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AUTHOR

T. H. Essig & R. B. Hall

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ENVIRONMENTAL STATUS OF THE HANFORD PROJECT

1965 ANNUAL SUMMARY

By

T. H. Essig and R. B. Hall

Environmental Studies Section
ENVIRONMENTAL HEALTH AND ENGINEERING DEPARTMENT

November 8, 1966

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

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ENVIRONMENTAL STATUS OF THE HANFORD PROJECT

1965 ANNUAL SUMMARY

I. Introduction

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

It is the purpose of this report to present data collected during 1965 for comparison with corresponding data for 1966. The data for 1966 appears in the BNWL-CC 637 report series.

The radiochemical data presented in this report were supplied by the Radiological Analysis Unit, Battelle-Northwest and the U. S. Testing Company during the first half of 1965 (transition period) and by the U. S. Testing Company during the last half of 1965.

II. Columbia River Water

The locations from which raw and sanitary water samples were obtained during 1965 are shown in Map 1.

A. Raw Water

Samples of raw water were obtained near Vernita Bridge twice per month and were analyzed for tritium, strontium-90, total alpha, and total beta. The monthly averages of results of raw water samples collected during 1965 are presented in Table II-1.

Table II-1 - Vernita Bridge

Month	H^3 (pCi/ℓ)	Sr^{90} (pCi/ℓ)	Total α (pCi/ℓ)	Total β (c/m/ml)
Jan.				< 0.2
Feb.				< 0.16
Mar.				< 0.02
Apr.	< 1000	0.72	< 1.0	< 0.02
May	< 1000	0.78	< 1.0	< 0.02
June	< 1000	0.67	1.1	< 0.02
July	< 1000	0.83	1.2	< 0.02
Aug.	1400	0.94	< 1.0	< 0.02
Sept.	1400	1.06	< 1.0	0.02
Oct.	1200	1.44	< 1.0	< 0.02
Nov.	< 1000	1.32	< 1.0	< 0.02
Dec.	< 1000	1.05	< 1.0	< 0.02

No entry indicates no analysis made.

The isotopic data from Ringold were obtained from analyses of monthly "grab" samples and are presented in Table II-2. The total beta activities in river water at Ringold and Hanford were obtained from analyses of weekly "grab" samples. These data are presented as monthly averages in Table II-3.

Table II-2 - Ringold (Isotopic Analyses)
(in units of pCi/ℓ)

Month	Na^{24}	P^{32}	Cr^{51}	Mn^{56}	Cu^{64}	Zn^{69m}	Ga^{72}	As^{76}	Np^{239}	RE+Y
Jan.										
Feb.										
Mar.	3600	230	4000	1300	2700	250	190	650	2200	1300
Apr. *	260	22	470	69	200	79	<70	65	68	86
May *	<35	<6	<70	<50	<32	<70	<70	4.9	<15	<5.5
June *	110	8.3	140	150	110	70	<70	36	42	21
July	1600	78	2400	1300	2000	<70	290	490	700	360
Aug.	1700	69	2200	540	1600	<70	270	480	650	140
Sept.	1600	80	1800	<50	1500	<70	240	230	460	88
Oct.	2300	170	3400	510	2400	<70	450	1000	1000	180
Nov.	1800	83	1400	400	1100	<70	140	310	450	130
Dec.										

* During April, May, and June, the river water sample from Ringold was influenced by the increased discharge rate of irrigation water from the Ringold Wasteway. The sampling location was subsequently moved to circumvent this diluting effect.

Table II-3 - Hanford and Ringold (Total Beta Analyses)
(in units of c/m/ml)

Month	Hanford	Ringold
Jan.	14	11
Feb.	12	11
Mar.	11	9.8
Apr.	11	7.6 *
May	5.7	< 0.36 *
June	5.4	1.1 *
July	6.6	2.7
Aug.	5.6	3.7
Sept.	4.1	7.8
Oct.	8.0	9.4
Nov.	4.4	8.7
Dec.		6.9

* See footnote on previous page.

B. Sanitary Water

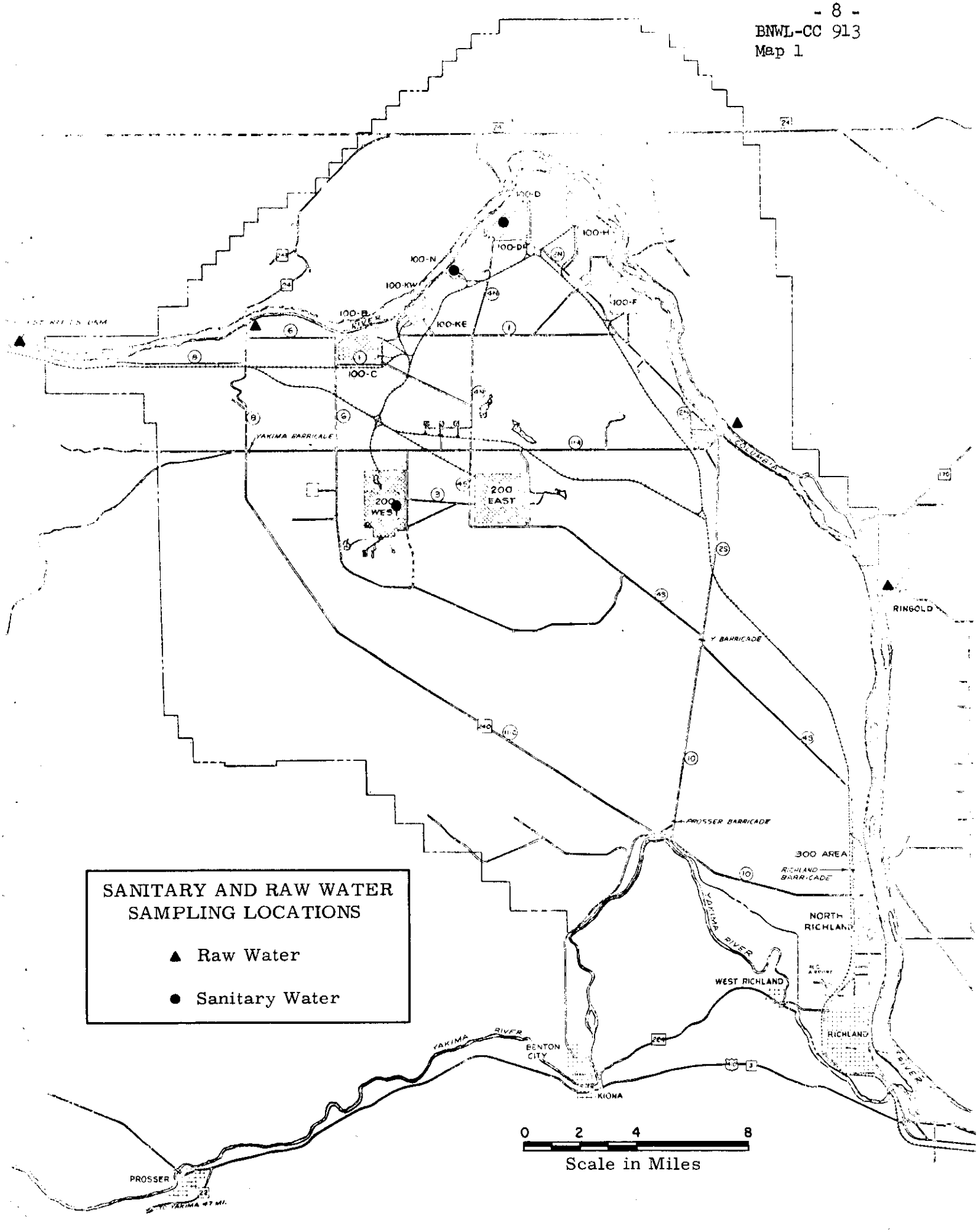
The running 12-month GI tract dose at 100-D Area is shown in Table II-4. This estimate is based on isotopic analyses of sanitary water collected at 100-D and on assumed intake rate of 1.2 liters per day, 5 days per week. Monthly average results of total beta analyses of sanitary water from 100-D, 100-N, and 200-W Areas are presented in Table II-5. Sanitary water data for off-plant locations for 1965 are presented in BNWL-316, "Evaluation of Radiological Conditions in the Vicinity of Hanford for 1965".

Table II-4 - GI Tract Dose Rate-100 D Area

Month	Dose Rate (mrem/year)
Jan.	32.1
Feb.	30.8
Mar.	28.2
Apr.	26.7
May	25.2
June	25.2
July	25.0
Aug.	23.9
Sept.	22.2
Oct.	23.5
Nov.	21.4
Dec.	20.7

Table II-5 - Total Beta Analyses

Month	100-D	100-N	200-W
Jan.			< 0.50
Feb.	2.3		0.12
Mar.			0.13
Apr.	12		0.11
May	4.4		0.05
June			< 0.03
July	2.3	0.99	0.03
Aug.	2.5	1.4	0.06
Sept.	7.4	6.5	0.20
Oct.	11	11	0.10
Nov.	6.6	8.0	0.08
Dec.	10	4.1	0.02


100-D
100-H
100-DR
100-N
100-KW
100-F
100-B
100-KE
100-C
YAKIMA BARRICADE
200 WEST
200 EAST
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

III. Swamps, Ditches, and Ponds

Open waters which may be used by migratory waterfowl are routinely sampled at the locations shown in Map 2. The monthly average results of samples collected during 1965 are shown in Table III-1. In those instances where the monthly average is influenced by an abnormally high sample, the high result appears in parentheses at the immediate right of the monthly average. The results of on-project waterfowl analyses are shown in Table III-2.

Table III-1 - Swamp, Ditch, and Pond Water Analyses
(in units of pCi/ℓ)

Month	Gable Swamp Inlet		Gable Swamp North	
	Gross Alpha	Gross Beta	Gross Alpha	Gross Beta
J	3	4000	< 1	4700
F	3	5300	4	21,000 (50,000)
M	2	20,000	5	6300
A	2	6300	1	2700
M	4	5300	< 1	8000
J	1	1500	9	1900
J	1	6600	2	1800
A	2	1200	3	2000
S	1	690	8	1000
O	1	770	17	500
N	2	980	2	780
D	1	4900 (12,000)	1	4600 (12,000)

Month	Purex Chem. Sewer		B Swamp North	
	Gross Alpha	Gross Beta	Gross Alpha	Gross Beta
J	4	770	5	980
F	< 1	360	4	1500
M	2	310	3	850
A	3	170	2	610
M	3	130	1	810
J	5	560	10	750
J	12	280	3	1100
A	< 1	56	3	320
S	6	3900 (15,000)	6	220
O	< 1	50	8	290
N	3	200	5	210
D	17	4400 (13,000)	1	1600 (4400)

Table III-1 - (Continued)
(in units of pCi/ℓ)

Month	Laundry Ditch Outlet Gross Alpha	Laundry Ditch Outlet Gross Beta	231 Ditch Outlet Gross Alpha
J	13	480	3
F	16	570	4
M	25	1200	4
A	9	270	8
M	10	990	97 (260)
J	2	110	6
J	4	110	4
A	16	12,000 (42,000)	6
S	27	2100	8
O	12	650	21
N	27	1200	32
D	5	320	34

Month	234-5 Ditch Outlet Gross Alpha	U Ditch Outlet Uranium
J	4900 (15,000)	
F	1800	6
M	130	< 2.5
A	3800 (18,000)	21
M	1600	12
J	400	10
J	34	89 (370)
A	23	38 (130)
S	64	150 (610)
O	52	< 2.5
N	91	7
D	2700 (12,000)	< 2.5

Month	U Swamp North Gross Alpha	U Swamp North Gross Beta	T Swamp Gross Alpha	T Swamp Gross Beta
J	110	340	4	330
F	76	1000	3	560
M	32	280	4	410
A	190 (860)	450	4	960 (3800)
M	18	1000	11	2800 (6700)
J	13	2100 (7000)	8	140
J	55	3500	4	610
A	43	490	3	2800
S	34	430	6	1400
O	36	290	2	810
N	140	1300	2	39,000 (110,000)
D	45	2400	19	16,000

Table III-1 - (Continued)
(in units of pCi/ℓ)

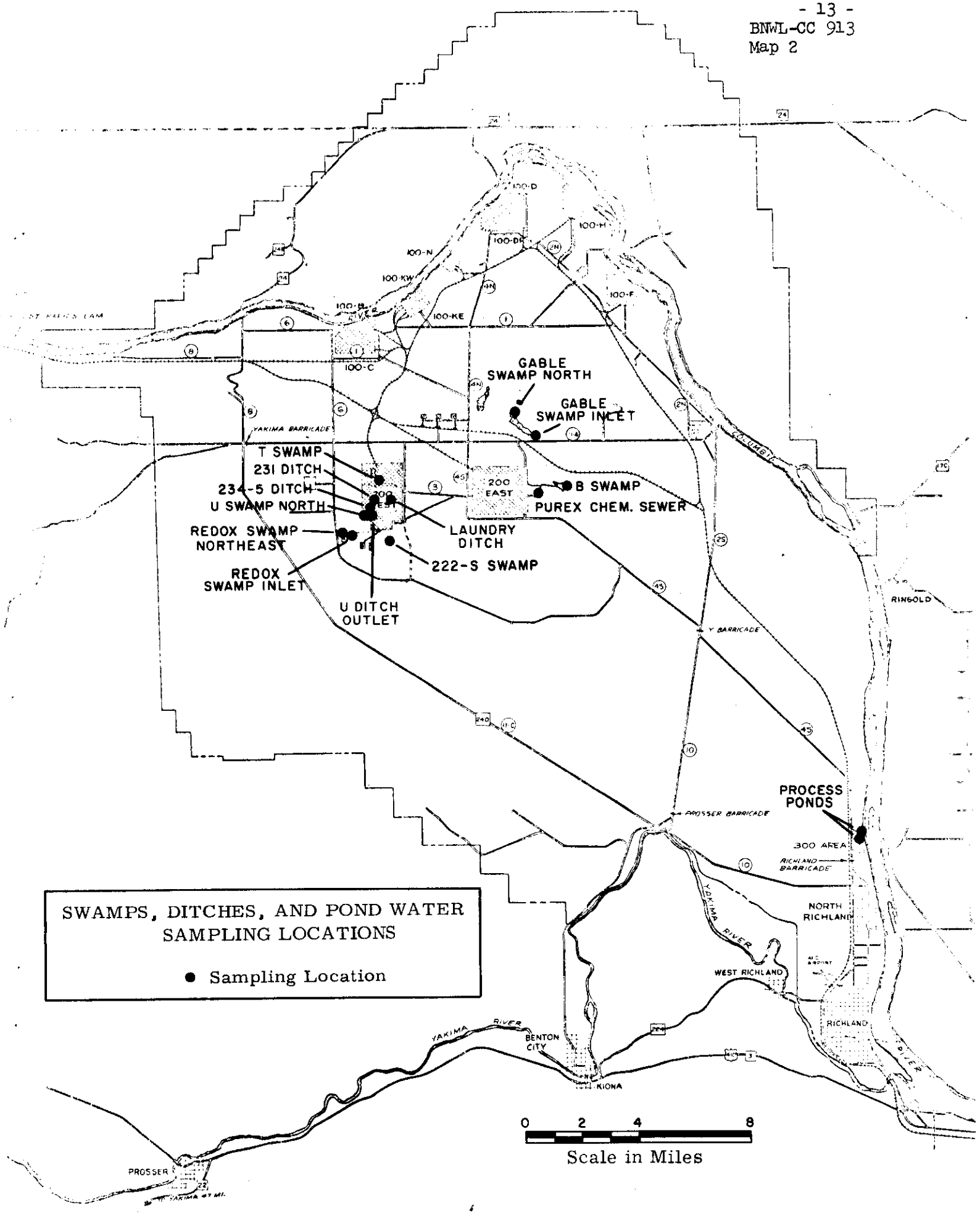
Month	Redox Swamp Inlet Gross Alpha	Redox Swamp Inlet Gross Beta	Redox Swamp Northeast Gross Alpha	Redox Swamp Northeast Gross Beta
J	13	1100	4	950
F	3	710	11	1700
M	2	340	6	490
A	4	530	8	610
M	49 (160)	3800	12	5700 (17,000)
J	38	3400 (12,000)	64 (200)	6300 (22,000)
J	9	440	4	360
A	6	460	11	810
S	6	250	18	750
O	29	3200	12	1200
N	9	3500	14	1100
D	5	360	11	900

