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ENVIRONMENTAL STATUS OF THE HANFORD RESERVATION FOR DECEMBER, 1966 (ANNUAL SUMMARY)

AUTHOR

T. H. Essig and R. B. Hall

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ENVIRONMENTAL STATUS OF THE HANFORD RESERVATION FOR DECEMBER, 1966 (ANNUAL SUMMARY)

By

T. H. Essig and R. B. Hall

Evaluations and Measurements Unit
Environmental Studies Section

ENVIRONMENTAL HEALTH AND ENGINEERING DEPARTMENT

March 20, 1967

PACIFIC NORTHWEST LABORATORY
RICHLAND, WASHINGTON
operated by
BATTELLE MEMORIAL INSTITUTE
for the
UNITED STATES ATOMIC ENERGY COMMISSION UNDER CONTRACT AT(45-1)-1830

84-1100-087 (6-68)
AEC-RLOO RICHLAND, WASH.

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ENVIRONMENTAL STATUS OF THE HANFORD RESERVATION FOR DECEMBER, 1966 (ANNUAL SUMMARY)

I. Introduction

The purpose of the on-site Hanford environmental surveillance program is threefold: (1) to assess radiation exposures to plant personnel which may result from Hanford waste disposal practices, (2) to detect the spread of radioactive materials outside of areas under direct control of operating contractors, and (3) to detect and assess unusually large releases of radioactive materials to the environs.

This report contains data collected within the Hanford Reservation for the on-site environmental surveillance program by the Evaluations and Measurements Unit, Environmental Studies Section, Environmental Health and Engineering Department, Battelle-Northwest. These environmental measurements are reported here for the information of the Richland Operations Office of the Atomic Energy Commission and its contractors.

All data from off-site sample analyses will be presented in the annual report, "Evaluation of Radiological Conditions in the Vicinity of Hanford for 1966", scheduled for issuance in June, 1967.

The next issue of this report will start a new year and contains a new set of graphs. It is suggested that this report for December, 1966, be retained for reference purposes by those readers who wish to make comparisons of 1967 data with those plotted here for 1966. Since this report contains all data collected during 1966 for the environmental surveillance program, the reader may, if he wishes, discard all previous reports in the BNWL-CC 637 series.

The "analytical limit", as used herein, is defined as the concentration at which the laboratory can measure a radionuclide with a precision of $\pm$ 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.

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

II. Surveillance Summary - 1966

During 1966, members of a population group having more restrictive radiation dose standards than the radiation zone workers were present in increasing numbers in the Hanford plant environs. This population group included persons regularly working on plant who are not employees of the AEC or its contractors, and for the first time, AEC and contractors' families were given routine access to the Hanford environs.

A summary of 1966 surveillance highlights is given below, with references to the page number(s) where more detail on the subject appears. The topics to be summarized are, in order of discussion, as follows:

1. Liquid waste handling and disposal
2. Transportation of radioactive materials
3. Gaseous waste disposal
4. Fallout from nuclear weapons testing

Three significant changes in environmental radiation levels related to liquid waste disposal to the Columbia River occurred during the year. A fuel element failure on February 11, 1966, resulted in the release of a large quantity of radioiodine to the river; however, the effects of the release were primarily off-plant in nature. During late March through mid-April, the annual increase in Mn^{56} concentrations which accompanies the spring run-off resulted in radiation levels of 50 mrads/hr at the river shoreline near White Bluffs (p. 66). During the extended reactor shutdown in July and August, concentrations of radionuclides in river water and drinking water fell below their respective analytical limits and remained there until shortly after reactor startup in late August (pp. 6,10). Shoreline exposure rates (principally at two upstream locations) started to increase as the river flow rate decreased during the summer months, but decreased following reactor shutdown (p. 66).

Liquid waste treatment and disposal operations in the chemical separations areas resulted in several instances of particulate contamination on the ground during the year (pp. 37,41,43), and in higher than normal total beta activity in the atmosphere during mid-October and late November (pp. 24,25). Iodine-131, which is not normally found in open liquid waste disposal sites, was measured in B Swamp water during October after the laboratory found this nuclide in duck flesh (pp. 12,21).

Contamination resulting from transportation of radioactive materials was detected twice during the year. During a railroad survey in March, contamination was found at five locations (pp. 37,38). In September, fourteen spots of contamination attributed to waste truck leakage were found on the highway north of the 300 Area (p. 38).

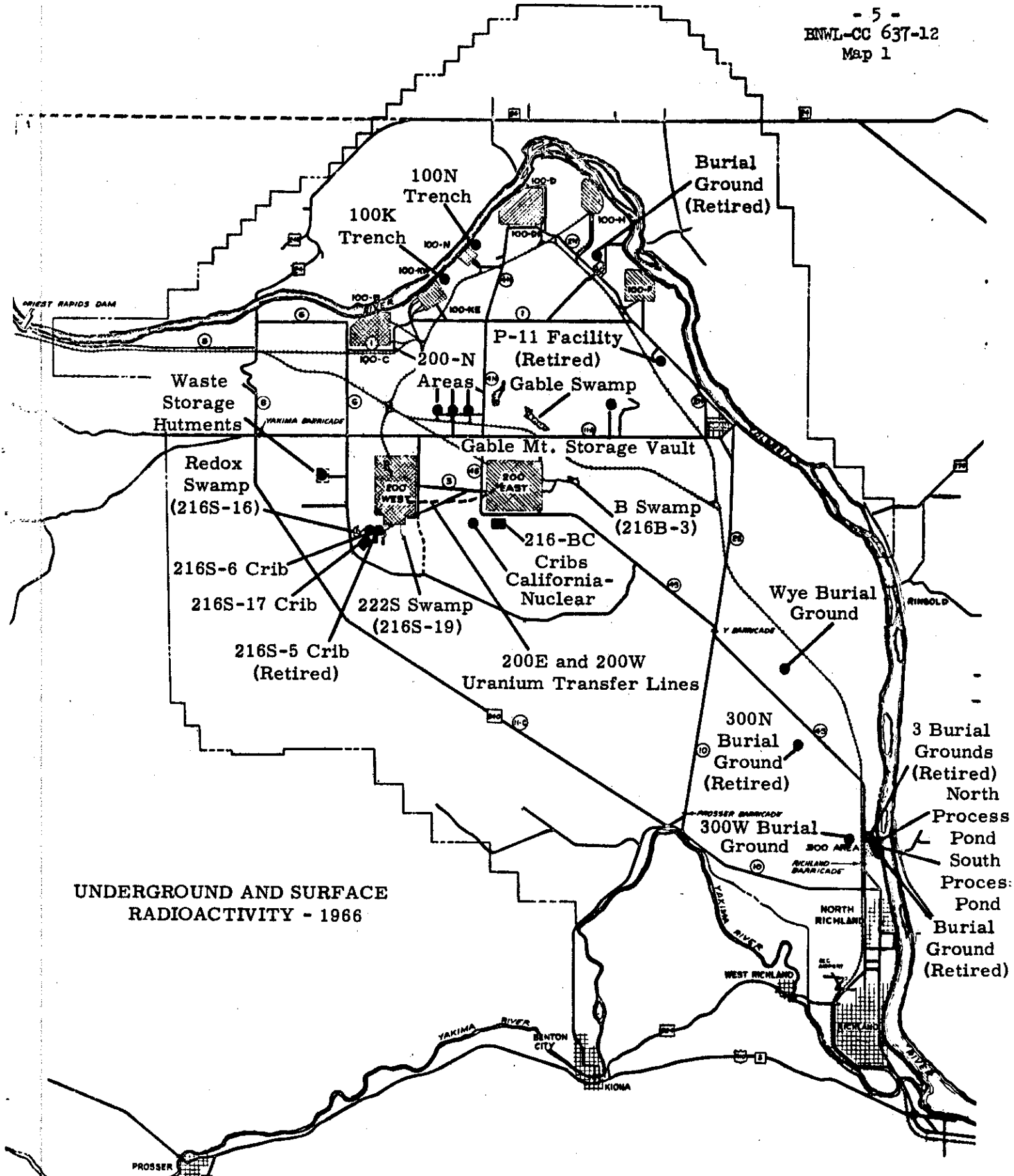
Two significant increases in concentrations of I^{131} (associated with gaseous waste disposal) in the atmosphere were noted during the year. During July, I^{131} concentrations increased to 2 pCi/m^3, and during October, concentrations increased to 1 pCi I^{131}/m^3 at 200 Area sampling locations, following an increase in the emission rate of I^{131} from a chemical separations facility (p. 24).

Fallout from nuclear weapons testing was detected twice during 1966. An increase in atmospheric total beta activity was noted at many air sampling locations following the May 9 Chinese weapons test and the October 27 Chinese and Russian nuclear tests. Maximum concentrations were about 5 pCi β/m^3 on May 23 and 2 pCi β/m^3 on November 7 (pp. 23,25).

The radiation exposures to radiation workers from all environmental sources were estimated to be < 0.3 percent of the applicable limits.

III. Summary of Underground and Surface Radioactivity

There are several locations within the Hanford project outside of area perimeter fences which contain underground or surface radioactivity and, therefore, require controlled access. These sites include swamps, ponds, burial grounds, etc., and are shown in Map 1 which follows.


100N Trench
100K Trench
Burial Ground (Retired)
P-11 Facility (Retired)
200-N Areas
Gable Swamp
Waste Storage Hutments
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 (Retired)
200E and 200W Uranium Transfer Lines
Wye Burial Ground
300N Burial Ground (Retired)
3 Burial Grounds (Retired)
North Process Pond
South Process Pond
300W Burial Ground
Burial Ground (Retired)
UNDERGROUND AND SURFACE RADIOACTIVITY - 1966
PRIEST RAPIDS DAM
YAKIMA BARRICADE
PROSSER BARRICADE
RICHLAND BARRICADE
Y BARRICADE
200 EAST
200 WEST
300 AREA
RINGOLD
NORTH RICHLAND
WEST RICHLAND
RICHLAND
BENTON CITY
KIONA
PROSSER
YAKIMA RIVER
COLUMBIA RIVER

IV. Columbia River Water

The locations from which raw and drinking water samples were obtained during 1966 are shown in Map 2.

A. Raw Water

Samples of raw water were obtained from the Vernita Bridge during the first six months of 1966 and from Priest Rapids Dam during the last half of the year. The monthly average results of raw water sample analyses are presented in Table 1. The figures in parentheses are the analytical limits for each analysis.

Table 1
Vernita Bridge/Priest Rapids Dam Water Sample Analyses

Month	H^3 (pCi/ℓ)	Sr^{90} (pCi/ℓ)	Total α (pCi/ℓ)	Total β (c/m/ml)
January	3200 (1000)	1.0 (0.50)	0.32 (1.0)	<0.02 (0.02)
February	4100	1.0	0.20	<0.02
March	4000	0.82	0.58	<0.02
April	1800	0.82	<1.0	0.02
May	2300	0.70	<1.0	<0.02
June	1300	0.82	<1.0	<0.02
July	<1000	0.61	<1.0	<0.02
August	<1000	0.67	<1.0	<0.02
September	1800	0.70	<1.0	0.003
October	1900	0.70	<1.0	0.004
November	2100	0.99	<1.0	0.004
December	*	0.79	<1.0	0.004

* Data not available at report time

The isotopic data from Ringold were obtained from analyses of monthly "grab" samples. These data are plotted in Figures 1 and 2. The total beta activity in river water at Ringold and Hanford was obtained from analyses of weekly "grab" samples and is shown at the bottom of Figure 2.

The most significant event influencing concentrations of radionuclides in the Columbia River during 1966 was the extended reactor shutdown during July and August (following the strike on July 8). Concentrations of all radionuclides in raw water samples collected during these two months were below their respective analytical limits, viz., Na^{24}-35 pCi/ℓ, P^{32}-6 pCi/ℓ, Cr^{51}-70 pCi/ℓ, Mn^{56}-50 pCi/ℓ, Cu^{64}-20 pCi/ℓ, Zn^{69m}-70 pCi/ℓ, Ga^{72}-70 pCi/ℓ, As^{76}-5 pCi/ℓ, Np^{239}-10 pCi/ℓ, and RE+Y-5 pCi/ℓ. During September, concentrations of most radionuclides returned to normally expected levels, following reactor startup during late August.

A comprehensive discussion of the effects of the extended reactor shutdown on environmental radiation levels is available in BNWL-CC 1056, "The Environmental Effects of an Extended Hanford Plant Shutdown", edited by J. P. Corley and R. F. Foster (SECRET).

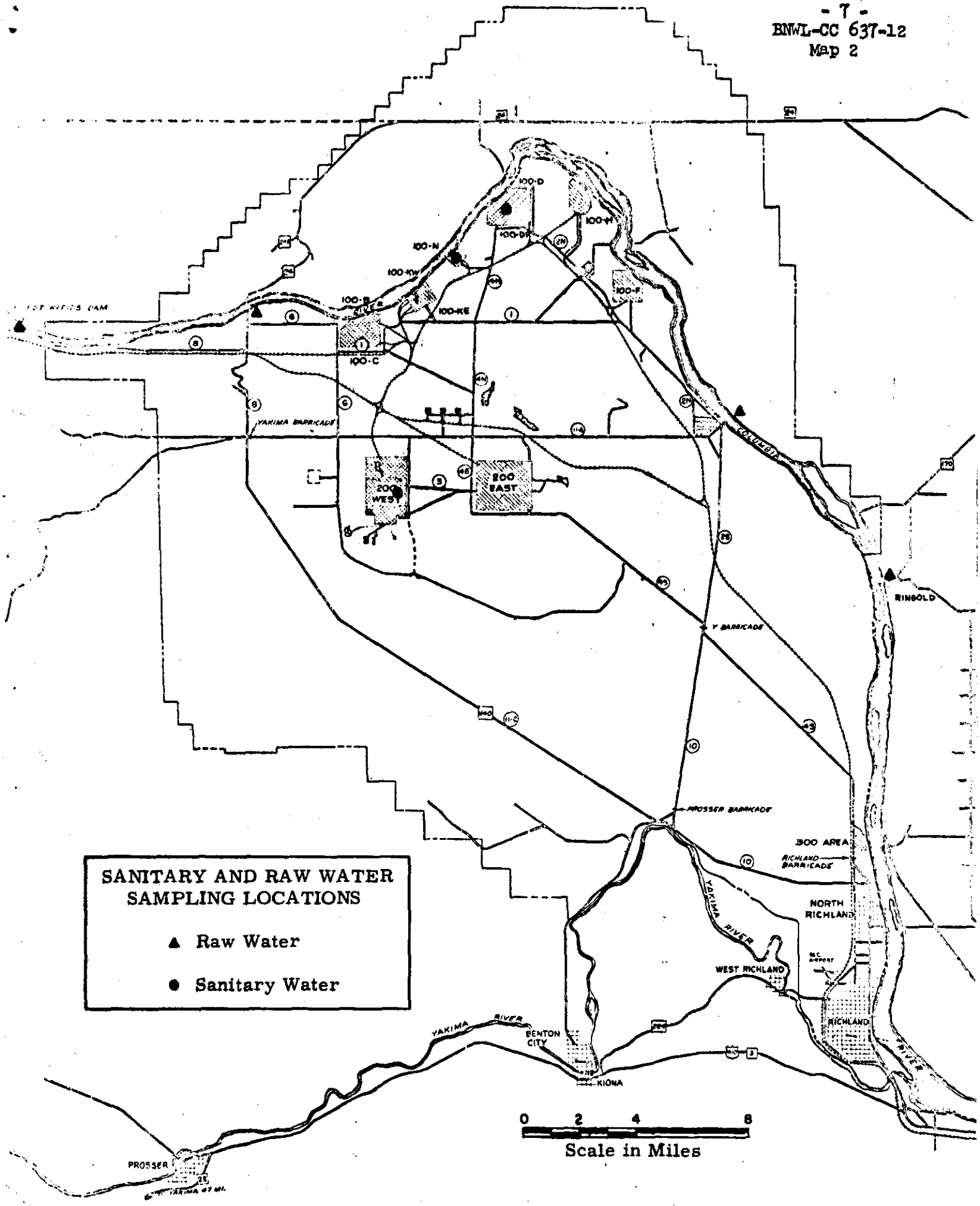

100-D
100-H
100-N
100-KW
100-DR
100-F
100-KE
100-B
100-C
YAKIMA BARRICADE
200 WEST
200 EAST
COLUMBIA
RINGOLD
Y BARRICADE
PROSSER BARRICADE
300 AREA
RICHLAND BARRICADE
NORTH RICHLAND
YAKIMA RIVER
WEST RICHLAND
RICHLAND
BENTON CITY
KIONA
PROSSER
SANITARY AND RAW WATER SAMPLING LOCATIONS
▲ Raw Water
● Sanitary Water
0 2 4 8
Scale in Miles

Figure 1 BNWL-CC 637-12

RADIOACTIVITY OF COLUMBIA RIVER RAW WATER (GRAB) SAMPLES
RINGOLD

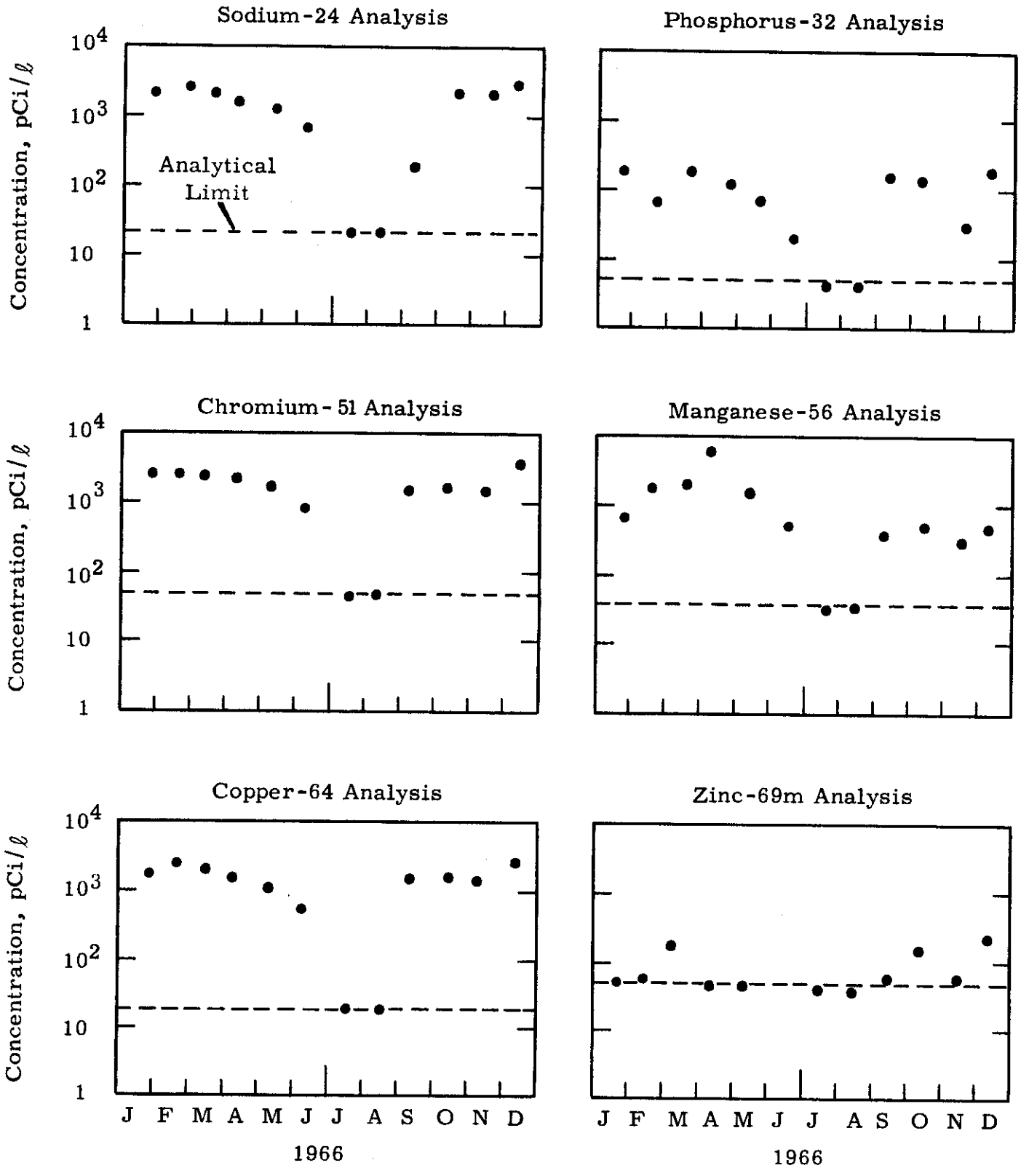
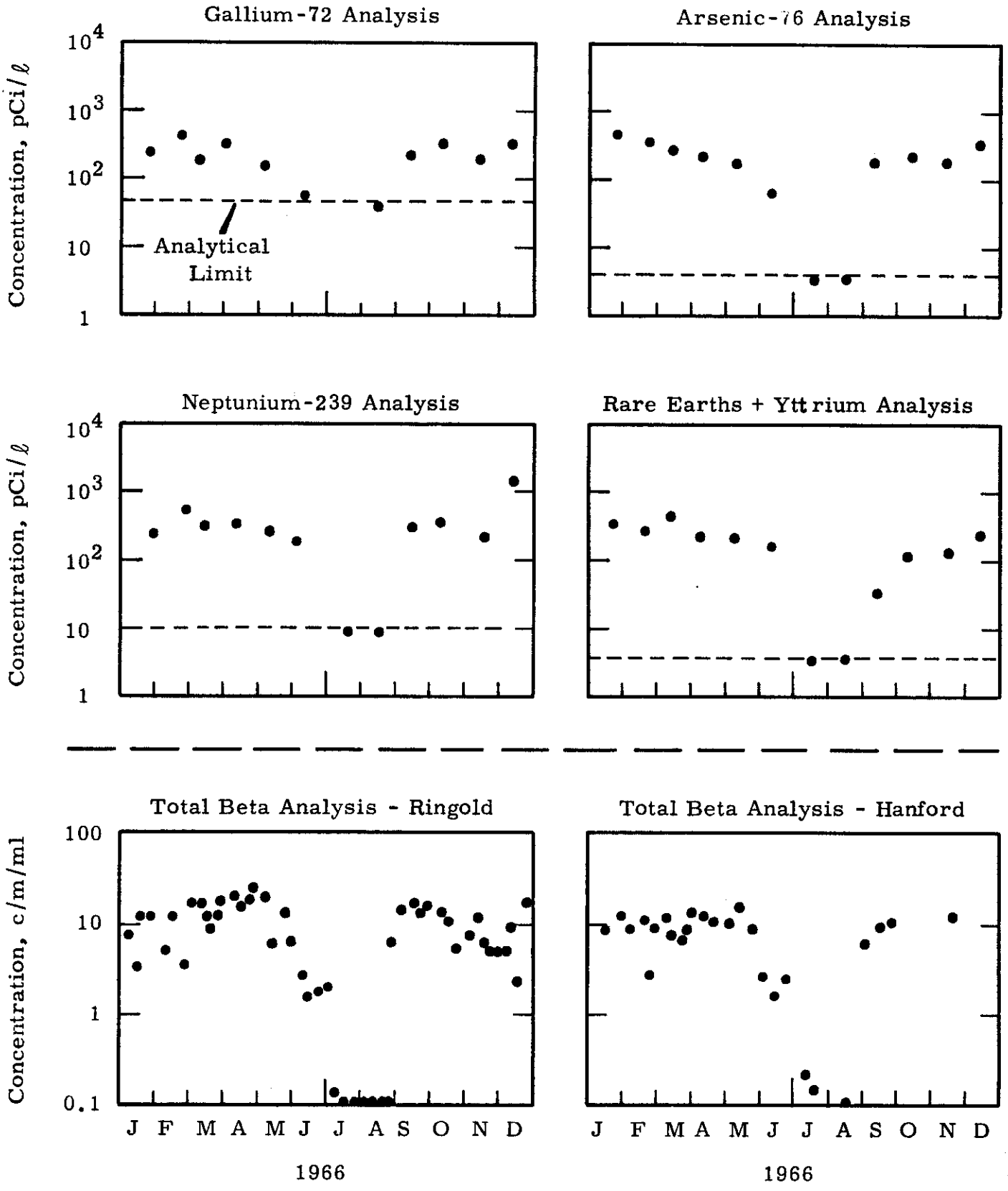


Figure 2

BNWL-CC 637-12

RADIOACTIVITY OF COLUMBIA RIVER RAW WATER (GRAB) SAMPLES
RINGOLD

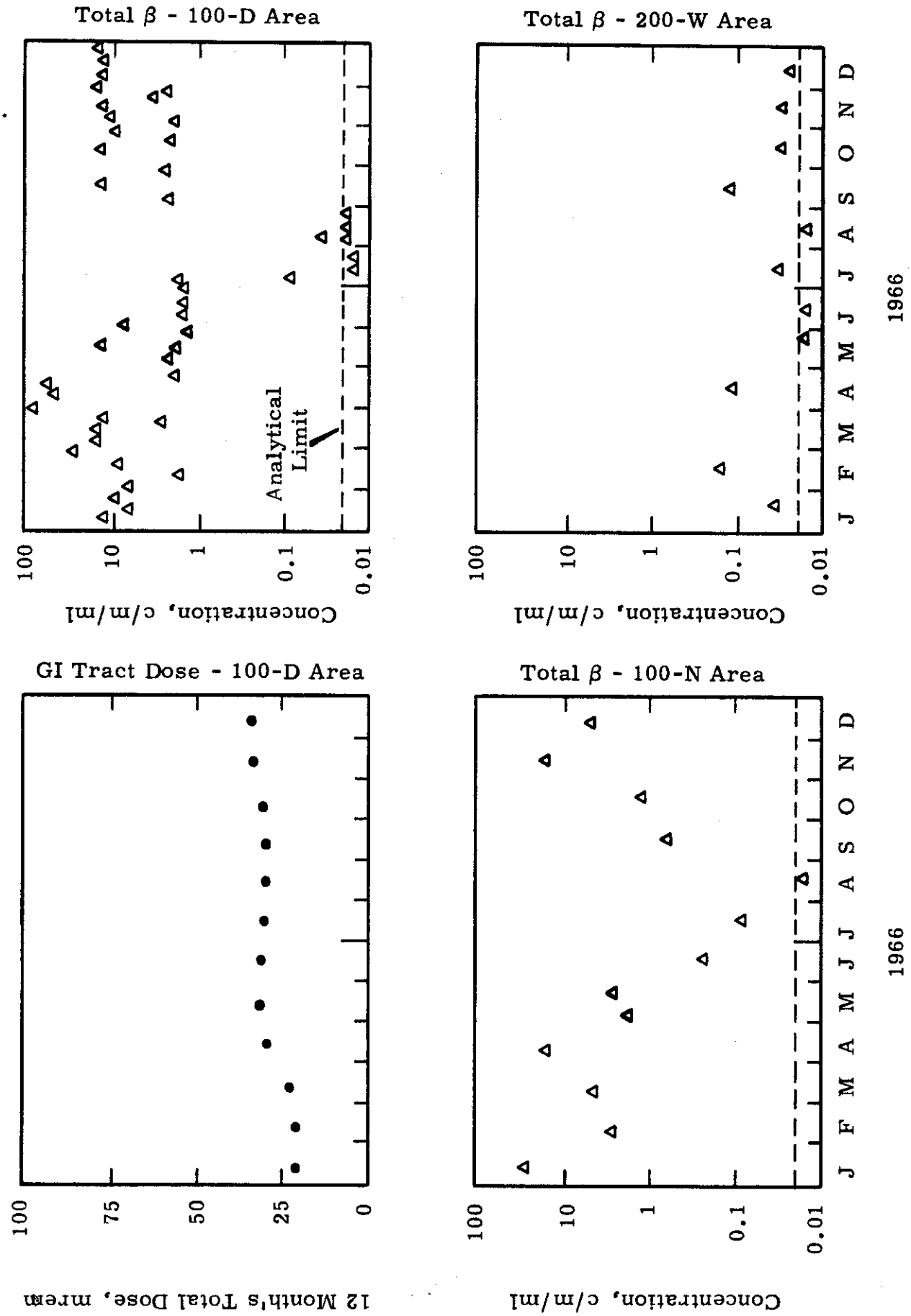


B. Drinking Water

Total beta analyses of drinking water samples taken from 100-D, 100-N and 200-W Areas are shown in Figure 3. These data showed a decrease during July and August, which again reflected the extended reactor shutdown. The dose to the GI tract is estimated from isotopic analyses of drinking water samples collected at 100-D. This estimate is based on an assumed intake of 1.2 liters per day, 5 days per week. The GI tract dose (Figure 3) integrated over the 12-month period ending December 31, 1966 was 35 mrem.

