of foam supporting mixed debris read 25,000 c/m at 100-F Area and 9,000 c/m at Sacajawea Park.

VI. RADIATION SURVEYS (Continued)

B. External Radiation Exposure Rates (Continued)

2. Exposure Rates at the Columbia River Shoreline (Continued)

June - Numerous particles with a maximum of 8,000 c/m were detected on a previously flooded area near the PRTR pump intake. After re-flooding and re-exposure, most of the particulate material was gone, and a maximum reading of 4,000 c/m was obtained on the remaining debris.

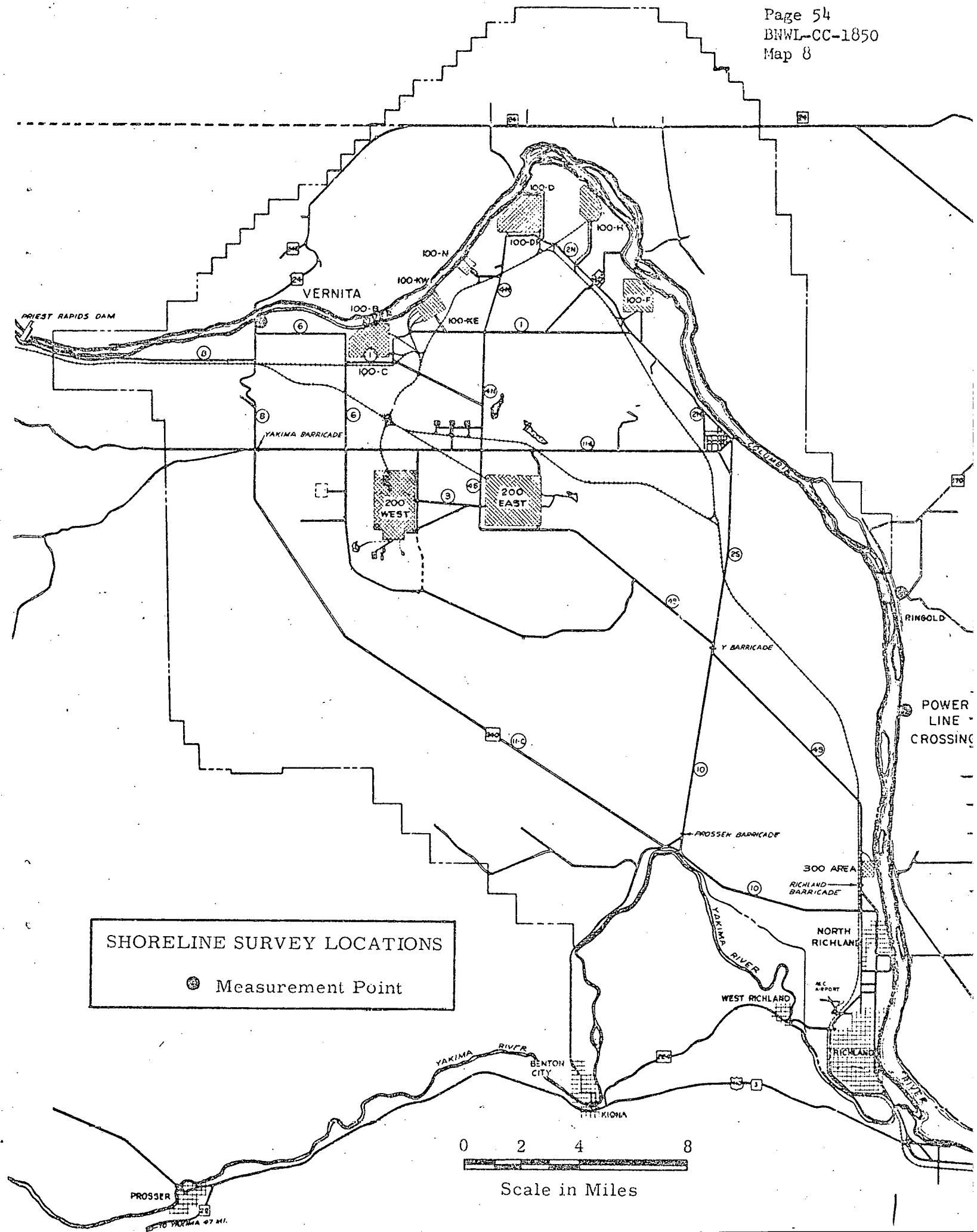

VERNITA
PRIEST RAPIDS DAM
100-B
100-C
100-D
100-DR
100-H
100-N
100-KW
100-KE
100-F
YAKIMA BARRICADE
200 WEST
200 EAST
COLUMBIA
RINGOLD
Y BARRICADE
POWER LINE CROSSING
PROSSER BARRICADE
300 AREA
RICHLAND BARRICADE
NORTH RICHLAND
YAKIMA RIVER
WEST RICHLAND
RICHLAND
BENTON CITY
KIONA
PROSSER
SHORELINE SURVEY LOCATIONS
Measurement Point
0 2 4 8
Scale in Miles