Month	222-S Swamp Gross Alpha	222-S Swamp Gross Beta	300 Area Process Pond (Inlet) Uranium	300 Area Process Pond (Inlet) Gross Beta
J			820	620
F	320	350	670	710
M	37	1200	220	820
A	890	390	500	740
M	1000	84,000	600	340
J	42	1700	470	160
J	120	2500	740	180
A	180	3500	200	96
S	390	14,000	940	380
O	< 1	65,000	150	480
N	1200	20,000	800	1500 (4800)
D	72	2000	420	330

Month	300 Area Process Pond (East) Uranium	300 Area Process Pond (East) Gross Beta
J	140	460
F	120	280
M	300	550
A	990	450
M		
J	54,000 (110,000)	520
J	63,000	160
A	140	95
S	50	100
O	160	210
N	34	310
D	140	220

Table III-2 - Waterfowl Analyses
(in units of pCi/gm)

Location	Date	Specie	Radionuclide Concentration in Muscle			Radionuclide Concentration in Heads		
			P^{32}	Zn^{65}	Cs^{137}	P^{32}	Zn^{65}	Cs^{137}
Redox Swamp	2/9/65	Golden Eye	55	5	0.1			
	2/9/65	Coot	4	<0.2	200			
	2/9/65	Coot	<1	0.2	200			
	2/9/65	Coot	<1	<0.2	200			
	2/9/65	Ruddy Duck	<1	0.5	120			
	9/29/65	Ruddy Duck	<1		0.1	1		<0.1
	9/29/65	Ruddy Duck	<1		0.6	11		<0.1
	9/29/65	Ruddy Duck	2		0.5	26		<0.1
	9/29/65	Ruddy Duck	<1		0.9	24		<0.1
	11/5/65	Bufflehead	8		29	16		14
	11/5/65	Bufflehead	11		19	16		9
	11/5/65	Bufflehead	6		78	63		27
U Swamp	2/9/65	Coot	<1	<0.2	160			
	2/9/65	Coot	7	3	140			
	2/9/65	Coot			200			
	2/9/65	Ruddy Duck	300	2	72			
	11/2/65	Mallard	2		100	<1		36
	11/2/65	Mallard	26		110	15		85
	11/2/65	Mallard	20	0.8	290	9	3	130
B Swamp	2/12/65	Coot	<1	2				
Gable Swamp	2/12/65	Mallard				1000	65	72
	3/2/65	Golden Eye		12	3			
	3/2/65	Golden Eye	4	2	8			
	3/2/65	Coot		5	310			
	3/2/65	Coot		3	66			
	3/2/65	Coot	1	0.3	0.6			
	11/5/65	Green Wing Teal	16	3	9	17	10	4


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

IV. The Atmosphere

A. Iodine-131 and Total Beta Activity

The atmosphere was routinely sampled at 22 locations (see Map 3) within the Hanford reservation during 1965. At most locations, the sampling equipment was contained within a small building designated "614". "Total beta" represents the activity of particles collected on H-70 filter paper during a one-week sampling period. The air is subsequently passed through a solution of NaOH for iodine-131 collection. Air filter and scrubber results for 1965 are tabulated below.*

Annual Average Total Beta and I^{131} Concentrations - 1965

Location	Total Beta (pCi/m^3)	I^{131} (pCi/m^3)
100 Areas	0.44	<0.03
200 Areas	0.80	0.14
Intermediate Locations	0.34	0.05

Table IV-1 - Monthly Average Total Beta and I^{131} Concentration
100 Areas and Vicinity
(in units of pCi/m^3)

	100-B Area		100-K Area		100-N Area		100-D Area	
Month	Total Beta	I^{131}	Total Beta	I^{131}	Total Beta	I^{131}	Total Beta	I^{131}
Jan.	0.45	<0.02	0.13	<0.02	0.34	<0.02	0.44	<0.02
Feb.	0.48	<0.02	0.44	<0.02	0.32	<0.02	0.49	<0.02
Mar.	0.83	0.02	0.51	<0.02	0.59	0.12	0.75	<0.02
Apr.	0.73	0.04	0.60	0.03	0.38	0.02	0.62	0.12
May	0.44	0.03	0.57	0.02	0.37	0.03	0.81	0.04
June	0.95	0.02	1.1	0.03	0.69	0.04	1.0	0.04
July	0.97	0.04	0.48	0.03	0.44	0.03	0.52	0.03
Aug.	0.37	<0.02	0.36	0.02	0.26	<0.02	0.42	<0.02
Sept.	0.84	0.04	0.55	0.02	0.59	0.03	0.55	0.02
Oct.	0.63	<0.02	0.60	0.02	0.48	0.02	0.51	0.02
Nov.	0.20	0.02	0.24	0.02	0.28	0.03	0.44	0.03
Dec.	0.44	0.05	0.20	0.03	0.20	<0.02	0.16	0.02

* Off-site air filter results appear in BNWL-316 "Evaluation of Radiological Conditions in the Vicinity of Hanford for 1965".

Table IV-1 (Continued)

Month	100-H Area		White Bluffs		100-F Area		Hanford	
	Total Beta	I^{131}	Total Beta	I^{131}	Total Beta	I^{131}	Total Beta	I^{131}
Jan.	0.26	0.02	0.20		0.22	<0.02	0.20	<0.02
Feb.	0.25	<0.02	0.44		0.19	0.02	0.28	<0.02
Mar.	0.57	<0.02	0.54	<0.02	0.53	<0.02	0.53	<0.02
Apr.	0.49	<0.02	0.47	0.02	0.58	<0.02	0.36	0.03
May	0.43	0.04	0.75	0.06	0.47	0.03	0.54	0.04
June	0.74	0.04	0.59	0.02	0.59	0.05	0.82	0.05
July	0.43	0.03	0.23	0.04	0.34	0.03	0.38	0.03
Aug.	0.28	<0.02	0.09	<0.02	0.14	<0.02	0.23	<0.02
Sept.	0.26	<0.02	0.33	<0.02	0.33	<0.02	0.17	0.02
Oct.	0.29	<0.02	0.42	0.02	0.27	0.02	0.29	0.03
Nov.	0.30	0.02	0.17	<0.02	0.26	0.02	0.18	<0.02
Dec.	0.28	0.02	0.23	<0.02	0.22	<0.02	0.26	<0.02

Table IV-2 - Monthly Average Total Beta and I^{131} Concentrations
200 West Area
(in units of pCi/m^3)

Month	Redox		West Center		East Center		Meteorology Tower
	Total Beta	I^{131}	Total Beta	I^{131}	Total Beta	I^{131}	Total Beta
Jan.	0.27	0.02	1.7	0.02	0.54	<0.02	0.26
Feb.	2.9	0.03	0.34		0.26	0.03	0.34
Mar.	2.2	0.05	0.65	0.03	0.69	0.02	0.57
Apr.	0.55	0.07	0.57	0.02	0.61	0.03	0.38
May	0.53	0.58	0.54	0.05	0.62	0.04	0.39
June	1.1	0.14	1.0	0.06	0.89	0.02	0.61
July	0.93	0.64	0.46	0.06	0.44	0.07	0.14
Aug.	0.56	0.32	0.19	<0.02	0.29	0.03	0.10
Sept.	4.6	0.18	1.2	0.02	0.81	0.02	0.33
Oct.	1.6	0.08	0.53	0.03	0.51	<0.02	0.17
Nov.	0.48	0.12	0.26	0.04	0.40	0.03	0.08
Dec.	0.48	0.02	0.32	0.02	0.43	0.02	0.13

Table IV-3 - Monthly Average Total Beta and I^{131} Concentrations
200 East Area
(in units of pCi/m^3)

Month	West Center		East Center		Southeast		Semiworks	
	Total Beta	I^{131}	Total Beta	I^{131}	Total Beta	I^{131}	Total Beta	I^{131}
Jan.	0.19	<0.02	4.2	<0.02	2.1	0.02	0.85	<0.02
Feb.	0.31	0.05	0.83	0.09	0.39	0.07	0.79	
Mar.	0.71	0.08	1.9	0.23	0.68	1.0	0.78	0.21
Apr.	0.42	0.07	0.80	1.1	0.41	0.43	0.26	0.10
May	0.43	0.15	0.92	0.21	0.47	0.24	0.66	0.14
June	0.96	0.04	1.1	0.41	0.89	0.38	1.1	0.45
July	0.35	0.04	0.99	0.12	0.44	0.15	0.62	0.02
Aug.	0.32	0.03	1.1	0.05	0.33	0.02	0.31	<0.02
Sept.	0.23	0.02	1.2	0.26	0.60	0.14	0.51	0.37
Oct.	0.28	<0.02	1.1	0.13	0.45	0.54	0.40	0.10
Nov.	0.20	0.06	0.48	0.37	0.29	0.12	0.23	0.11
Dec.	0.59	0.03	0.52	0.24	0.40	0.13	7.8	0.14

Table IV-4 - Monthly Average Total Beta and I^{131} Concentrations
Intermediate Locations
(in units of pCi/m^3)

Month	Rattlesnake Springs		Emergency Relocation Center		Wye Barricade	
	Total Beta	I^{131}	Total Beta	I^{131}	Total Beta	I^{131}
Jan.	0.19		0.11		0.37	
Feb.	0.33		0.24		0.22	
Mar.	0.44	0.02	0.51	0.06	0.49	0.02
Apr.	0.34	0.05	0.36	0.03	0.36	0.02
May	0.41	0.10	0.39	0.06	0.42	0.09
June	0.78	0.03	0.99	0.04	0.75	0.10
July	0.36	0.03	0.36	0.03	0.33	0.03
Aug.	0.19	<0.02	0.19	<0.02	0.20	0.05
Sept.	0.28	<0.02	0.55	0.04	0.28	0.05
Oct.	0.27	<0.02	0.25	0.02	0.22	0.03
Nov.	0.17	0.04	0.13	<0.02	0.16	0.06
Dec.	0.18	<0.02	0.15	0.03	0.17	0.04

Table IV-4 (Continued)

Month	Prosser Barricade		300 Area		700 Area	
	Total Beta	I^{131}	Total Beta	I^{131}	Total Beta	I^{131}
Jan.	0.19	<0.02	0.34	<0.02	0.15	<0.02
Feb.	0.27	0.02	0.41	0.04	0.28	<0.02
Mar.	0.48	<0.02	0.59	0.04	0.19	0.03
Apr.	0.26	<0.02	0.50	0.02	0.38	0.03
May	0.41	0.07	0.39	0.08	0.54	0.03
June	0.78	0.02	0.92	0.85	0.85	0.05
July	0.25	0.03	0.38	0.21	0.37	0.04
Aug.	0.15	0.05	0.27	0.02	0.21	<0.02
Sept.	0.26	0.03	0.37	0.12	0.22	0.02
Oct.	0.19	<0.02	0.32	0.04	0.27	0.03
Nov.	0.09	0.02	0.28	<0.02	0.16	0.03
Dec.	0.19	0.03	0.25	0.02	0.19	0.03

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. Total alpha concentrations measured during 1965 are tabulated below.