Figure 3

RADIOACTIVITY OF SANITARY WATER (GRAB) SAMPLES



V. Swamps, Ditches, and Ponds

A. Water

Open waters which may be used by migratory waterfowl are routinely sampled in the locations shown in Map 3. Figures 4, 5, and 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 or near the 200 East Area, and Figure 8 shows data collected from the 300 Area pond.

During 1966, several transient increases in total beta concentrations in swamp waters were observed. A month-by-month summary of each change in concentration follows.

June - The total beta concentrations in both Purex Chem Sewer and B Swamp started to increase during May, and reached their maxima on June 10 and June 17, respectively. Two of the swamp samples were given gamma scan analyses to define the sample composition.

		Result (pCi/ℓ)		
Location	Date	Total Beta	Ru^{103}-Rh^{103m}	Ru^{106}-Rh^{106}
Purex Chem Sewer	6/3/66	87,000	430,000	250,000
	6/10/66	180,000	*	*
B Swamp	6/17/66	30,000	90,000	95,000

* Not analyzed

October - The total beta concentration in T Swamp inlet water increased to 1.0×10^5 pCi/ℓ, as shown by the sample collected on October 7. Results of subsequent samples were within the range of concentrations observed the previous three months. Results of a gamma scan of the October 7 sample were: Ru^{103}-Rh^{103m}, 800 pCi/ℓ; Cs^{134}, 1400 pCi/ℓ; Cs^{137}-Ba^{137m}, 7800 pCi/ℓ; and Ce^{144}-Pr^{144}, 31,000 pCi/ℓ.

- I^{131} is usually not detectable in swamp water; however, gamma scan analyses of B Swamp samples were requested when the laboratory found I^{131} in duck flesh (Table 2). Results of the gamma scans are given below.

	Radionuclide Concentration, pCi/ℓ				
Date	Zr-Nb^{95}	Ru^{103}-Rh^{103m}	Ru-Rh^{106}	I^{131}	Cs^{137}-Ba^{137m}
10/21	-*	-	-	98,000	-
10/28	-	-	-	130,000	-
11/4	-	-	-	32,000	-
11/11	-	-	-	14,000	-
11/18	-	-	-	6800	20
11/23	120	180	1100	9200	38
12/2	-	50	620	14,000	40

* The (-) indicates that the radionuclide was not detected.

No I^{131} was detected in any other swamp waters.

November - The total beta concentration in Purex Chemical Sewer water increased to 8100 pCi/ℓ on November 4. Results of subsequent samples were similar to concentrations measured during September and October.

- The total beta concentration in Gable Swamp water also showed an increase during November. The maximum concentration measured was 84,000 pCi β/ℓ on November 18. Results of a gamma scan of this sample and three samples taken from the north side of Gable Swamp were:

		Radionuclide Concentration, pCi/ℓ			
Location	Date	Cr^{51}	Zn^{65}	Cs^{137}-Ba^{137m}	Ce-Pr^{144}
Gable Inlet	11/18	2500	620	2900	96,000
Gable North	11/11	680	13	64	-*
	11/18	400	3	98	-
	11/23	800	51	150	2300

* The (-) indicates that the radionuclide was not detected.

B. Summary of Radiation Levels Measured Near Swamps, Ditches, and Ponds - 1966

Prior to the collection of a sample of swamp water, the radiation level at the sampling point is measured for those swamps, ditches, and ponds which normally contain beta-gamma emitting radionuclides. The measurement is usually made with a GM counter probe held about six inches above the sampling point. A summary of radiation levels measured during 1966 is given below:

1. Laundry Ditch Outlet - generally between 200 and 800 c/m
2. U Ditch Outlet - generally between 100 and 600 c/m
3. U Swamp North - generally between 1000 and 5000 c/m
4. T Swamp Inlet - 300-800 c/m during January, generally 3000-10,000 c/m for remainder of year
5. Redox Swamp Inlet - 2500-6000 c/m during January-April, 200-1000 c/m during May-December and 1000-2000 c/m during November-December
6. Redox Swamp Northeast - generally 2000-3000 c/m from January to mid-June (maximum of 9000 c/m in February), generally 200-1000 c/m for remainder of year (maximum of 9000 in July).
7. Purex Chem Sewer - generally 200-1000 c/m from January to mid-May (maximum of 3000 c/m in mid-February), generally 2000-10,000 c/m for remainder of year (maximum of 30,000 c/m in mid-July).
8. B Swamp North - generally 200-1000 c/m during January-June, generally 3000-40,000 c/m for remainder of year.
9. Gable Swamp Inlet - generally 200-1000 c/m all year, with maxima of 40,000 c/m in late July and 10,000 c/m in late November.
10. Gable Swamp Inlet - generally between 200 and 600 c/m all year.
11. Process Pond Inlet (300 Area) - generally 200-800 c/m all year, with maxima of 5000 c/m in late February and 6000 c/m in mid-November.
12. Process Pond East (300 Area) - generally 100-500 c/m

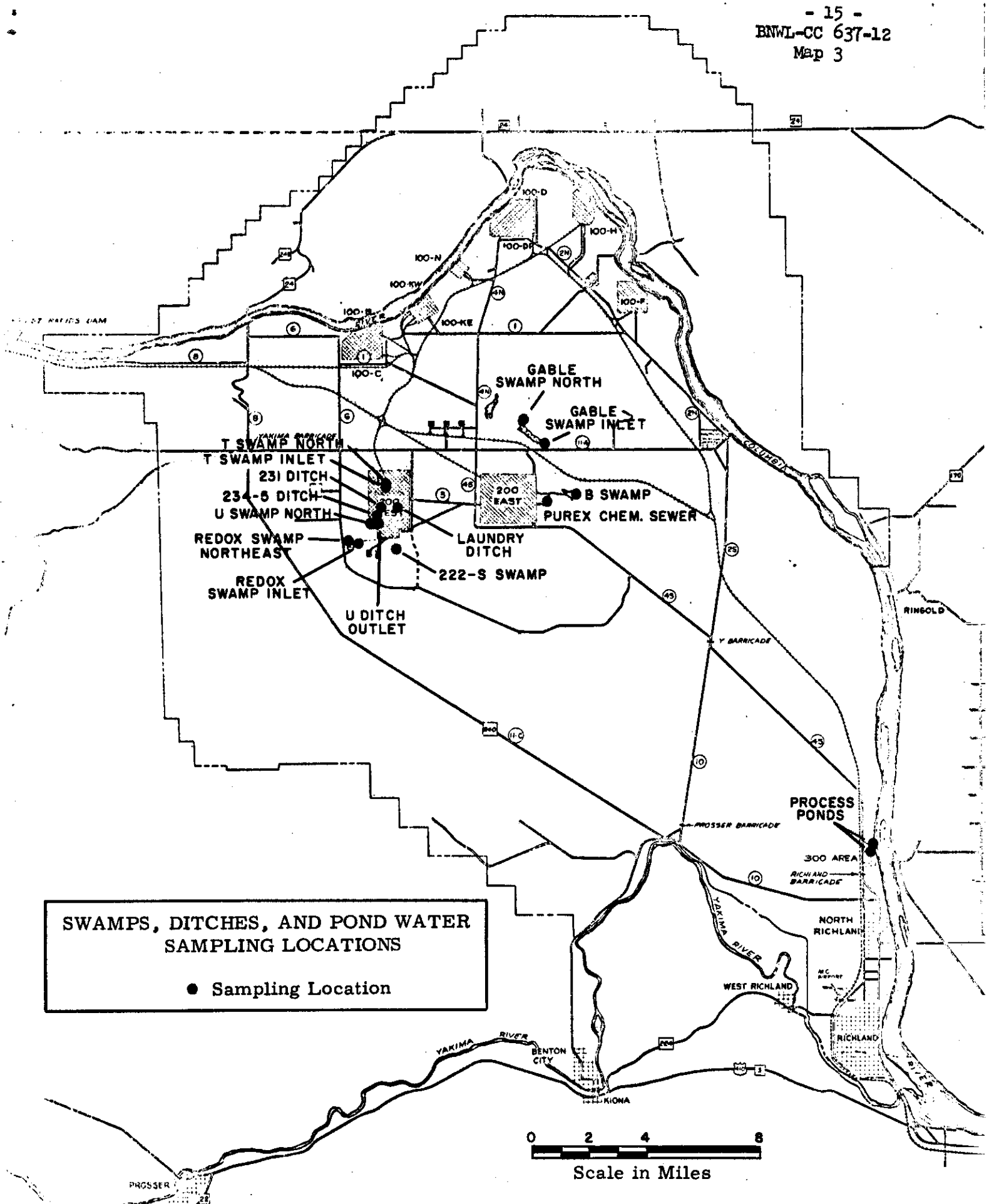

GABLE SWAMP NORTH
GABLE SWAMP INLET
T SWAMP NORTH
T SWAMP INLET
231 DITCH
234-5 DITCH
U SWAMP NORTH
REDOX SWAMP NORTHEAST
REDOX SWAMP INLET
U DITCH OUTLET
LAUNDRY DITCH
222-S SWAMP
B SWAMP
PUREX CHEM. SEWER
200 EAST
PROCESS PONDS
300 AREA
RICHLAND BARRICADE
PROSSER BARRICADE
Y BARRICADE
YAKIMA BARRICADE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

Figure 4 BNWL-CC 637-12

RADIOACTIVITY OF WASTE WATER SAMPLES
200-W AREA

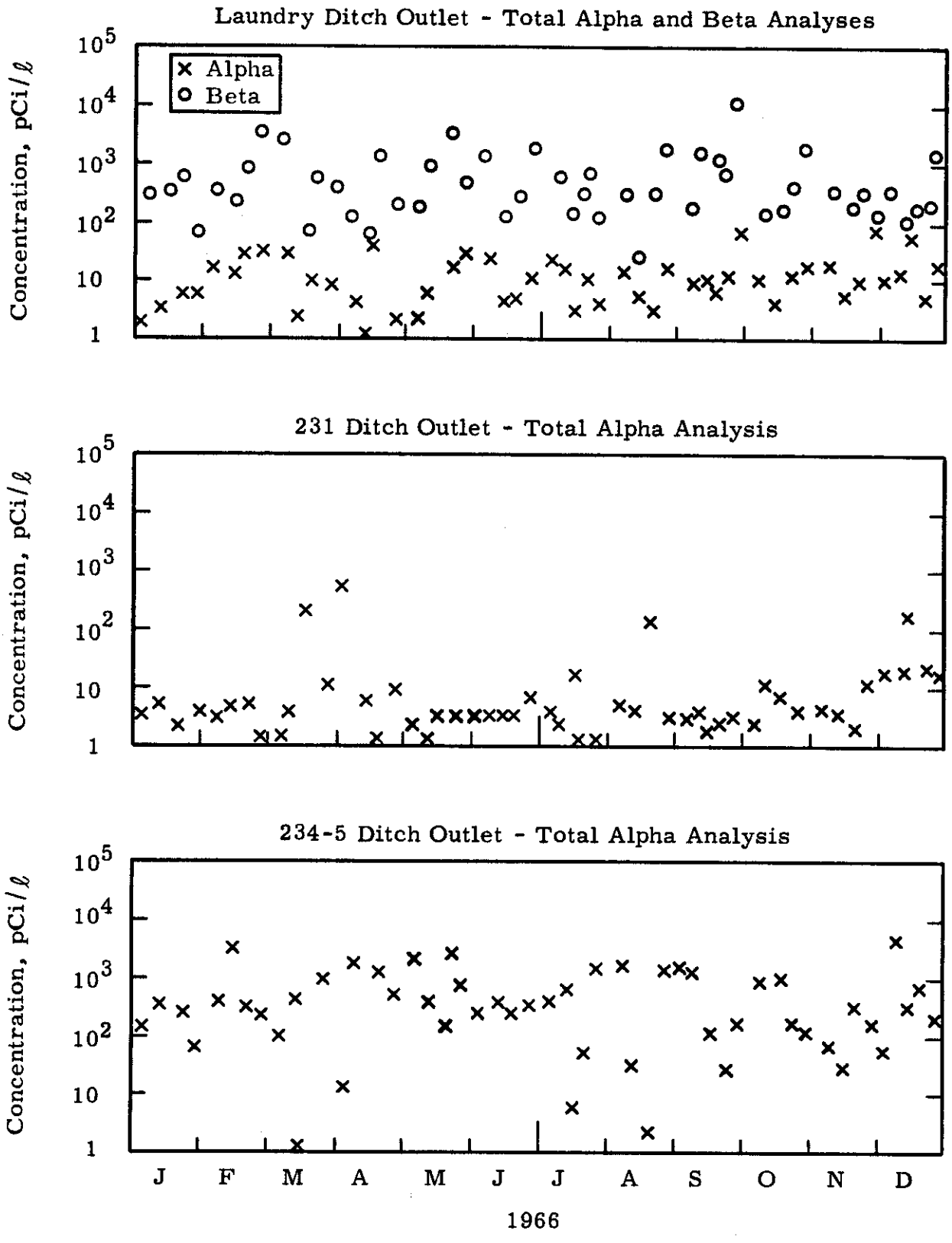


Figure 5 BNWL-CC 637-12

RADIOACTIVITY OF WASTE WATER SAMPLES
200-W AREA

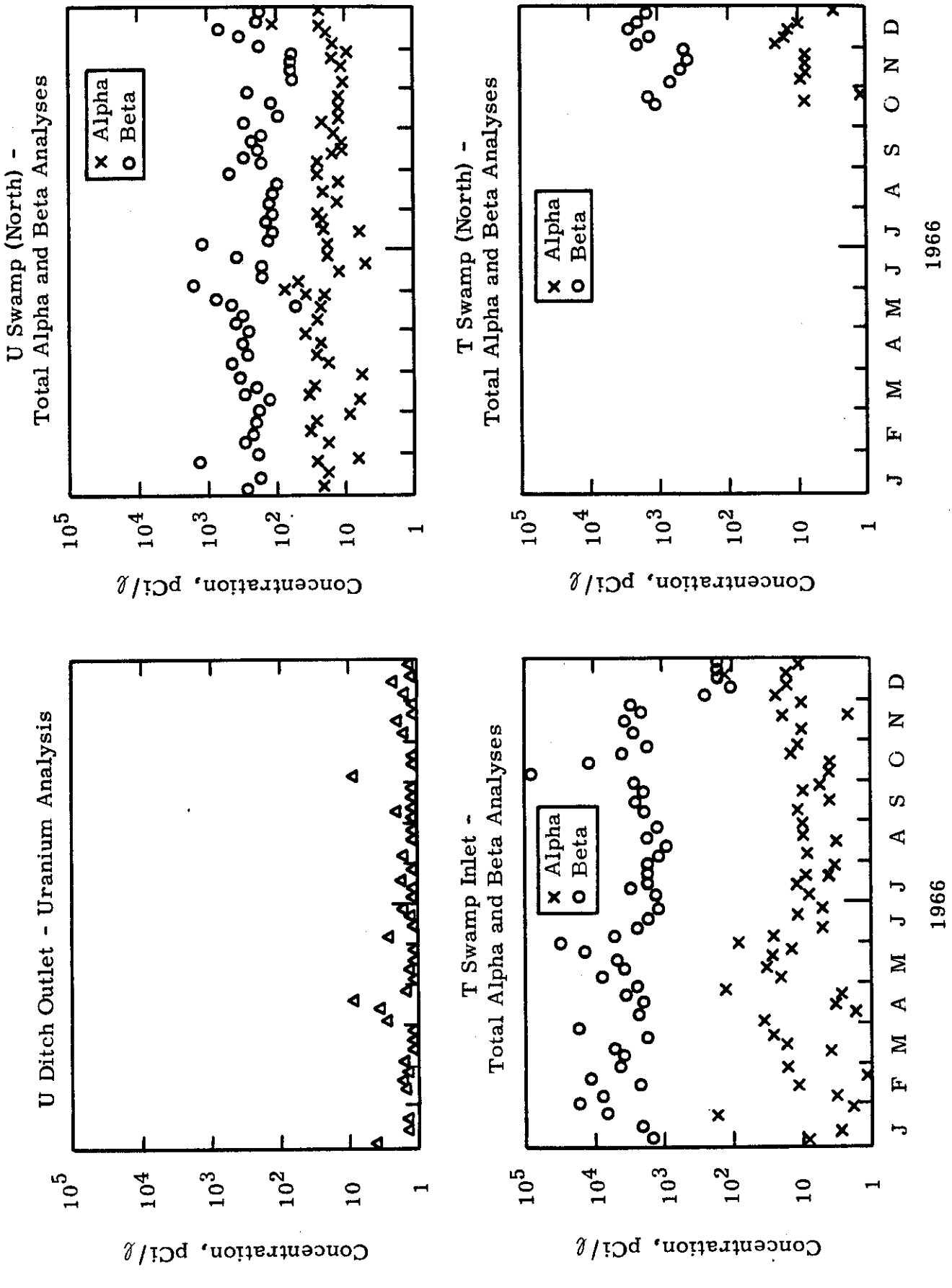


Figure 6

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RADIOACTIVITY OF WASTE WATER SAMPLES
200-W AREA

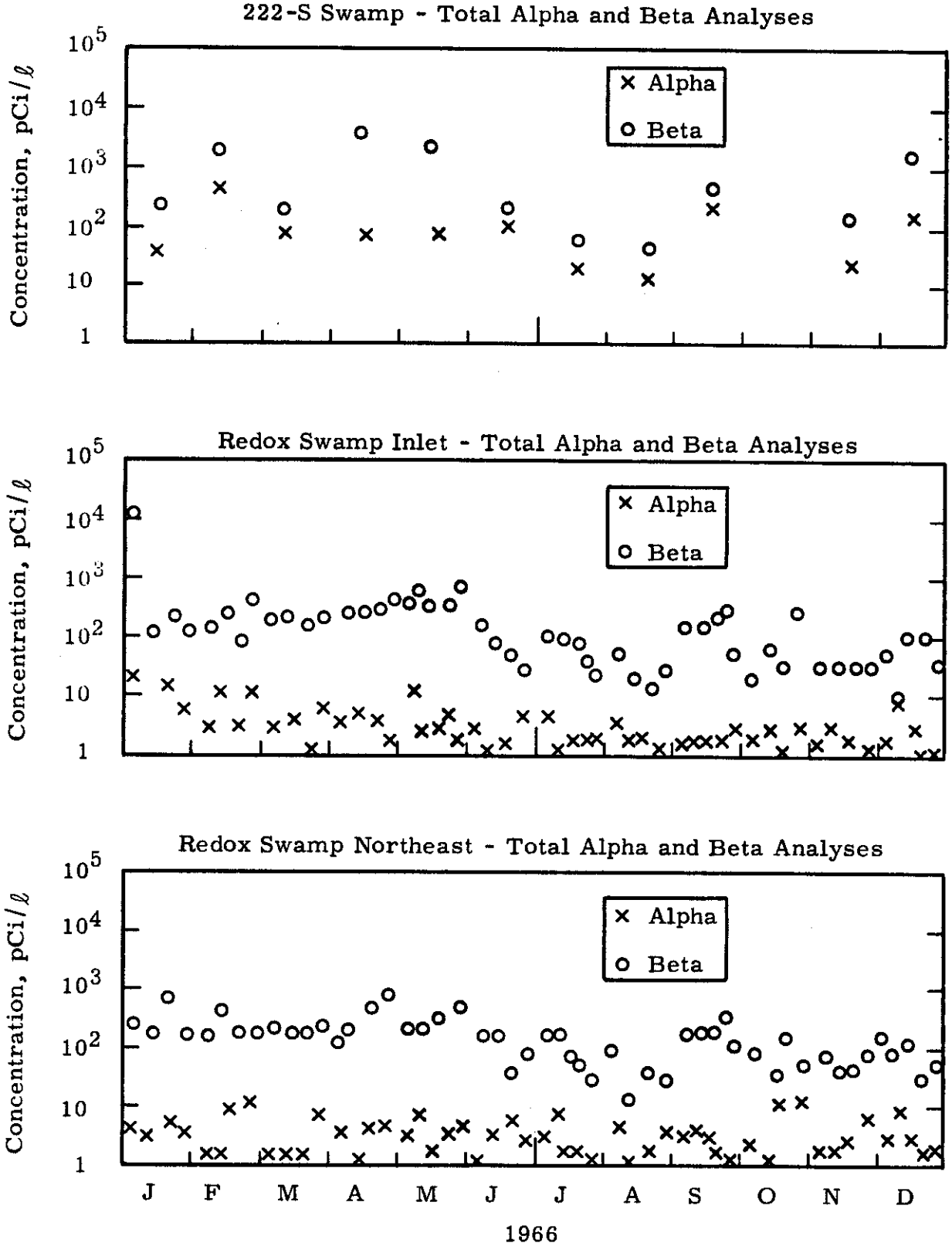


Figure 7 BNWL-CC 637-12

RADIOACTIVITY OF WASTE WATER SAMPLES
200-E AREA

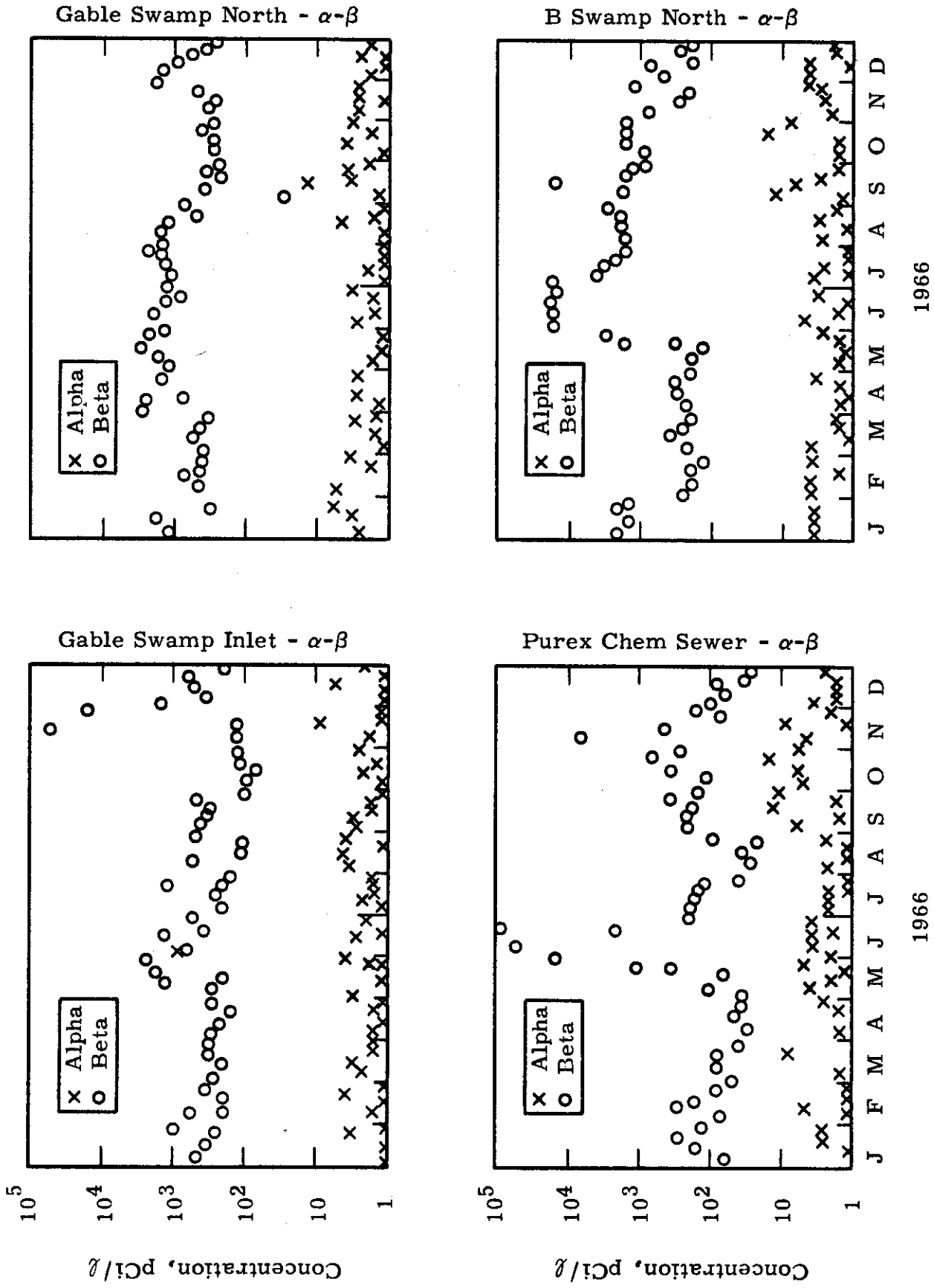
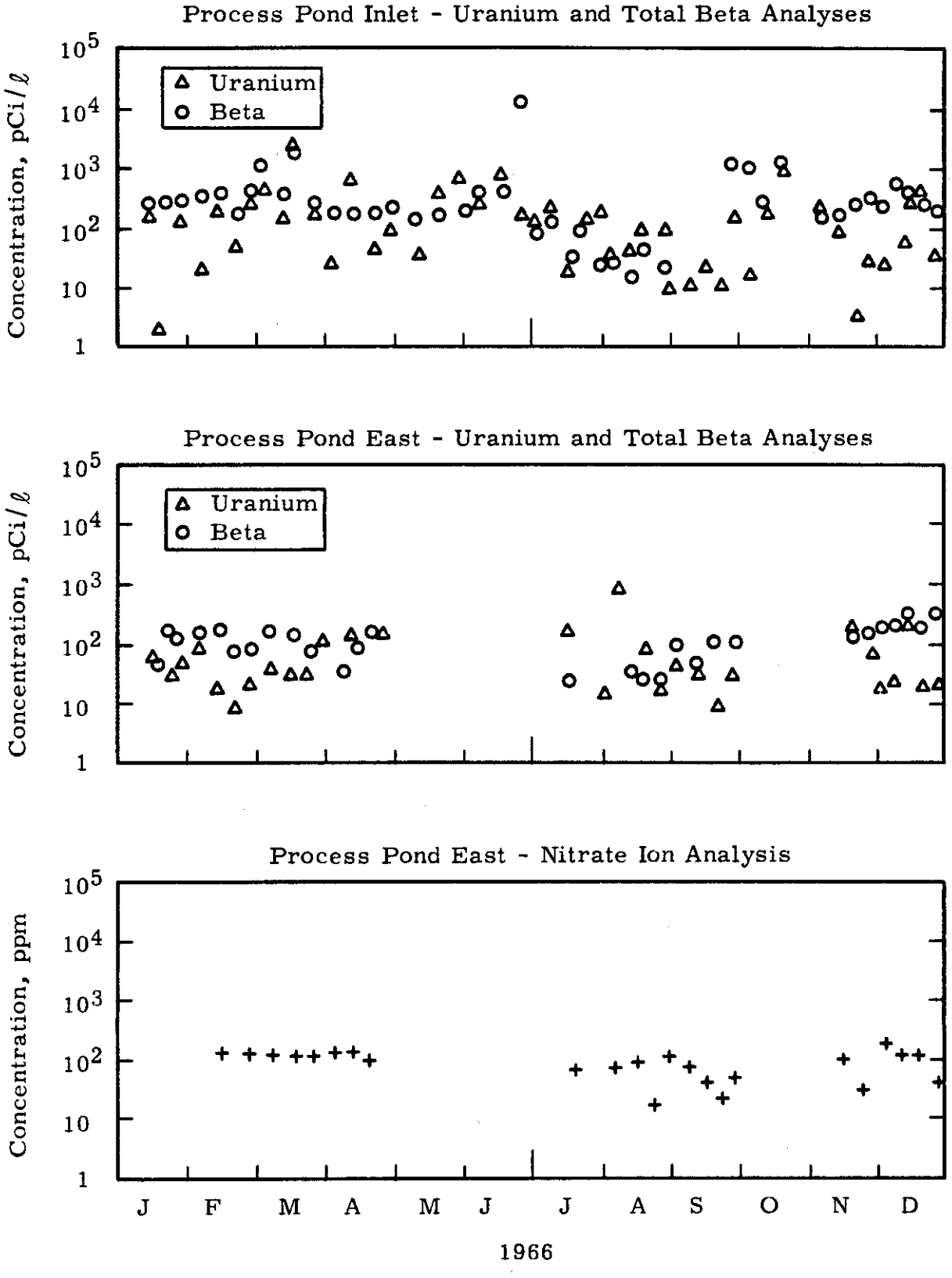


Figure C BNWL-CC 637-12

WASTE WATER SAMPLE ANALYSES
300 AREA



C. Waterfowl

Migratory waterfowl that have utilized swamps and ponds within the Hanford Reservation may contain P^{32}, Zn^{65}, Cs^{137}-Ba^{137m}, and other radionuclides. Some of these waterfowl remain in this general area throughout the year. Results of radioassays of waterfowl collected during November are shown in Table 2.

