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TITLE

DOSE-RATE MEASUREMENTS OF BEACHES AND ISLANDS ON THE COLUMBIA RIVER BETWEEN RINGOLD AND RICHLAND

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DOSE-RATE MEASUREMENTS OF BEACHES AND
ISLANDS ON THE COLUMBIA RIVER
BETWEEN RINGOLD AND RICHLAND

by

D. McConnon

ENVIRONMENTAL STUDIES AND EVALUATION
RADIATION PROTECTION OPERATION
HANFORD LABORATORIES OPERATION

August 10, 1962

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

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DOSE-RATE MEASUREMENTS OF BEACHES AND
ISLANDS ON THE COLUMBIA RIVER
BETWEEN RINGOLD AND RICHLAND

INTRODUCTION

The section of the Columbia River between Ringold and the 300 Area has some potential for recreational use in addition to the fishing now available from the east shore. In order to determine probable dose rates which would be experienced in this section of the river if it were used by boating enthusiasts, bathers, and picnickers, surveys were made during mid-summer and early fall of 1961. A follow-up survey was conducted during the spring of 1962 to extend the range of coverage to the Richland area. Included in the surveys were measurements of the dose rate in and above the river water, and on the beaches. Selected areas of the ground were also surveyed for particulate contamination.

METHODS

Three surveys were made - the first from July 18 to July 21, 1961, the second from October 2 to October 6, 1961, and the third on March 29 and 30, 1962. Measurements were taken in approximately the same areas during the first two surveys. In the third survey, some measurements were repeated in the Ringold - 300 Area section of the river, but emphasis was placed on the section opposite Richland.

In general, the areas surveyed were chosen on the basis of attractiveness for recreational use. The first two surveys were conducted from Savage Island, across which the primary plant boundary extends, to the point below 300 Area which is the present boundary for recreational boating. The third survey extended from the Plant boundary to Nelson's Island. Figure 1 shows

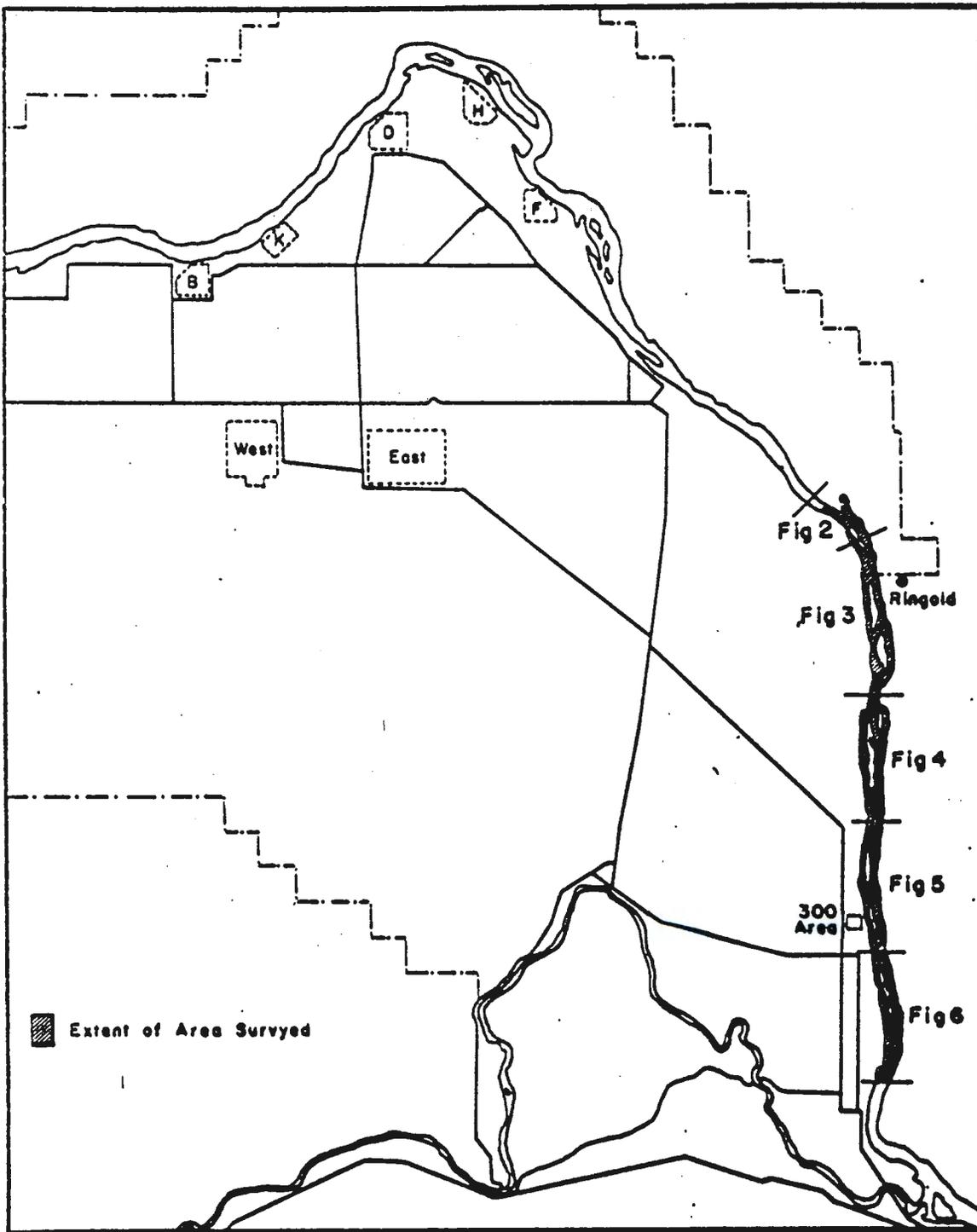


FIGURE 1

Portion of the River Surveyed and its Relation to Plant Facilities

the section of the river surveyed and its relation to plant facilities. Figures 2, 3, 4, 5, and 6, show detailed sections of the area surveyed and the 33 specific locations chosen for the land surveys.