Figure 27

EXTERNAL RADIATION AT THE COLUMBIA RIVER SHORELINE

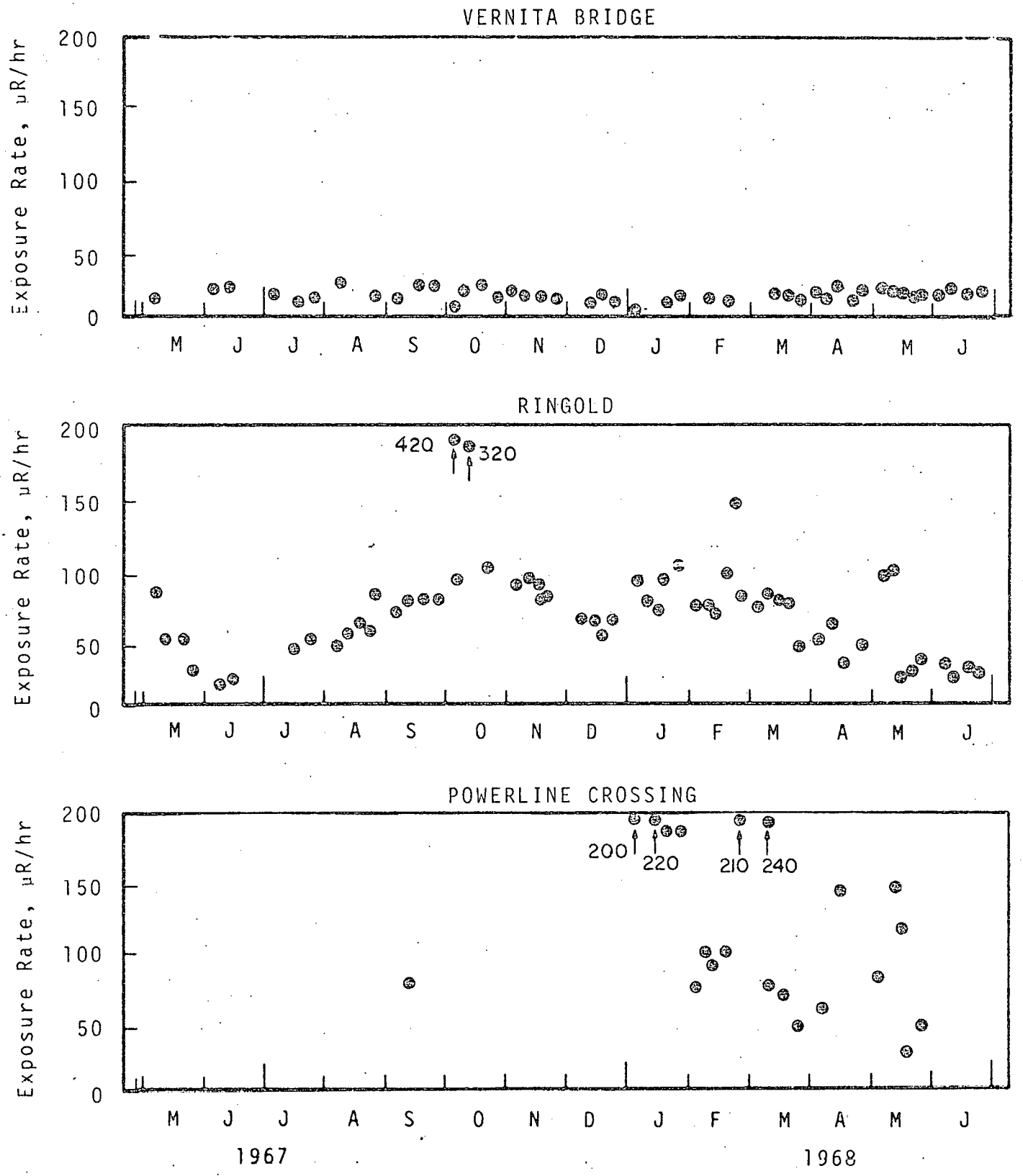


Figure 28

EXTERNAL RADIATION AT THE COLUMBIA RIVER SHORELINE

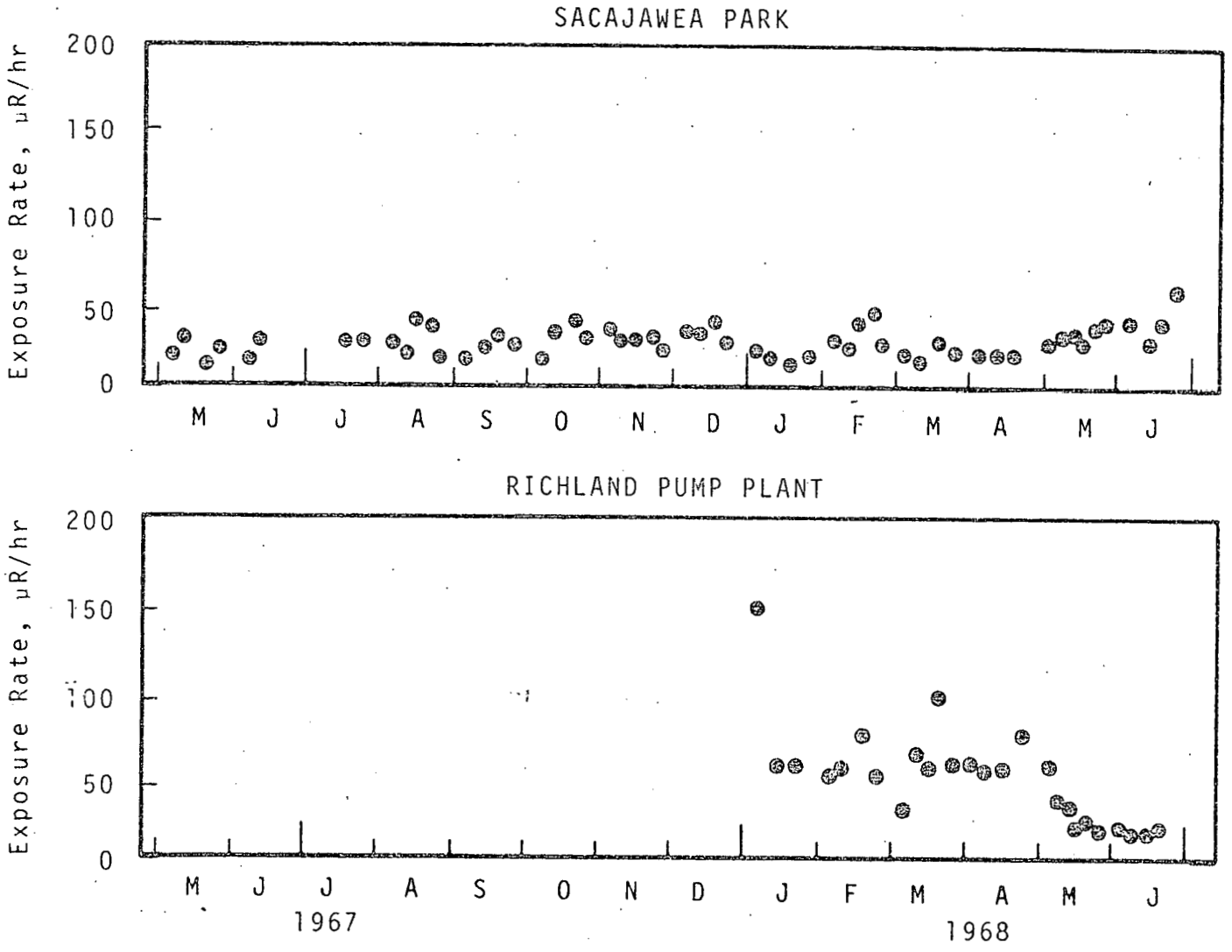


TABLE 9

MONTHLY RIVER SHORELINE SURVEYS - JANUARY-JUNE, 1968

(Maximum Readings)

Location	January 17		February 2		March 21		May 3		May 28		June 27	
	µR/hr @ 3ft.	c/m @ Surf.	µR/hr @ 3ft.	c/m @ Surf.	µR/hr @ 3ft.	c/m @ Surf.	µR/hr @ 3ft.	c/m @ Surf.	µR/hr @ 3ft.	c/m @ Surf.	µR/hr @ 3ft.	c/m @ Surf.
Above 181-KW-Plant Shore	90	500	90	500	64	300	50	200	45	100	56	250
Below 181-KW-Plant Shore	140	800	1550	3000	180	1000	150	700	70	150	67	250