Table 2
Fowl Analyses

Location	Date	Analytical Limit / Specie	Radionuclide Concentration in Muscle (pCi/g) P^{32} 1.0	Zn^{65} 0.2	I^{131} 0.15	Cs^{134}	Cs^{137}-Ba^{137m} 0.1
Redox Swamp	3-3	Bufflehead	18	1.3	-	-	12
	3-3	Bufflehead	25	1.4	-	-	24
	3-3	Bufflehead	48	0.22	-	-	15
	10-19	Mallard	10	2.8	-	-	74
	10-20	Mallard		3.5	-	-	120
	11-7	Mallard	11	0.37	-	-	3.1
	11-7	Mallard		6.8	-	-	20
	11-8	Mallard	110	6.0	-	-	14
	12-8	Green Wing Teal	48	7.1	-	-	12
	12-8	Bufflehead	37	8.8	-	-	4.1
	12-8	Golden Eye	37	8.0	-	-	4.5
	12-27	Mallard	7.2	5.2	-	-	37
	12-27	Scaup	6.9				
	12-27	Bufflehead	20				
	12-27	Bufflehead	4.5				
U Swamp	10-19	Lesser Canadian Goose	5.7	0.05	-	-	47
	11-7	Pintail	170	1.1	-	-	430
	11-8	Mallard		6.3	-	-	170
	11-8	Mallard	120	4.0	-	-	130
	12-7	Mallard	2.0	-	-	-	7.7
	12-7	Mallard	-	-	-	-	6.2
B Swamp	10-21	Mallard		-	9.1	-	0.64
	10-26	Mallard	9.1	0.26	20	-	6.0
	10-26	Mallard	87	9.9	0.36	-	54
	10-26	Coot	46	3.1	79	-	9.1
	11-7	Coot	50				
Gable Swamp	10-21	Teal	20	1.8	0.15	-	0.34
	10-21	Mallard	1.0	-	-	-	0.38
	10-21	Mallard	2.7	1.5	0.34	-	0.32
	10-21	Mallard	7.4	0.30	0.80	-	2.0
	10-21	Mallard	205	6.8	-	-	29
	11-7	Bufflehead	230	5.4	-	-	190
	11-7	Bufflehead	80	3.0	-	-	41

A blank indicates the result has not yet been reported.
A (-) indicates it was not detected.

Table 2 (Continued)
Fowl Analyses

Location	Date	Specie	Radionuclide Concentration in Muscle (pCi/g) P^{32}	Zn^{65}	I^{131}	Cs^{134}	Cs^{137}-Ba^{137m}
		Analytical Limit	1.0	0.2	0.15		0.1
Gable Swamp (Cont)	11-7	Bufflehead	27	2.8	-	-	55
	11-7	Bufflehead	49	2.9	-	-	70
	12-8	Mallard	14	2.8	-	-	20
	12-8	Mallard	22	13	-	-	49
	12-8	Mallard	2.0	0.57	-	-	0.25
	12-27	Pintail	6.3	7.4	-	0.73	23
	12-27	Pintail	7.4	1.2	-	1.0	32
	12-28	Mallard	12	0.31	-	2.2	83
	12-28	Bufflehead	27	2.2	-	11	380
	12-28	Bufflehead	25	4.1	-	5.9	230
	12-28	Bufflehead	32				
	12-28	Golden Eye	71				
	12-28	Canadian Goose		0.17	-	-	0.1

A blank indicates the result has not yet been reported.
A (-) indicates it was not detected.

VI. The Atmosphere

A. Iodine-131 and Total Beta Activity

The atmosphere was routinely sampled at 22 locations (see Map 4) within the Hanford reservation during 1966. At most locations, the sampling equipment was contained within a small building designated "614". "Total beta" represents the activity of particulates collected on H-70 filter paper during a one-week sampling period. The air is subsequently passed through a solution of NaOH for I^{131} collection. During 1966, several transient increases in total beta and/or I^{131} concentrations were observed. A month-by-month summary of each change in concentrations follows.

May - During the latter part of the month, air filters from most sampling locations showed an increase in total beta activity following the Chinese nuclear weapons test on May 9, 1966. The highest results were 4.6 pCi β/m^3 at the Wye Barricade on 5/25/66 and 4.2 pCi β/m^3 at the Met Tower on 5/31/66. Results of a gamma scan of several air filters taken during the influx of fallout is presented in Table 3. Three relatively "fresh" fission products were found, viz., 8 day I^{131}, 11 day Nd^{147}, and 13 day $Ba\text{-}La^{140}$.

Table 3
Gamma Scan Analyses of May Air Filters

Location (Date)	Radionuclide Concentration, pCi/m^3							
	$Zr\text{-}Nb^{95}$	$Ru\text{-}Rh^{106}$	Sb^{125}	I^{131}	$Cs^{137}\text{-}Ba^{137m}$	$Ba\text{-}La^{140}$	$Ce\text{-}Pr^{144}$	Nd^{147}
100 B (5/23/66)	0.29	0.32	-	0.01	-	0.18	1.94	0.05
200 ESE (5/23/66)	3.80	0.50	-	-	0.14	1.04	13.1	0.35
200 WEC (5/23/66)	0.17	0.35	-	-	0.08	-	1.24	-
ERC (5/25/66)	1.32	-	-	-	0.03	0.44	2.94	0.14
Wye Barr. (5/25/66)	0.57	-	-	-	0.03	0.40	1.25	0.06
Yakima (5/20/66)	-*	0.49	0.07	-	0.10	-	-	-

* The (-) indicates that the radionuclide was not detected.

July - Several 200 Area sampling locations showed an increase in I^{131} concentrations due to an increase in the release rate of I^{131} from a chemical separations facility. The concentration increase began in late June and continued into July. The highest results were obtained from the Redox 614 building: 1.8 pCi/m^3 on 6/20/66, 2.1 pCi/m^3 on 7/5/66, and 1.5 pCi/m^3 on 7/11/66.

August - Several 200 Area sampling locations showed an increase in total beta concentrations following a larger than usual Ru^{106} emission from a chemical processing facility. The maximum concentration was 6.0 pCi β/m^3 at the Redox 614 building on 8/15/66.

October - During the latter part of the month, increases were noted in both I^{131} and total beta concentrations in the atmosphere, following increased emissions of I^{131} and mixed fission products from a waste treatment facility in 200 East Area. The maximum I^{131} concentration was 1.1 pCi/m^3 at the 200 EEC sampling location on 10/24/66. Air filters having the highest total beta activity were given a quantitative gamma scan analysis to identify all contributing radionuclides. The results appear in Table 4.

Table 4
Gamma Scan Analyses of October Air Filters

Location	Week Ending	Radionuclide Concentration, pCi/m^3				
		$Zr\text{-}Nb^{95}$	$Ru\text{-}Rh^{103m}$	$Ru\text{-}Rh^{106}$	$Cs\text{-}Ba^{137m}$	$Ce\text{-}Pr^{144}$
Redox	10/11/66	-*	1.4	3.5	1.4	-
	10/17/66	0.27	2.8	10	-	-
200 WWC	10/17/66	0.12	0.30	2.0	-	-
200 WEC	10/11/66	-	0.18	0.48	0.55	-
	10/17/66	0.13	0.26	1.0	-	-
200 EEC	10/17/66	4.3	-	0.40	-	1.1
	10/24/66	0.50	-	-	0.23	-
200 ESE	10/17/66	2.0	0.07	0.10	-	-
Semiworks	10/17/66	19	-	0.39	-	1.1
	Daily					
700 Area	10/26/66	-	-	-	-	-
	10/28/66	-	-	-	-	0.01

* The (-) indicates that the radionuclide was not detected.

November - During the first week of the month, air filters from many sampling stations showed a slight increase in total beta concentration as a result of the Chinese and Russian nuclear tests on October 27.

Results of gamma scan analyses of four air filters are given in Table 5. The first two samples were collected during the influx of fallout from the nuclear tests on October 27. It was expected that "fresh" fission products (e.g. Mo^{99} and $Ba\text{-}La^{140}$) would be present in measurable concentrations, however, they were not reported. The latter two samples indicate larger than usual airborne activity from waste handling operations.

Table 5
Gamma Scan Analyses of November Air Filters

Location	Week Ending	Radionuclide Concentration, pCi/m^3					
		$Zr\text{-}Nb^{95}$	$Ru^{103}\text{-}Rh^{103m}$	$Ru\text{-}Rh^{106}$	$Cs^{137}\text{-}Ba^{137m}$	Ce^{141}	$Ce\text{-}Pr^{144}$
200 WWC	11/7	0.18	0.13	0.59	0.10	0.20	0.60
ERC	11/9	0.11	0.12	0.35	0.03	0.22	-*
200 EEC	11/28	10	-	-	-	-	1.5
Semi Works	11/28	33	-	-	-	-	1.7

* The (-) indicates that the radionuclide was not detected.

The average I^{131} and total beta concentrations for 1966 are presented in Table 6 below, and for comparison, averages for 1965 are also shown.

Table 6
Annual Average I^{131} and Total Beta Concentrations

Location	I^{131} (pCi/m^3)		Total Beta (pCi/m^3)	
	1966	1965	1966	1965
100 Areas	0.29	0.44	0.02	<0.03
200 Areas	0.58	0.80	0.10	0.14
Intermediate Locations	0.24	0.34	0.02	0.05

Individual air sample results from the 100 Areas are shown in Figures 9 and 10, from the 200 Areas in Figures 11 and 12, and from intermediate locations in Figures 13 and 14.

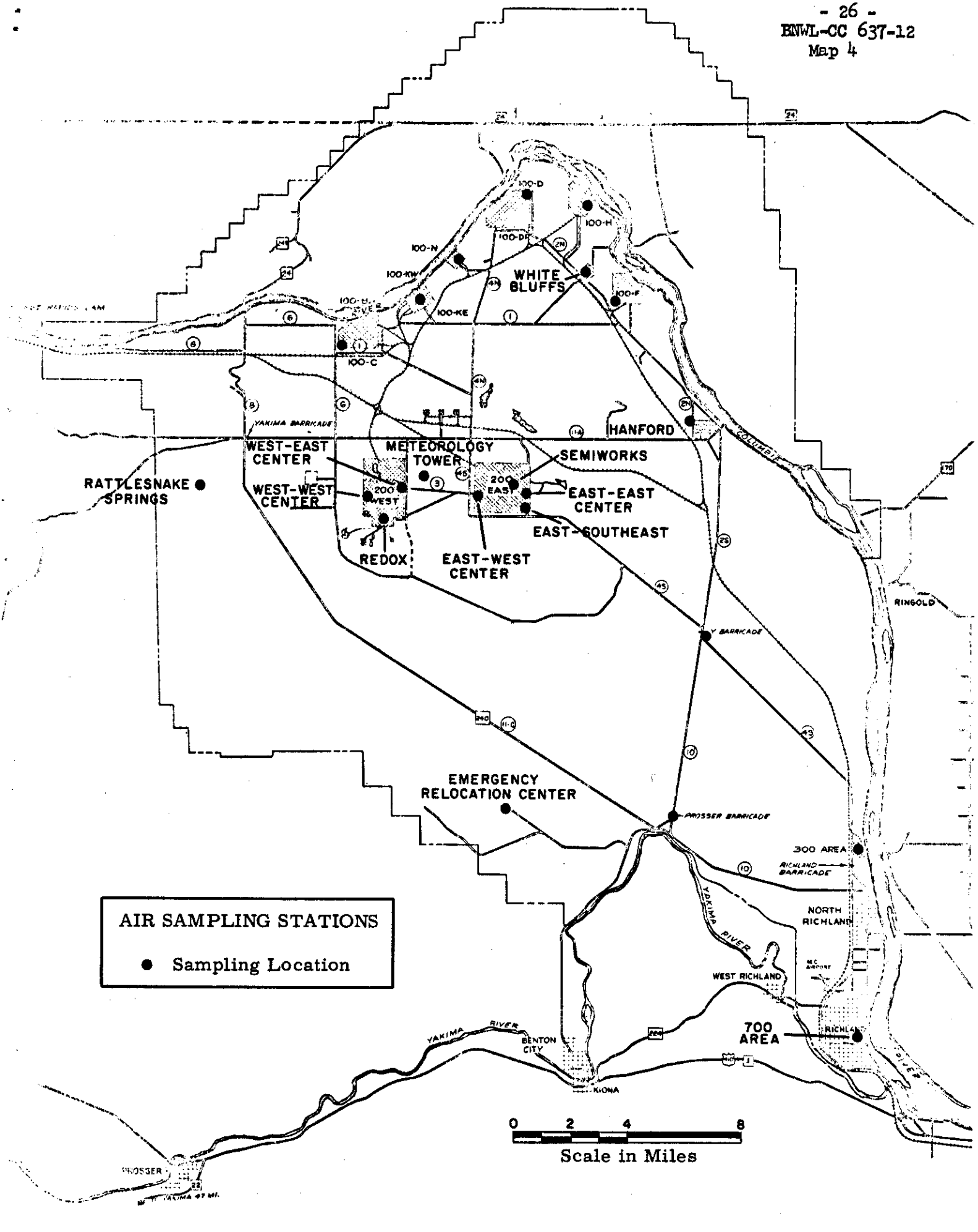

100-D
100-H
100-DR
100-N
100-KW
WHITE BLUFFS
100-F
100-KE
100-C
YAKIMA BARRICADE
HANFORD
WEST-EAST CENTER
METEOROLOGY TOWER
SEMIWORKS
RATTLESNAKE SPRINGS
WEST-WEST CENTER
200 WEST
200 EAST
EAST-EAST CENTER
EAST-SOUTHEAST
REDOX
EAST-WEST CENTER
COLUMBIA
RINGOLD
BARRICADE
EMERGENCY RELOCATION CENTER
PROSSER 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

Figure 9

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

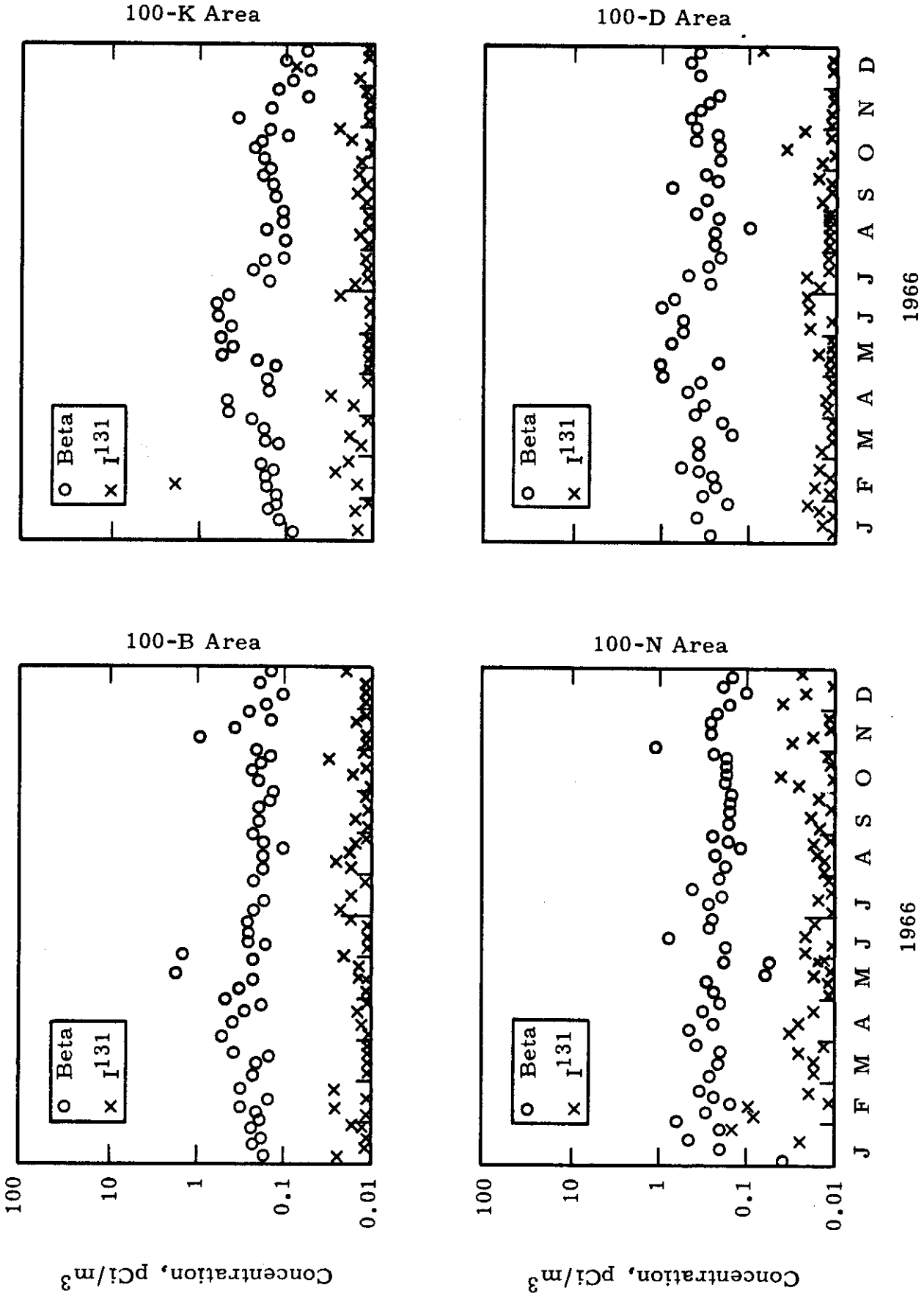


Figure 10

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

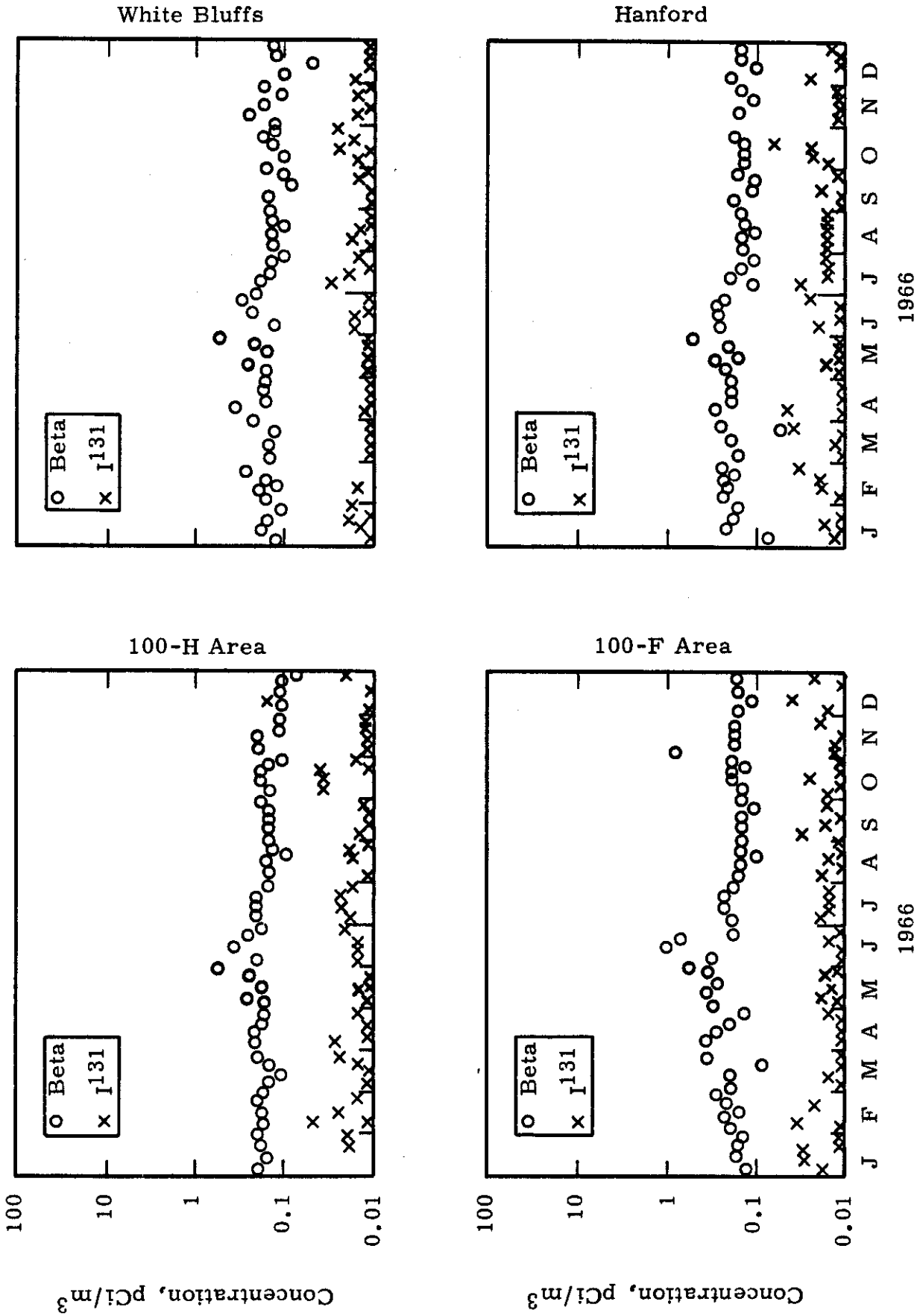
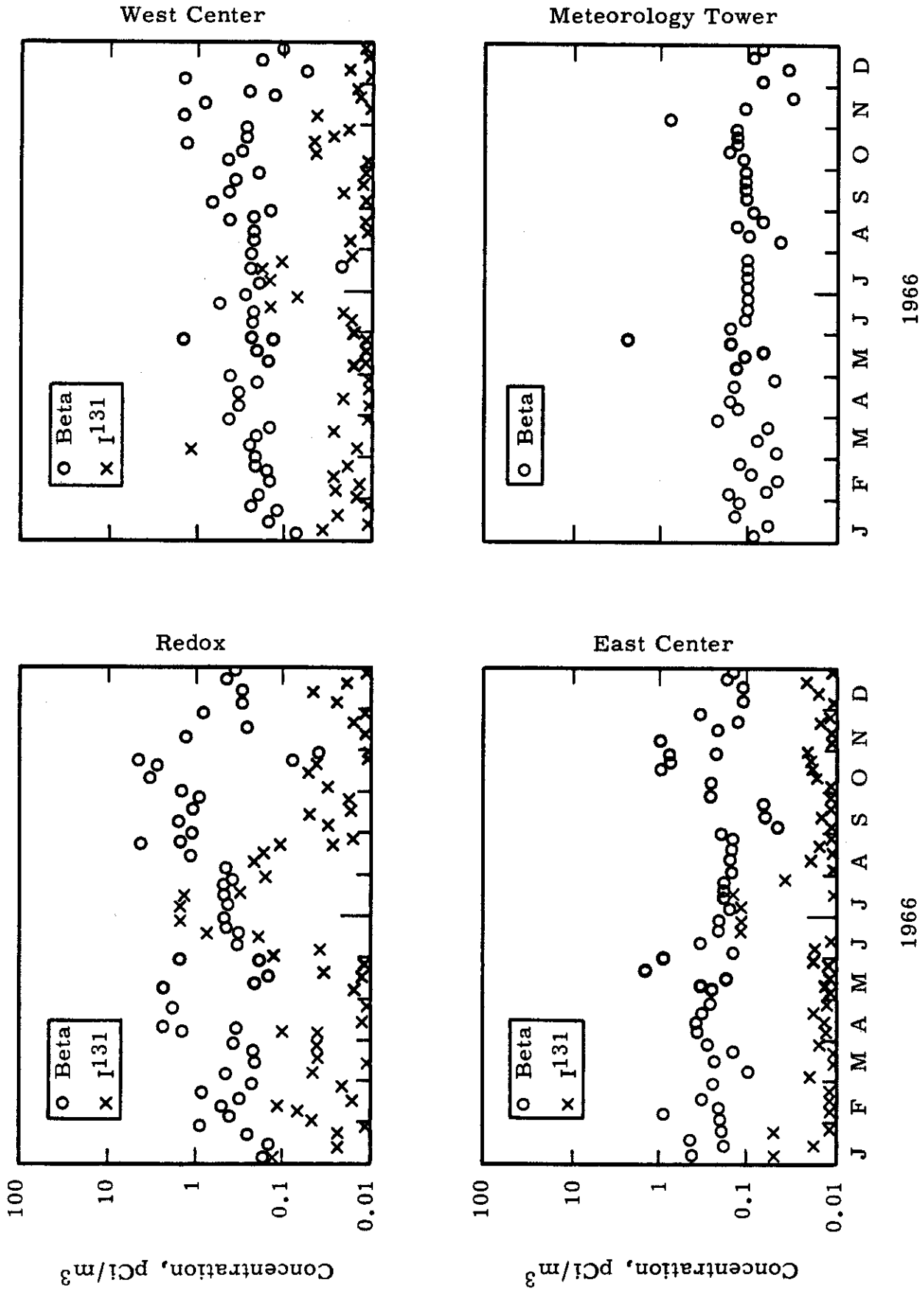
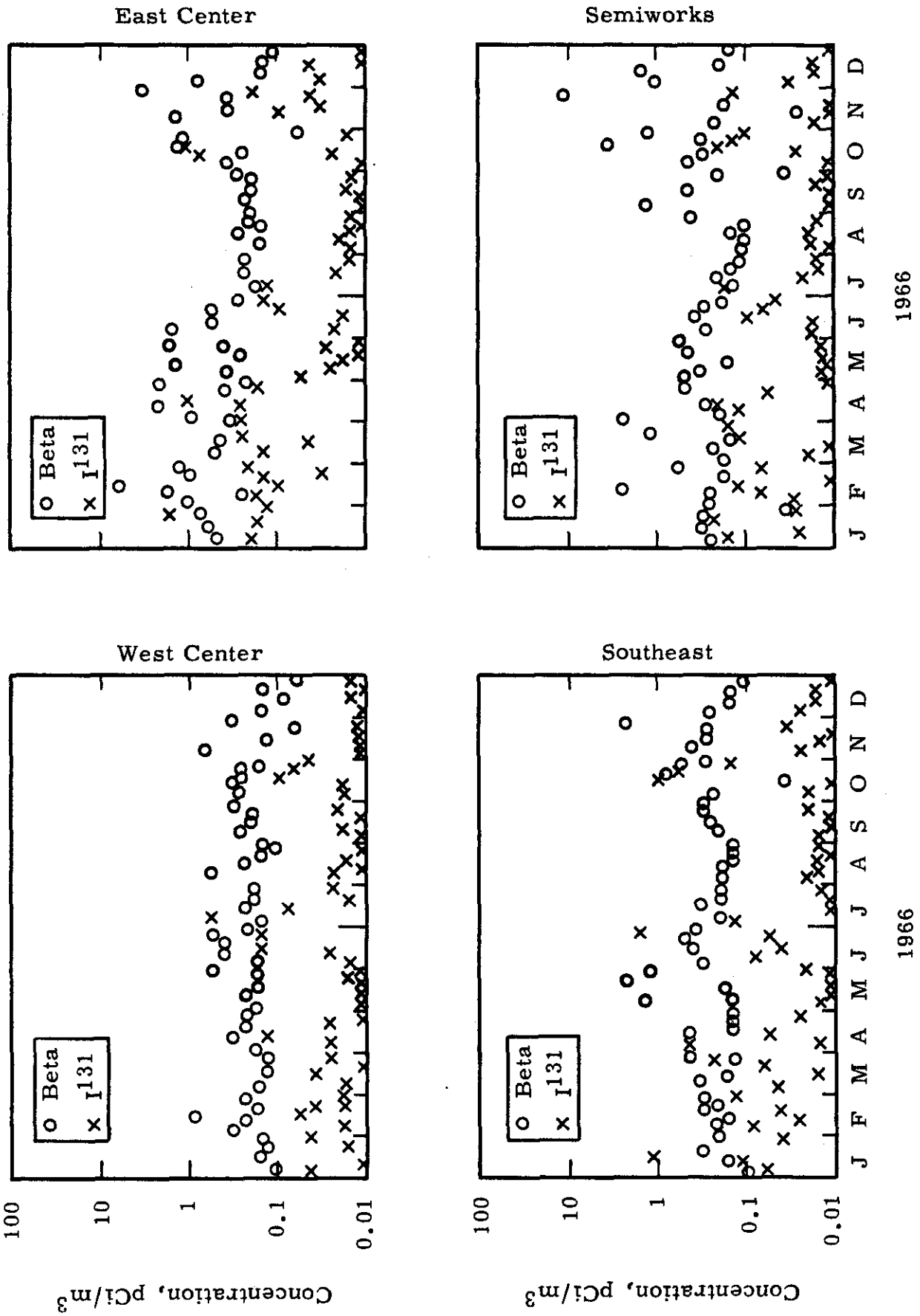