Four types of radiation detection instruments were used during the survey -

- 1) a portable GM instrument to determine the extent and intensity of contamination,
- 2) a 40-liter ionization chamber to measure extremely low dose rates⁽¹⁾
- 3) small pencil-type ionization chambers to measure the integrated dose over a one week period at a given location⁽²⁾, and
- 4) a five inch plastic scintillation detector to determine the dose rate existing in a boat at various locations on the river.⁽³⁾

At least ten ground level measurements were taken with the portable GM instrument and the 40-liter chamber at each survey location. The ten measurements were averaged to give a general indication of the radiation levels existing at the survey site.

Two sets of "pencils" were exposed at selected beaches for a period of one week. The first set was placed at ground level to measure the dose rate that a person might receive while lying on the beach. The second set of "pencils" was placed approximately three feet above the ground on a stake to estimate the dose rate to the lower trunk region of a person while standing. In addition, "pencils" were submerged in 4 to 8 feet of water approximately 10 to 15 feet off-shore from some of the more appealing beaches to measure the dose rate that a person might receive while swimming in these waters.

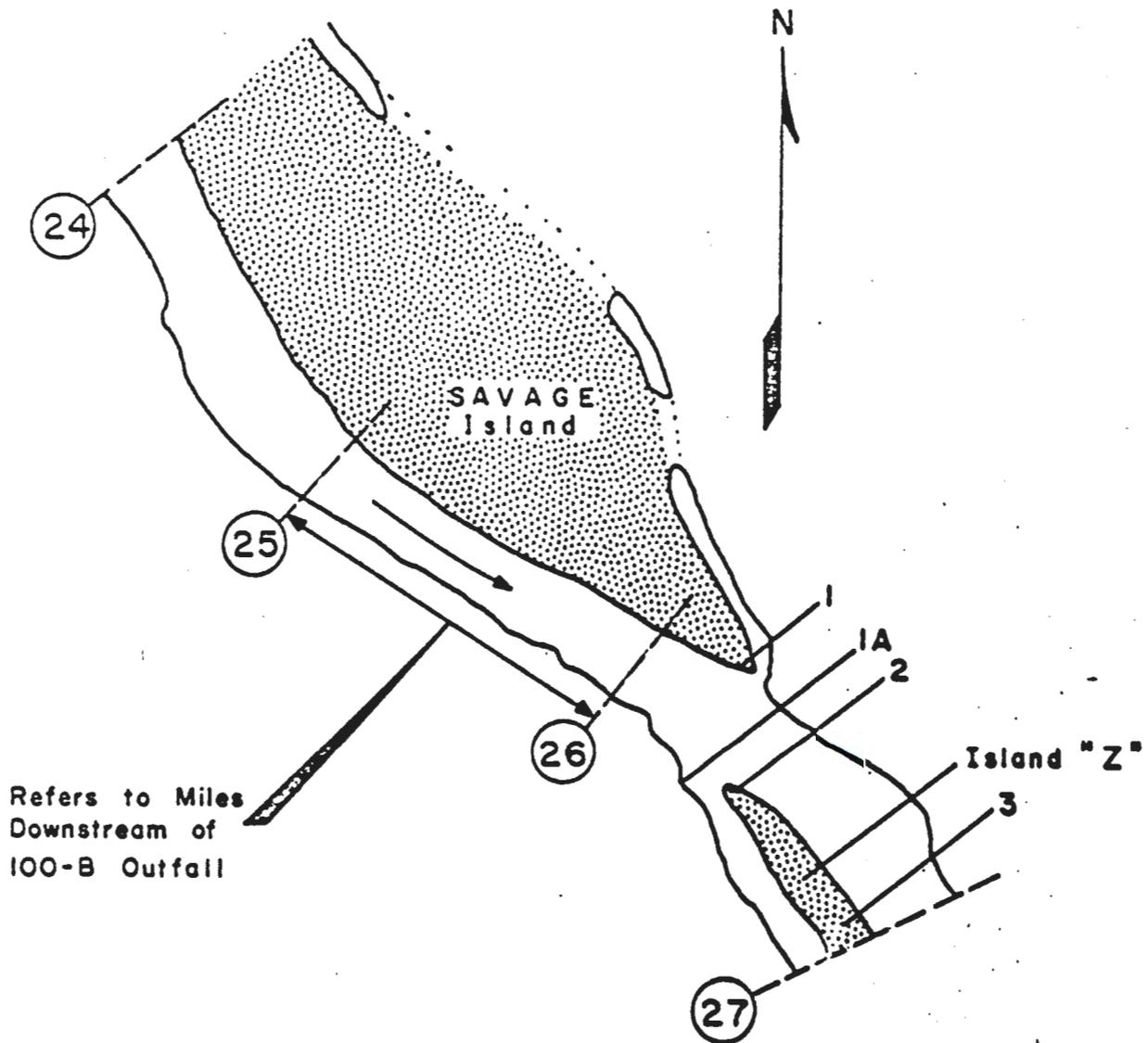


FIGURE 2
Land Survey Locations 1, 2, and 3
River Mile 24 to Mile 27

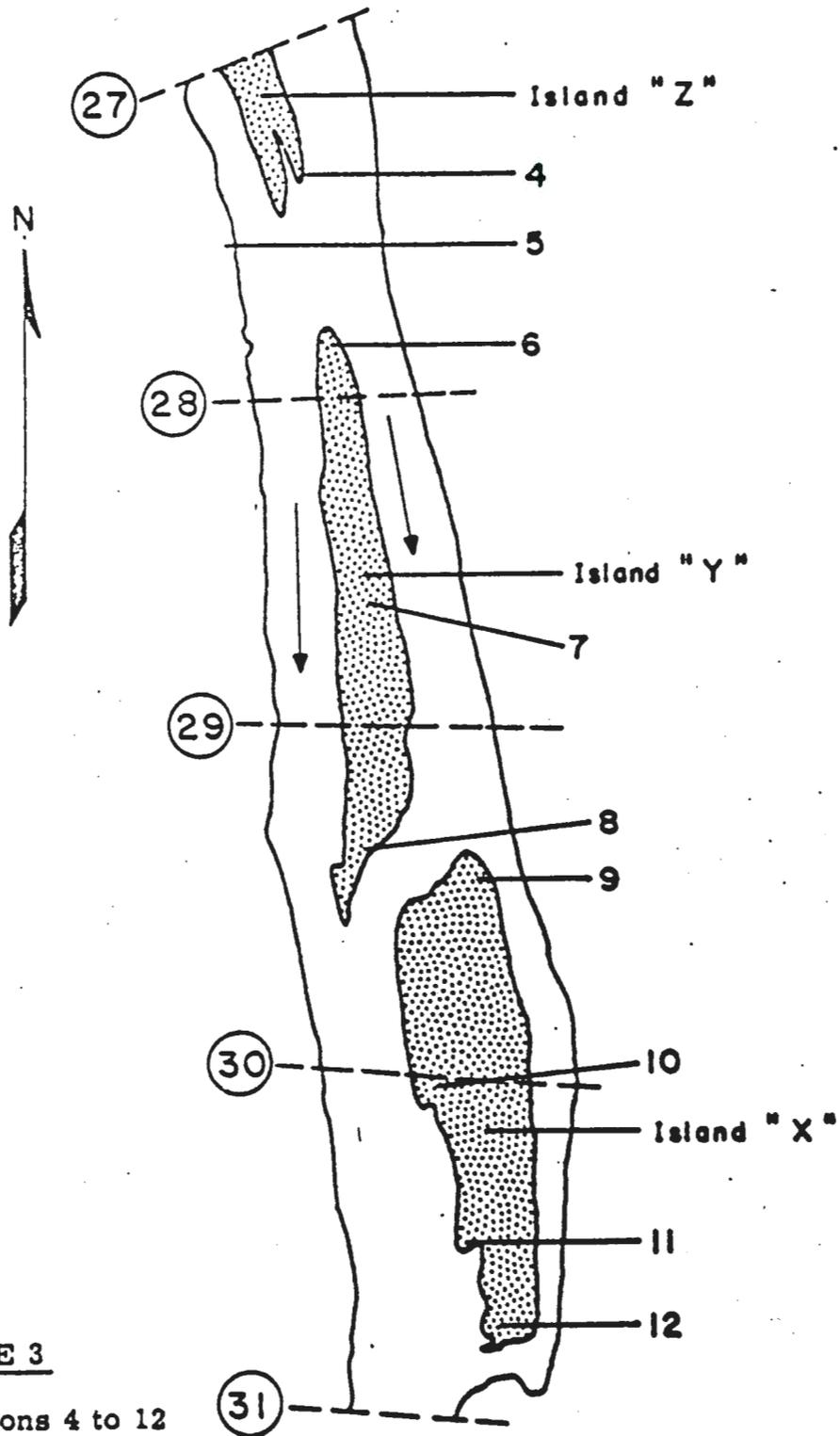


FIGURE 3

Land Survey Locations 4 to 12
River Mile 27 to Mile 31

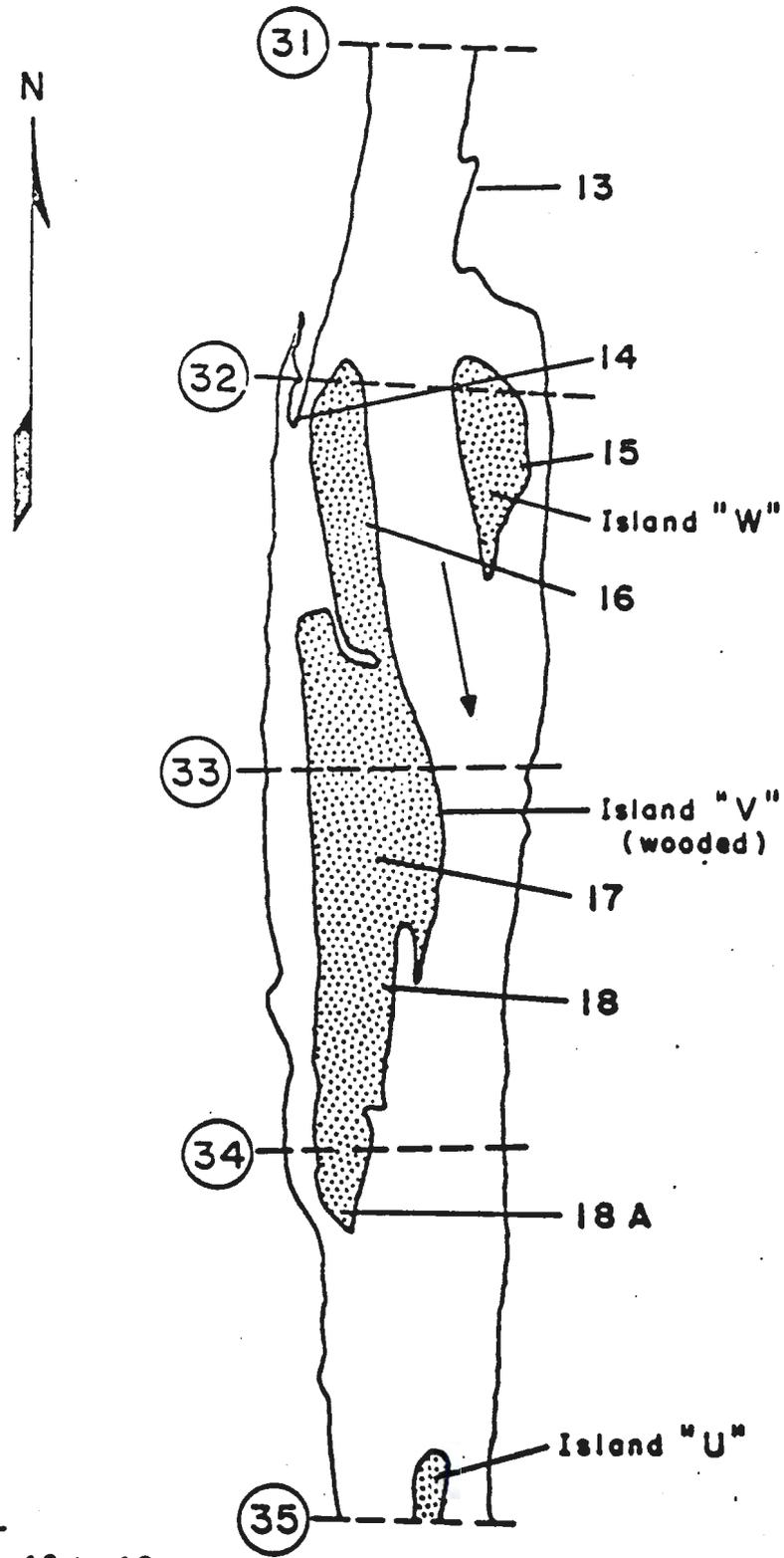


FIGURE 4

Land Survey Locations 13 to 18
River Mile 31 to Mile 35

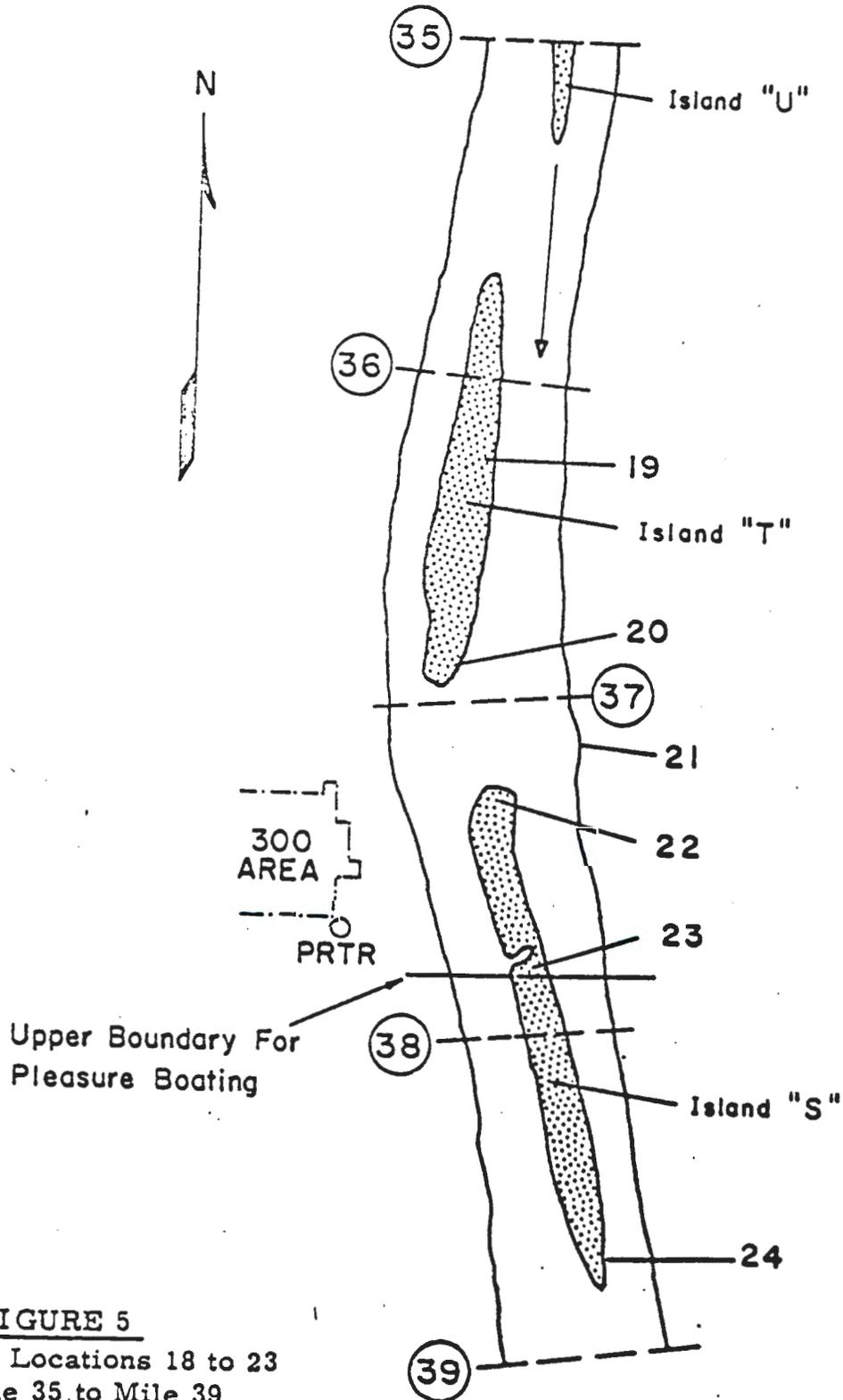


FIGURE 5
Land Survey Locations 18 to 23