Annual Average Total Alpha Concentrations - 1965

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

Table IV-5
Monthly Average Total Alpha Concentration
(in units of pCi/m^3)

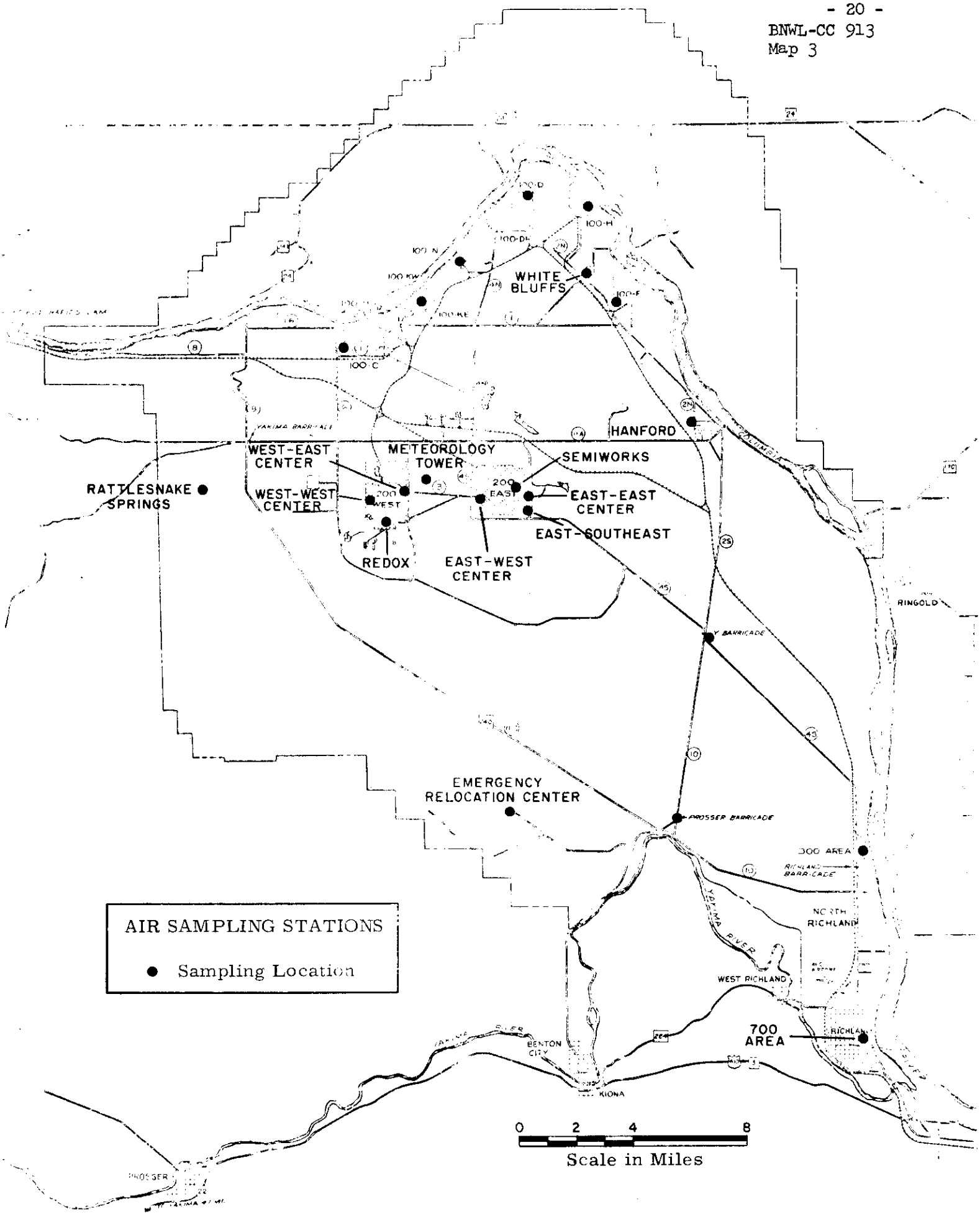
Month	100-B Area	100-N Area	300 Area	700 Area
Jan.		0.04	0.20	0.02
Feb.		<0.01	0.13	<0.01
Mar.		0.03	0.06	0.02
Apr.		0.07	0.14	0.02
May		0.03	0.13	<0.01
June	<0.01	0.03	0.13	0.02
July	<0.01	<0.01	0.05	<0.01
Aug.	<0.01	<0.01	0.03	<0.01
Sept.	0.03	<0.01	0.02	0.01
Oct.	0.02	0.03	0.05	0.03
Nov.	<0.01	<0.01	0.04	0.02
Dec.	0.01	<0.01	0.02	<0.01

Table IV-6
Monthly Average Total Alpha Concentrations
200 West Area
(in units of pCi/m³)

Month	Redox	West Center	East Center
Jan.	<0.01	0.04	0.12
Feb.	<0.01	0.01	0.08
Mar.	0.02	0.04	0.08
Apr.	0.05	0.02	0.08
May	0.02	0.02	0.11
June	0.01	0.03	0.06
July	<0.01	<0.01	0.08
Aug.	<0.01	<0.01	0.01
Sept.	<0.01	<0.01	0.02
Oct.	0.03	0.02	0.09
Nov.	0.01	0.01	0.03
Dec.	<0.01	<0.01	0.01

Table IV-7
Monthly Average Total Alpha Concentrations
200 East Area
(in units of pCi/m³)

Month	West Center	East Center	Southeast	Semiworks
Jan.	0.01	0.02	0.03	<0.01
Feb.	0.03	0.05	0.02	0.03
Mar.	0.02	0.06	0.04	0.04
Apr.	0.02	0.02	0.01	0.02
May	0.02	0.03	0.02	0.02
June	0.02	<0.01	0.02	0.01
July	<0.01	<0.01	<0.01	<0.01
Aug.	<0.01	<0.01	<0.01	<0.01
Sept.	<0.01	<0.01	<0.01	<0.01
Oct.	<0.01	0.02	0.02	0.01
Nov.	0.02	0.02	0.01	0.01
Dec.	<0.01	<0.01	<0.01	<0.01

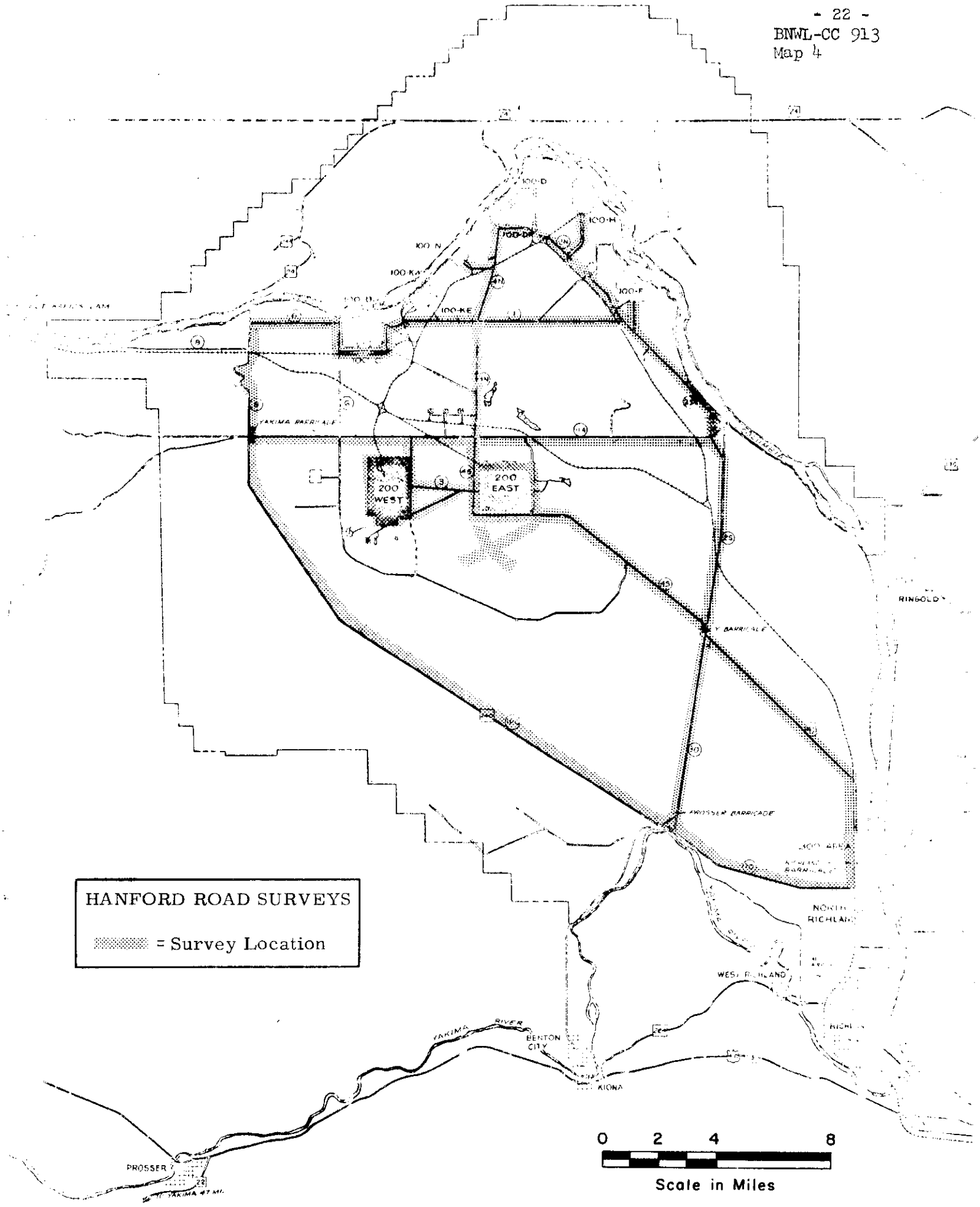

100-D
100-H
100-DR
100 N
100 KW
100-KE
WHITE BLUFFS
100-F
100 C
HANFORD
YAKIMA BARRICADE
WEST-EAST CENTER
METEOROLOGY TOWER
SEMIWORKS
RATTLESNAKE SPRINGS
WEST-WEST CENTER
200 WEST
200 EAST
EAST-EAST CENTER
EAST-SOUTHEAST
REDOX
EAST-WEST CENTER
RINGOLD
BARRICADE
EMERGENCY RELOCATION CENTER
PROSSER BARRICADE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

V. 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. Eleven routine road surveys were conducted during 1965, and no contamination was detected. The minimum level of contamination that can be detected by the road monitor corresponds to a portable GM counter response of approximately 1000 c/m/probe area. The roads that were surveyed during 1965 are shown on Map 4 which follows.

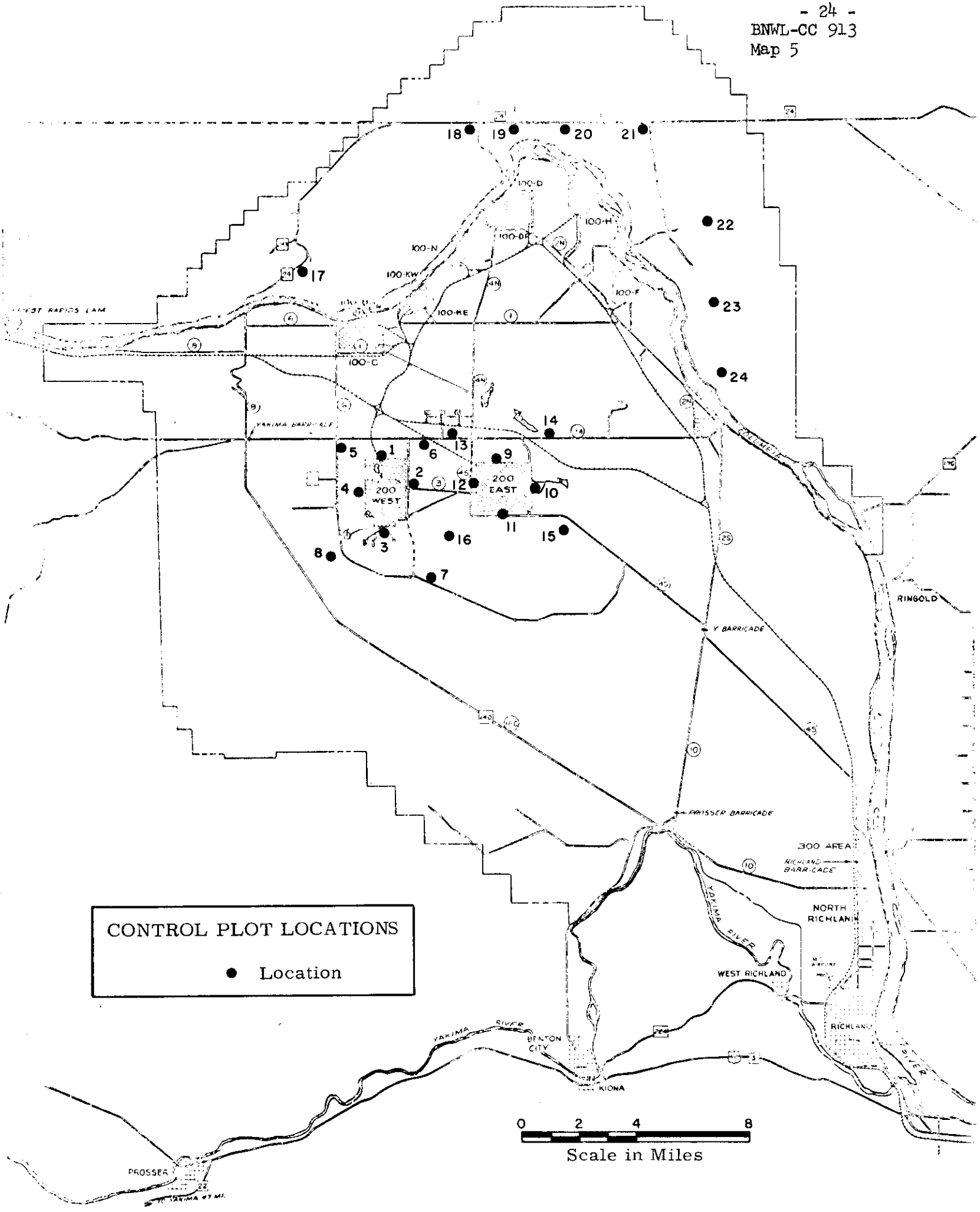

100-D
100-H
100 N
100-DR
100-KA
100-F
100-KE
200 WEST
200 EAST
RINGOLD
PROSSER BARRICADE
NORTH RICHLAND
WEST RICHLAND
YAKIMA RIVER
BENTON CITY
KIONA
PROSSER
HANFORD ROAD SURVEYS
= Survey Location
0 2 4 8
Scale in Miles

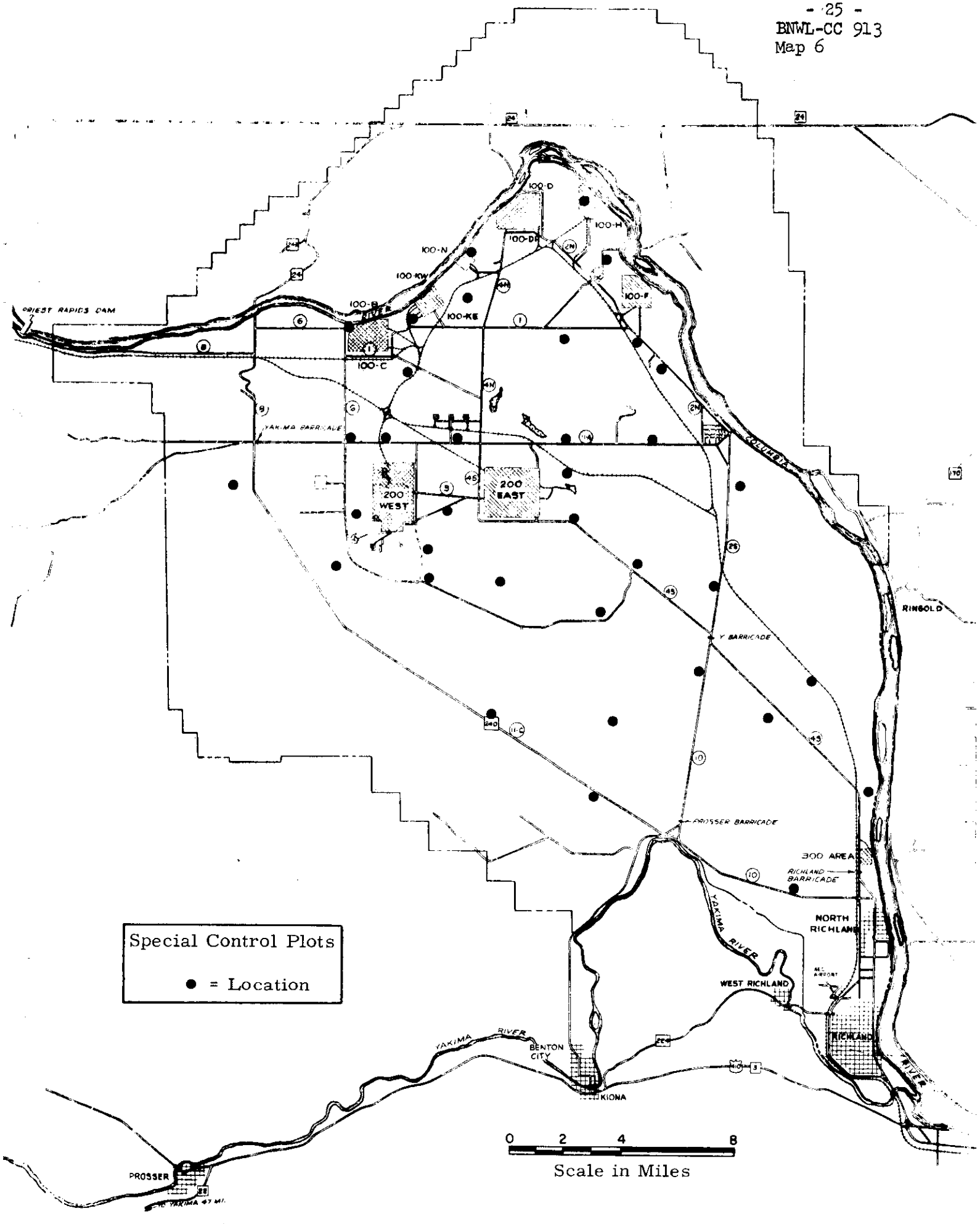
2. Control Plots

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. During June, 1965, a particle having an activity of 2500 c/m was found on control plot No. 3. In September, 1965 three particles were found: 800 c/m (control plot No. 3), 6000 c/m (control plot No. 9), and 16,000 c/m (control plot No. 10). The location of these control plots is shown in Map 5.