Below 181-KW-Far Shore	26	250	34	500	22	100	24	100	40	100	14	200
Above 181-NE-Plant Shore	130	400	170	2500	100	700	150	2000	36	150	20	250
Below 181-NE-Plant Shore	130	2000	140	2500	100	600	155	2000	28	150	26	200
Above 181-D-Far Shore	20	250	22	200	26	100	30	100	24	100	18	150
D Island-Far Shore	300	2500	240	3000	96	500	190	1000	54	300	46	800
Below 181-D-Plant Shore	125	800	125	2000	72	400	205	2200	55	300	28	300
Below 181-D-Far Shore	36	250	38	250	28	100	34	100	23	100	15	150
Below 181-H-Plant Shore	260	2500	165	2500	98	600	150	2000	40	100	36	400
White Bluffs Ferry-Plant Shore	180	800	190	3000	74	400	115	800	30	150	23	200
White Bluffs Ferry-Far Shore	86	600	110	2500	38	150	46	300	28	100	15	150
Hanford-Plant Shore	175	1000	110	2000	76	500	120	1500	58	300	23	200
Hanford-Far Shore	75	500	120	2000	81	300	58	500	27	100	22	200
Ringold-Far Shore	76	600	86	800	42	300	60	800	26	200	18	200
Powerline-Plant Shore	200	1000	160	2000	100	600	110	700	27	250	37	450
Powerline-Far Shore	170	600	190	1000	74	500	90	600	22	200	23	200
Byer's Landing-Far Shore	56	250	88	1000	65	250	50	200	56	200	38	400
PRTR-Plant Shore	86	600	98	900	82	1000	92	1000	32	200	26	250
Richland Ferry-Plant Shore	42	400	54	500	50	1500	85	700	42	200	24	200