River Mile 35 to Mile 39

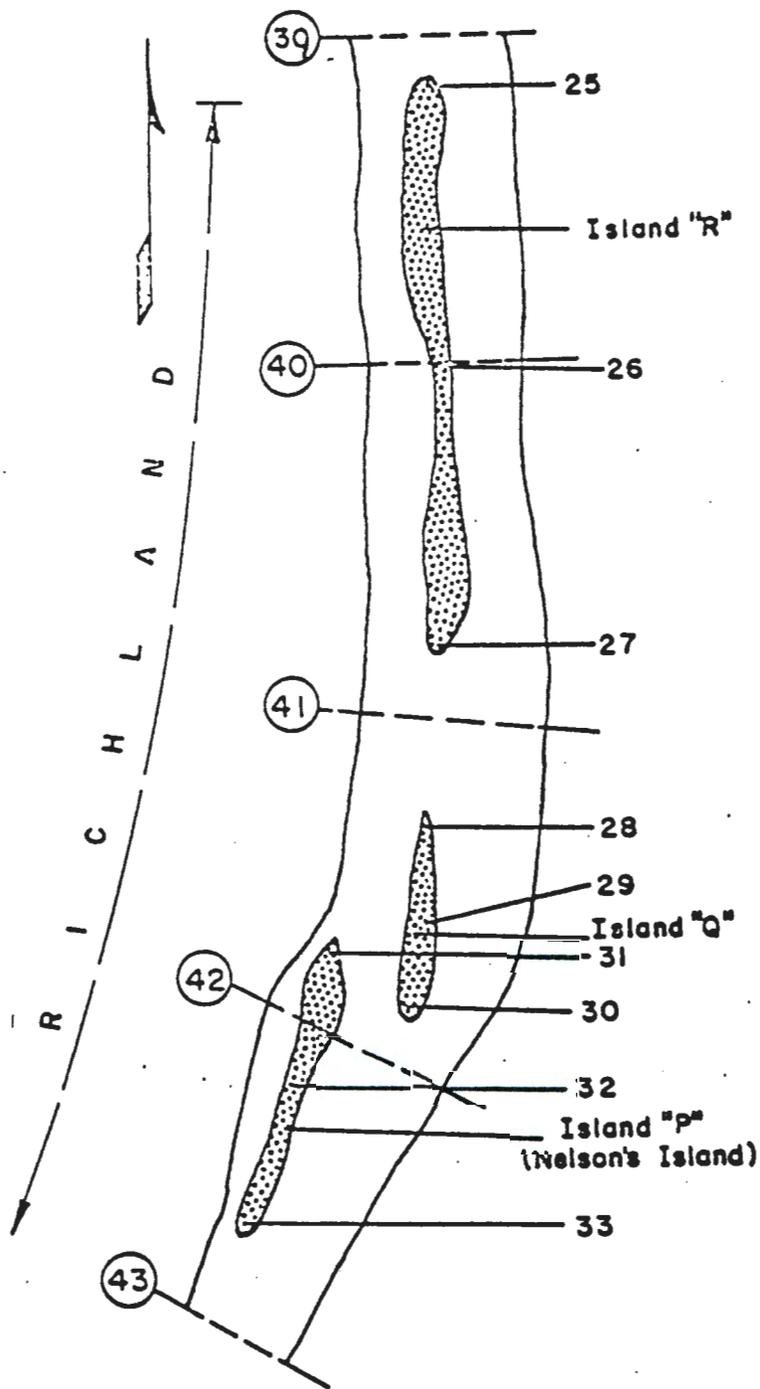


FIGURE 6

Land Survey Locations 25 to 33 River Mile 30 to Mile 43

The flow rate of the Columbia (Figure 7) at the time of the July survey was approximately 175,000 cfs; substantially lower than the peak of approximately 500,000 cfs reached in June, but quite usual for this month. By October, the flow had dropped to 60,000 cfs, while at the end of March, 1962, the flow was approximately 50,000 cfs.

RESULTS

July Survey

Surveys with portable GM instruments showed radioactivity over the beaches and ground in the range of 200 counts per minute (background) to maximums of 600 counts per minute, as shown in Table 1. Although the highest readings were on the upper half of Island "2", near the upriver limit of the study, (Survey Locations 2 and 3, Figure 2) there was not a consistent decrease downstream. The radioactive contamination did not appear to be associated with scattered particles but rather seemed to be spread quite uniformly over the surfaces being surveyed.

Table 2 summarizes the data obtained with the "pencils" at the ten locations where these instruments were set out. At ground level the dose rates were in the range of 0.06 to 0.19 $\mu\text{r}/\text{hr}$. Three feet above the ground the values were about half as much. "Pencils" submerged in the water off-shore from the selected beaches indicated dose rates in the range of 0.05 to 0.09 $\mu\text{r}/\text{hr}$.

Many more measurements were possible with the 40-liter chamber than with the "pencils" but they represent transient, rather than integrated, conditions. The results are summarized in Table 3. The measurements made with the 40-liter chamber are plotted in Figure 8 which illustrates the variability at