Figure 11

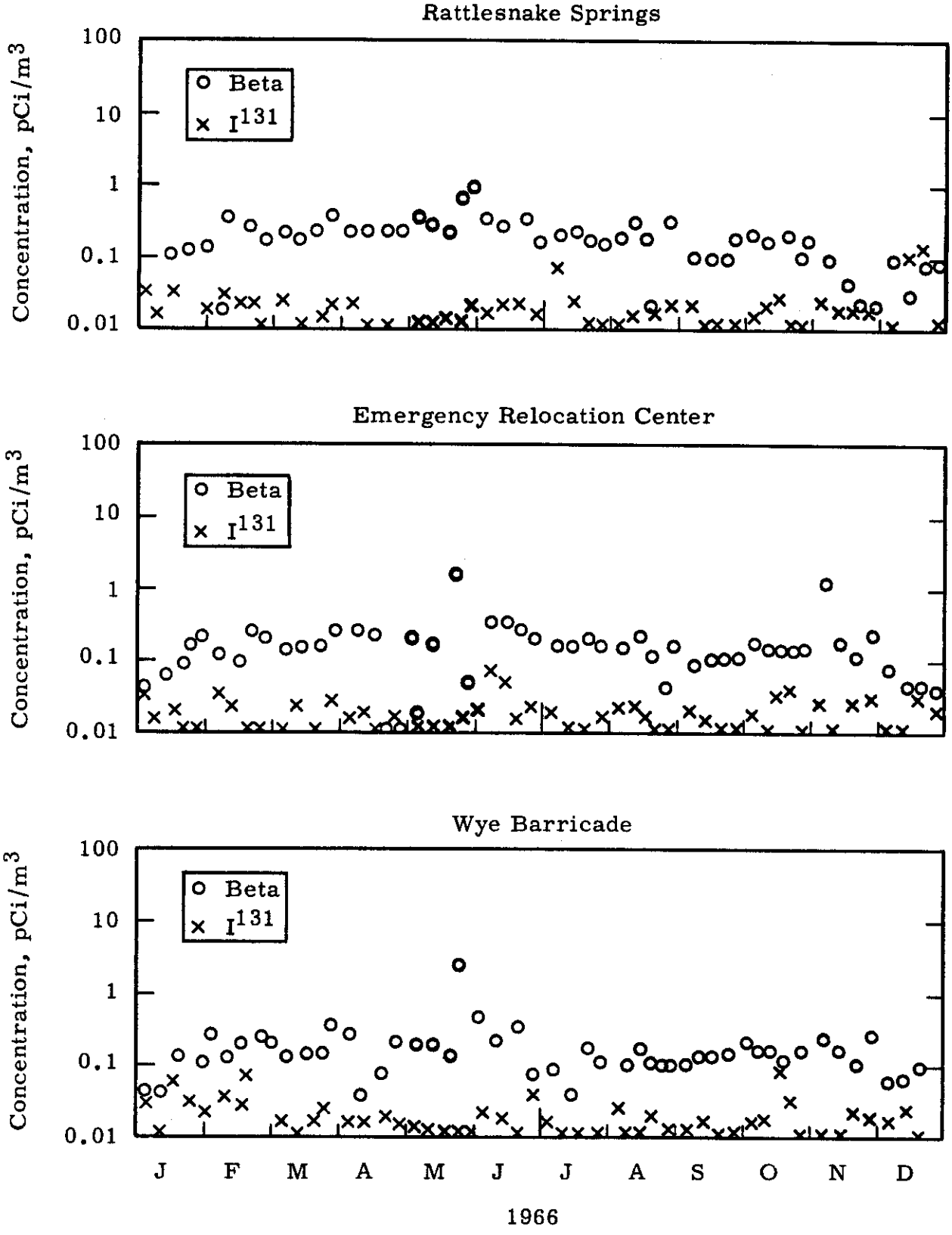
IODINE-131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE
200-W AREA



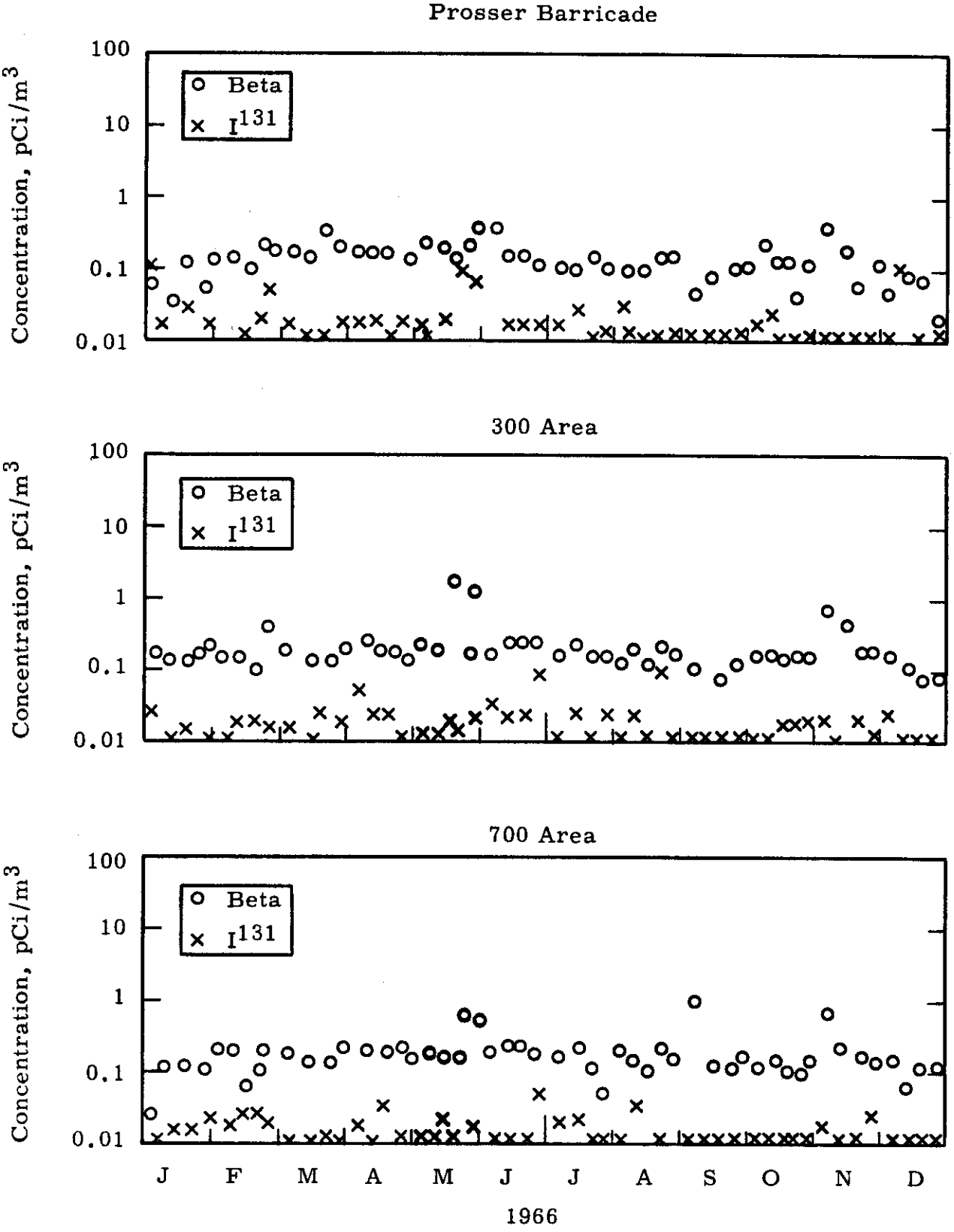
IODINE-131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE
200-E AREA



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



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



B. Total Alpha Activity

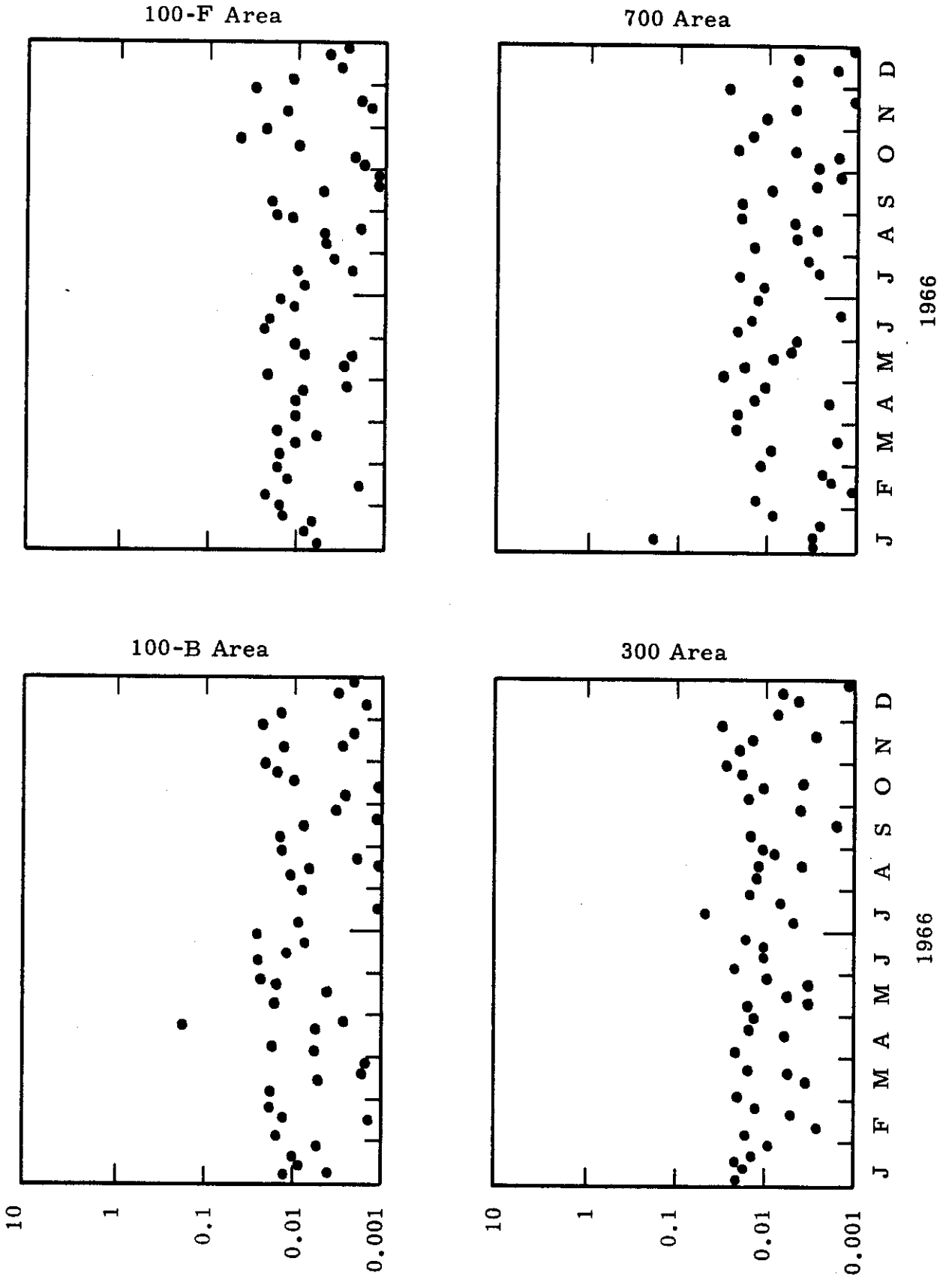
Eleven of the 22 weekly filters which collect beta-gamma emitting radionuclides are also analyzed for alpha activity, with most of the sampling sites located in the 200 Areas. These data are presented in Figures 15, 16, and 17. The annual average total alpha concentrations in the atmosphere for 1966 are presented in Table 7 below, and for comparison, averages for 1965 are also shown.

Table 7
Annual Average Total Alpha Concentrations

Location	Total Alpha Concentration (pCi/m^3) 1966	1965
100 Areas	0.01	<0.02
200 Areas	0.01	<0.03
300 Area	0.02	0.08
700 Area	0.02	<0.02

Figure 15

TOTAL ALPHA ACTIVITY IN THE ATMOSPHERE



TOTAL ALPHA ACTIVITY IN THE ATMOSPHERE
200 WEST AREA

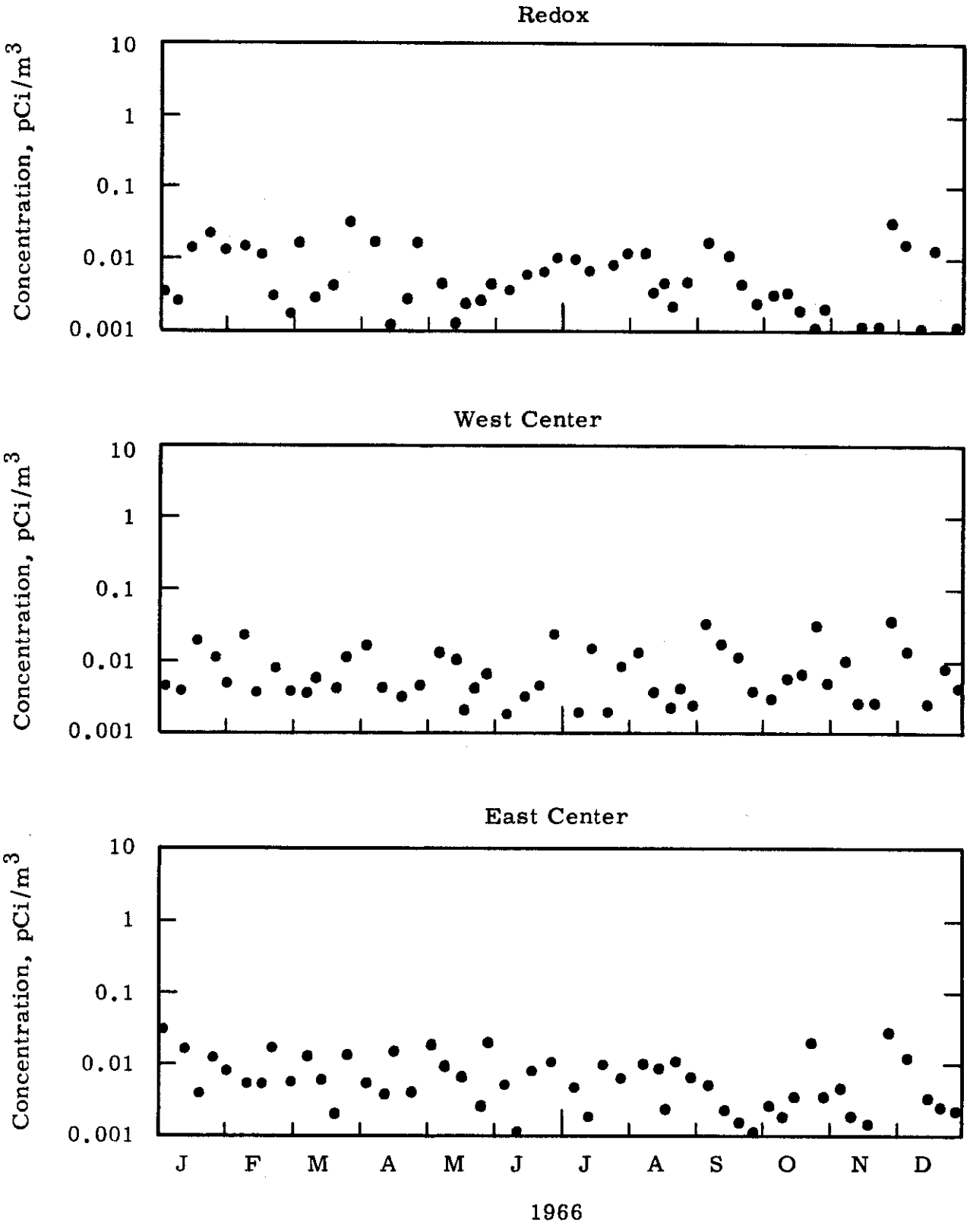
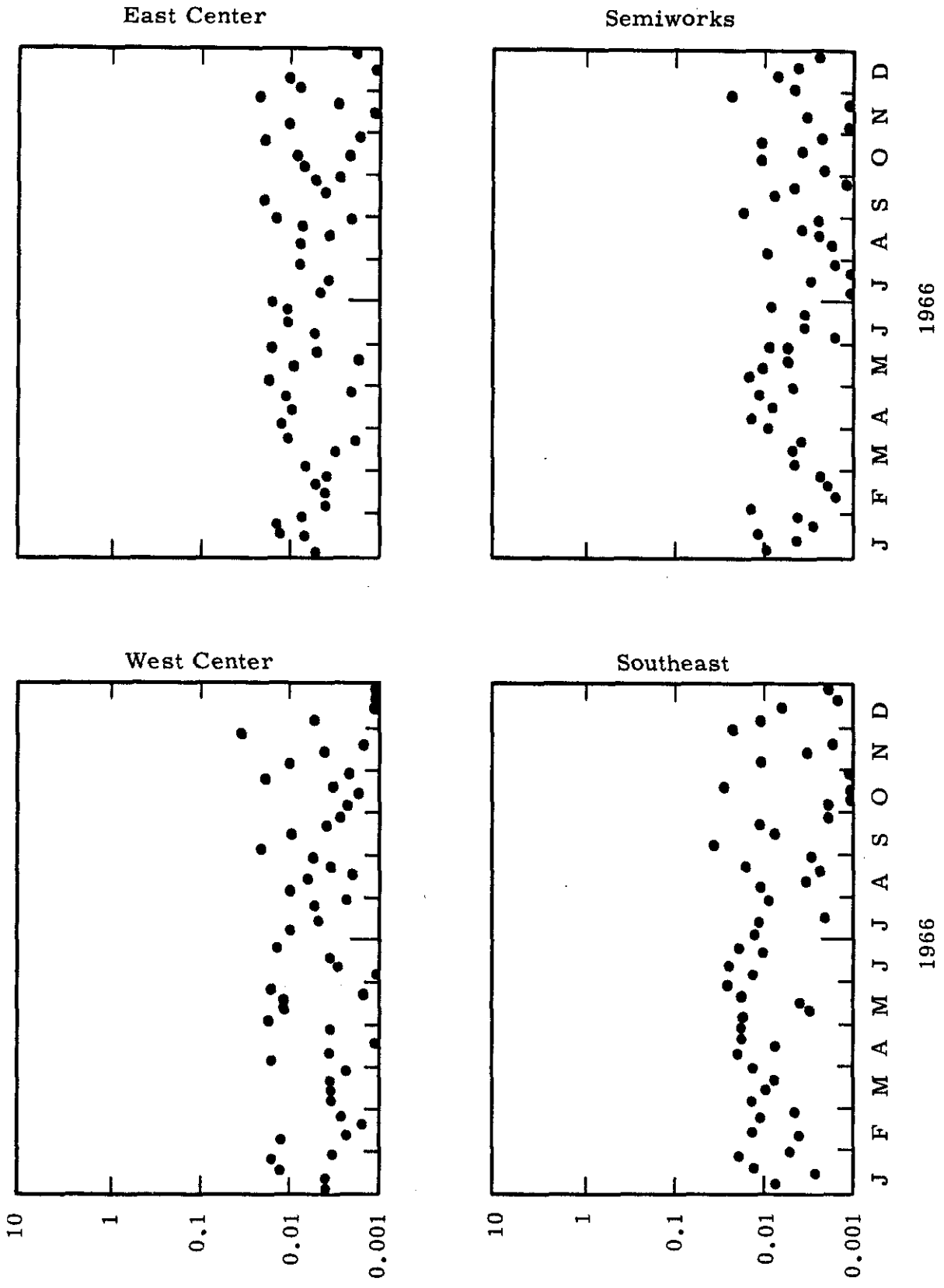


Figure 17

BNWL-CC 637-12

TOTAL ALPHA ACTIVITY IN THE ATMOSPHERE
200-E AREA



VII. Radiation Surveys

A. Contamination

1. Hanford Roads

Hanford roads are surveyed with a bioplastic scintillation detector which is attached to the front end of a truck and is positioned about two feet above the surface of the road. This "road monitor" is not only used for road surveying, but can be used for railroad and general land surveys as well. The monitor is particularly effective in defining boundaries of contaminated areas (~ plane sources). Examples of this are a special survey of the 100-K environs during January (discussed below) and routine surveillance of the 216 B-C crib area (see Map 1, page 5).

During 1965, an extensive effort was made to deny rabbits access to the 216 B-C cribs, and to stop plant growth near the cribs. Surveys during 1966 indicated that the abundance and radioactivity of particulates from rabbit droppings and weeds in the 216-BC environs were somewhat less than the radiation levels of 100-300 mrads/hr observed during 1965.

A month-by-month summary of significant findings during 1966 follows.

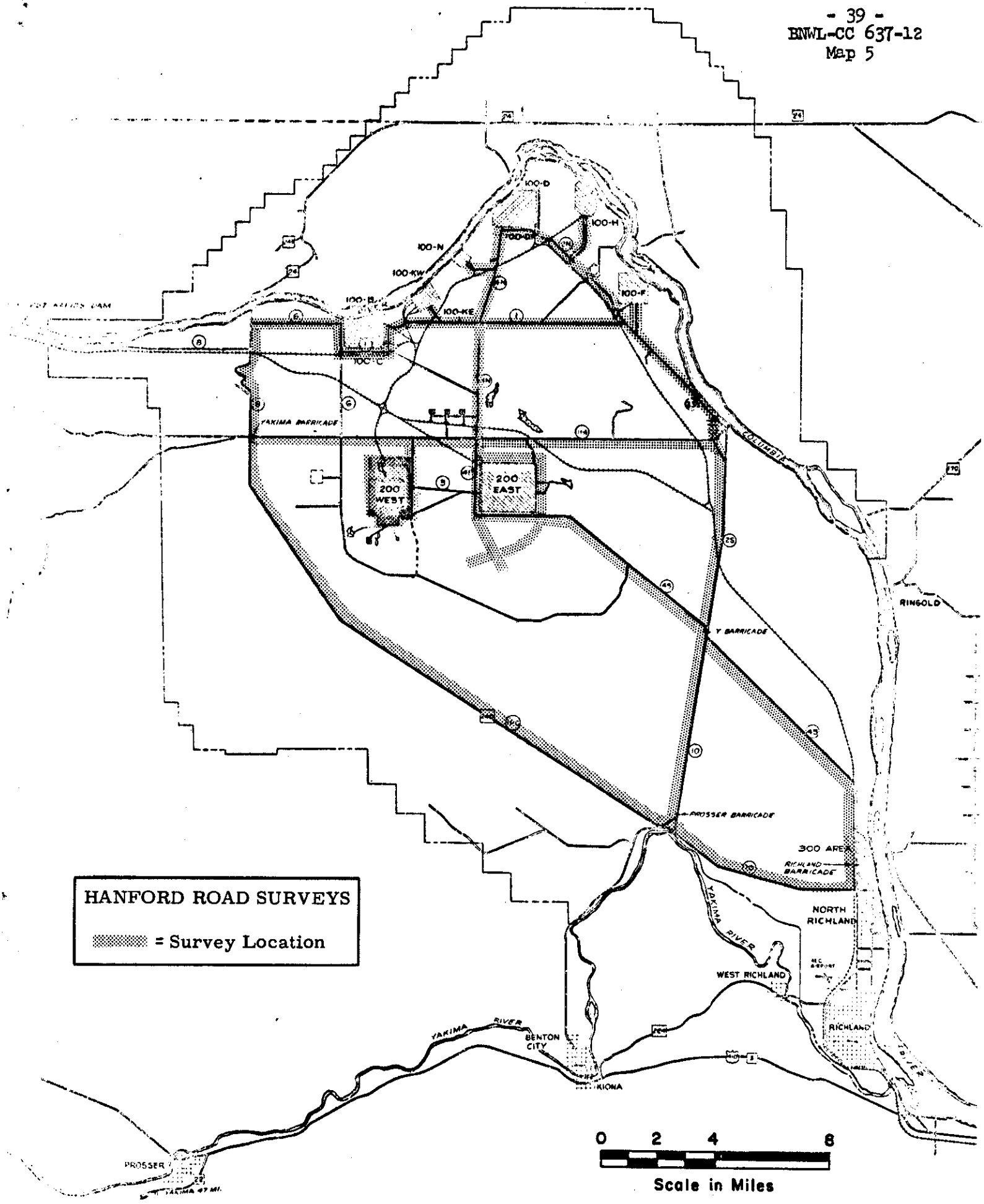
January - A follow-up survey of the 100-K environs was made on January 28, 1966 to measure contamination levels 7 months after the wind spread contamination from a dry 107-K Basin (June, 1965). The contamination spread was still confined to a well defined path which extended from 100-K Area toward the Central Fire Station. The January, 1966 radiation survey showed that the contamination level had decreased approximately four-fold in seven months, and that the contamination was apparently fixed (i.e., no personnel or vehicle contamination was incurred during the survey). Activities measured at contact with the ground during the re-survey were approximately 100 c/m (above a 150 c/m background) from the 100-K perimeter fence to the Central Fire Station. The more highly radioactive (10,000 c/m) particulates found during June, 1965 were no longer present.

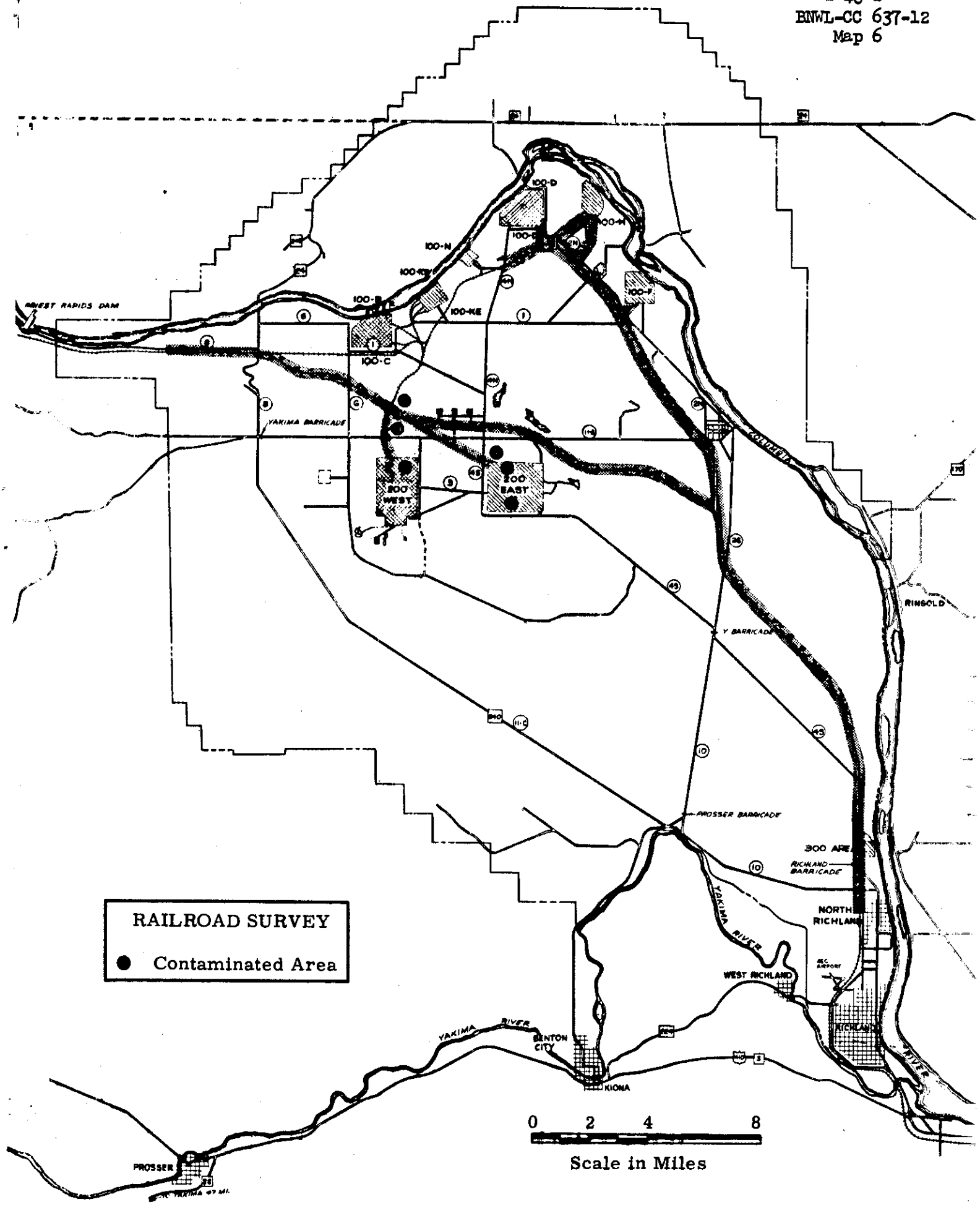
March - A radiation survey of the plant railroads outside of the exclusion area fences and inside of the 200 Areas was made during the month. The surveys were made with the road monitor attached to a "motor car" two feet above the ties. Contamination was detected at six locations: 2 particles at Susie Junction (300 and 1000 c/m); 1 particle 100 yards west of the 200 East Area entrance (~ 500 mrads/hr); 2 particles within the 200 East Area, just inside the area

gate (1000 c/m) and near 202-A Warehouse (2500 c/m); and a 12 square foot area within the 200 West Area, near 211-T (1000 c/m). Map 6 shows the railroad track which was surveyed and the approximate location of the contaminated areas. Some sections of tract were omitted from the survey because they were either blocked by a parked railroad car or the background radiation level was too high for the detector to distinguish radioactive particulates located near the track. All measurements were made with a portable survey instrument at contact.