3. Special Control Plots

During June, 1965, a radiation survey (GM instrument) of 36 areas (100 square feet each) surrounding Hanford Test Wells was conducted. No radioactive particulates were detected. The locations of these special control plots are shown in Map 6.


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


100-D
100-H
100-N
100-DR
100-KW
100-F
100-KE
100-B
100-C
PRIEST RAPIDS DAM
YAKIMA BARRICADE
COLUMBIA
200 WEST
200 EAST
Y BARRICADE
RINGOLD
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

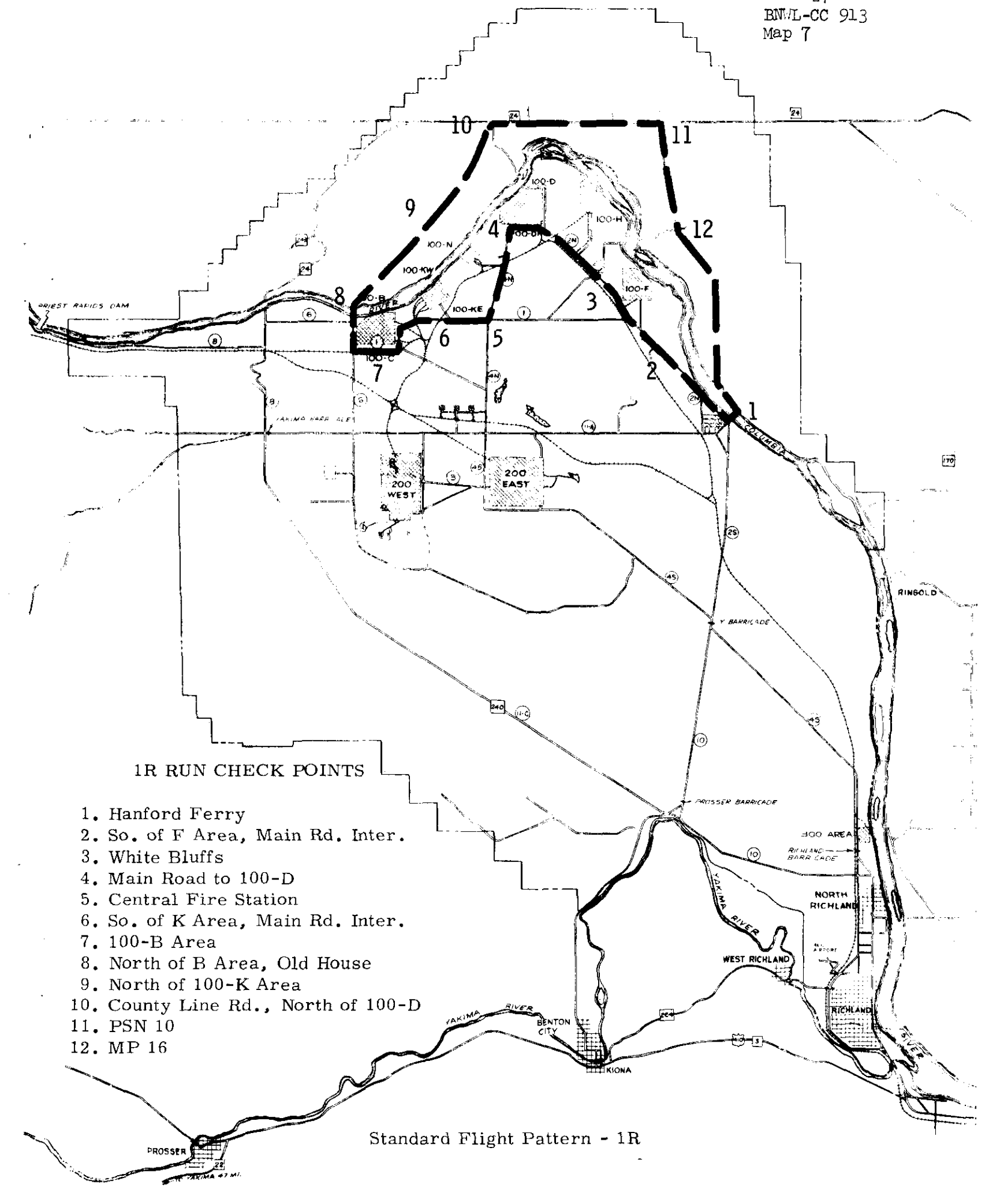
4. Aerial Surveys

Unlike road and control plot surveys, the function of an aerial survey is to detect contamination which is spread over a large land area. An aerial survey, like road and control plot surveys, is 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".

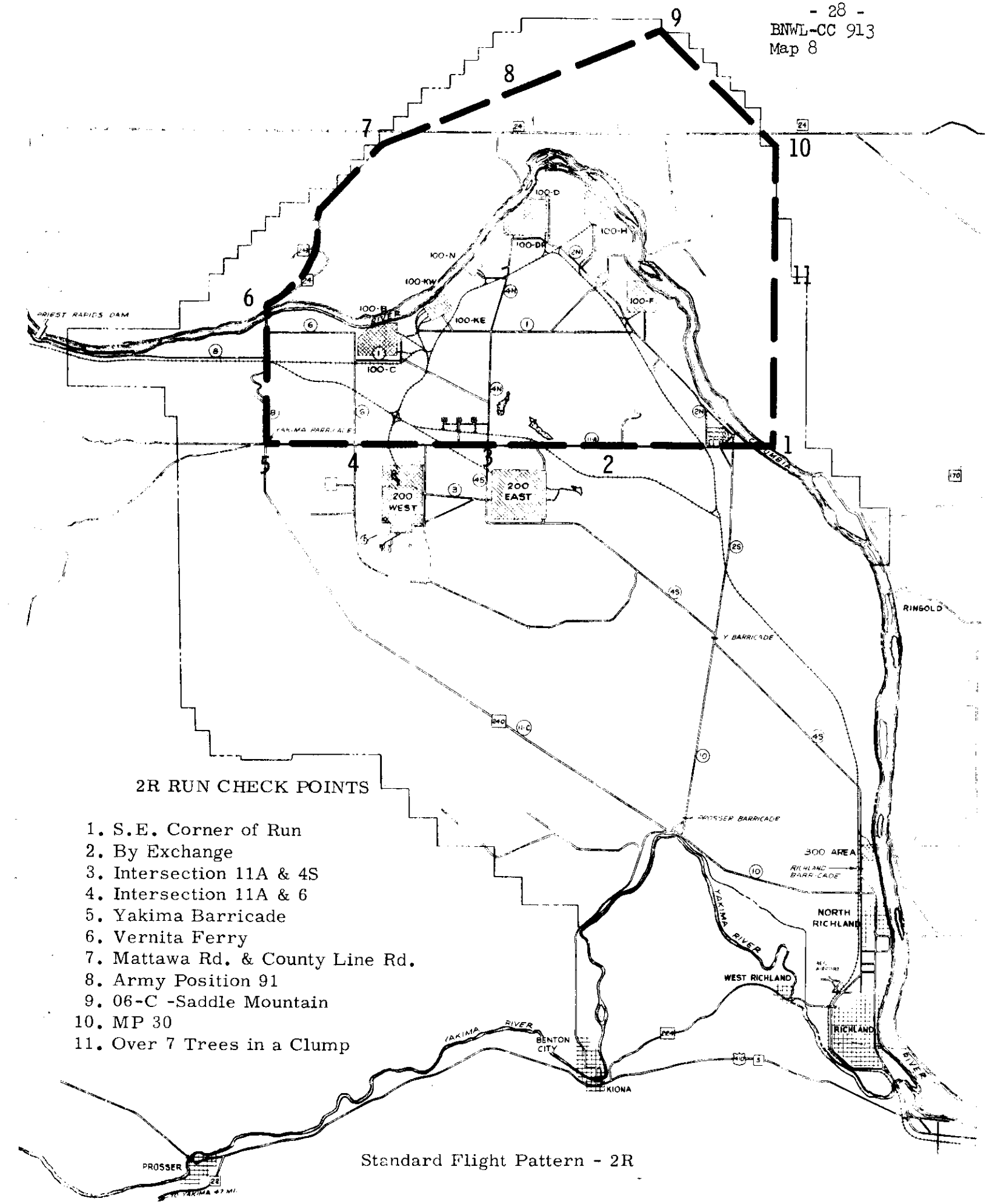
Twenty-two aerial surveys were made during 1965 and are shown on Maps 7-19 which follow. In all surveys, no ground contamination was detected.