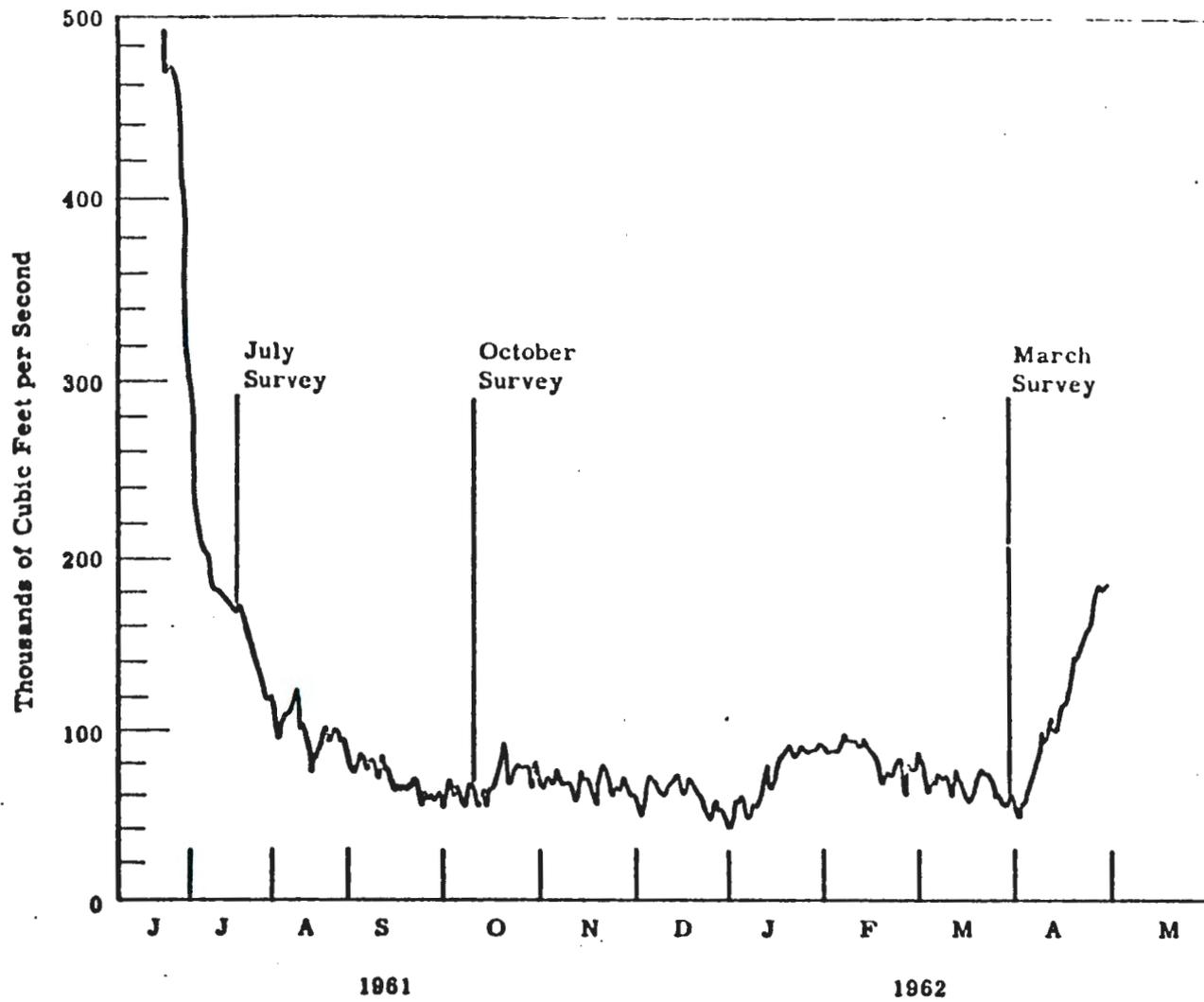


FIGURE 7

Columbia River Flow as Measured at Priest Rapids Dam June 15, 1961
to April 30, 1962

TABLE 1

SUMMARY OF DATA OBTAINED OVER GROUND SURVEYED WITH REM INSTRUMENT, 1961

Units of c/m

Location Pits. 2-5	July			October		
	Average	Maximum	Minimum	Average	Maximum	Minimum
1	250	500	200	500	1,500	200
1A	--	--	--	300	2,500	300
2	500	800	400	400	2,000	200
3	600	800	500	400	2,000	150
4	400	700	300	--	--	--
5	300	500	200	400	3,000	200
6	200	350	150	500	5,000	150
7	350	600	200	500	5,000	200
8	300	500	200	--	--	--
9	250	500	250	450	2,000	200
10	150	450	150	450	3,000	200
11	200	450	200	400	2,000	200
12	200	500	200	--	--	--
13	200	350	200	450	2,500	200
14	300	500	300	--	--	--
15	250	500	200	500	3,000	200
16	500	700	400	500	1,500	200
17	350	500	250	300	600	200
18	400	600	300	450	1,500	200
18A	--	--	--	350	2,000	200
19	400	600	250	150	2,500	150
20	300	500	300	500	900	400
21	400	600	300	200	550	200
22	350	500	250	300	800	300
23	300	400	200	500	600	500

TABLE 2
 SUMMARY OF DATA OBTAINED WITH PENCIL-TYPE
 IONIZATION CHAMBERS, 1961

 Units of mr/hr

Location Figs. 2-5	Land				River	
	July		October		July	October
	0 ft	3 ft	0 ft	3 ft		
1	--	--	--	--	--	--
2	--	--	--	--	--	--
3	--	--	--	--	--	--
4	0.19	0.06	0.16	0.13	--	--
5	0.06	0.05	0.14	0.12	0.09	0.17
6	0.09	0.06	0.14	0.11	0.09	0.19
7	--	--	--	--	--	--
8	--	--	--	--	--	--
9	--	--	--	--	--	--
10	0.13	0.09	0.19	0.19	0.07	0.12
11	--	--	--	--	--	--
12	--	--	--	--	--	--
13	0.11	0.06	0.12	0.09	0.07	0.13
14	--	--	--	--	--	--
15	0.13	0.10	0.21	0.15	--	--
16	0.15	0.07	0.11	0.09	--	--
17	--	--	--	--	--	--
18	0.16	0.08	0.14	0.11	--	--
18A	--	--	--	--	--	--
19	0.16	0.12	0.08	0.07	--	--
20	--	--	--	--	--	--
21	0.16	0.07	0.06	0.05	0.05	0.12
22	--	--	--	--	--	--
23	--	--	--	--	--	--

TABLE 3

SUMMARY OF DATA OBTAINED OVER GROUND SURVEYED WITH 40-LINER CHAMBER, 1961
Units of nr/hr

Location Hrs. 2-5	July			October		
	Average	Maximum	Minimum	Average	Maximum	Minimum
1	0.19	0.32	0.10	0.18	0.42	0.05
1 ₁	--	--	--	0.36	0.65	0.12
2	0.17	0.28	0.12	0.26	0.42	0.18
3	0.31	0.50	0.12	0.27	0.70	0.10
4	0.20	0.32	0.12	0.39	0.60	0.16
5	0.13	0.20	0.08	0.36	0.70	0.18
6	0.13	0.18	0.09	0.26	0.78	0.08
7	0.13	0.32	0.07	0.19	0.65	0.07
8	0.16	0.19	0.13	0.20	0.46	0.07
9	0.12	0.15	0.08	0.15	0.32	0.08
10	0.20	0.42	0.09	0.15	0.55	0.06
11	0.25	0.32	0.19	0.32	0.74	0.18
12	0.24	0.28	0.18	--	--	--
13	0.15	0.18	0.12	0.31	0.60	0.13
14	0.29	0.37	0.18	--	--	--
15	0.18	0.28	0.11	0.43	1.1	0.11
16	0.27	0.50	0.15	0.26	0.46	0.12
17	0.20	0.42	0.13	0.22	0.37	0.08
18	0.25	0.42	0.13	0.40	0.65	0.18
18 ₁	--	--	--	0.35	0.60	0.18
19	0.29	0.37	0.21	0.24	0.50	0.09
20	0.21	0.42	0.12	0.22	0.46	0.13
21	0.26	0.42	0.08	0.16	0.42	0.10
22	0.14	0.20	0.11	0.19	0.27	0.16
23	0.11	0.16	0.09	0.24	0.42	0.13