September - On 9/23/66, road contamination was detected during a routine road monitor survey of route 4-S. Follow-up surveys revealed the presence of 14 spots of contamination having radiation levels from 1000-80,000 c/m (as measured with a GM counter). The contamination was confined to a narrow path along three miles of highway, beginning 3 miles north of and ending approximately 6 miles north of the 300 Area. The contamination was attributed to leakage from a truck which was transporting radioactive waste. A gamma scan analysis indicated that the road contamination was composed of the following: $Ce\text{-}Pr^{144}$ (50%), $Ru^{103}\text{-}Rh^{103m}$ + $Ru\text{-}Rh^{106}$ (25%), and $Zr\text{-}Nb^{95}$ (25%). In all locations, the contamination was fixed with paint until removal operations were accomplished.

No other contamination was found with the road monitor during the year. Map 5 shows the road surveys made during 1966.

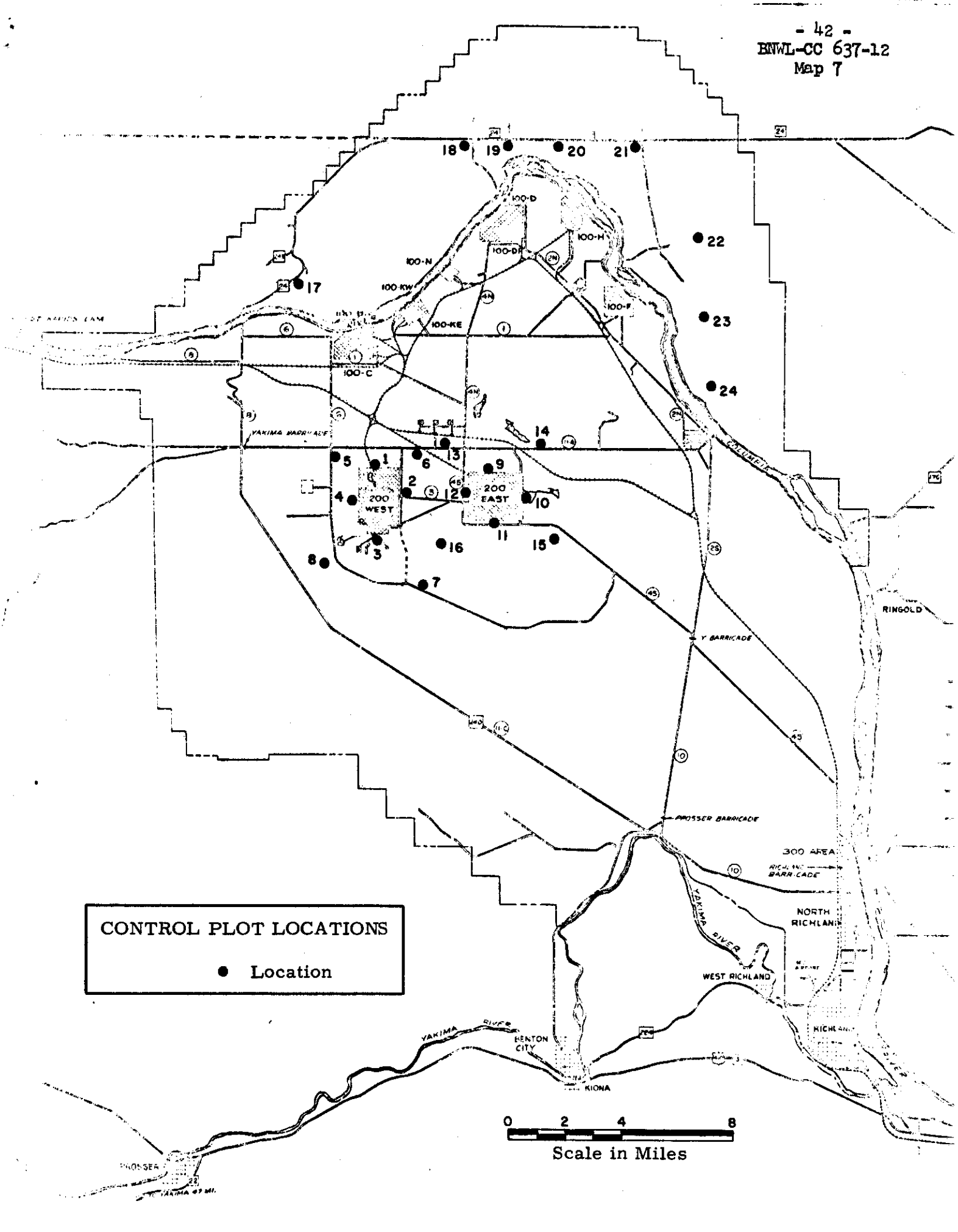

100-D
100-H
100-N
100-KW
100-KE
100-F
100-B
100-C
YAKIMA BARRICADE
200 WEST
200 EAST
COLUMBIA
RINGOLD
Y BARRICADE
PROSSER BARRICADE
300 AREA
RICHLAND BARRICADE
NORTH RICHLAND
YAKIMA RIVER
WEST RICHLAND
RICHLAND
BENTON CITY
KIONA
PROSSER
HANFORD ROAD SURVEYS
= Survey Location
0 2 4 6
Scale in Miles


100-D
100-H
100-N
100-KW
100-KE
100-F
100-B
100-C
WANAPUM RAPIDS DAM
YAKIMA BARRICADE
200 WEST
200 EAST
COLUMBIA
RINGOLD
Y BARRICADE
PROSSER BARRICADE
300 ARE
RICHLAND BARRICADE
NORTH RICHLAND
WEST RICHLAND
YAKIMA RIVER
BENTON CITY
KIONA
PROSSER
RAILROAD SURVEY
Contaminated Area
0 2 4 8
Scale in Miles

2. Control Plots

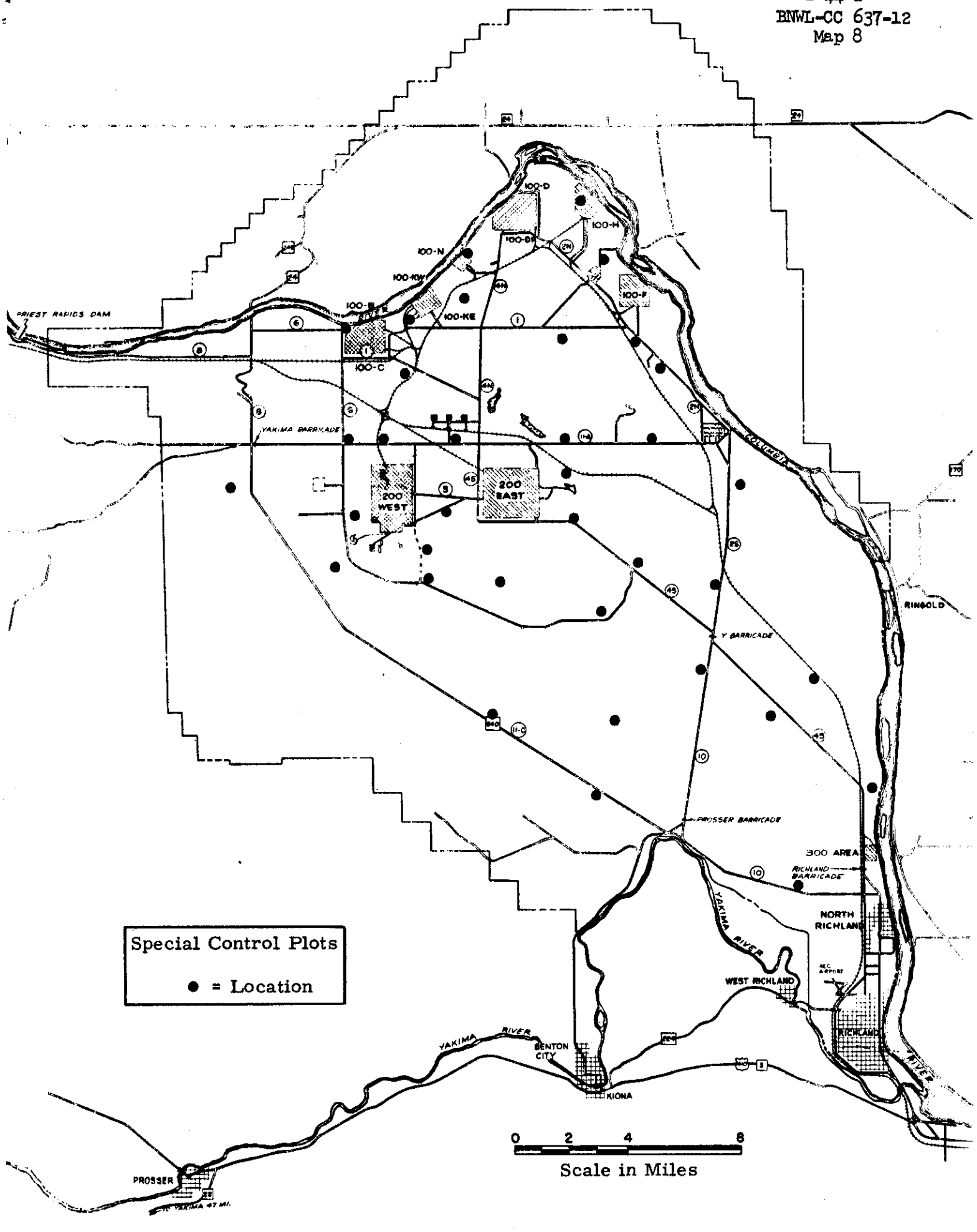
Twenty-four land areas, measuring 10 feet by 10 feet, are located on the Wahluke Slope and near the 200 Areas. These plots are periodically surveyed with a portable GM counter to determine if radioactive particulates have been deposited on the ground. Control plot locations are shown on Map 7. A summary of findings from control plot surveys is given below.

Date	Control Plot No.	Contamination Form	Radiation Level	Laboratory Analysis
2/8/66	10	Particle	1000 c/m	Ru^{106}-Rh^{106}-0.19 nCi Cs^{137}-0.01 nCi Zr^{95}-Nb^{95}-0.004 nCi
2/22/66	10	Particle	1000 c/m	Not analyzed
2/22/66	9	Tumbleweed	60,000 c/m	1.2 nCi Cs^{137}/g 100 nCi Sr^{90}/g
3/1/66	1	Particle	12,000 c/m	Not analyzed
3/8/66	9	Particle	2500 c/m	Not analyzed
3/8/66	10	Particle	18,000 c/m	Not analyzed
3/22/66	9	Particle	5000 c/m	Not analyzed
7/21/66	1	Particle	5000 c/m	Not analyzed
	1	Particle	20,000 c/m	100 nCi Sr^{90}
	1	Particle	50 mrad/hr	800 nCi Sr^{90}
8/12/66	1	Particle	100,000 c/m	Not analyzed
	9	Particle	3000 c/m	Not analyzed
	16	Particle	1000 c/m	Not analyzed
9/8/66	9	Particle	1000 c/m	60 nCi Sr^{90} 1 nCi Cs^{137}
12/8/66	1	Tumbleweed	7000 c/m	100 nCi Cs^{137}/g


18
19
20
21
22
23
24
17
100-D
100-H
100-N
100-KW
100-DR
100-F
100-KE
100-C
YAKIMA BARRICADE
14
13
5
1
6
9
2
4
200 WEST
12
200 EAST
10
11
3
16
15
8
7
RINGOLD
Y BARRICADE
PROSSER BARRICADE
300 AREA
RICHLAND BARRICADE
NORTH RICHLAND
YAKIMA RIVER
WEST RICHLAND
RICHLAND
YAKIMA RIVER
BENTON CITY
KIONA
PROSSER
CONTROL PLOT LOCATIONS
Location
0 2 4 8
Scale in Miles

3. Special Control Plots

Special control plots are land areas (100 square feet each) surrounding Hanford Test Wells (see Map 8). These areas are usually surveyed twice per year with a portable GM counter to see if particulates have been deposited on the ground. During January-February, 52 special control plots were surveyed, and no radioactive particulates were found. During June, 1966, 31 special control plots were surveyed, and 1 particle (8000 c/m) was found near 100-N Area. Results of a gamma scan analysis of this particle were: Ce^{144}-Pr^{144}, 30 nCi; Ru^{103}-Rh^{103m}, 6 nCi; and Zr^{95}-Nb^{95}, 2 nCi.


100-D
100-H
100-DR
100-N
100-KW
100-F
100-KE
100-B
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
BENTON CITY
KIONA
PROSSER
Special Control Plots
● = Location
0 2 4 8
Scale in Miles

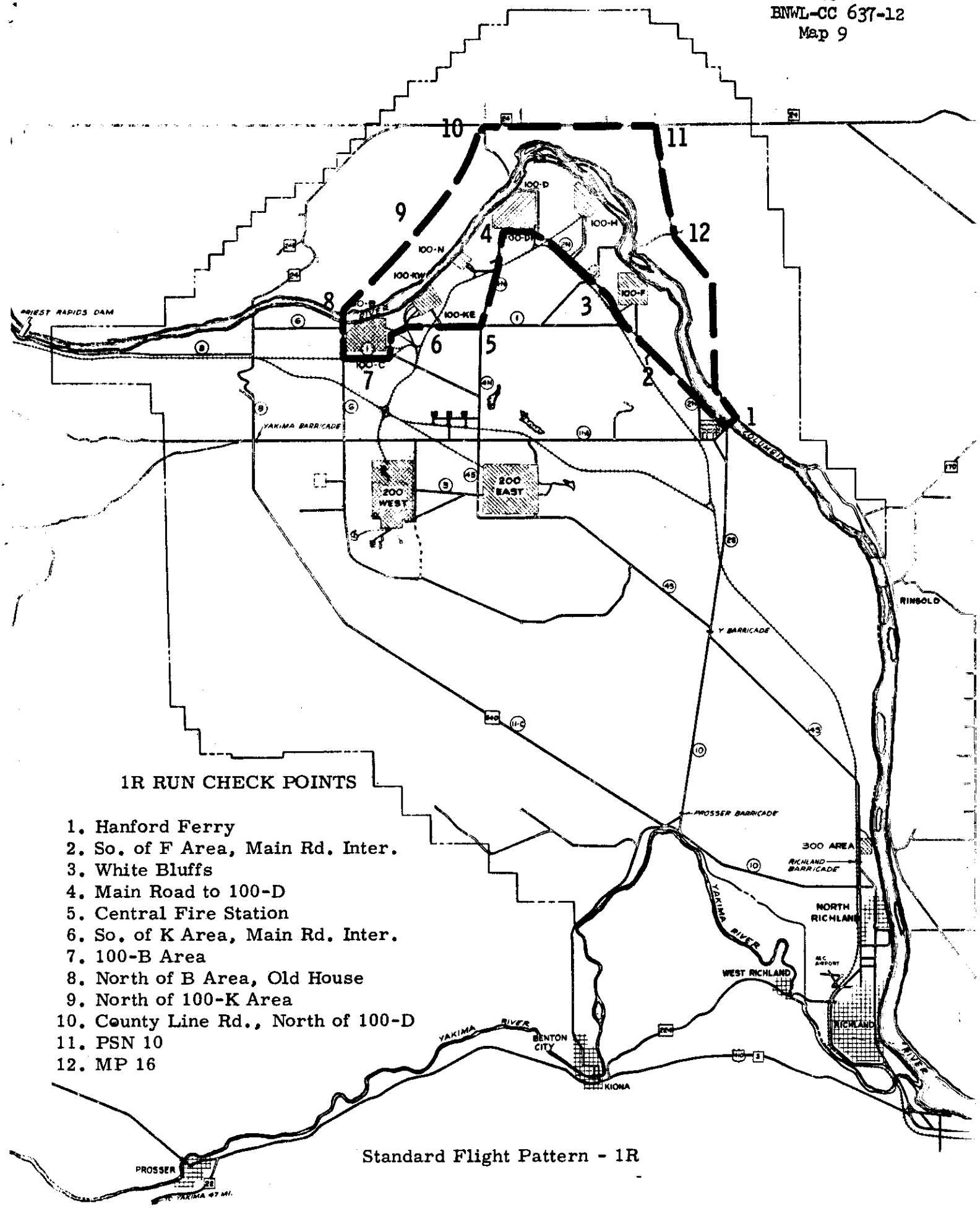
4. Aerial Surveys

The purpose of aerial surveys is to detect contamination which is spread over a large land area. Like road and control plot surveys, aerial surveys are qualitative in nature, and through routine use of this technique, a capability for rapid assessment of an emergency situation is maintained.

All surveys are conducted at an altitude of 150 meters (500 feet). At this height, the monitor has an effective detection area of 0.2 km^2. The detector is a three inch by five inch NaI(Tl) scintillation crystal, and has a minimum detection limit for I^{131}, for example, of about 0.5 Ci/km^2.

Ten flight patterns are located within and near the Hanford project perimeter. In addition, two flight patterns cover the Columbia River from Priest Rapids Dam to the Pacific Ocean and two other flight patterns cover the Richland-Pendleton-Spokane "triangle" and the Richland-Ellensburg-Ritzville "triangle".

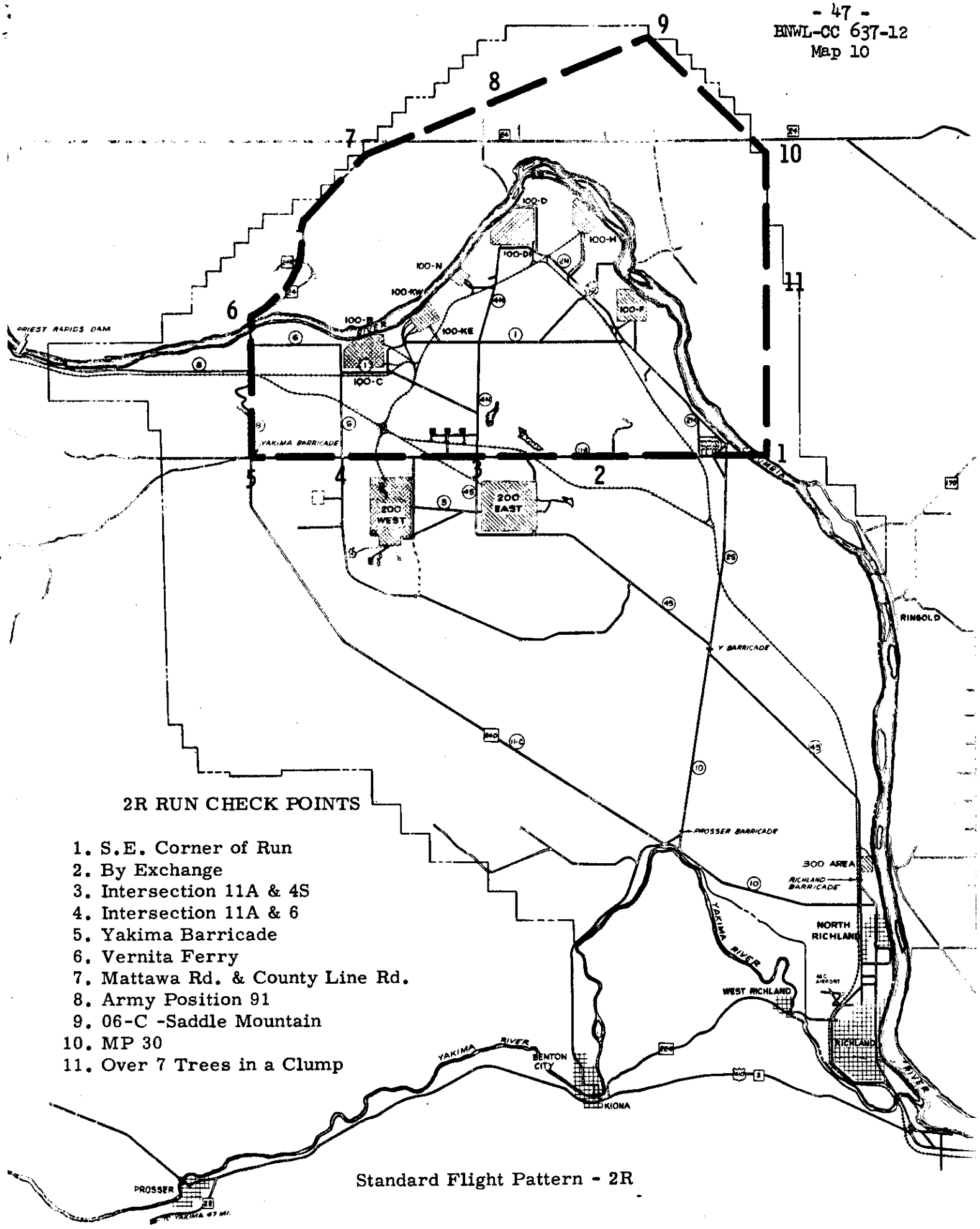
Twenty-seven aerial surveys were made during 1966 and are shown on Maps 9-21 which follow. In all surveys, no ground contamination was detected.



1R RUN CHECK POINTS

1. Hanford Ferry
2. So. of F Area, Main Rd. Inter.
3. White Bluffs
4. Main Road to 100-D
5. Central Fire Station
6. So. of K Area, Main Rd. Inter.
7. 100-B Area
8. North of B Area, Old House
9. North of 100-K Area
10. County Line Rd., North of 100-D
11. PSN 10
12. MP 16

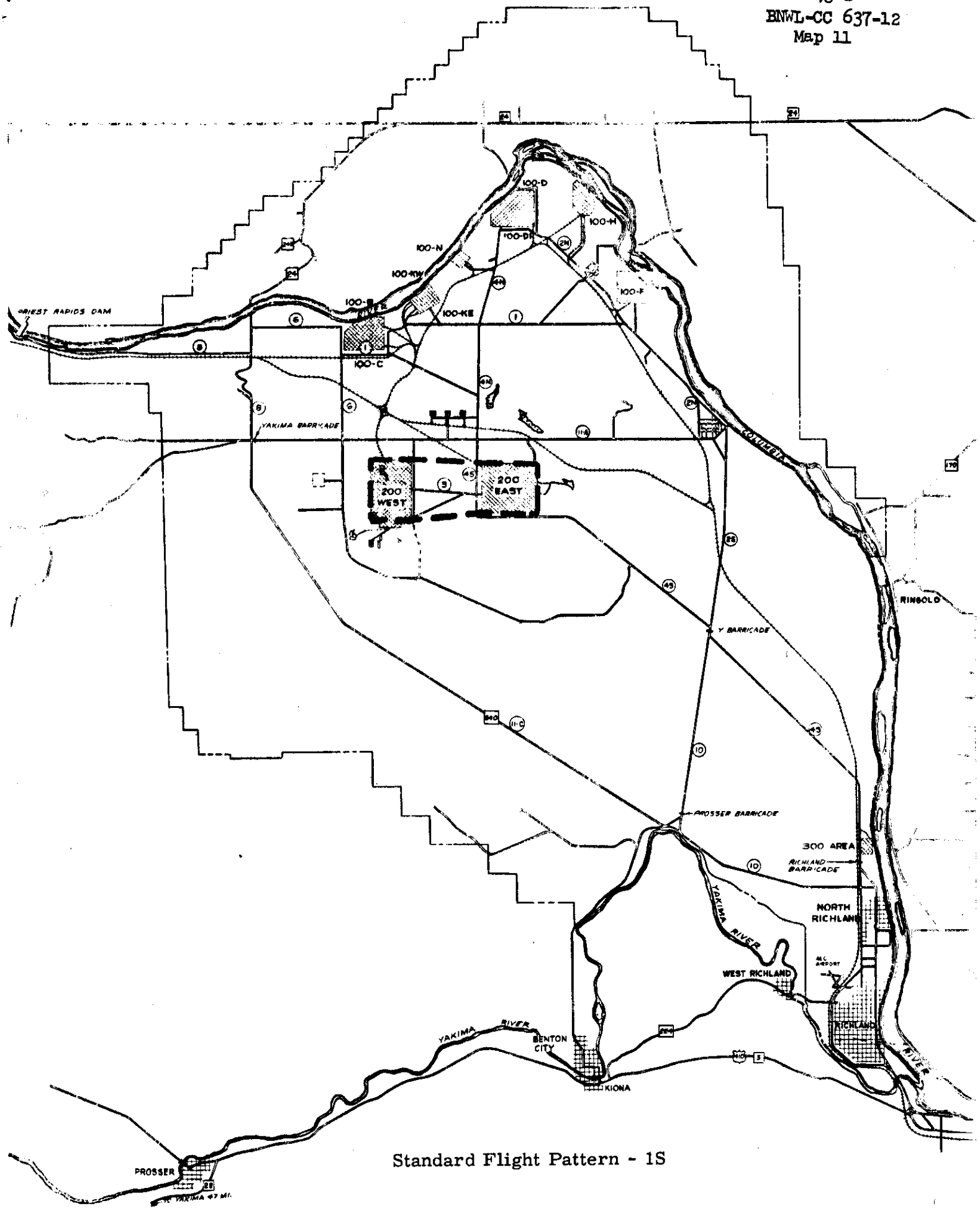
Standard Flight Pattern - 1R



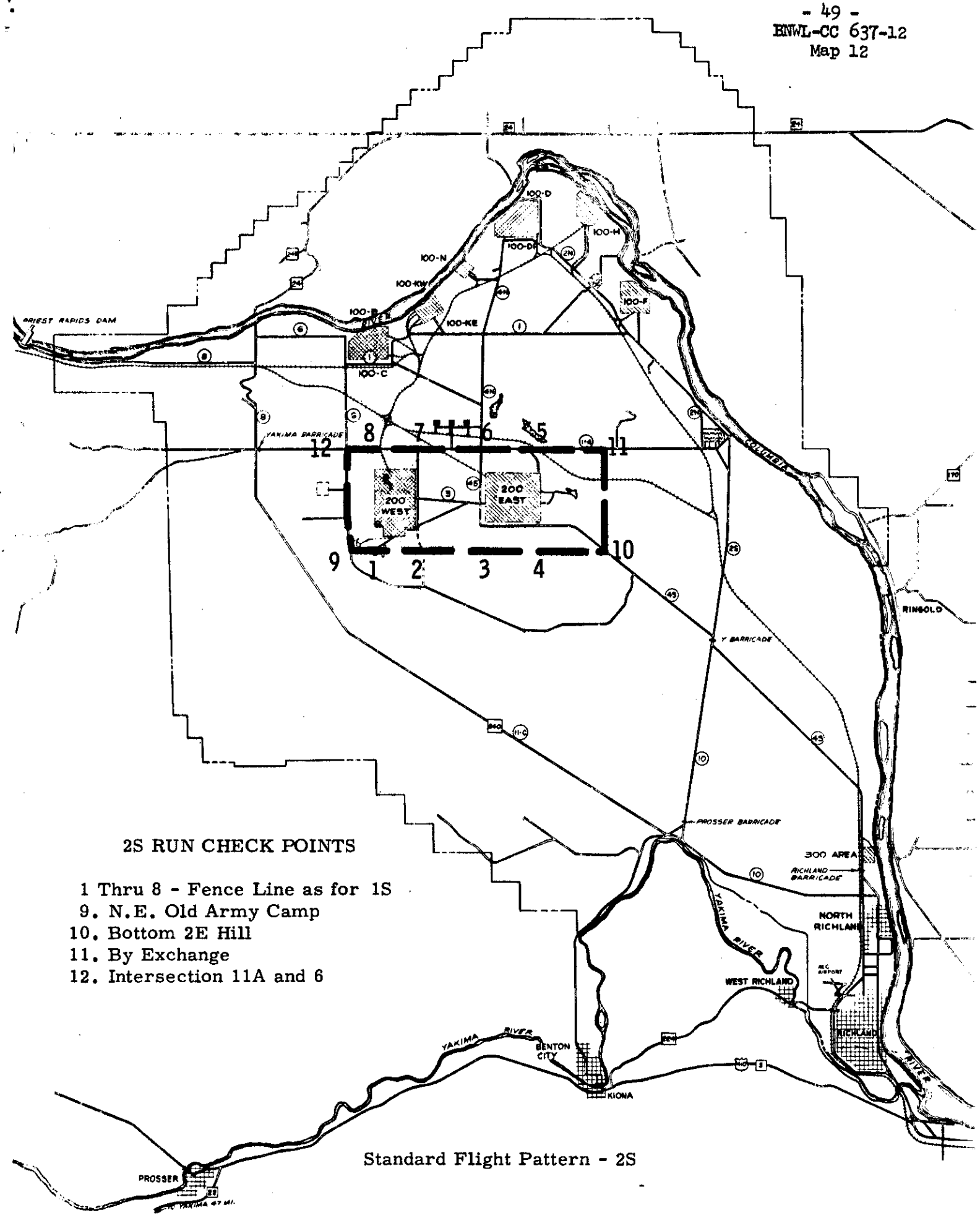
2R RUN CHECK POINTS

1. S.E. Corner of Run
2. By Exchange
3. Intersection 11A & 4S
4. Intersection 11A & 6
5. Yakima Barricade
6. Vernita Ferry
7. Mattawa Rd. & County Line Rd.
8. Army Position 91
9. 06-C -Saddle Mountain
10. MP 30
11. Over 7 Trees in a Clump