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

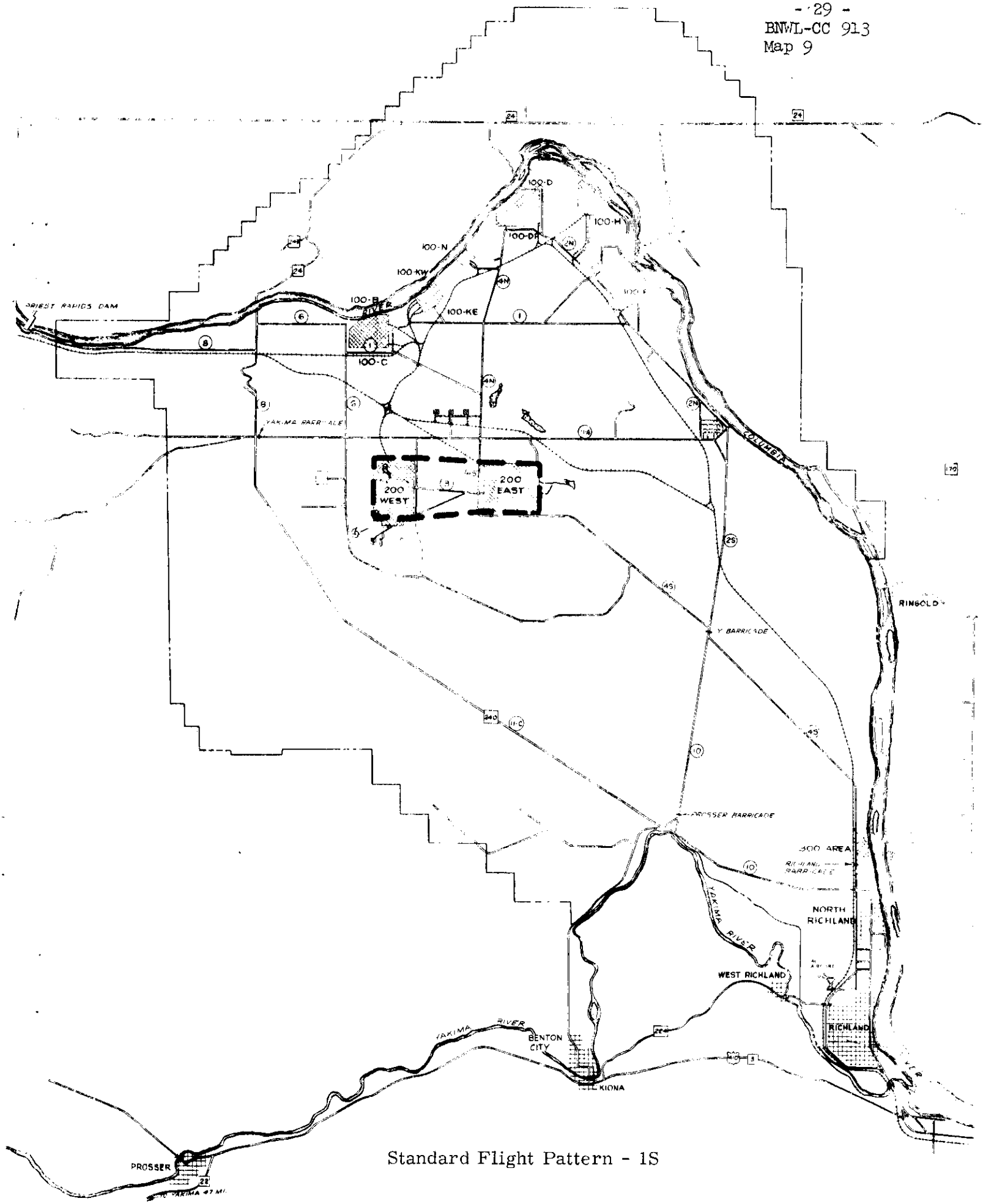
Standard Flight Pattern - 1R



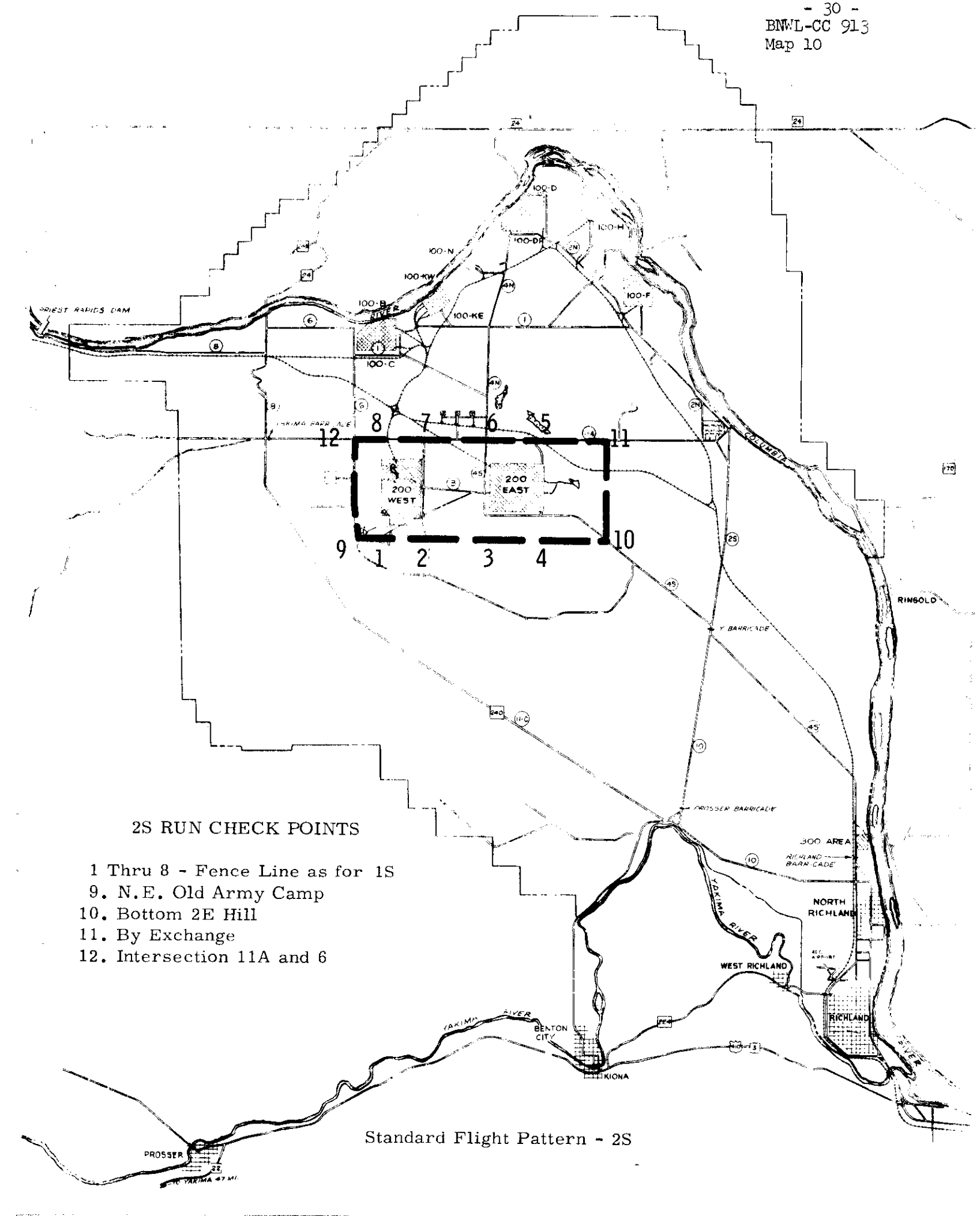
2R RUN CHECK POINTS

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



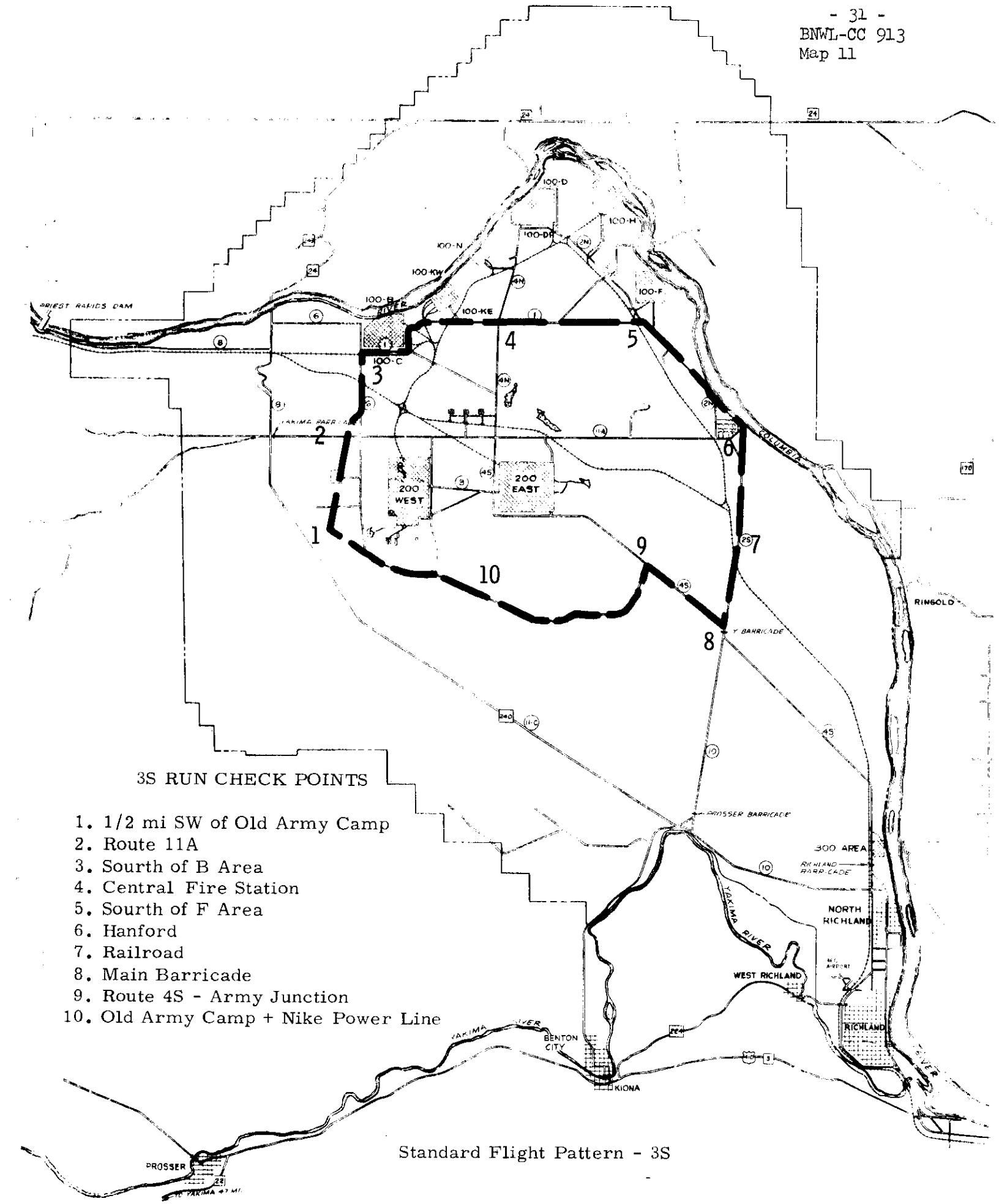
Standard Flight Pattern - 1S



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

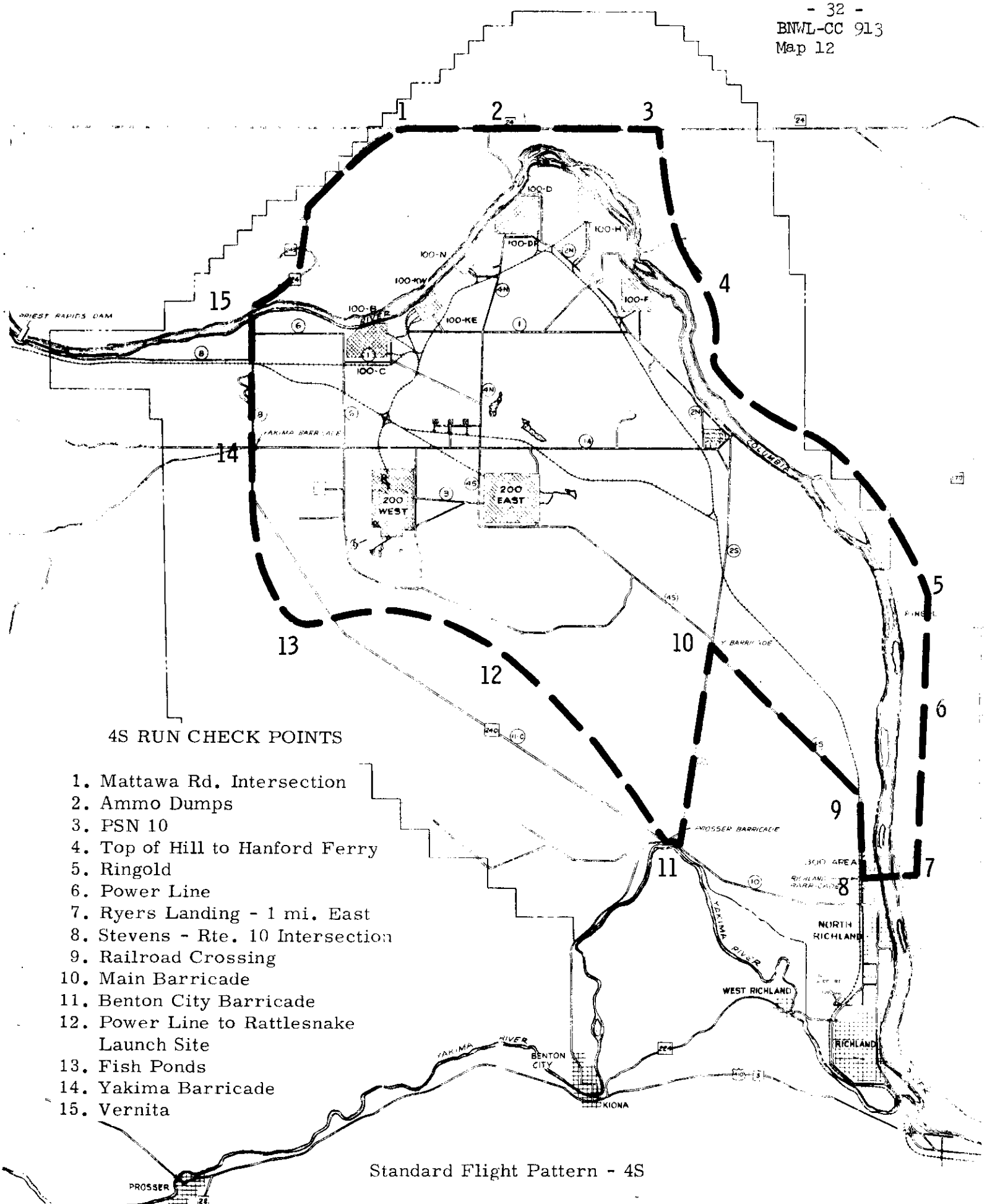
Standard Flight Pattern - 2S



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

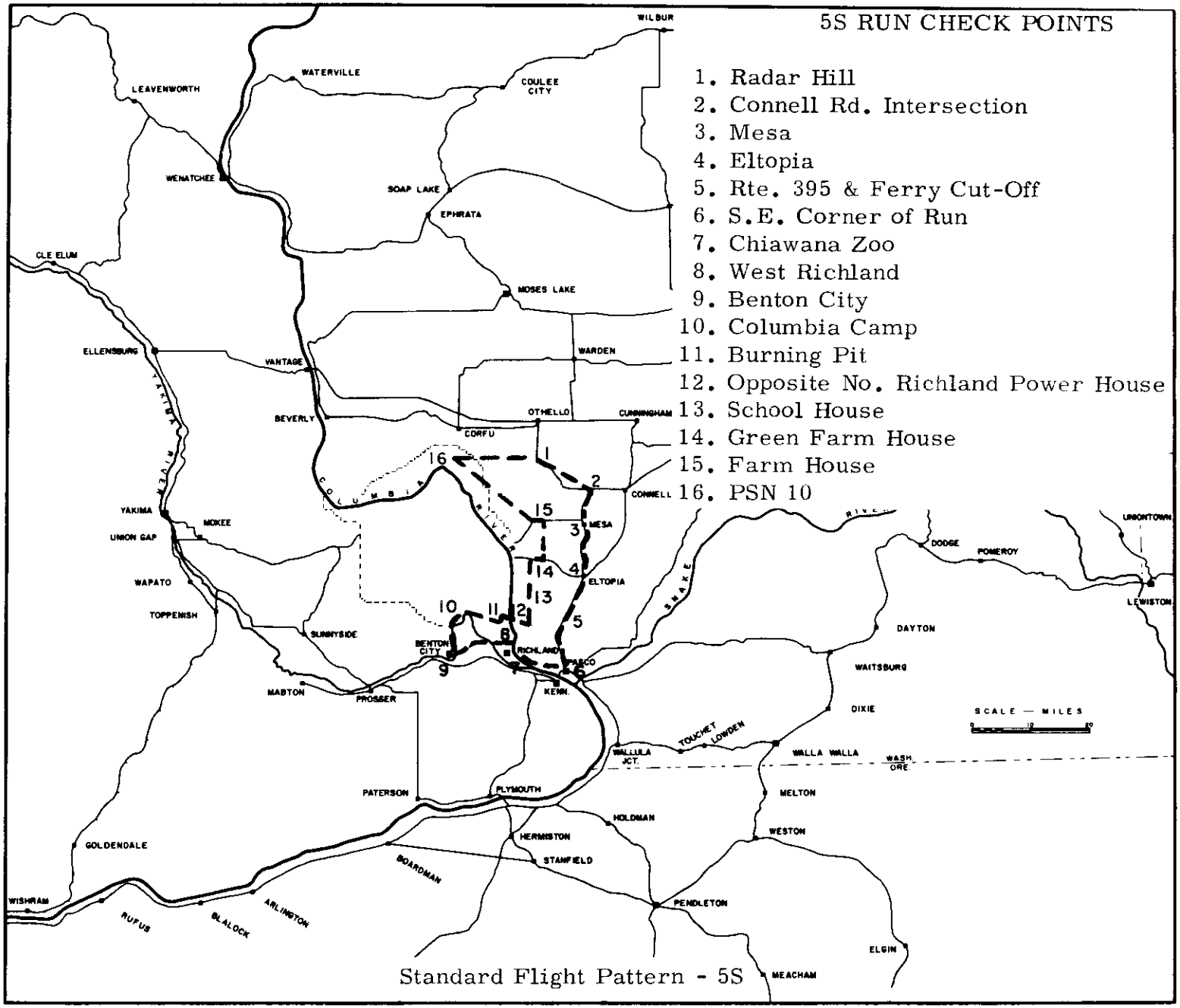
Standard Flight Pattern - 3S

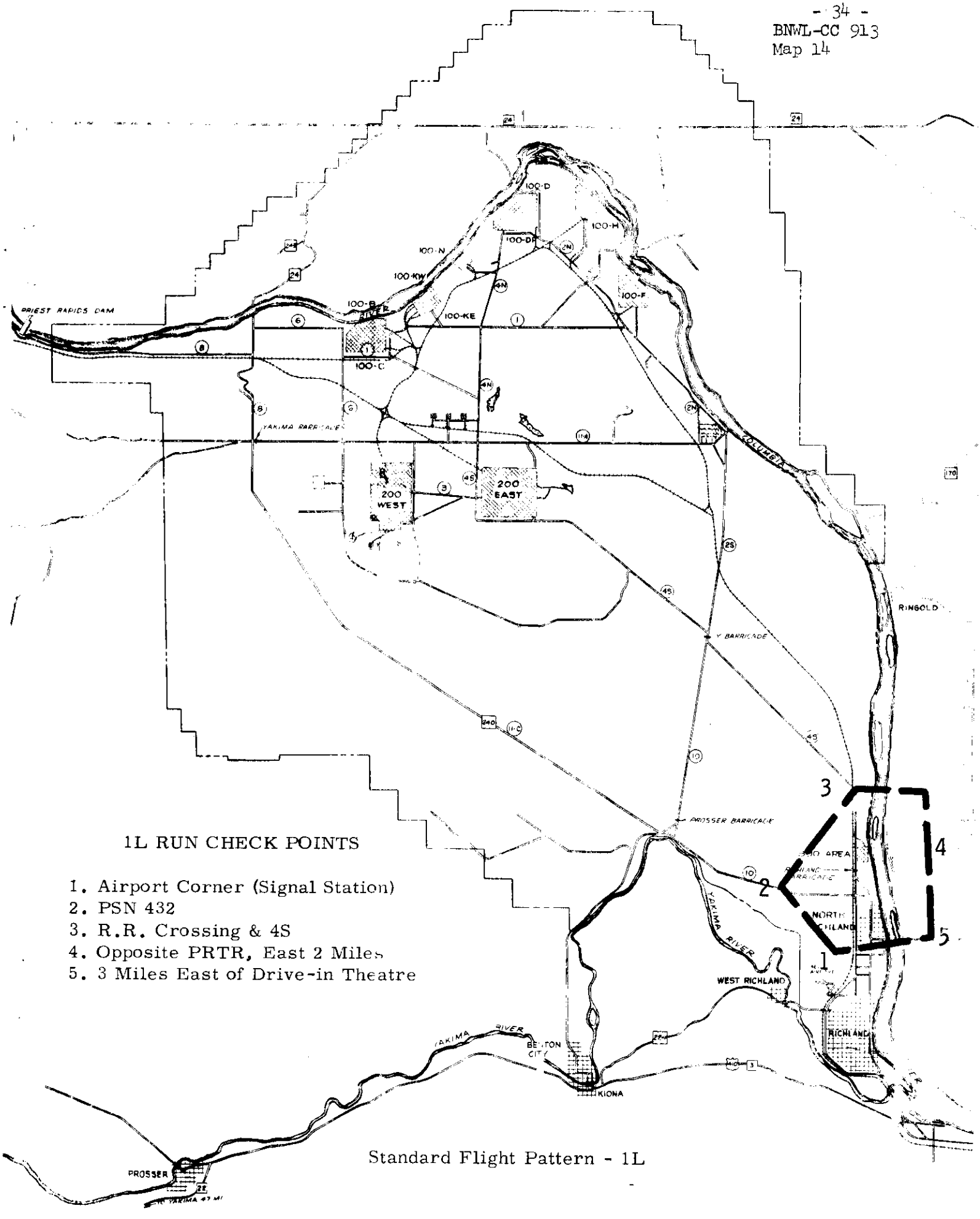


4S RUN CHECK POINTS

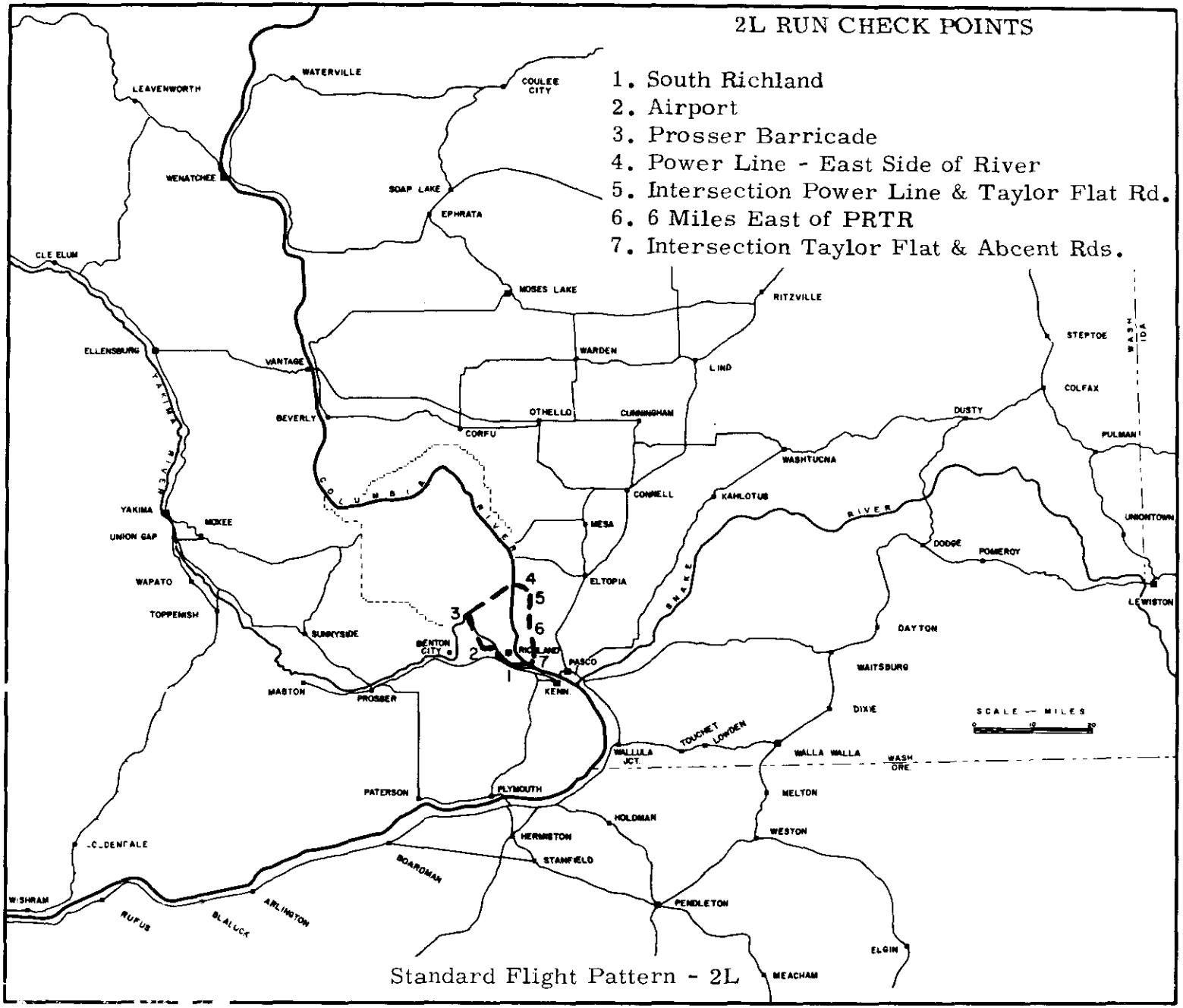
1. Mattawa Rd. Intersection
2. Ammo Dumps
3. PSN 10
4. Top of Hill to Hanford Ferry
5. Ringold
6. Power Line
7. Ryers Landing - 1 mi. East
8. Stevens - Rte. 10 Intersection