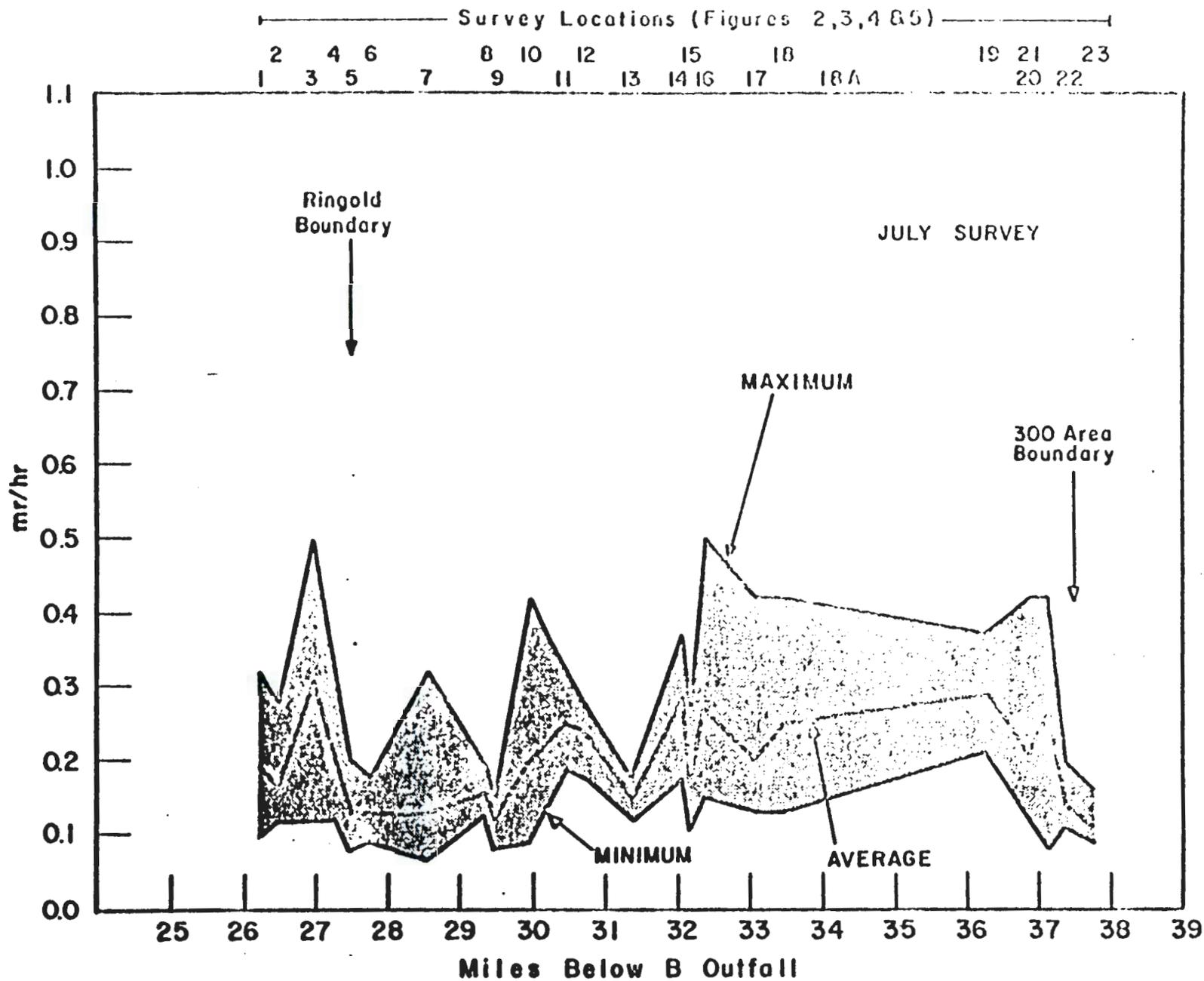


FIGURE 8
Comparison of Dose Rates at Various Survey Locations, July, 1961

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individual locations and the lack of any distinct change with distance downstream. This technique usually indicated dose rates which were slightly higher than shown by the "pencils".

Response of the scintillation detector carried in the boat as it moved between survey locations indicated a maximum dose rate of 0.025 mr/hr.

October Survey

With diminishing river flow, strips of the beach which were flooded in July became exposed. Radioactive materials which were deposited on the beach as the water receded resulted in higher dose rates in October. As shown in Table 1 some measurements with the portable GM instruments were as high as 5,000 counts per minute. The maximum value obtained with the 40-liter chamber was 1.1 mr/hr (Table 3).

Measurements made with the "pencils" at ground level were in the range of 0.06 to 0.21 mr/hr (Table 2) which was not significantly higher than found in July. Where the "pencils" were submerged in the river water, however, the dose rate in October was about twice that found during July, as would be expected because of the higher concentration of contaminants at the lower river flow.

The measurements made with the 40-liter chamber during October are plotted in Figure 9. As in the case of the July survey, there was considerable variability in the data with no appreciable decline in dose rate through this twelve-mile stretch of the river.

March Survey

This survey was conducted to estimate the radiological status of the Ringold - 300 Area section of the river at the start of the outdoor recreational