Standard Flight Pattern - 2R



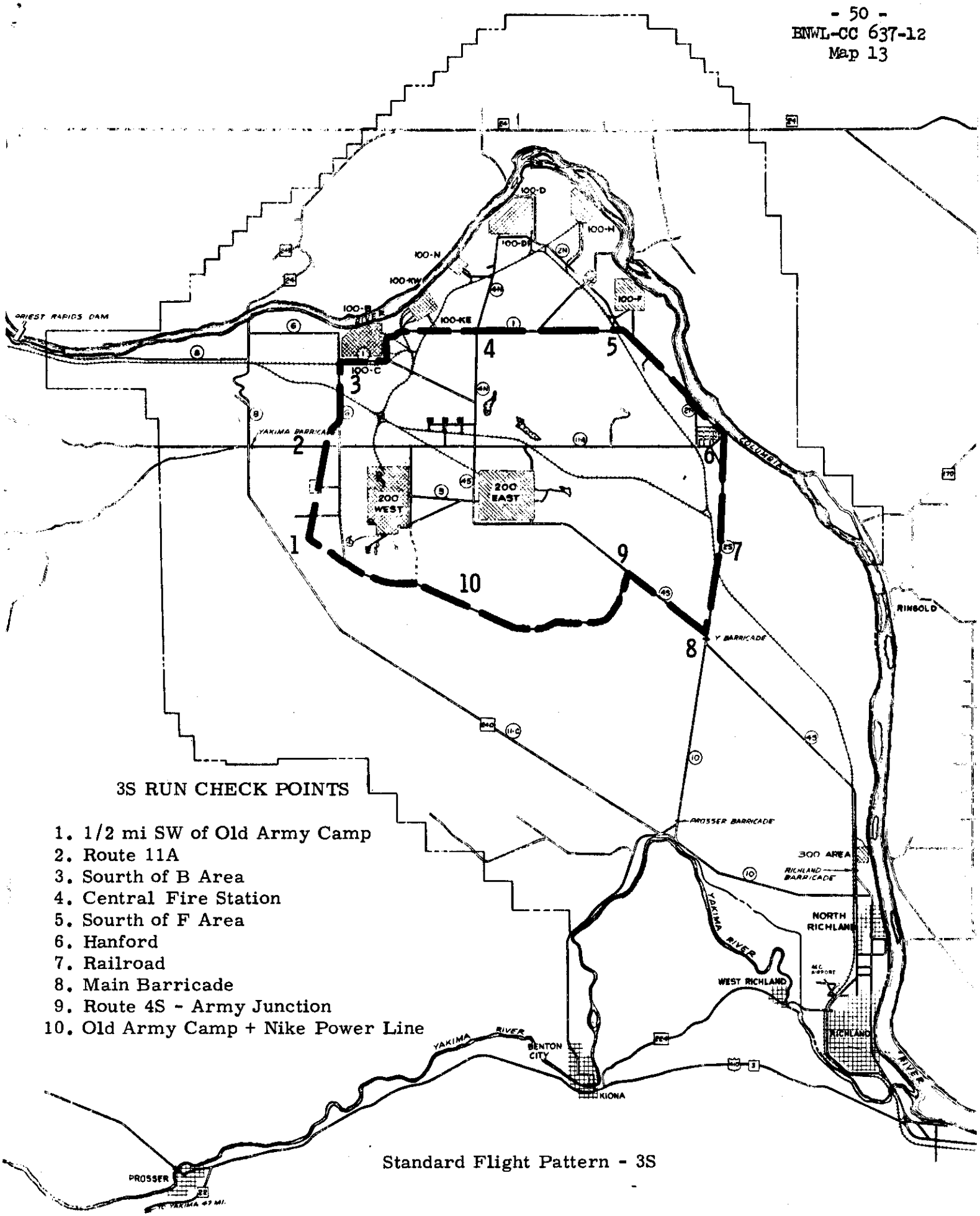
Standard Flight Pattern - 1S



2S RUN CHECK POINTS

1 Thru 8 - Fence Line as for 1S
9. N.E. Old Army Camp
10. Bottom 2E Hill
11. By Exchange
12. Intersection 11A and 6

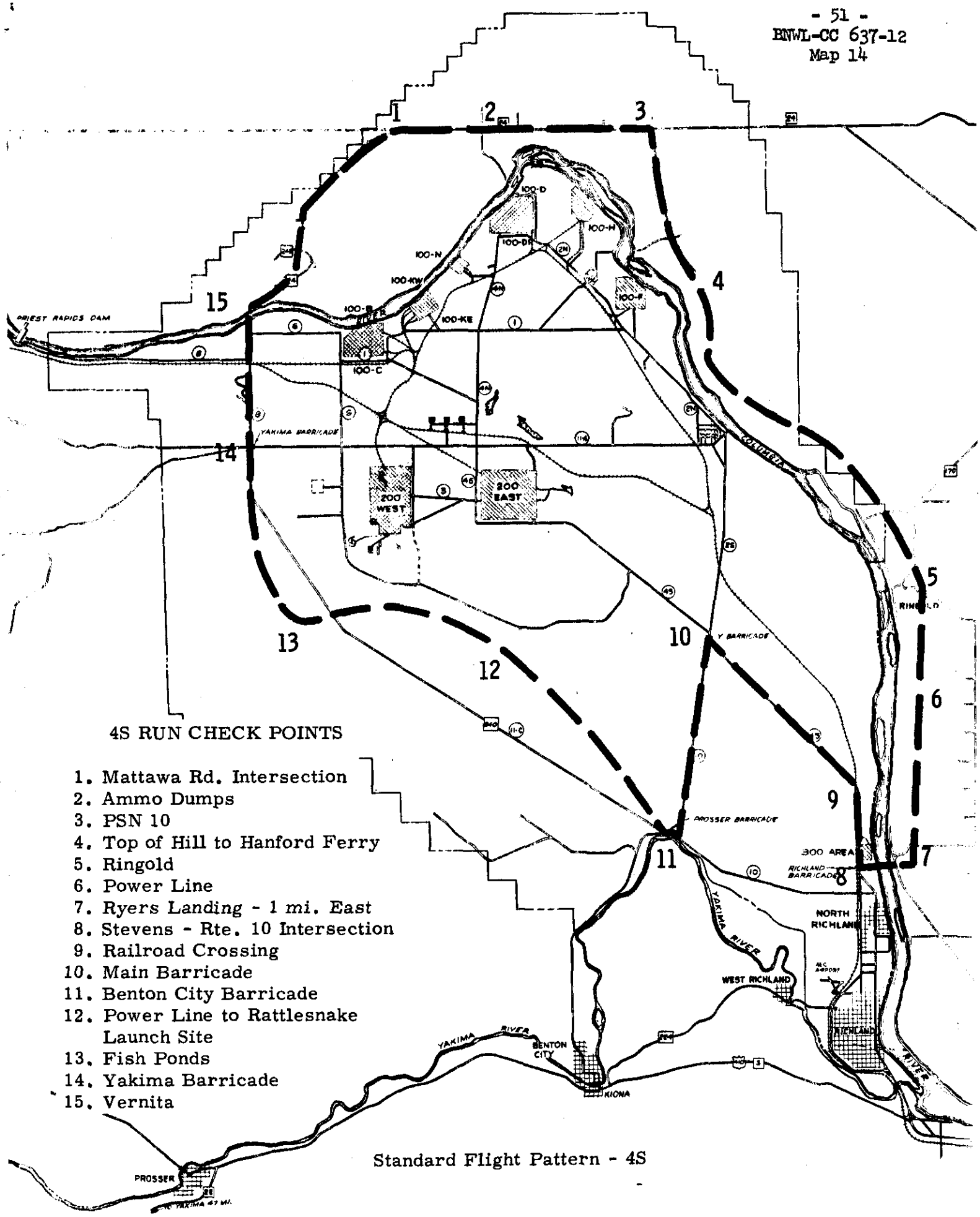
Standard Flight Pattern - 2S



3S RUN CHECK POINTS

1. 1/2 mi SW of Old Army Camp
2. Route 11A
3. Sourth of B Area
4. Central Fire Station
5. Sourth of F Area
6. Hanford
7. Railroad
8. Main Barricade
9. Route 4S - Army Junction
10. Old Army Camp + Nike Power Line

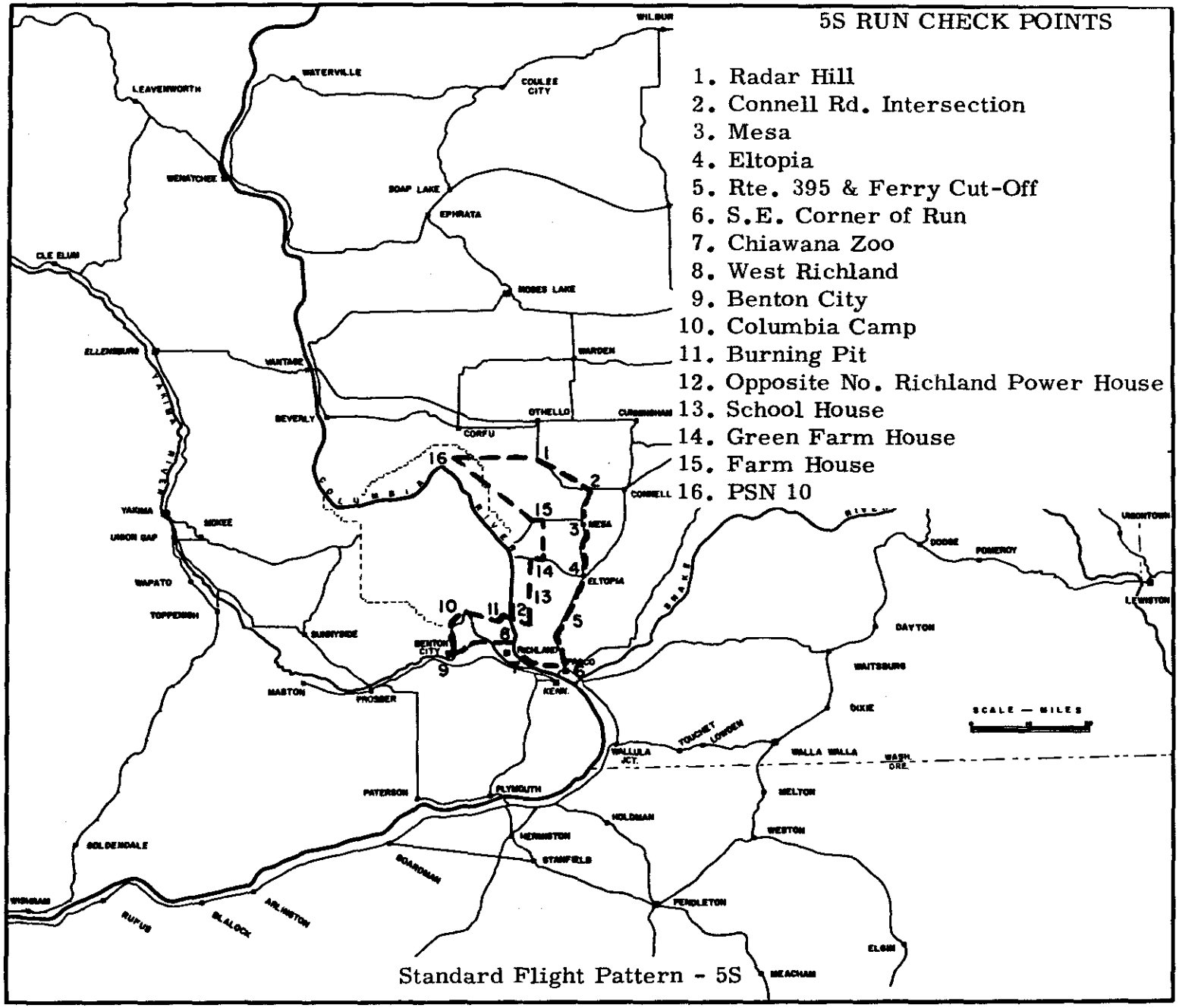
Standard Flight Pattern - 3S

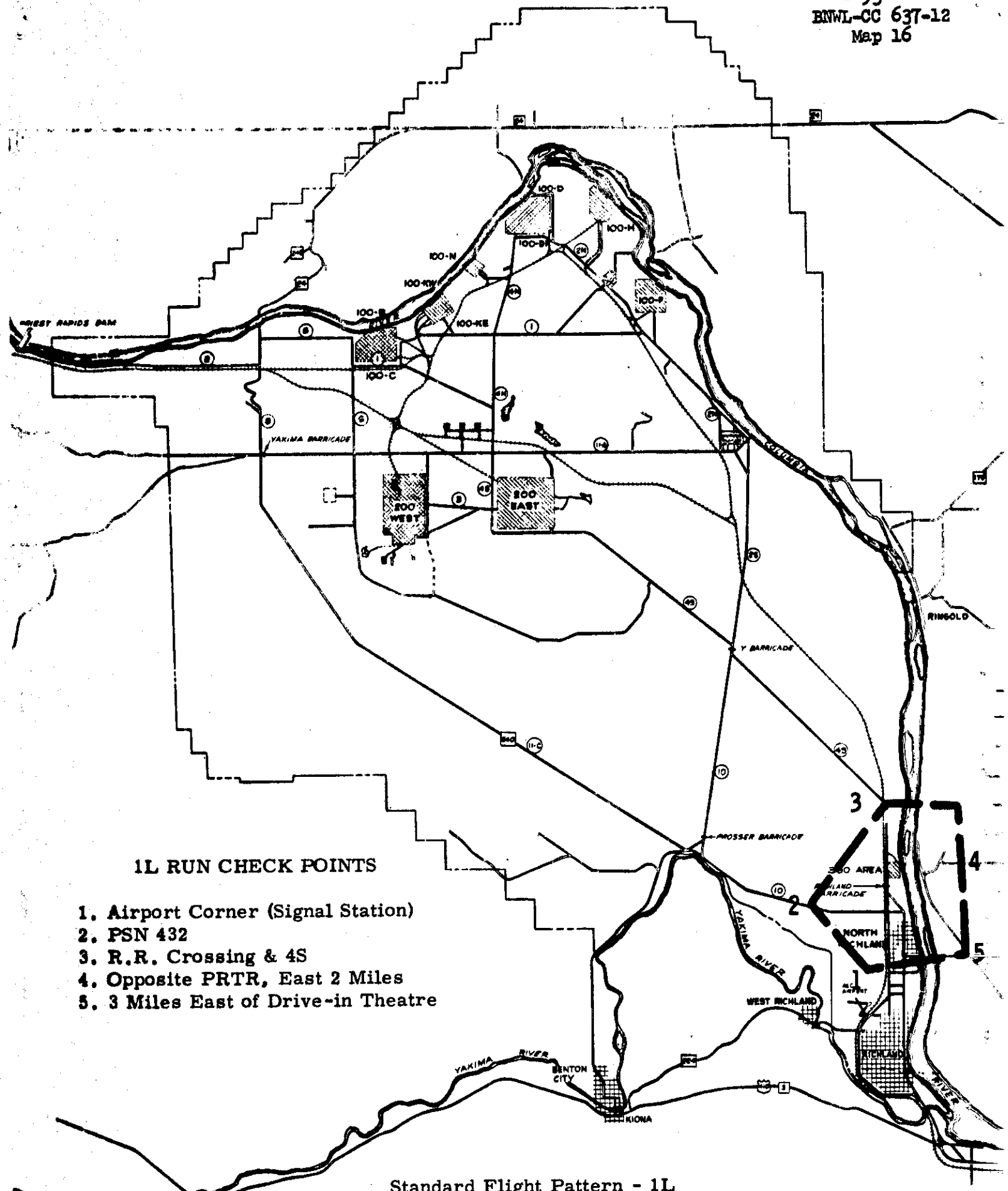


4S RUN CHECK POINTS

1. Mattawa Rd. Intersection
2. Ammo Dumps
3. PSN 10
4. Top of Hill to Hanford Ferry
5. Ringold
6. Power Line
7. Ryers Landing - 1 mi. East
8. Stevens - Rte. 10 Intersection
9. Railroad Crossing
10. Main Barricade
11. Benton City Barricade
12. Power Line to Rattlesnake Launch Site
13. Fish Ponds
14. Yakima Barricade
15. Vernita

Standard Flight Pattern - 4S

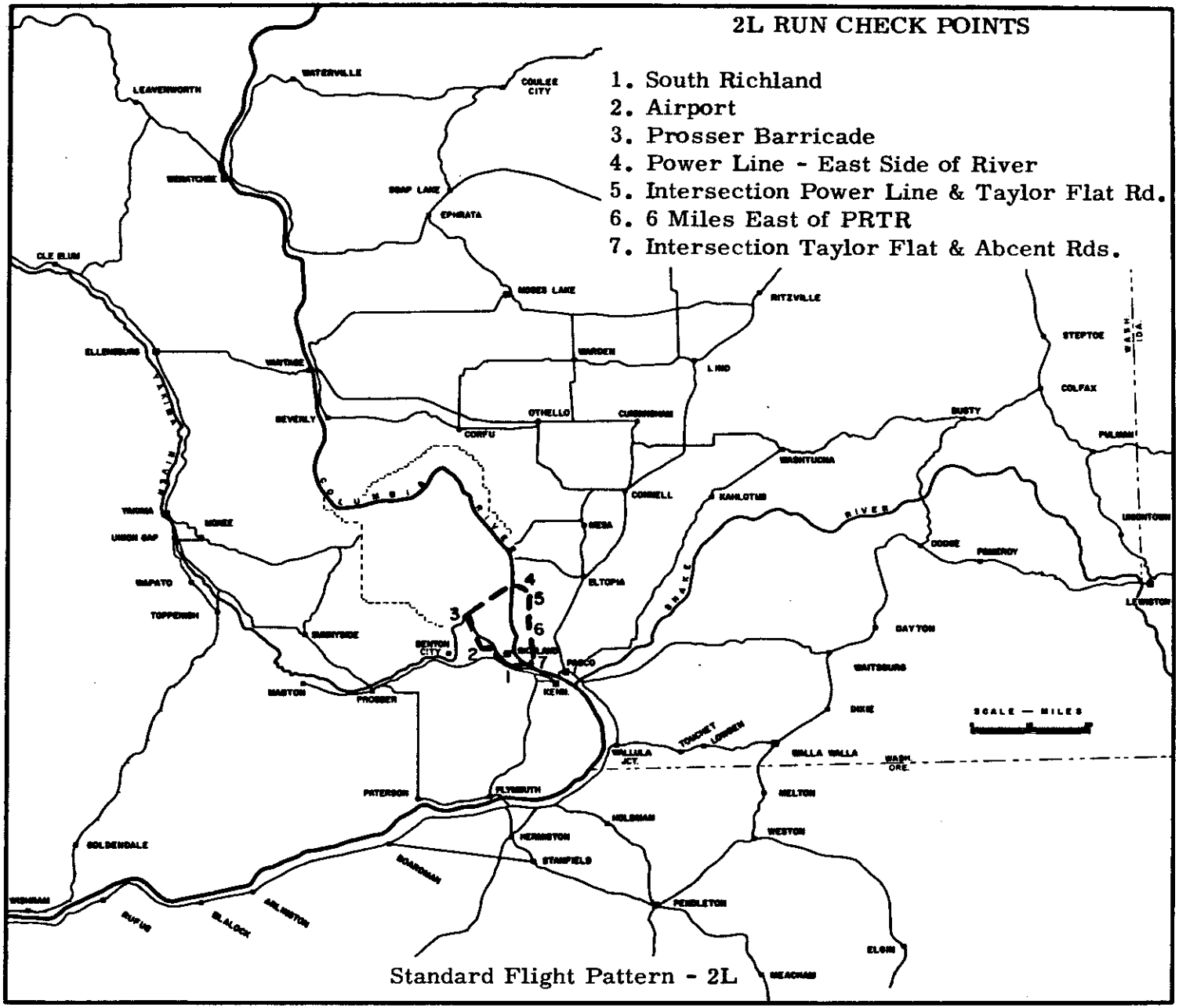

5S RUN CHECK POINTS
1. Radar Hill
2. Connell Rd. Intersection
3. Mesa
4. Eltopia
5. Rte. 395 & Ferry Cut-Off
6. S.E. Corner of Run
7. Chiawana Zoo
8. West Richland
9. Benton City
10. Columbia Camp
11. Burning Pit
12. Opposite No. Richland Power House
13. School House
14. Green Farm House
15. Farm House
16. PSN 10
WILBUR
WATERVILLE
COULEE CITY
LEAVENWORTH
WENATCHEE
SOAP LAKE
EPHRATA
CLE ELUM
ROSES LAKE
ELLENSBURG
VANTAGE
WARDEN
BEVERLY
OTHELLO
CORFU
CONNELL
MESA
ELTOPIA
YAKIMA
MOXEE
UNION GAP
WAPATO
TOPPENISH
SUNNYSIDE
BENTON CITY
RICHLAND
KENN.
MABTON
PROSSER
PATERSON
PLYMOUTH
WALLULA JCT.
TOUCHET
LOWDEN
WALLA WALLA
WASH.
ORE.
DAYTON
WAITSBURG
DIXIE
DODGE
POMEROY
LEWISTON
UNIONTOWN
MELTON
WESTON
HOLDMAN
HERMISTON
STANFIELD
GOLDENDALE
BOARDMAN
PENDLETON
ELGIN
MEACHAM
WISHRAM
RUFUS
BLALOCK
ARLINGTON
SCALE — MILES
Standard Flight Pattern - 5S

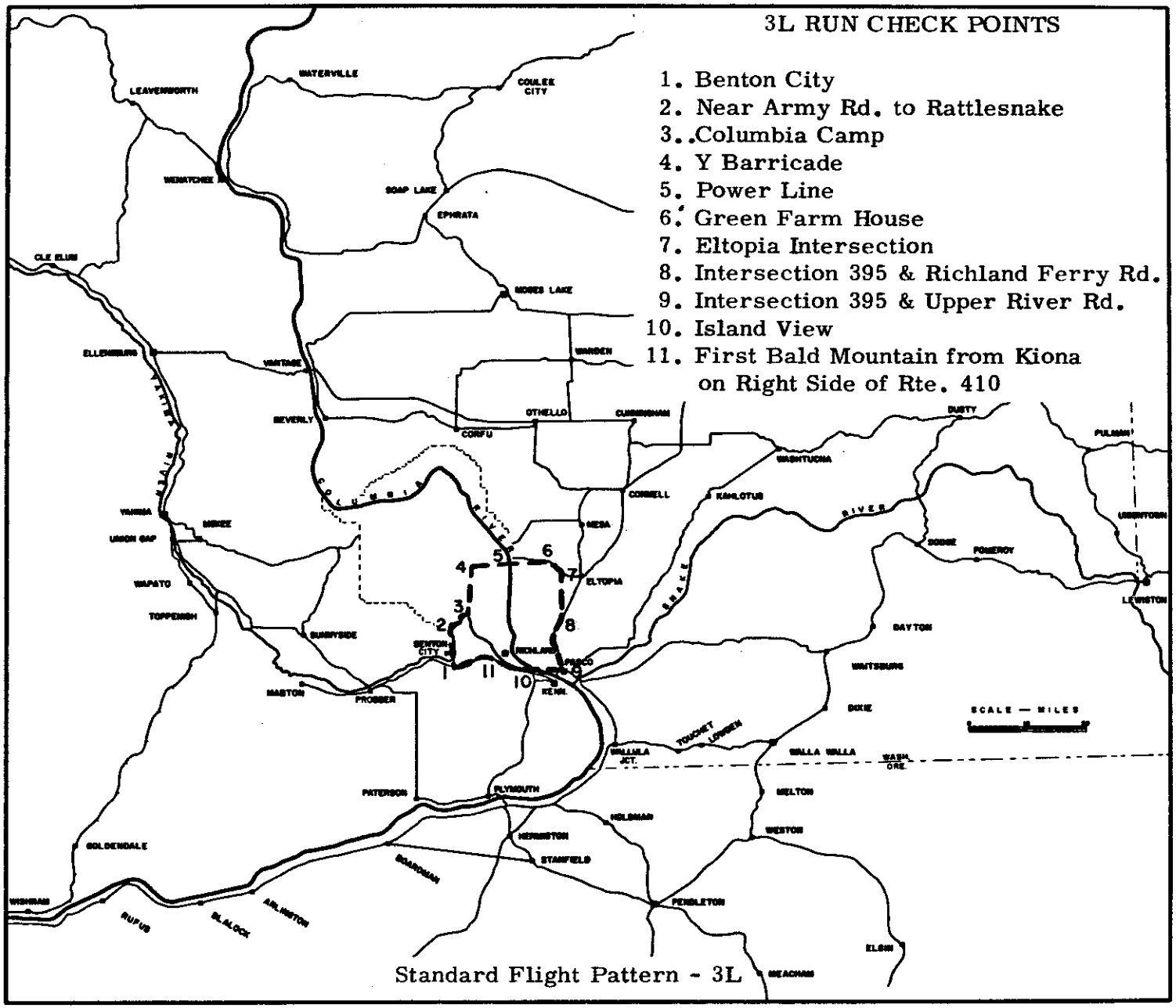


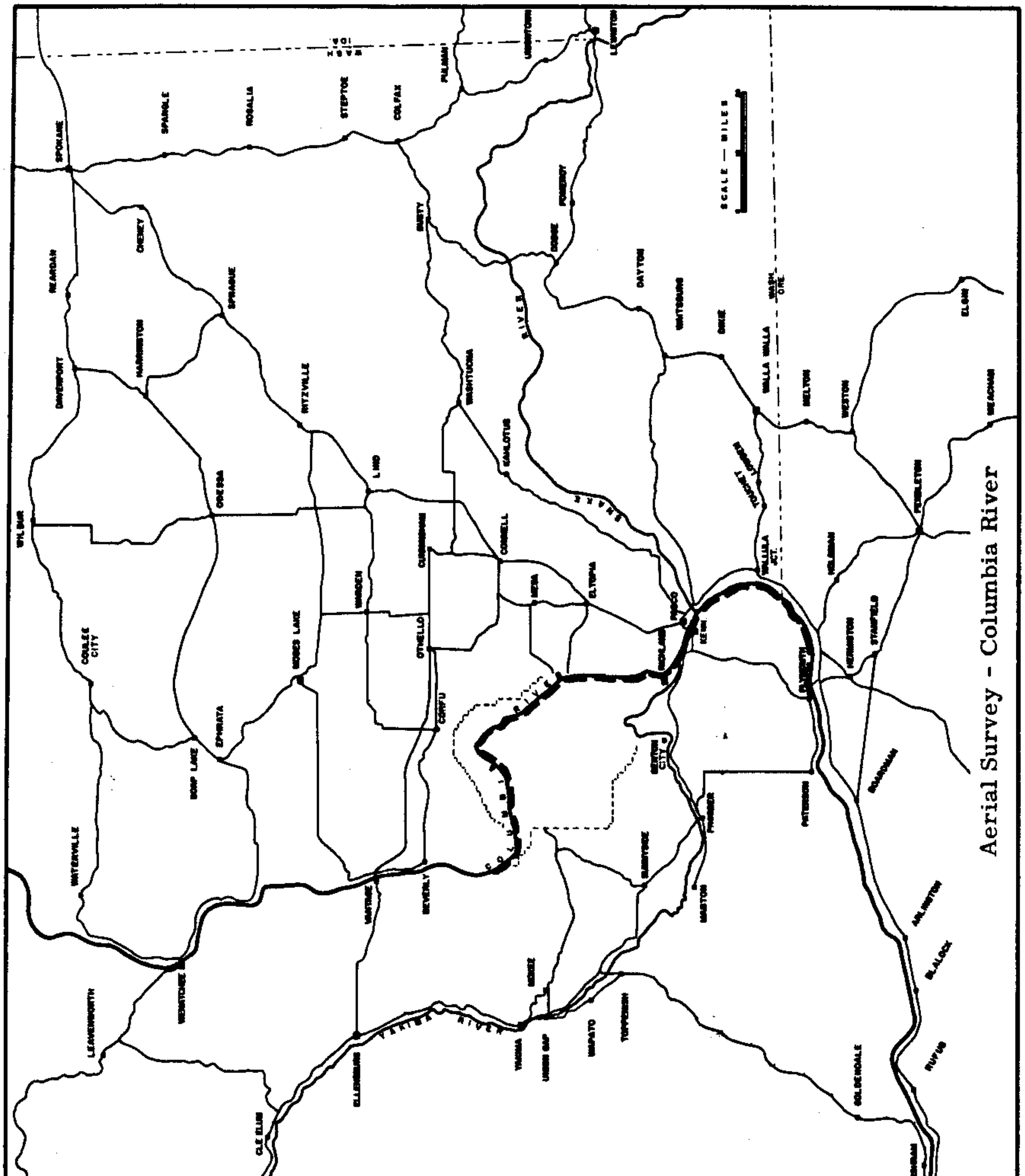
1L RUN CHECK POINTS

1. Airport Corner (Signal Station)
2. PSN 432
3. R.R. Crossing & 4S
4. Opposite PRTR, East 2 Miles
5. 3 Miles East of Drive-in Theatre