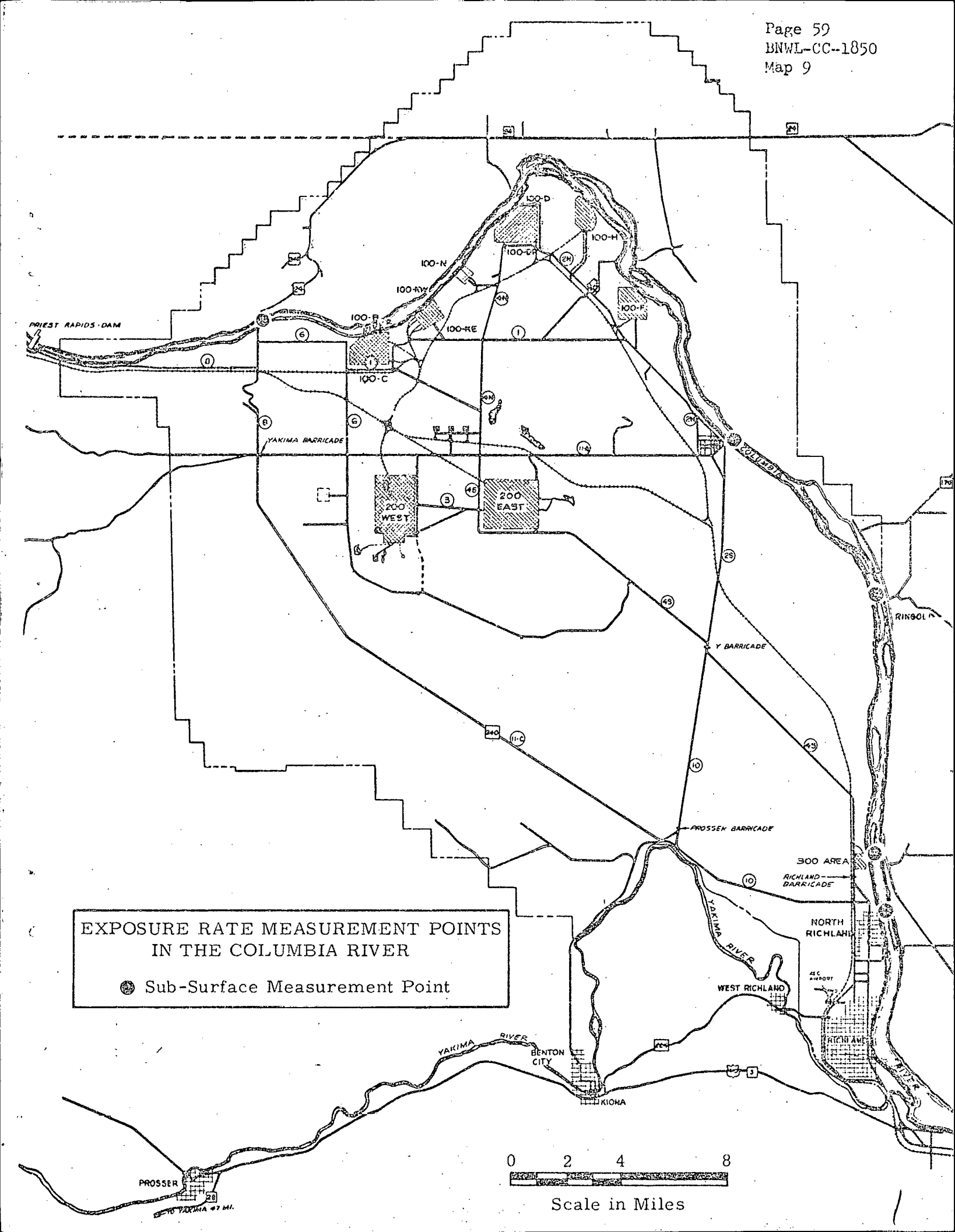
Notes: Measurements reported in µR/hr are taken with a 40-liter ionization chamber, the center of the chamber 3 ft. above the water's edge; measurements reported in c/m are the maximum found with a GM in the immediate area of the water's edge.