9. Railroad Crossing
10. Main Barricade
11. Benton City Barricade
12. Power Line to Rattlesnake Launch Site
13. Fish Ponds
14. Yakima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

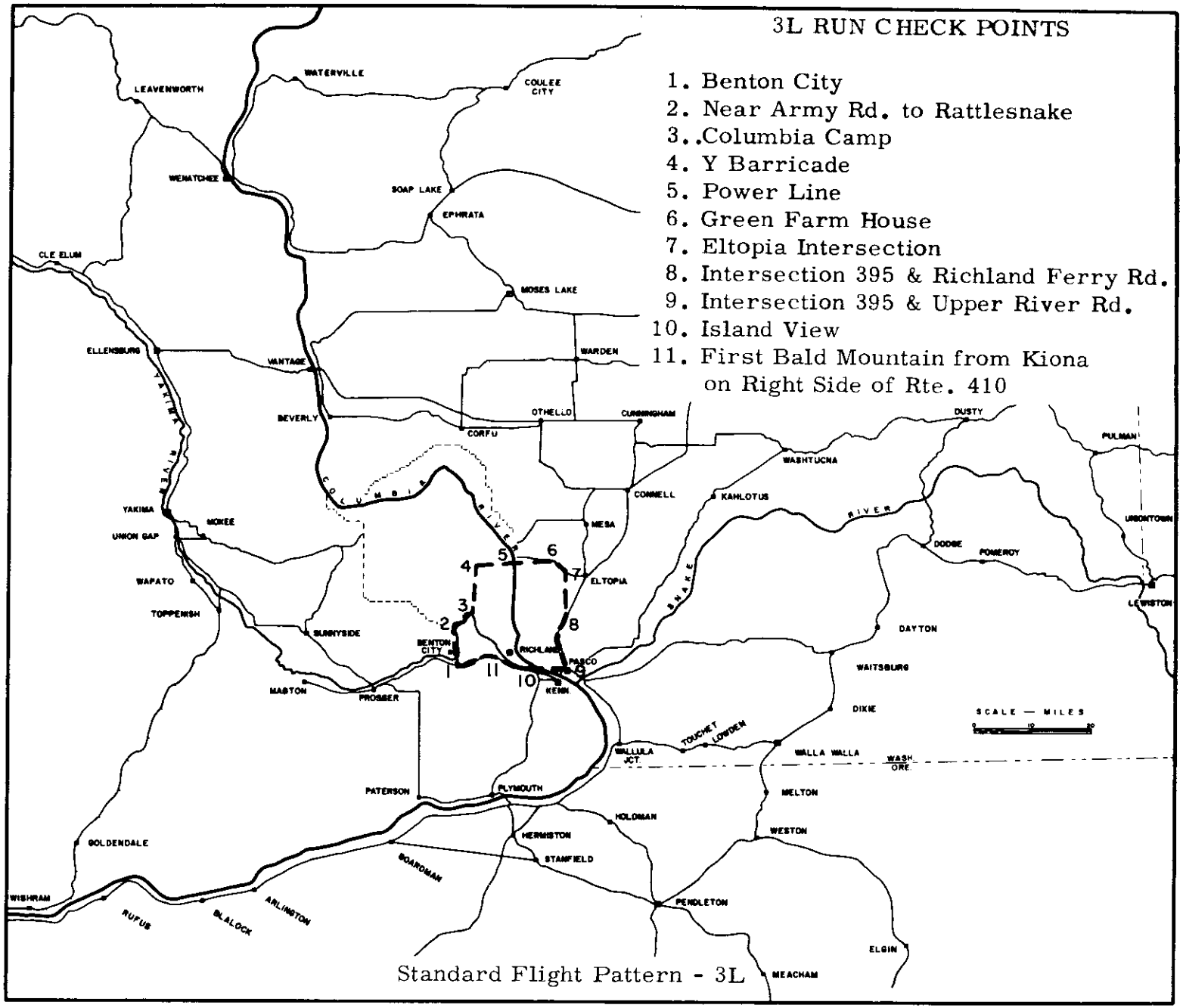
Standard Flight Pattern - 4S


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
LEAVENWORTH
COULEE CITY
WENATCHEE
SOAP LAKE
EPHRATA
CLE ELUM
MOSES LAKE
ELLENSBURG
VANTAGE
WARDEN
YAKIMA
BEVERLY
OTHELLO
CUNNINGHAM
CORFU
CONNELL
MOXEE
UNION GAP
MESA
ELTOPIA
WAPATO
TOPPENISH
SUNNYSIDE
BENTON CITY
RICHLAND
PASCO
KENN.
MABTON
PROSSER
DODGE
POMEROY
UNIONTOWN
LEWISTON
DAYTON
WAITSBURG
DIXIE
SCALE — MILES
WALLULA JCT.
TOUCHET
LOWDEN
WALLA WALLA
WASH.
ORE.
PATERSON
PLYMOUTH
MELTON
HOLDMAN
WESTON
HERMISTON
STANFIELD
GOLDENDALE
BOARDMAN
PENDLETON
WISHRAM
RUFUS
BLALOCK
ARLINGTON
ELGIN
MEACHAM
Standard Flight Pattern - 5S