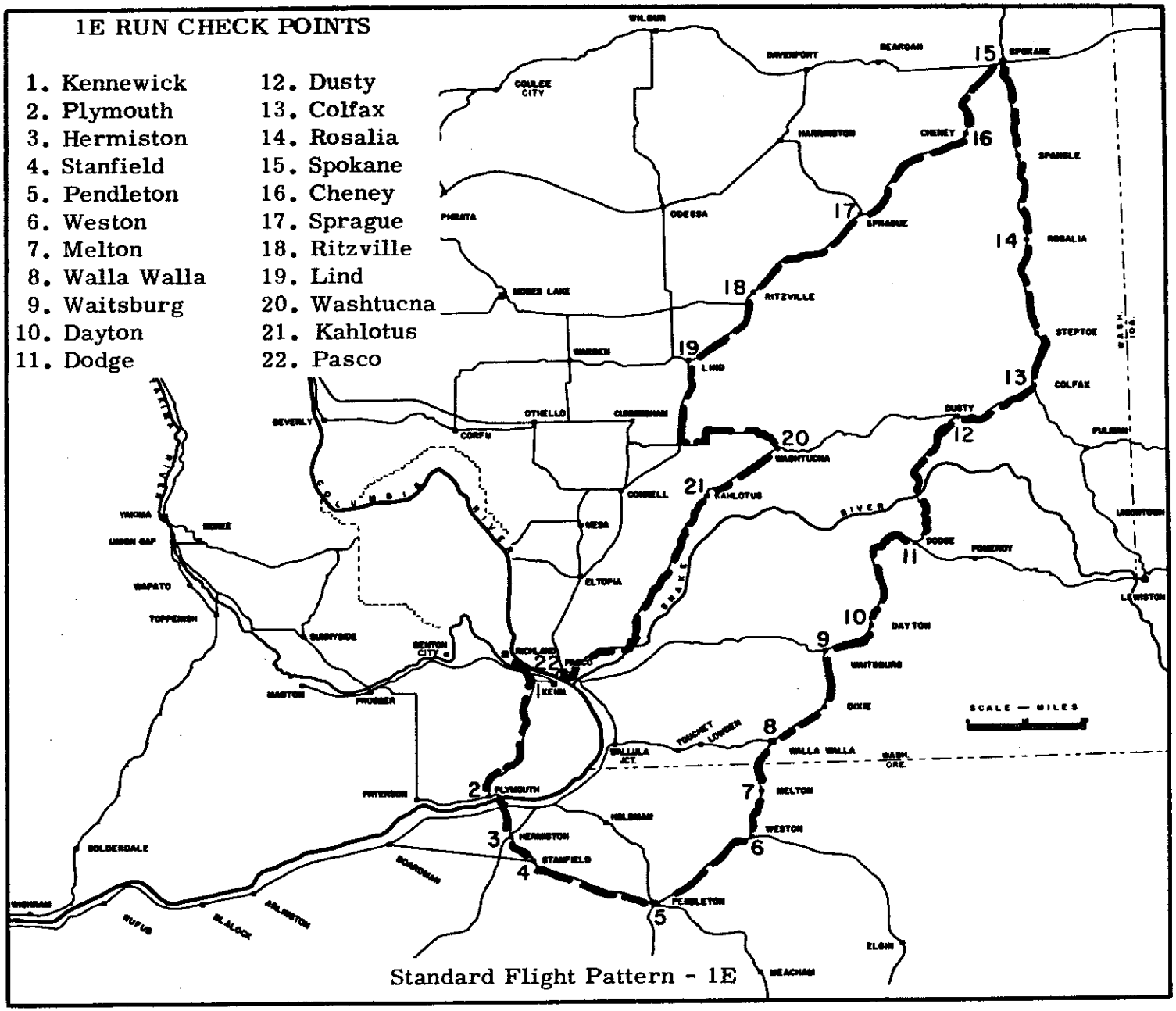
Standard Flight Pattern - 1L

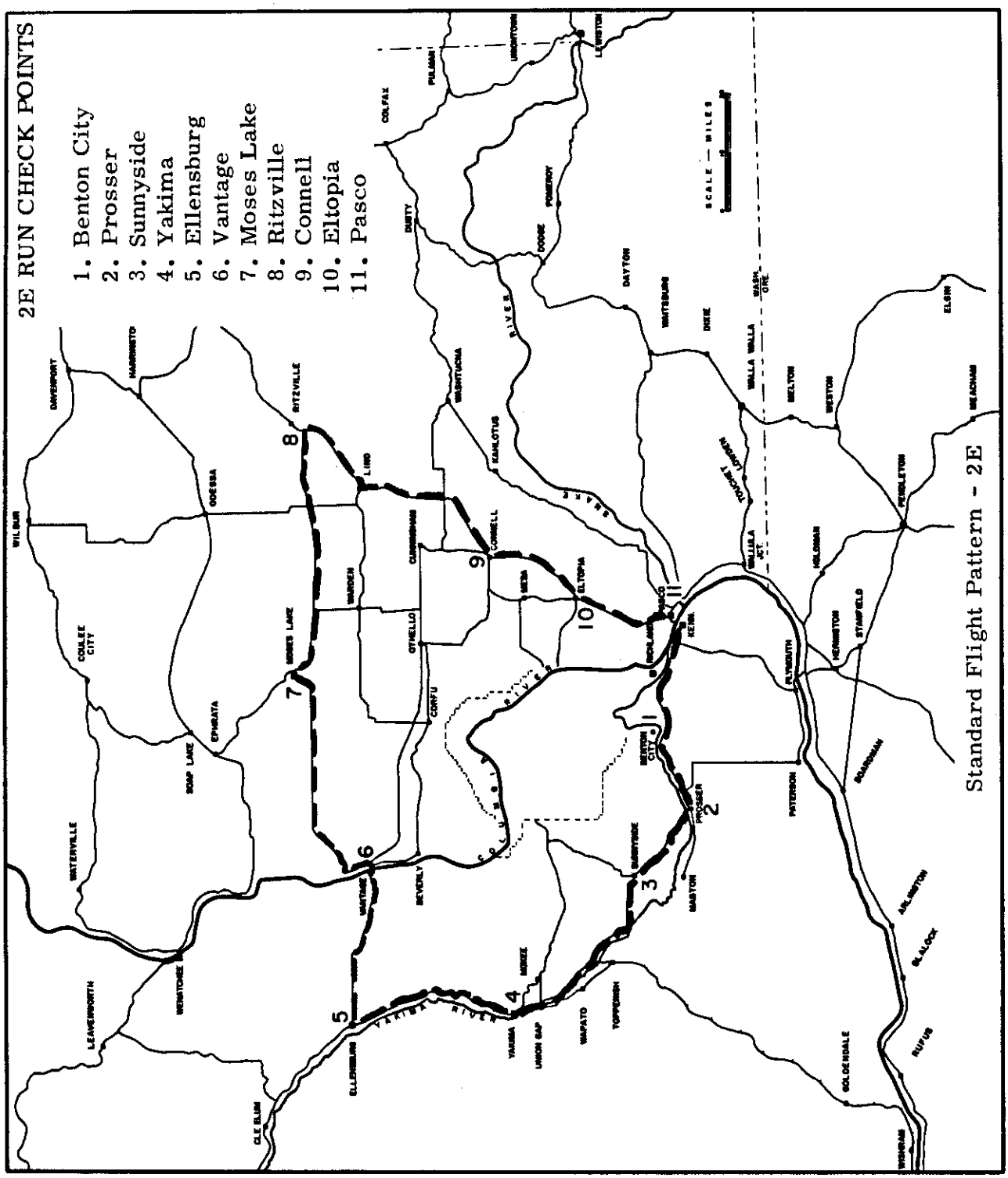

2L RUN CHECK POINTS
1. South Richland
2. Airport
3. Prosser Barricade
4. Power Line - East Side of River
5. Intersection Power Line & Taylor Flat Rd.
6. 6 Miles East of PRTR
7. Intersection Taylor Flat & Abcent Rds.
Standard Flight Pattern - 2L
SCALE — MILES
WATERVILLE
COULEE CITY
LEAVENWORTH
WENATCHEE
SOAP LAKE
EPHRATA
ELLENSBURG
YAKIMA
MOSES LAKE
RITZVILLE
WARDEN
LIND
STEPTOE
COLFAX
PULLMAN
BUSTY
OTHELLO
CUNNINGHAM
CONFLU
BEVERLY
WASHTUCNA
CONNELL
KAHLOTUS
MESA
ELTOPIA
TOPPENISH
SUNNYSIDE
BENTON CITY
KENNEWICK
PASCO
DAYTON
WAITSBURG
DIXIE
WALLULA JCT.
WALLA WALLA
MILTON
WESTON
PENDLETON
PATERSON
PROSSER
GOLDENDALE
HERMISTON
STANFIELD
BOARDMAN
ARLINGTON
BLALOCK
RUFUS
WISHRAM
ELGIN
MEACHAM


3L RUN CHECK POINTS
1. Benton City
2. Near Army Rd. to Rattlesnake
3. Columbia Camp
4. Y Barricade
5. Power Line
6. Green Farm House
7. Eltopia Intersection
8. Intersection 395 & Richland Ferry Rd.
9. Intersection 395 & Upper River Rd.
10. Island View
11. First Bald Mountain from Kiona on Right Side of Rte. 410
Standard Flight Pattern - 3L
SCALE — MILES
LEAVENWORTH
WATERVILLE
COULEE CITY
WENATCHEE
SOAP LAKE
EPHRATA
ELLENSBURG
MOSES LAKE
WARDEN
VANTAGE
BEVERLY
OTHELLO
CUNNINGHAM
CORFU
COLUMBIA RIVER
CONNELL
MESA
ELTOPIA
YAKIMA
MABEE
UNION GAP
WAPATO
TOPPENISH
SUNNYSIDE
GRANDVIEW
MABTON
PROSSER
RICHLAND
PASCO
KENNEWICK
WASHTUCNA
KAHLOTUS
SNAKE RIVER
DUSTY
PULLMAN
POMEROY
LEWISTON
DAYTON
WAITSBURG
DIXIE
WALLULA JCT.
WALLA WALLA
WASH.
ORE.
TOUCHET
LOWDEN
MELTON
WESTON
PATERSON
PLYMOUTH
HOLLMAN
HERMISTON
STANFIELD
GOLDENDALE
BOARDMAN
PENDLETON
ELGIN
MEACHAM
WISHRAM
RUFUS
BLALOCK
ARLINGTON



Aerial Survey - Columbia River


1E RUN CHECK POINTS
1. Kennewick
2. Plymouth
3. Hermiston
4. Stanfield
5. Pendleton
6. Weston
7. Melton
8. Walla Walla
9. Waitsburg
10. Dayton
11. Dodge
12. Dusty
13. Colfax
14. Rosalia
15. Spokane
16. Cheney
17. Sprague
18. Ritzville
19. Lind
20. Washtucna
21. Kahlotus
22. Pasco
SCALE — MILES
Standard Flight Pattern - 1E

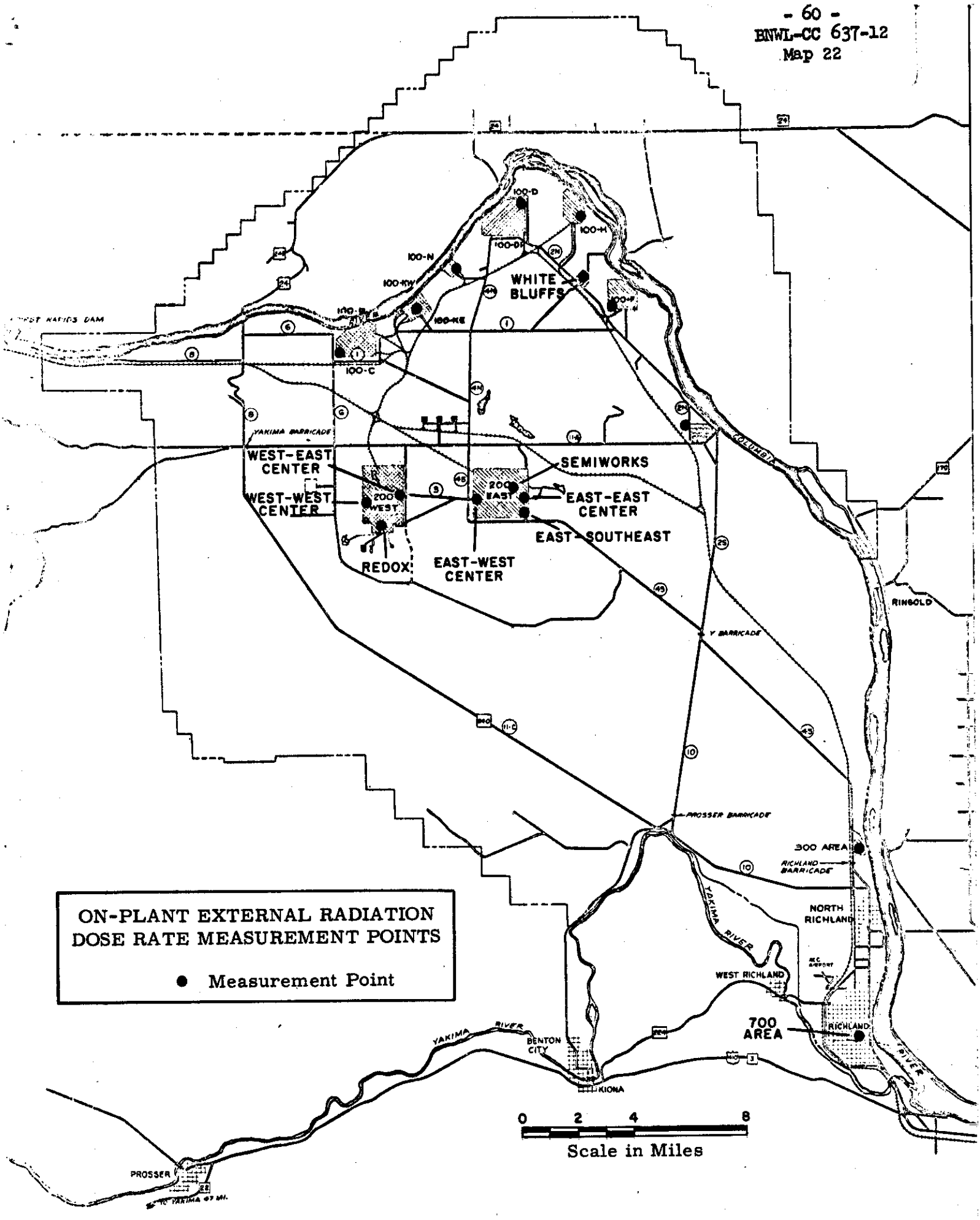

2E RUN CHECK POINTS
1. Benton City
2. Prosser
3. Sunnyside
4. Yakima
5. Ellensburg
6. Vantage
7. Moses Lake
8. Ritzville
9. Connell
10. Eltopia
11. Pasco
Standard Flight Pattern - 2E

B. External Radiation Exposure Rates

1. Exposure Rates on Plant

External radiation exposure rates (in units of mR/day) were determined from pocket dosimeters located within buildings designated "614" (Map 22). Individual results for 1966 are shown in Figures 18 through 22. Average results for the year are given below.

Location		Average Exposure Rate (mR/day)
100 Areas	100-B	0.64
	100-K	1.3
	100-N	0.67
	100-D	0.58
	100-H	0.47
	White Bluffs	0.51
	100-F	0.53
	Hanford	0.53
200-W Area	Redox	0.95
	West Center	0.48
	East Center	0.58
200-E Area	West Center	0.45
	East Center	0.55
	Southeast	0.59
	Semiworks	1.6
300 Area		0.47
700 Area		0.50



ON-PLANT EXTERNAL RADIATION
DOSE RATE MEASUREMENT POINTS

● Measurement Point

Figure 18

EXTERNAL RADIATION ON PLANT
100 AREAS

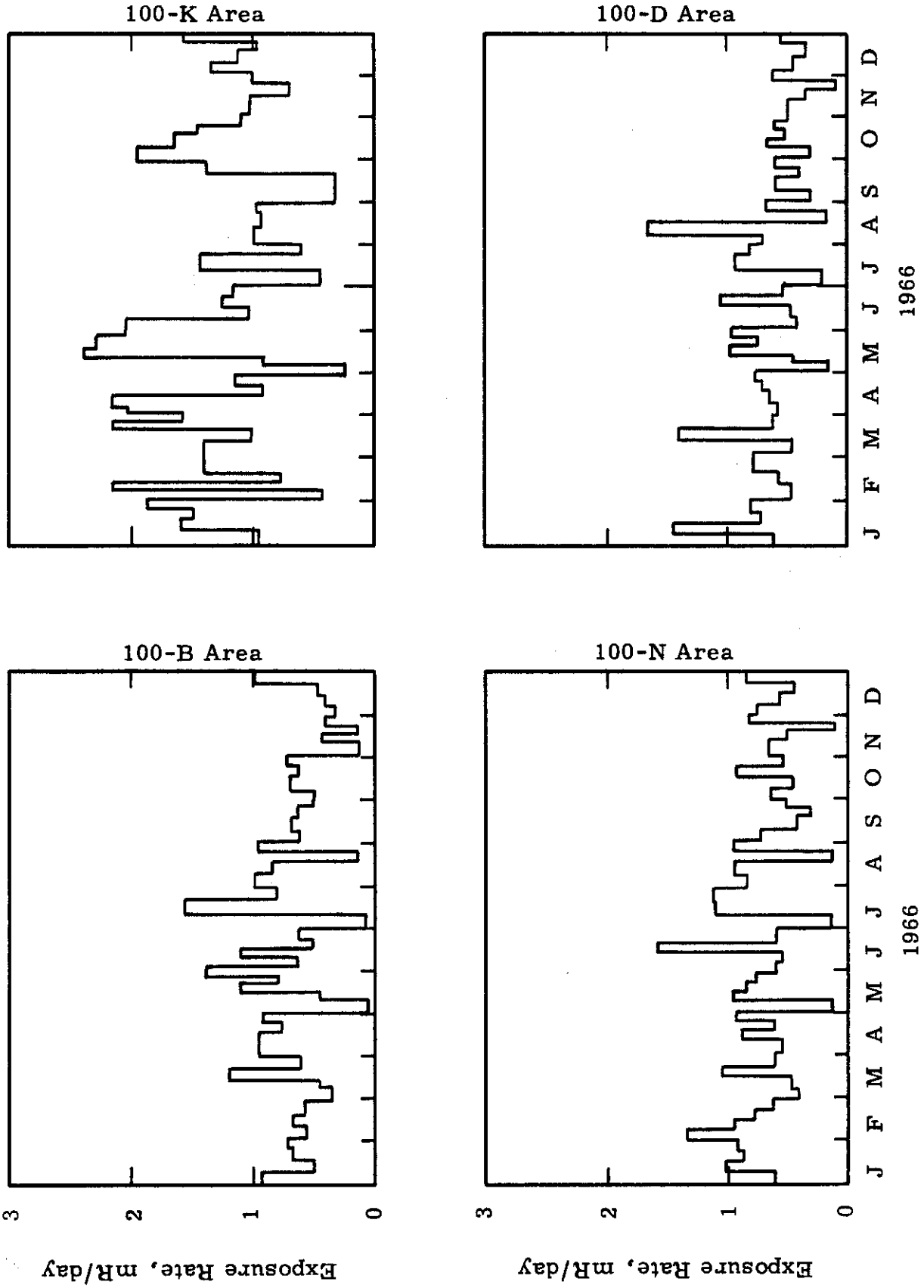
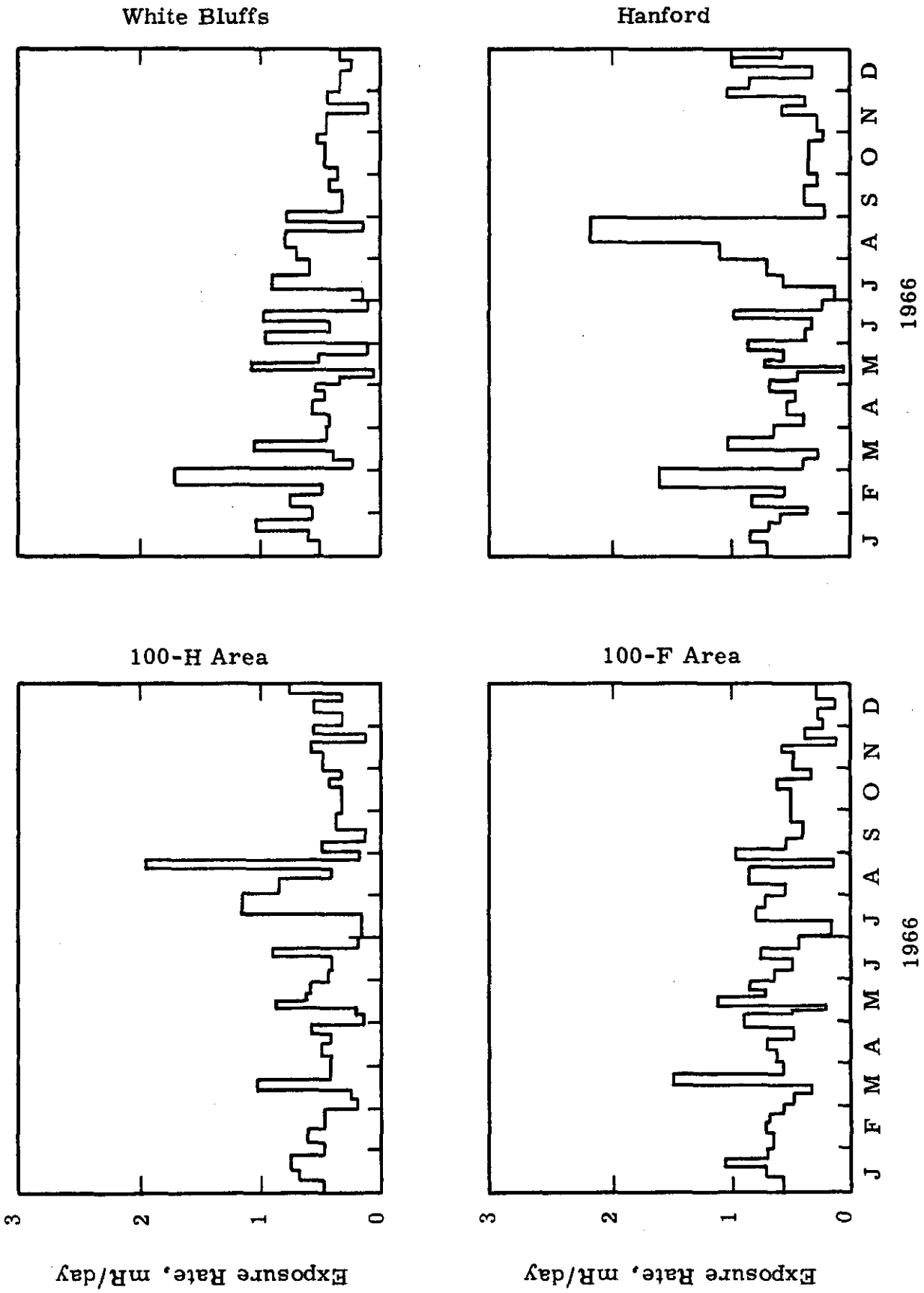