VI. RADIATION SURVEYS (Continued)

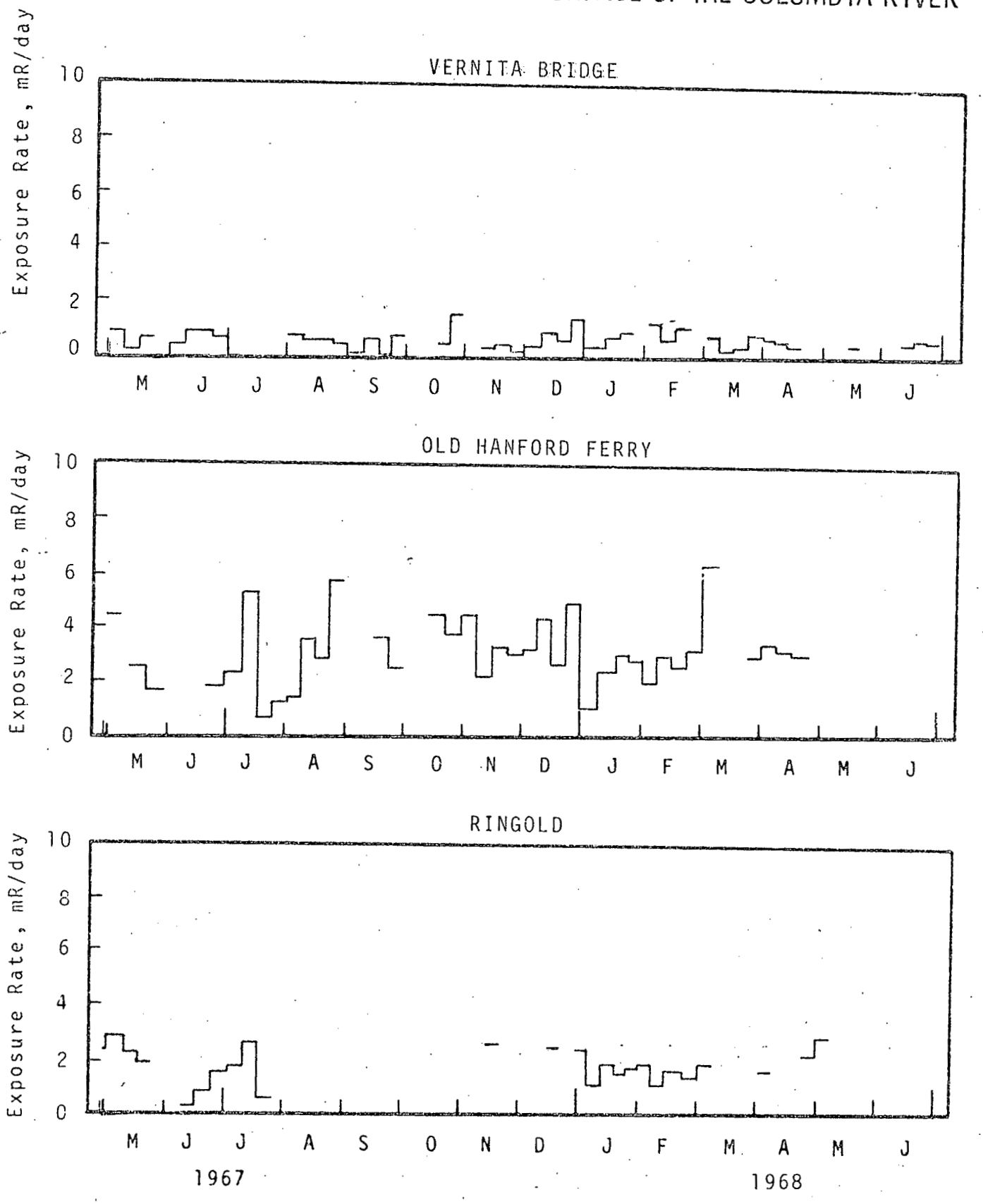
B. External Radiation Exposure Rates (Continued)

3. Exposure Rates Below the Surface of the Columbia River

Exposure rates in the river were determined from pocket dosimeters contained within submerged bottles at the locations shown in Map 9. Missing data were the result of lost containers or equipment malfunctions. (See Figures 29 and 30). Average dose rates for the first half of 1968 at the 300 Area and Richland were somewhat lower than for the same period of 1967.


EXPOSURE RATE MEASUREMENT POINTS
IN THE COLUMBIA RIVER
Sub-Surface Measurement Point
PRIEST RAPIDS DAM
100-D
100-H
100-DR
100-N
100-RX
100-B
100-RE
100-F
100-C
YAKIMA BARRICADE
200 WEST
200 EAST
COLUMBIA
Y BARRICADE
RINGOLD
PROSSER BARRICADE
300 AREA
RICHLAND BARRICADE
NORTH RICHLAND
YAKIMA RIVER
WEST RICHLAND
RICHLAND
BENTON CITY
KIONA
PROSSER
0 2 4 8
Scale in Miles

EXTERNAL RADIATION BELOW THE SURFACE OF THE COLUMBIA RIVER



EXTERNAL RADIATION BELOW THE SURFACE OF THE COLUMBIA RIVER