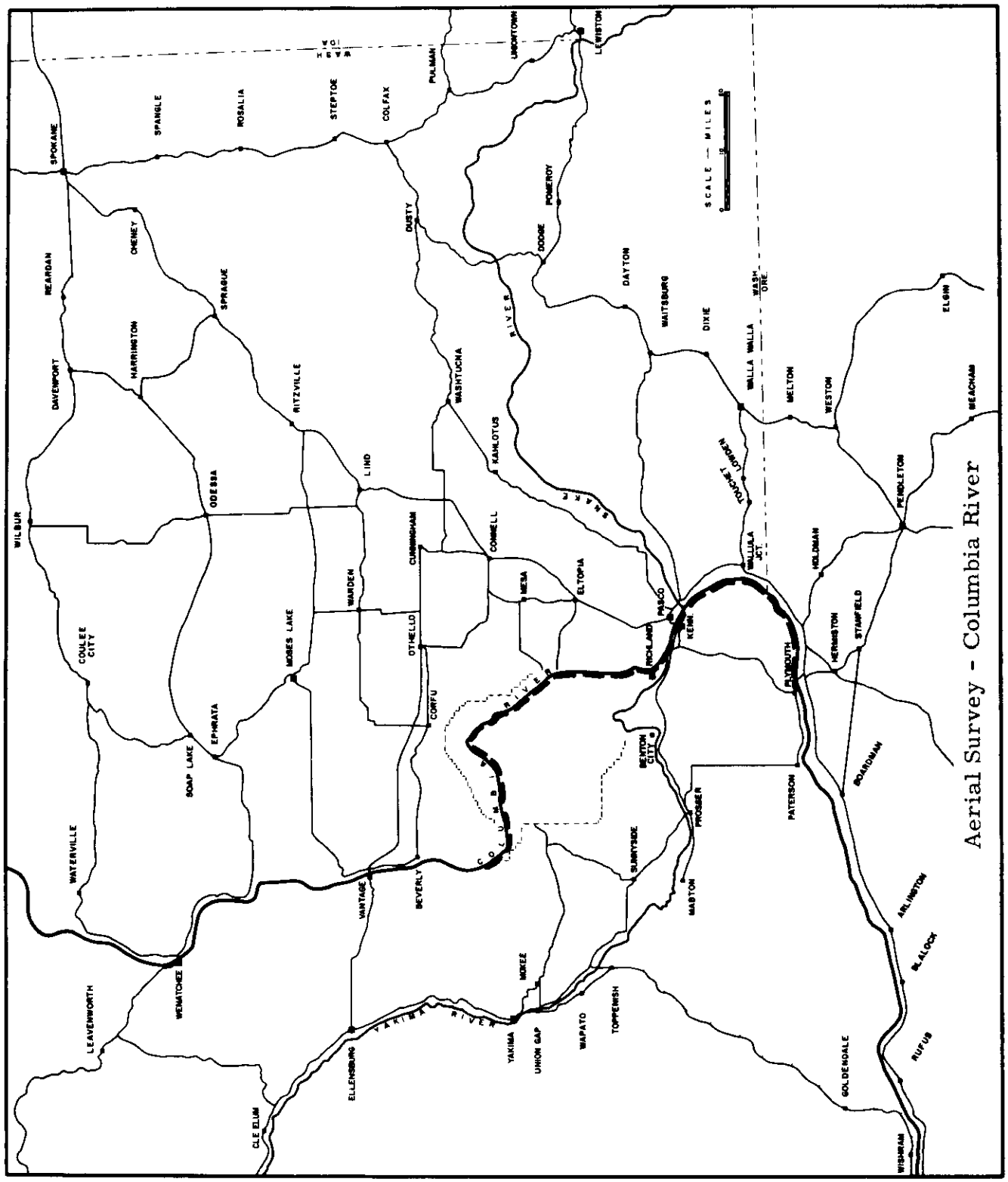


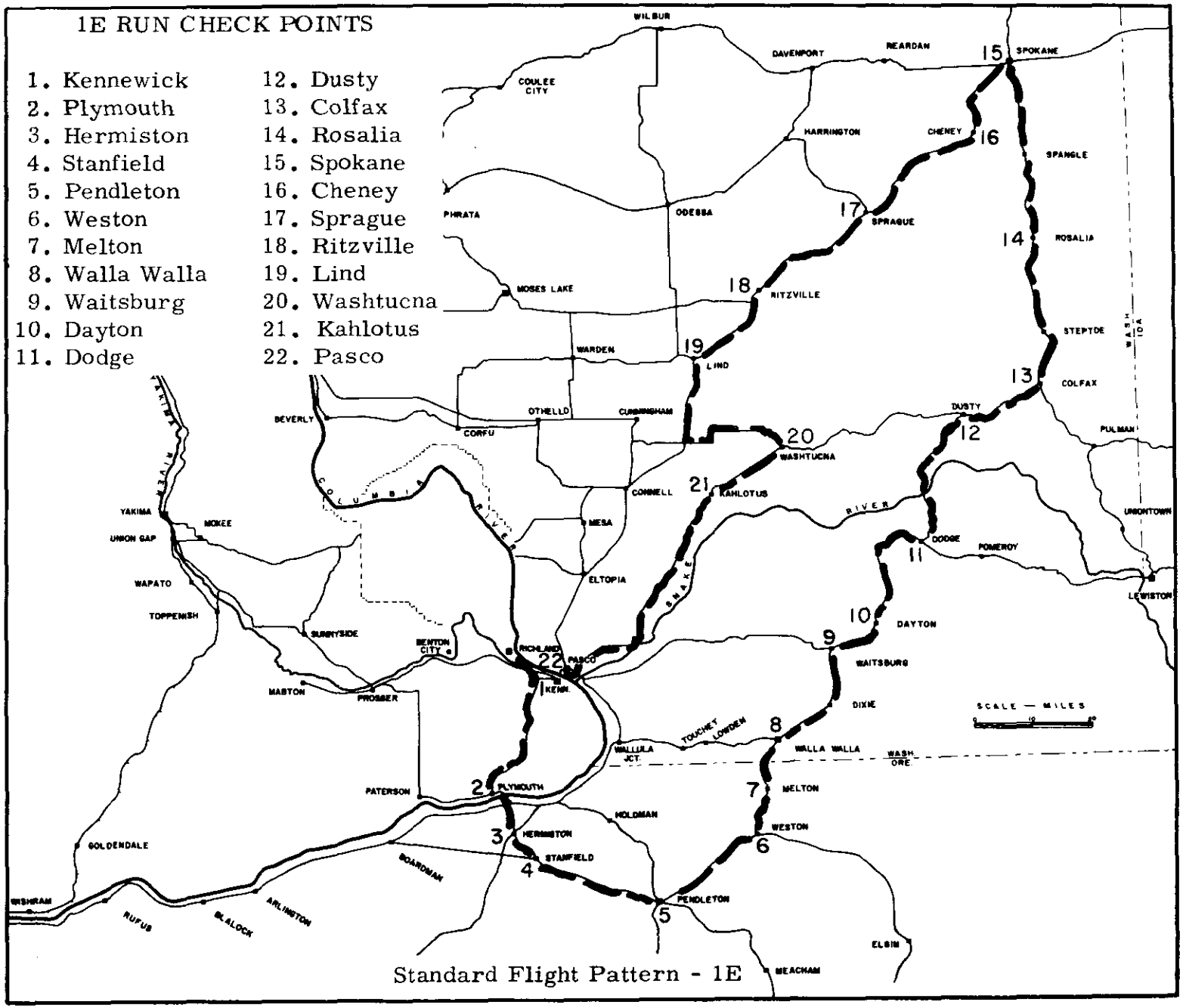
Standard Flight Pattern - 1L

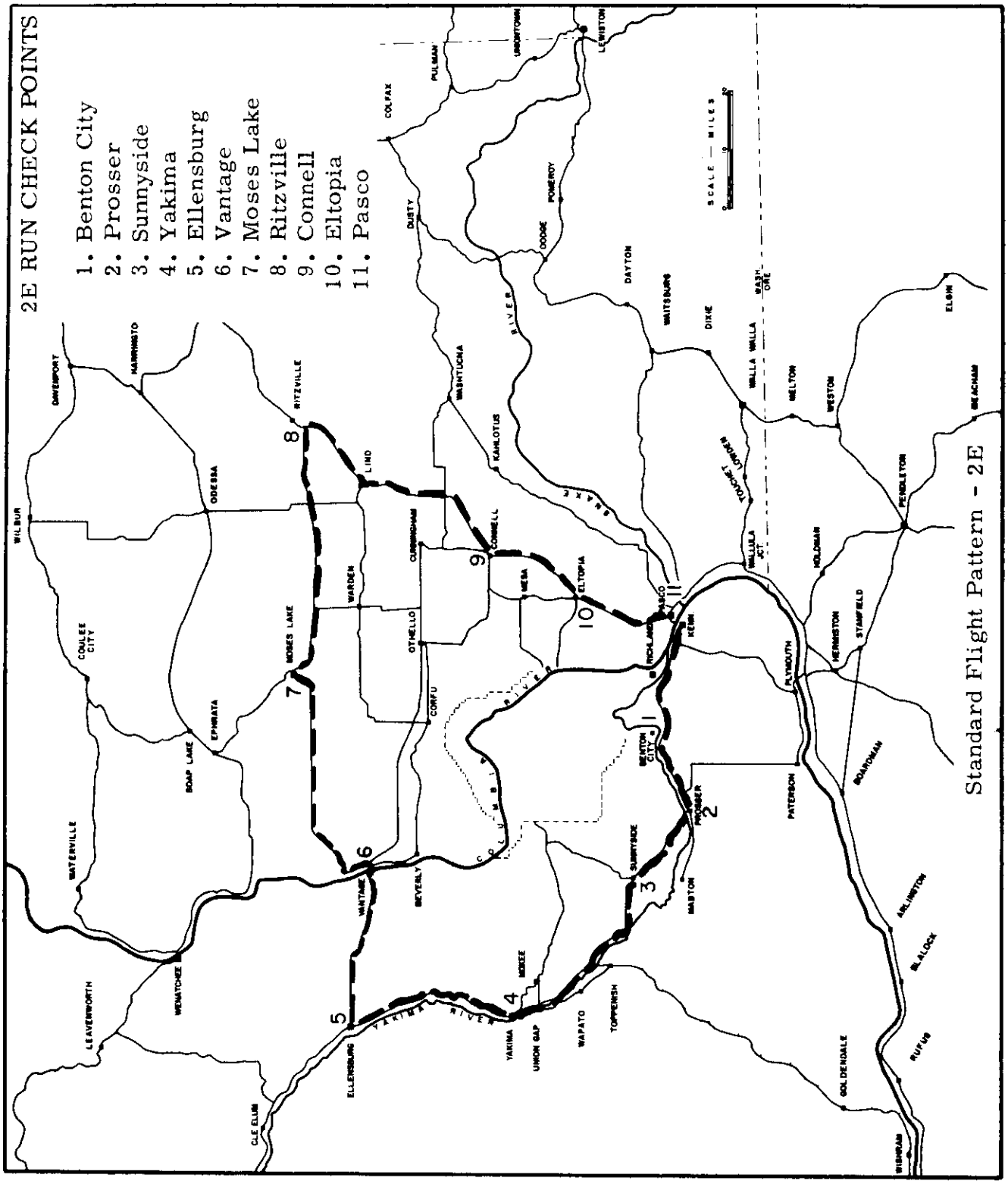

2L RUN CHECK POINTS
1. South Richland
2. Airport
3. Prosser Barricade
4. Power Line - East Side of River
5. Intersection Power Line & Taylor Flat Rd.
6. 6 Miles East of PRTR
7. Intersection Taylor Flat & Abcent Rds.
WATERVILLE
COULEE CITY
LEAVENWORTH
WENATCHEE
SOAP LAKE
EPHRATA
CLE ELUM
MOSES LAKE
RITZVILLE
ELLENSBURG
YAKIMA RIVER
VANTAGE
WARDEN
LIND
BEVERLY
OTHELLO
CUNNINGHAM
CORFU
COLUMBIA RIVER
STEPTOE
WASH
IDA
COLFAX
DUSTY
PULMAN
WASHTUCNA
CONNELL
KAHLOTUS
MESA
ELTOPIA
SNAKE RIVER
YAKIMA
MOXEE
UNION GAP
WAPATO
TOPPENISH
SUNNYSIDE
BENTON CITY
RICHLAND
PASCO
KENN
MABTON
PROSSER
DODGE
POMEROY
UNIONTOWN
LEWISTON
DAYTON
WAITSBURG
DIXIE
SCALE — MILES
WALLULA JCT.
TOUCHET
LOWDEN
WALLA WALLA
WASH.
ORE.
PATERSON
PLYMOUTH
MELTON
HOLDMAN
WESTON
HERMISTON
STANFIELD
BOARDMAN
PENDLETON
ELGIN
MEACHAM
WISHRAM
RUFUS
BLALOCK
ARLINGTON
Standard Flight Pattern - 2L



Standard Flight Pattern - 3L

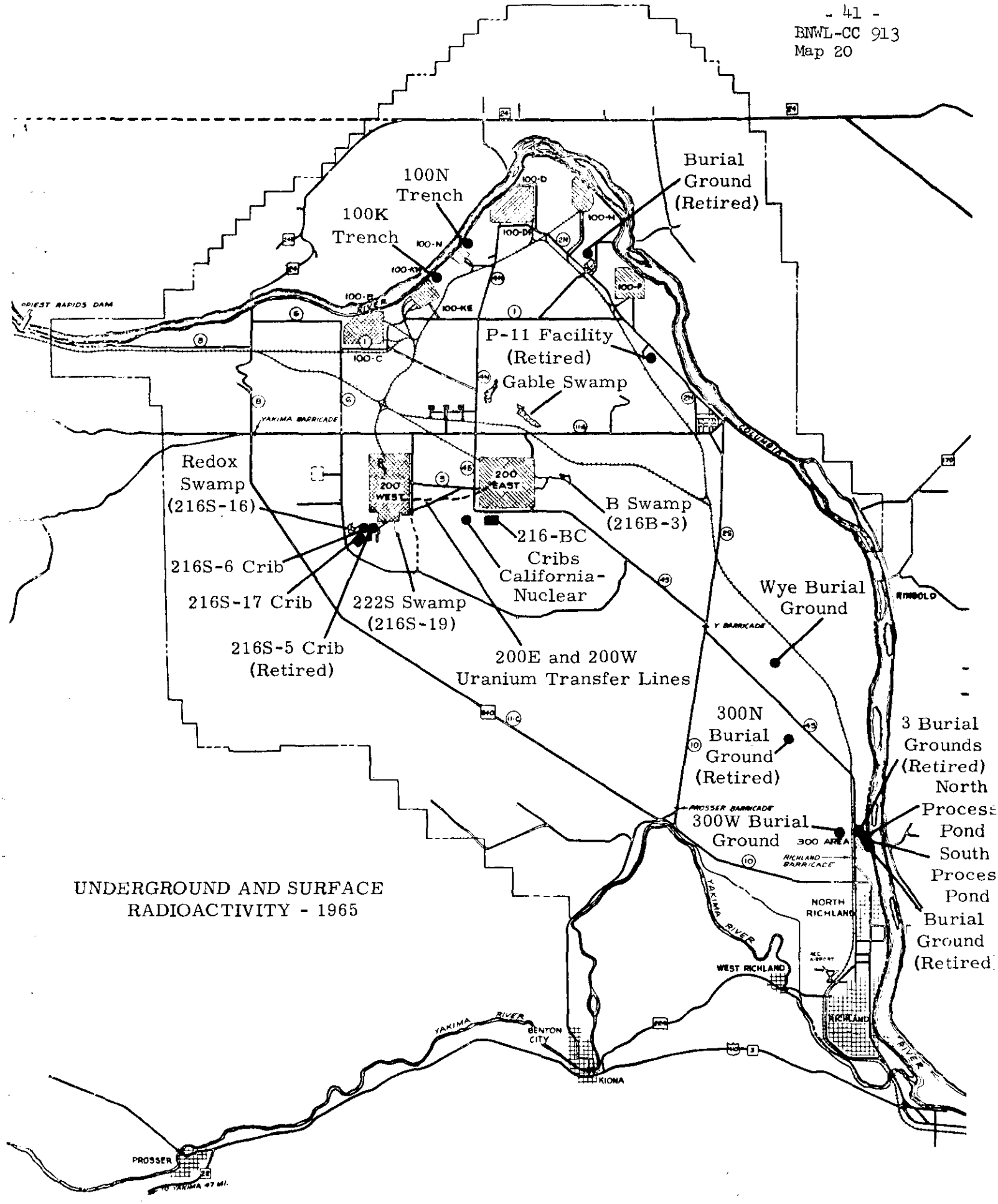

Aerial Survey - Columbia River
SCALE — MILES
SPOKANE
SPANGLE
ROSALIA
STEPTOE
COLFAX
PULMAN
LEWISTON
UNIONTOWN
REARDAN
CHENEY
DAVENPORT
HARRINGTON
SPRAGUE
RITZVILLE
DUSTY
POMEROY
DODGE
DAYTON
WAITSBURG
DIXIE
WALLA WALLA
WASH-ORE
ELGIN
MELTON
WESTON
WILBUR
ODESSA
LIND
WASHTUCNA
KAMLOTUS
SNAKE RIVER
TOUCHET
PENDLETON
BEACHAM
COULEE CITY
WARDEN
CUNNINGHAM
CONNELL
MESA
ELTOPIA
PASCO
KENNEWICK
HOLDMAN
HERMISTON
STANFIELD
PLYMOUTH
MOSES LAKE
OTHELLO
CORFU
COLUMBIA RIVER
BENTON CITY
WATERVILLE
SOAP LAKE
EPHRATA
PROSSER
PATERSON
BOARDMAN
SUNNYSIDE
MABTON
WENATCHEE
VANTAGE
BEVERLY
YAKIMA RIVER
ARLINGTON
BLALOCK
LEAVENWORTH
ELLENSBURG
YAKIMA
MOXEE
UNION GAP
WAPATO
TOPPENISH
GOLDENDALE
RUFUS
CLE ELUM
WISHRAM


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

5. 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 20 which follows.