Figure 19

EXTERNAL RADIATION ON PLANT
100 AREAS



EXTERNAL RADIATION ON PLANT
200 WEST AREA

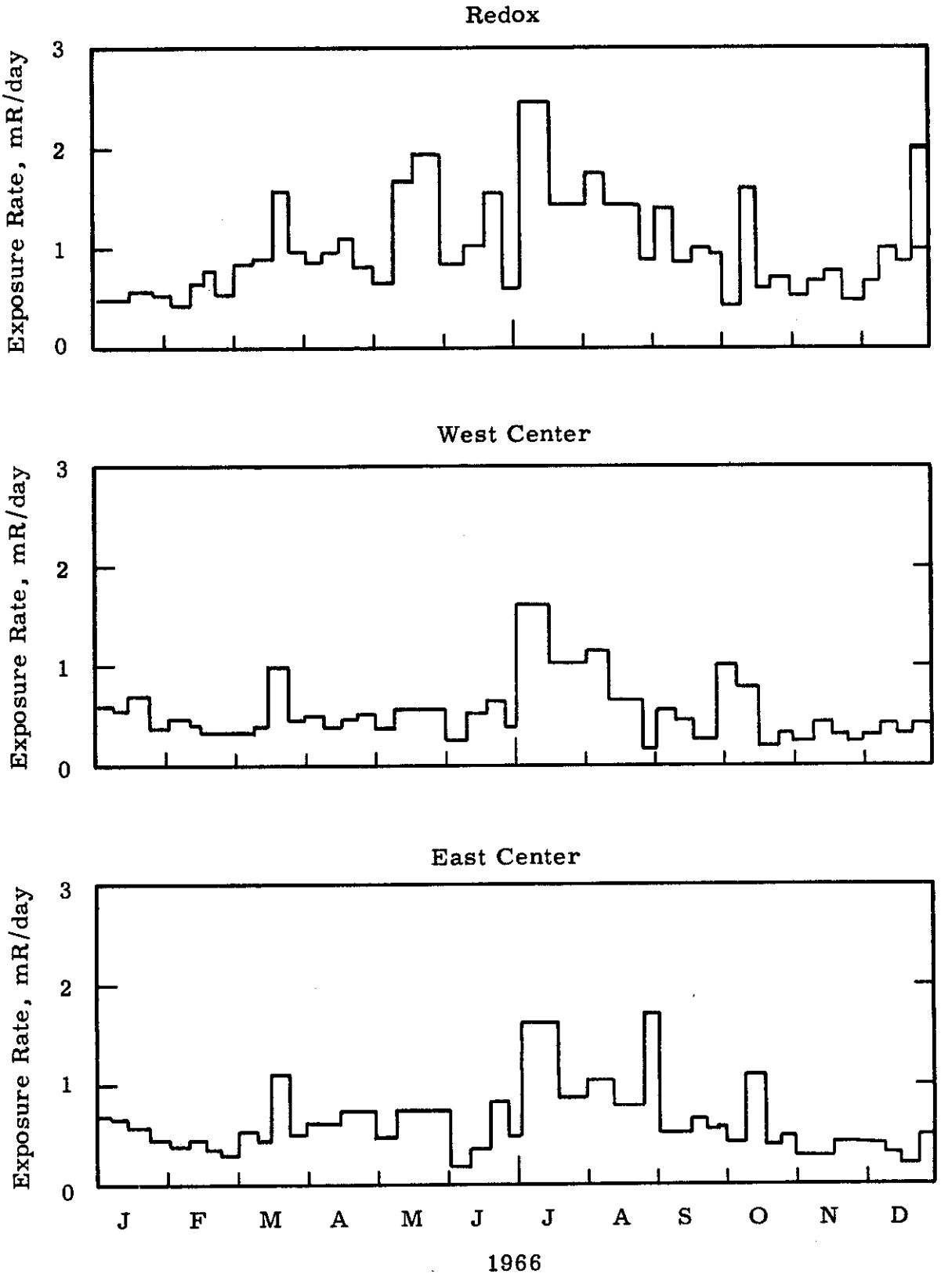
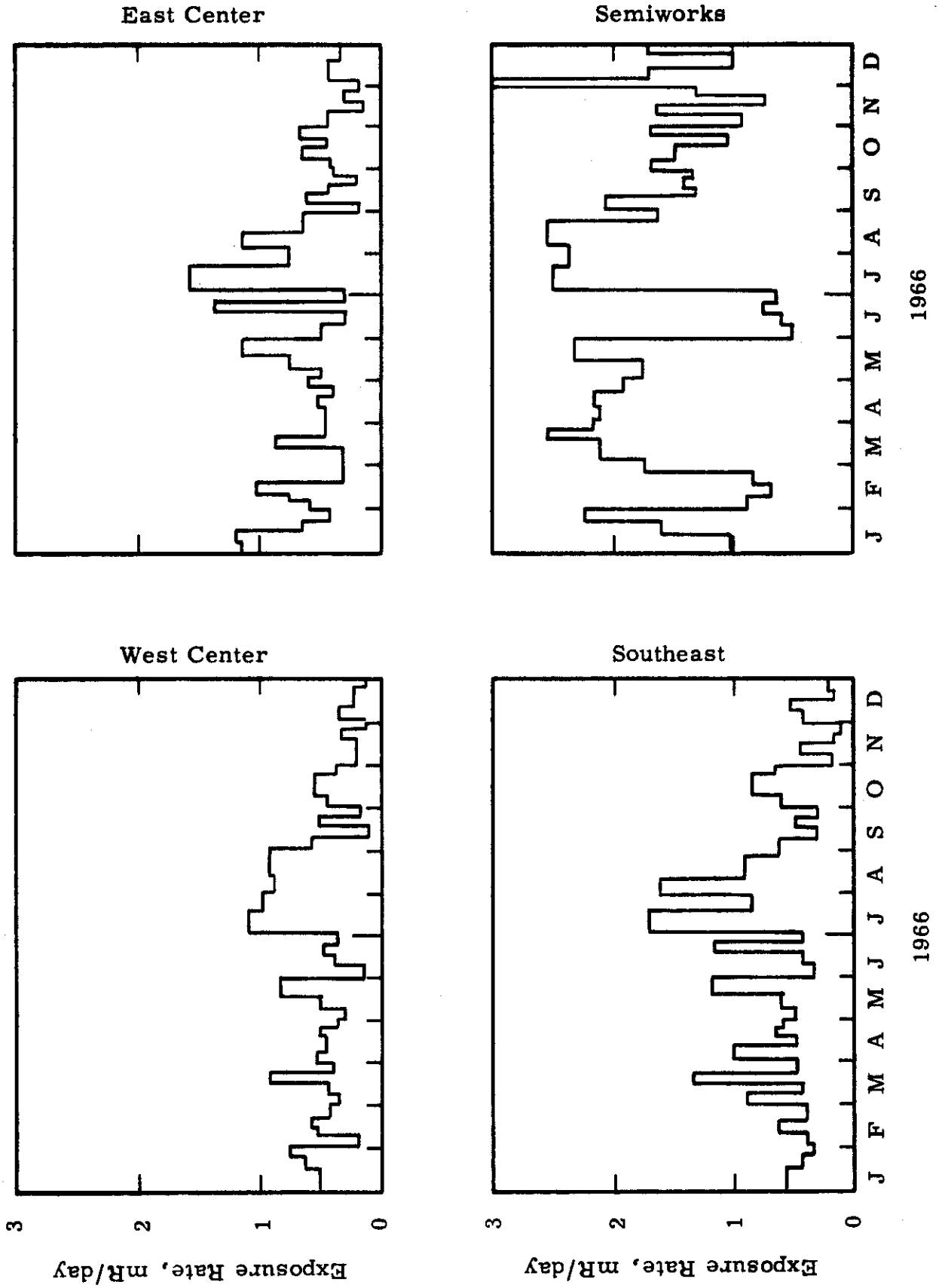
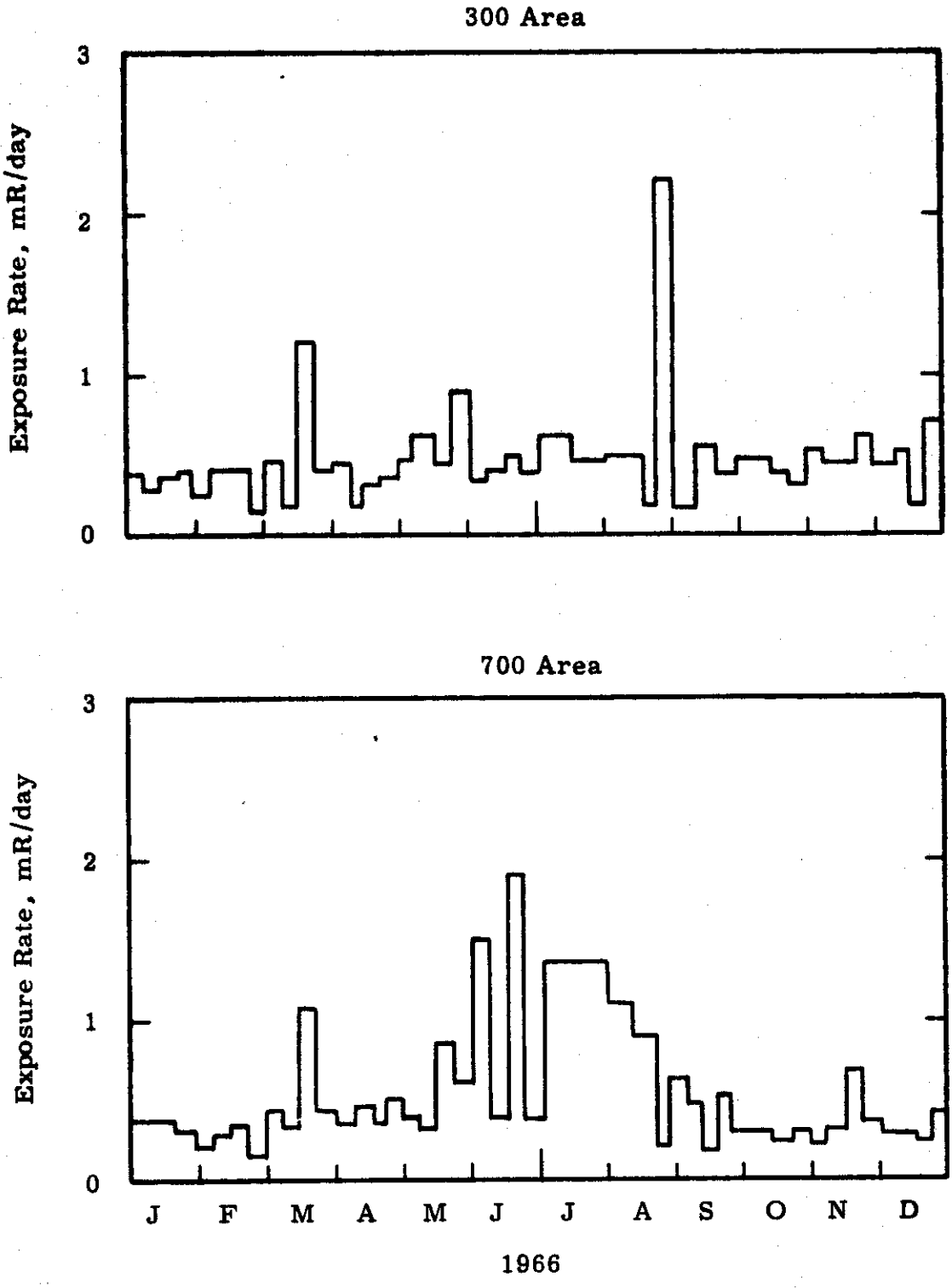


Figure 21

EXTERNAL RADIATION ON PLANT
200 EAST AREA



EXTERNAL RADIATION ON PLANT 300 AND 700 AREAS



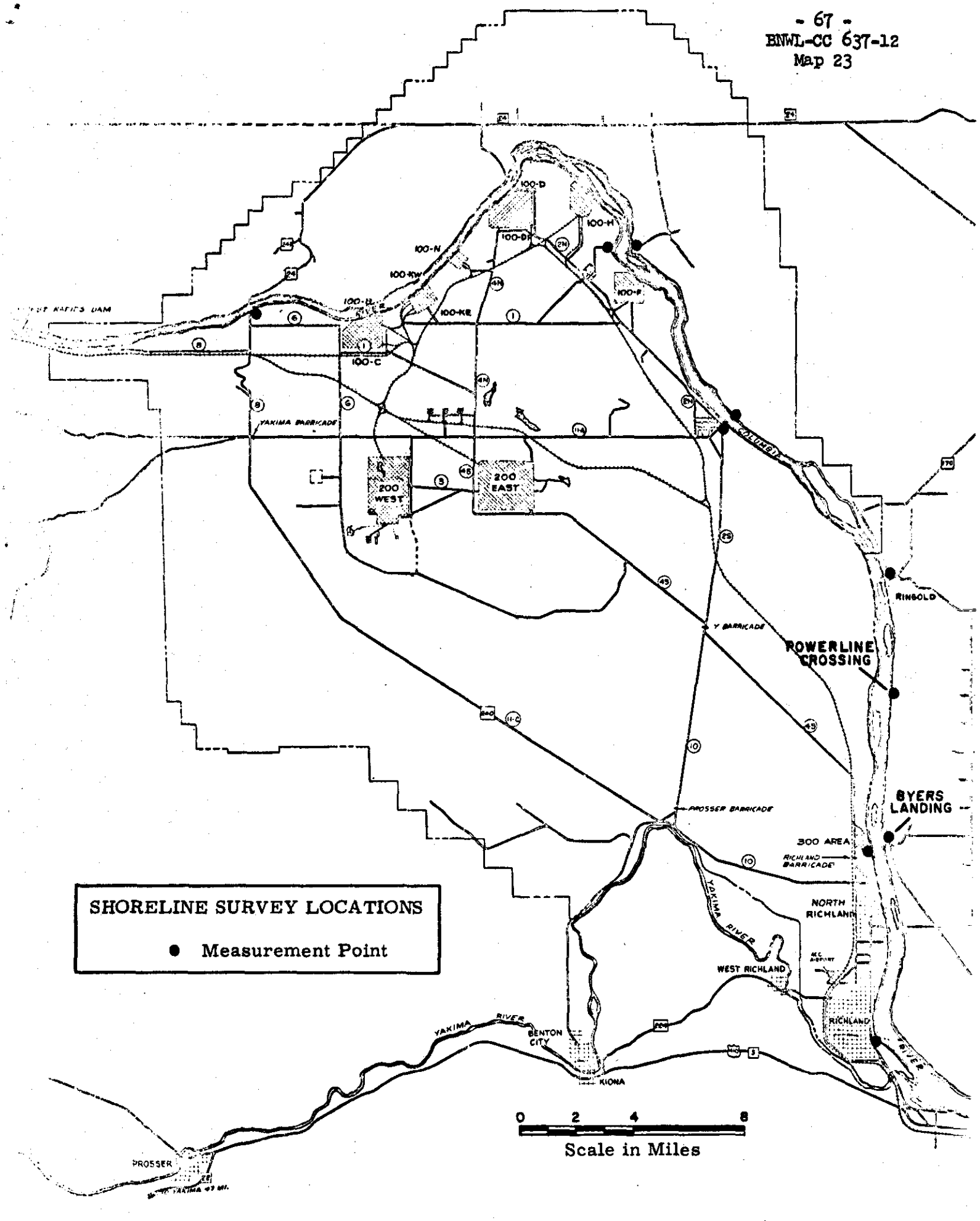
2. Exposure Rates at the Columbia River Shoreline

Shoreline exposure rates were measured during 1966 with a NaI(Tl) scintillation detector for the first 7 months of the year, and with a 40-ℓ ionization chamber for the remainder of the year. In each case, the instrument response was interpreted in terms of μR/hour (radium-gamma calibration). The measurements were made with the detector's center 3 feet above ground, thus approximating the dose rate to a person standing on the riverbank. These data follow in Figures 23 and 24. In addition to the locations shown in Map 23, measurements were also made at Burbank and Sacajawea Park.

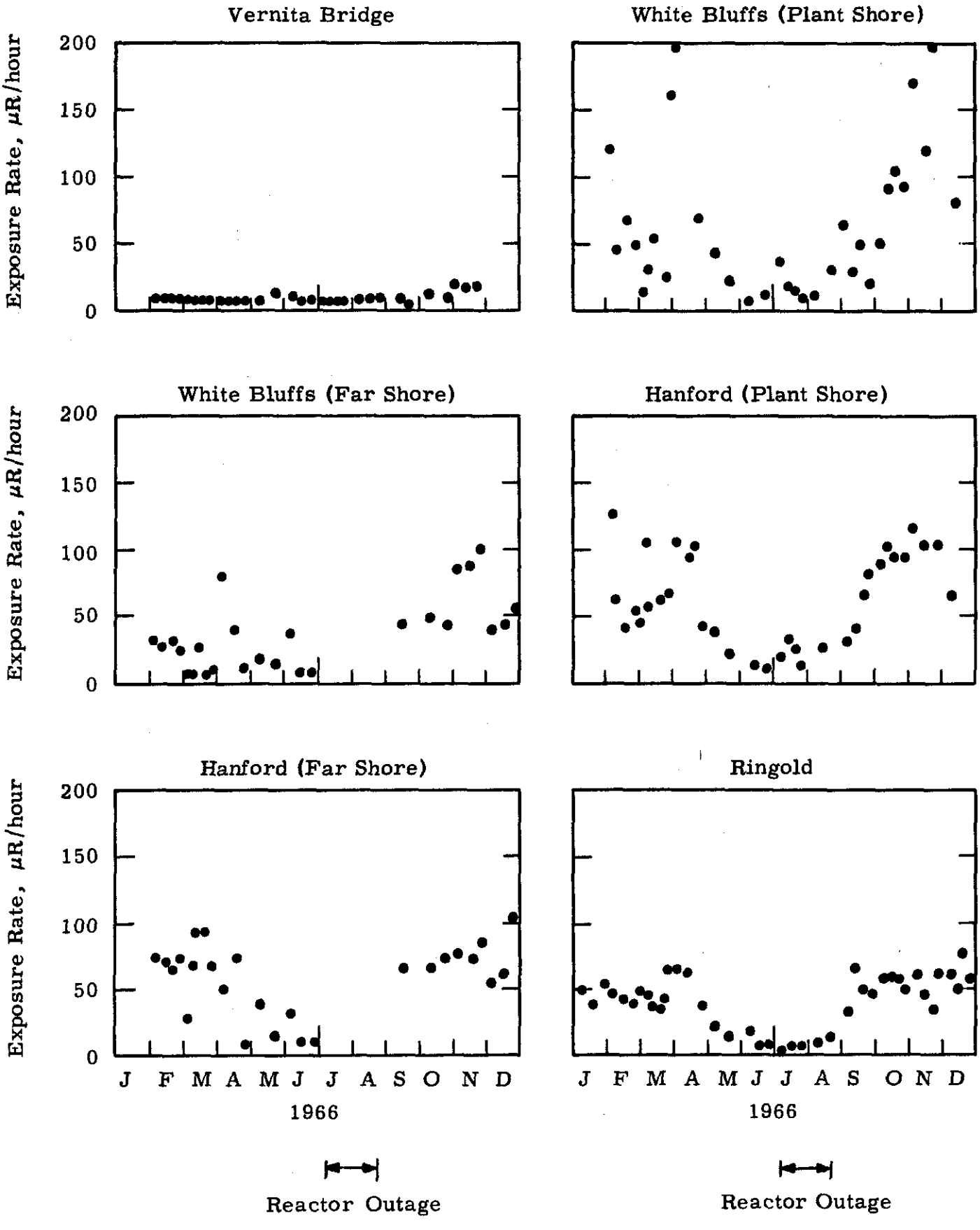
The increases in exposure rates during the latter part of March through mid-April resulted from seasonal increases of Mn^{56} concentrations in the Columbia River. These higher concentrations of Mn^{56} are due to increased concentrations of stable Mn^{55} which accompanies the spring run off. On April 5 and 19 at White Bluffs, the exposure rate was off scale (> 200 μR/hr) on the scintillation detector. The radiation level at contact with the river bank was measured with a CP and was found to be about 50 mrad/hour including 5 mR/hour on both occasions. Exposure rates measured during the same period at Ringold and below were 100 μR/hour or less, which is not signficantly different from those observed during 1965. Comparable routine measurements above Ringold were not made in past years.

At the end of June, the exposure rates at all locations were at the annual minimum because of the high flow rate of the river. There is an indication, especially at White Bluffs and Hanford, that shoreline contamination had begun to increase early in July coincident with the receding river flow rate. However, the extended reactor shutdown during the summer interrupted any sustained increase that might have occurred. With the startup of the reactors in late August, the exposure rates gradually returned to normally expected levels.

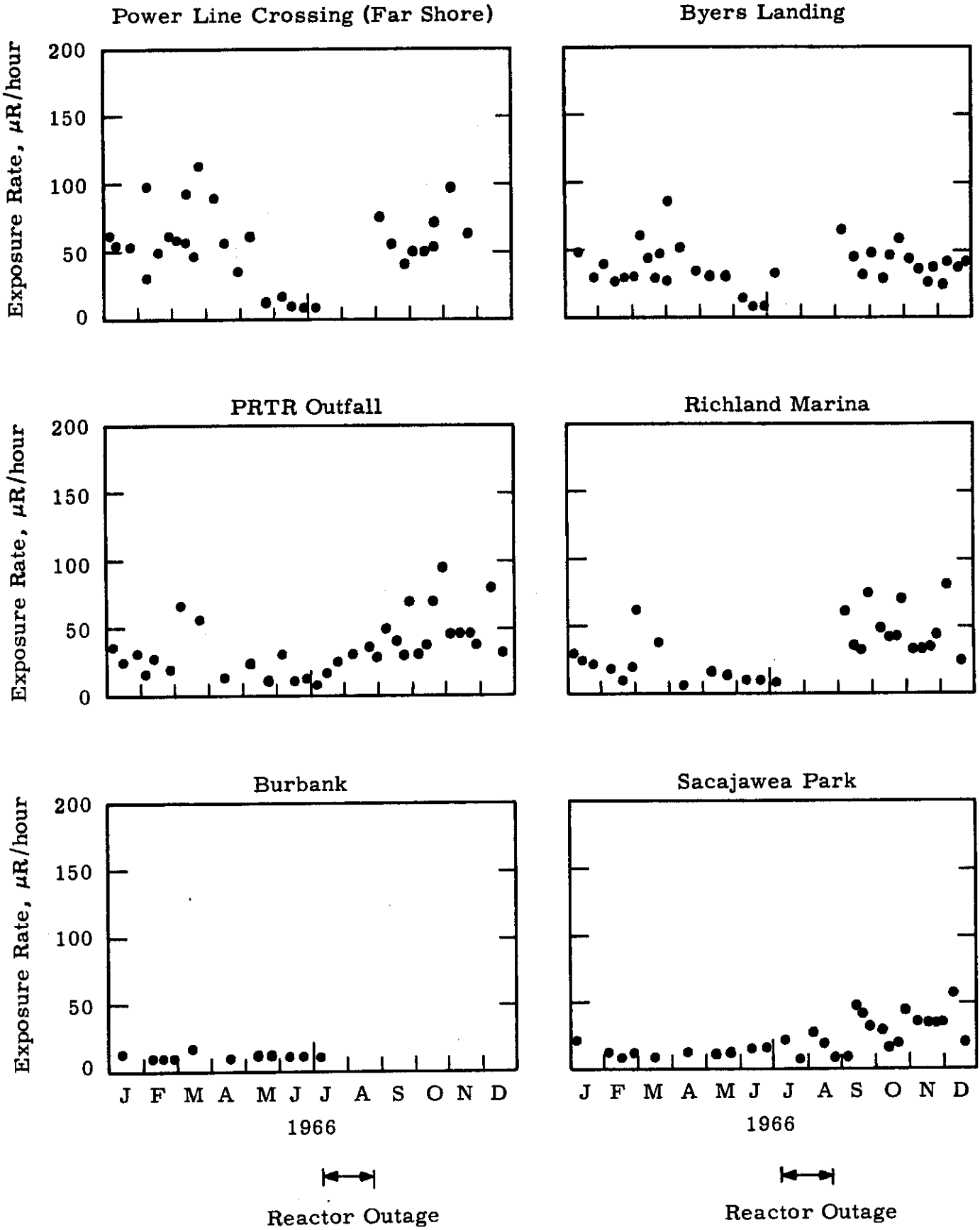
The increases in shoreline exposure rates during the fall months at many measurement points are like those observed in past years. The increase results from decreasing river flow rates during the fall months which expose more river shoreline.


100-D
100-H
100-DR
100-N
100-KW
100-KE
100-F
100-C
YAKIMA BARRICADE
200 WEST
200 EAST
CALLIGAN
RINGOLD
Y BARRICADE
POWERLINE CROSSING
PROSSER BARRICADE
BYERS LANDING
300 AREA
RICHLAND BARRICADE
YAKIMA RIVER
NORTH RICHLAND
WEST RICHLAND
RICHLAND
BENTON CITY
KIONA
PROSSER
SHORELINE SURVEY LOCATIONS
Measurement Point
0 2 4 8
Scale in Miles

EXTERNAL RADIATION AT THE COLUMBIA RIVER SHORELINE



EXTERNAL RADIATION AT THE COLUMBIA RIVER SHORELINE



3. Exposure Rates Below the Surface of the Columbia River

Exposure rates in the river are determined from pocket dosimeters contained within submerged bottles. The measurement points are shown in Map 24. The results appear in Figure 25.

Many data points are missing from the figures owing to a decreased effort in this area during the strike because of a manpower shortage and lost dosimeters. Dosimeters from all locations often produced erratic results. Exposure rates at the 300 Area measurement point were, in general, inversely proportional to the river flow rate, and do show (neglecting the anomaly in August) a decreasing trend during the extended reactor shutdown.

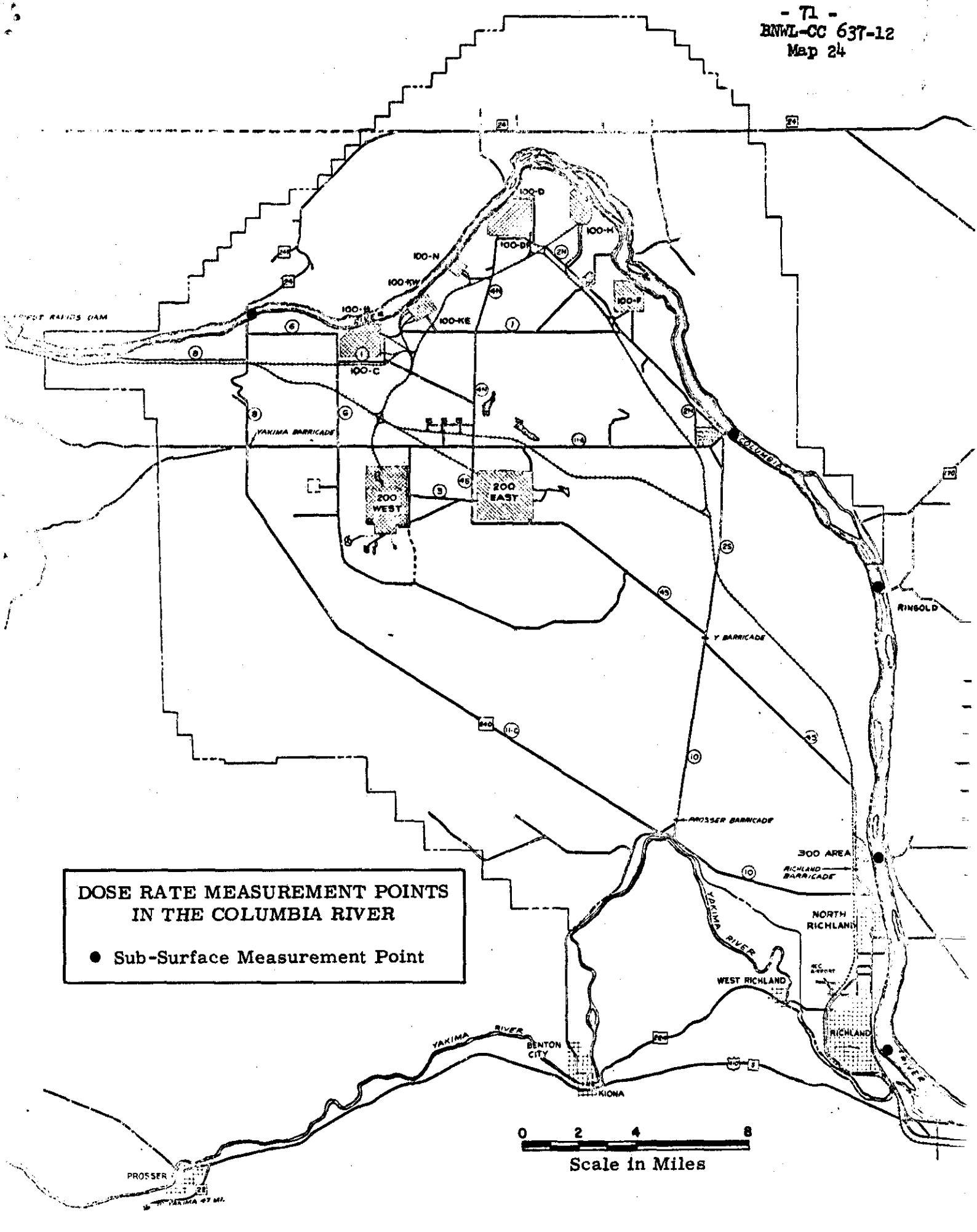

100-D
100-H
100-DR
100-N
100-KW
100-F
100-KE
100-B
100-C
YAKIMA BARRICADE
200 WEST
200 EAST
COLUMBIA
RINGOLD
Y BARRICADE
PROSSER BARRICADE
300 AREA
RICHLAND BARRICADE
NORTH RICHLAND
YAKIMA RIVER
WEST RICHLAND
RICHLAND
BENTON CITY
KIONA
PROSSER
DOSE RATE MEASUREMENT POINTS IN THE COLUMBIA RIVER
● Sub-Surface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

Figure 25

EXTERNAL RADIATION BELOW THE SURFACE OF THE COLUMBIA RIVER