100N Trench
100K Trench
Burial Ground (Retired)
P-11 Facility (Retired)
Gable Swamp
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)
300W Burial Ground
3 Burial Grounds (Retired)
North Process Pond
South Process Pond
Burial Ground (Retired)
UNDERGROUND AND SURFACE RADIOACTIVITY - 1965
PRIEST RAPIDS DAM
YAKIMA BARRICADE
PROSSER BARRICADE
RICHLAND BARRICADE
Y BARRICADE
200 WEST
200 EAST
300 AREA
NORTH RICHLAND
WEST RICHLAND
RICHLAND
BENTON CITY
KIONA
PROSSER
YAKIMA RIVER
COLUMBIA RIVER

6. Special Surveys

100-K Area

On June 2, 1965, wind blew radioactive particles out of a dry 107-KW Basin. The contamination was confined to a path which extended southeast from the 107-KW Basins. The contamination path outside of 100-K Area was about 500 feet wide and about 1000 feet long, and contained particles having radiation levels up to 10,000 c/m (GM measurement). Two particles were recovered for a gamma scan analysis, with the following results:

	Radionuclide			
Particle Location	Sc^{46} (nCi)	Cr^{51} (nCi)	Zn^{65} (nCi)	Np^{239} (nCi)
100-K Area Fenceline	2.5	12	1.0	3.0
Power Line Road	4.0	16	2.6	6.0

Since the contaminated area was away from principal roads and the contamination was reasonably well fixed, no special restrictions or control measures were invoked for the 100-K Area environs.

200-W Area

During the period September 17-19, 1965, a large quantity of Ru^{103} and Ru^{106} was released from the 202-S Building stack. A thorough survey of the environs within the Hanford project and off-project failed to reveal any discrete particles. The only measurable effects of the radioruthenium release were increases in atmospheric contamination at several air sampling sites. A summary of ruthenium concentrations measured in air following the release is given below.

		Ru^{103}-Ru^{106} (in units of pCi/m³)		
Location	Week Ending	Average	Maximum	% 40-hr MPC_a* (max.)
200-W Area	9/20/65	37	84	0.11
200-E Area	9/20/65	5.1	7.7	0.01
100 Areas	9/20/65	4.5	9.8	0.01
ERC	9/22/65	9.8	9.8	0.01
Rattlesnake Springs	9/22/65	2.2	2.2	0.003
All other locations	9/22/65	0.92	1.3	0.002

* The most restrictive MPC_a (Ru^{106}) was used in this calculation.

300 Area

On September 29, 1965, the process tube in the Fuel Element Rupture Test Facility at the PRTR failed, resulting in a release of tritium, radioiodines and noble gases to the atmosphere and to the Columbia River. The effects of this release were minor and did not affect the environs within the Hanford project. The off-plant effects of the release are included in BNWL-316, "Evaluation of Radiological Conditions in the Vicinity of Hanford for 1965".

B. External Radiation Exposure Rates

1. Exposure Rates on Plant

Both scintillation-type gamma monitors and film badges were used during 1965 to measure ambient exposure rates. Neither system provided data comparable to that obtained in 1966 with ionization chambers. The gamma monitors were designed for emergency levels and were too insensitive to measure the normal background radiation levels. The film badge results were erratic, probably because of weather transients.

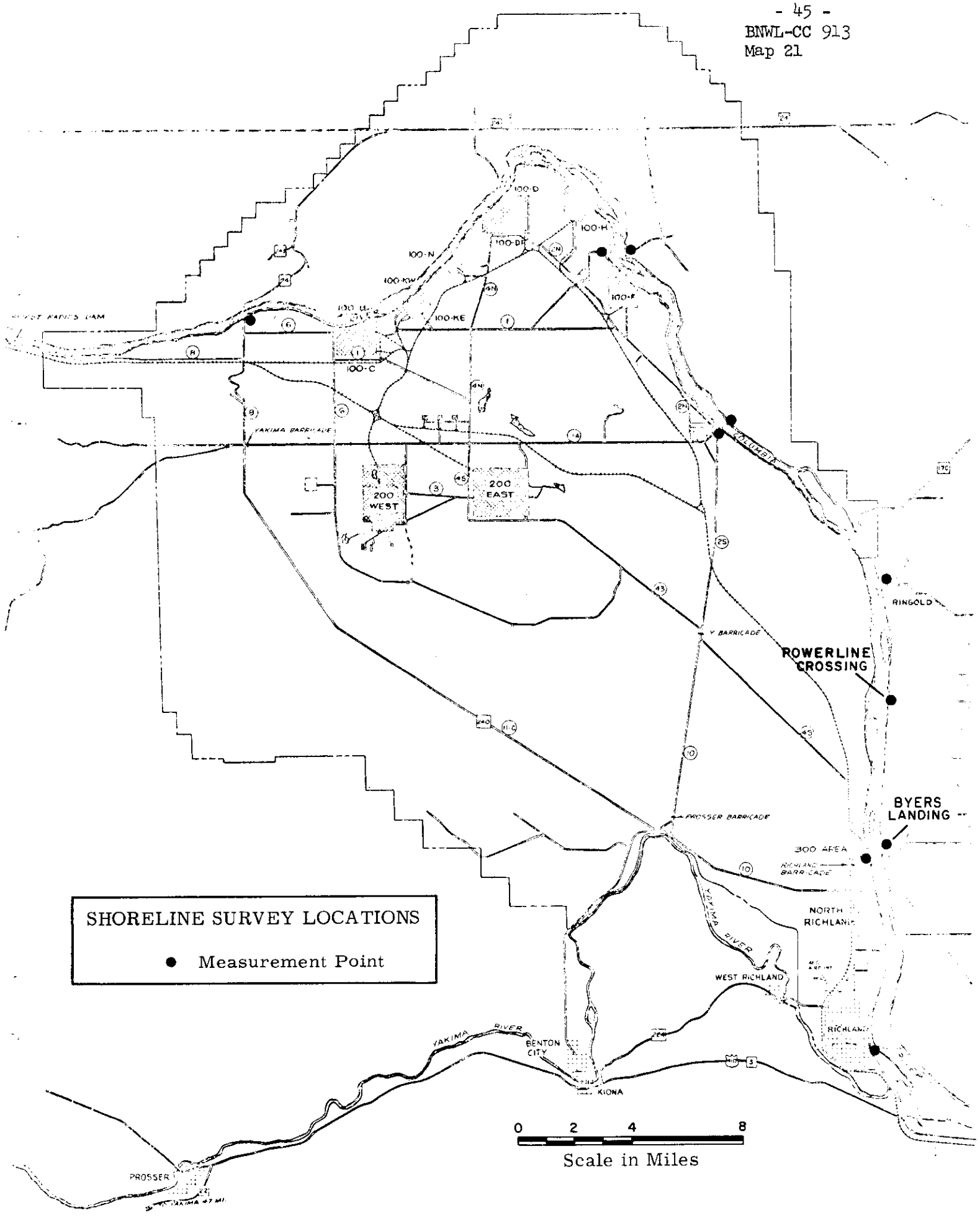
2. Exposure Rates at the Columbia River Shoreline

Shoreline exposure rates are measured with a NaI(Tl) scintillation detector, whose response is interpreted in terms of μR/hour (radium-gamma calibration). The measurements are made 3 feet above ground, thus approximating the dose rate to the gonads of a person standing on the river bank. Results of shoreline surveys conducted during 1965 are shown in Table V-1. In addition to the locations shown in Map 21, measurements were also made at Burbank and Sacajawea Park.

Table V-1
Monthly Average Shoreline Exposure Rates *
(in units of μR/hr)

Month	Ringold	Power Line Crossing	Byers Landing	Richland Marina	Burbank	Sacajawea Park
Jan.	56		54	41	13	
Feb.	59		53	52	23	
Mar.	53		52	56	15	
Apr.	57		39	34	11	
May	15		24	24	10	
June	16		13	18	11	
July	32		21	22	10	
Aug.	48		31		15	
Sept.	39	86	70		14	21
Oct.	47	55	36		11	22
Nov.	76	95	51		12	16
Dec.	29	73	26	25	10	13

* No 1965 data were available for the following locations used in 1966: Vernita Bridge, White Bluffs (Plant and far shore), Hanford (plant and far shore), and PRTR Outfall.

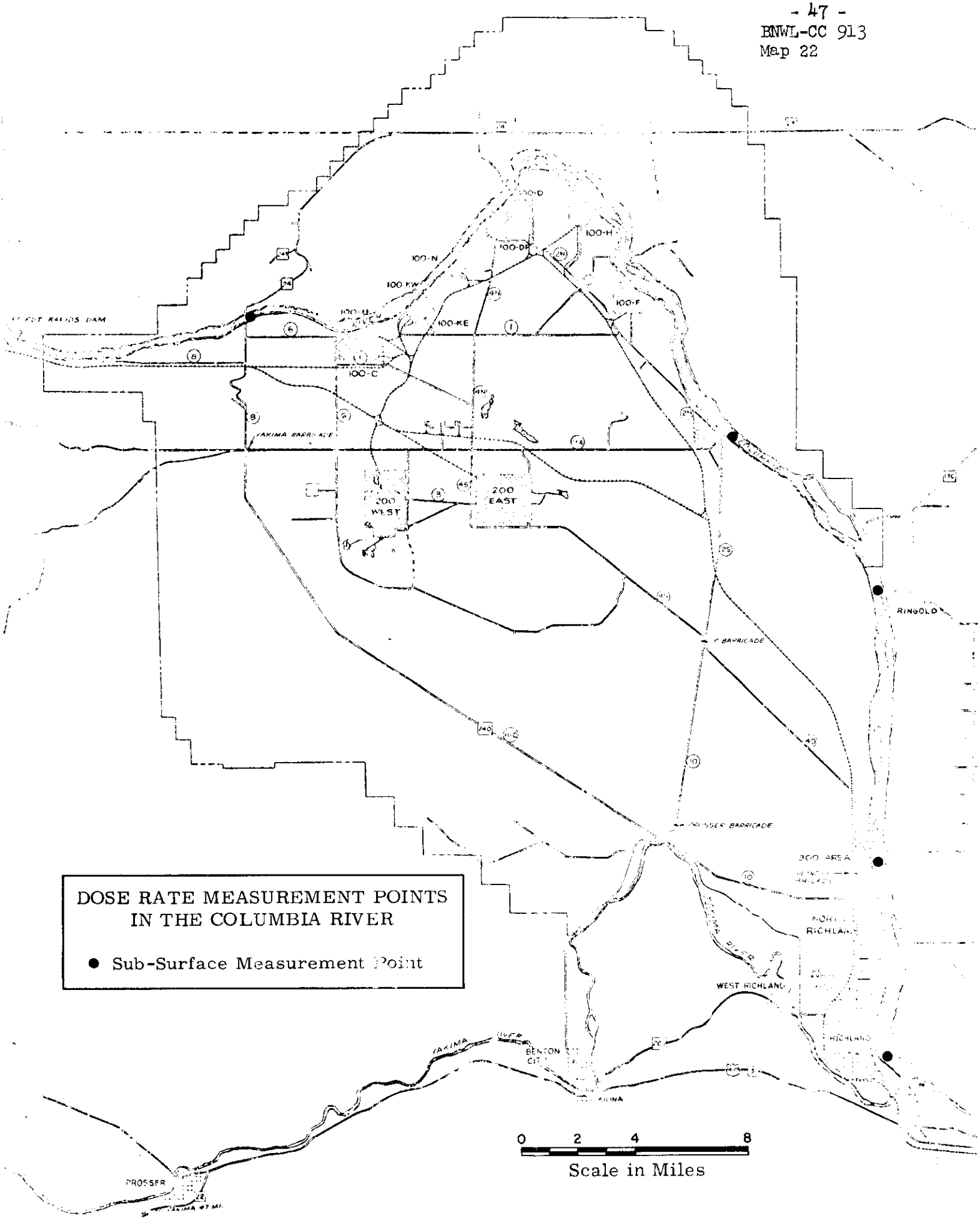

100-D
100-H
100-DR
100-N
100-KW
100-KE
100-F
100-C
200 WEST
200 EAST
YAKIMA BARRICADE
COLUMBIA
Y BARRICADE
PROSSER BARRICADE
RICHLAND BARRICADE
POWERLINE CROSSING
BYERS LANDING
RINGOLD
300 AREA
NORTH RICHLAND
WEST RICHLAND
RICHLAND
YAKIMA RIVER
BENTON CITY
KIONA
PROSSER
SHORELINE SURVEY LOCATIONS
Measurement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

3. Exposure Rates Below the Surface of the Columbia River

Exposure rates in the river are determined from pocket dosimeters contained within submerged bottles. Immersion exposure rates measured during 1965 are given in Table V-2. The measurement points are shown in Map 22.

Table V-2
Monthly Average Immersion Exposure Rates
(in units of mR/day)

Month	Vernita Bridge	Old Hanford Ferry	Ringold	300 Area	Richland Marina
Jan.	0.44	6.2		2.9	2.4
Feb.	0.26	5.2		3.1	1.9
Mar.	0.32	5.6		2.8	2.8
Apr.	0.31	6.3		3.6	3.0
May	0.27	3.6		2.9	2.2
June	0.29	3.3		1.4	1.5
July	0.17	2.8		1.8	1.2
Aug.	0.72	3.7		1.6	1.5
Sept.	0.80	2.8	1.7	2.3	2.1
Oct.	0.46	2.6	1.7	1.9	1.9
Nov.	0.73	3.5	3.0	2.1	1.9
Dec.		3.8	2.6	2.1	1.8


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