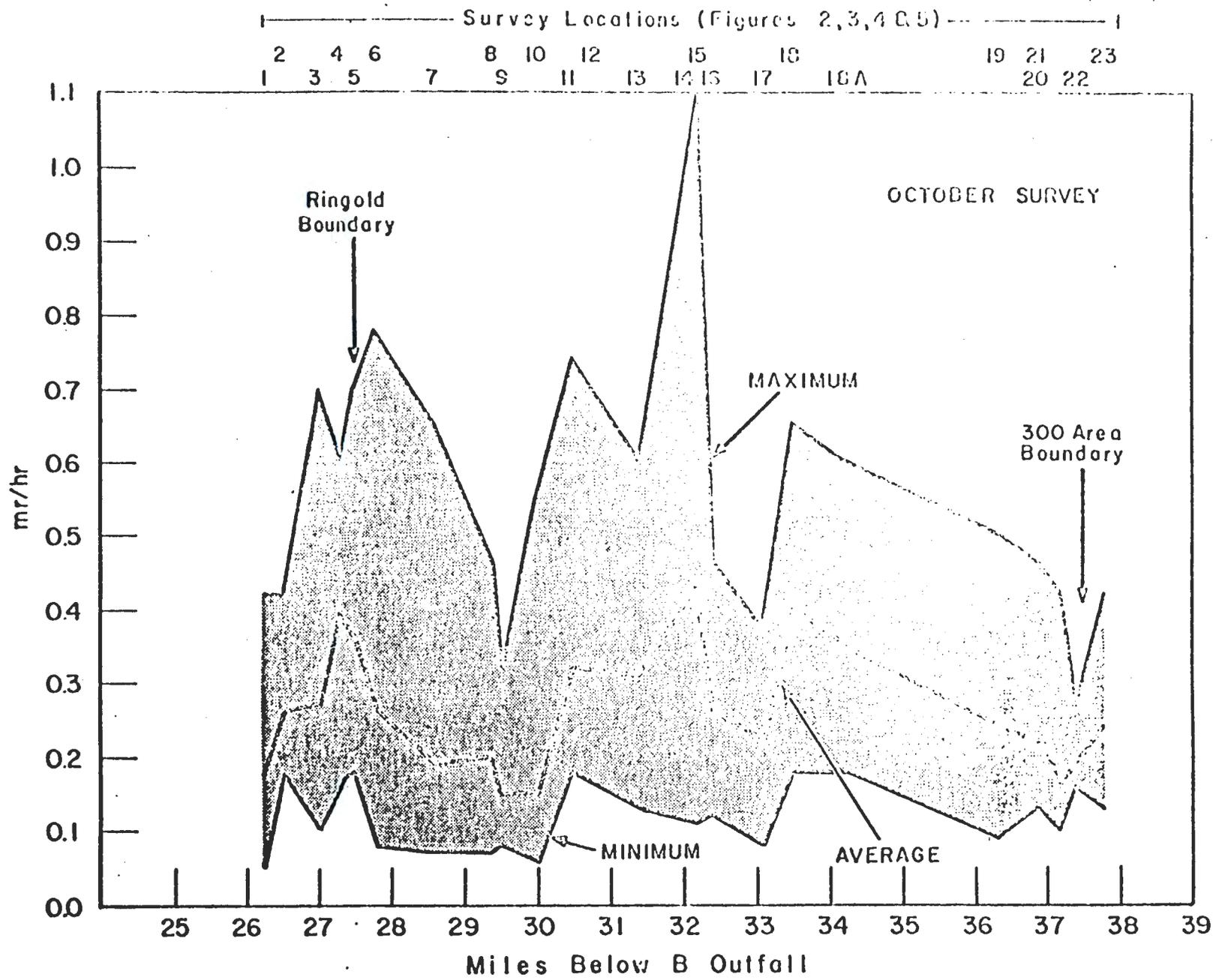


FIGURE 9

Comparison of Dose Rates at Various Survey Locations, October, 1961

season, and to extend the survey area to Richland. The measurements taken with the 40-liter chamber and portable GM instruments are presented in Table 4. On the average, the results indicate no substantial increase in dose rate or contamination over the October results at the locations surveyed. The dose rates measured at survey locations 24 to 33 are not significantly different from those previously measured in the vicinity of Richland. (3) (4)

During the July and October surveys, it was noted that at all of the survey locations, the highest dose rates were invariably found on the portion of the beach closest to the water line. This is due to the daily fluctuations in river flow which causes the freshest contaminants to be deposited at the water's edge. Radioactive decay of the older contamination inland results in lower dose rates.

Samples of sand were collected by the water's edge at five locations and analyzed by gamma spectroscopy for the major radionuclides. The results are given in Table 5. The spectrum of gamma emitters observed in each sample decayed with a half-life varying from two to seven days.

CONCLUSIONS

For conditions similar to those which existed during 1961 and early 1962, the average dose rate which may be expected to prevail on beaches and islands of the Columbia River between Ringold and Richland is about 0.2 mr/hr during mid-summer and 0.3 mr/hr in spring and late summer. Swimmers would receive between 0.05 and 0.1 mr/hr while in the water at times when the river flow was on the order of 175,000 cfs and about twice this amount late in the season when the flow has dropped to about 50,000 cfs. Persons in boats would receive exposure at a rate less than half that received by swimmers.

TABLE 4SUMMARY OF DATA OBTAINED DURING THE MARCH SURVEY

<u>Location</u> <u>Piro. 2-6</u>	<u>40-liter chamber - m³/hr</u>			<u>REM Instrument - c/m</u>		
	<u>Average</u>	<u>Maximum</u>	<u>Minimum</u>	<u>Average</u>	<u>Maximum</u>	<u>Minimum</u>
3	0.61	1.1	0.12	500	5000	200
5	0.64	1.1	0.17	1000	2500	550
7	0.27	0.65	0.10	1000	7500	250
13	0.19	0.28	0.15	300	400	250
18	0.43	0.55	0.22	1000	4500	400
19	0.27	0.42	0.16	500	5000	250
23	0.12	0.20	0.09	300	700	250
24	0.20	0.42	0.10	400	3500	150
25	0.22	0.37	0.10	350	2500	150
26	0.16	0.24	0.10	300	4000	200
27	0.14	0.26	0.08	300	800	150
28	0.25	0.42	0.10	450	2000	150
29	0.18	0.26	0.09	400	700	150
30	0.09	0.16	0.05	200	350	150
31	0.33	0.70	0.12	500	3000	200
32	0.20	0.32	0.10	400	3000	200
33	0.19	0.27	0.13	250	850	200

TABLE 5

SPECTRUM OF ISOTOPES DETECTED IN SAND SAMPLES
COLLECTED DURING MARCH, 1962

10^{-6} uc/g

<u>Isotope</u>	<u>Location 5</u>	<u>Location 7</u>	<u>Location 18</u>	<u>Location 19</u>	<u>Location 27</u>
Na ²⁴	1.6	5.9	2.5	2.9	-
Sr ⁹⁰	38	110	61	17	10
La ¹⁴⁰	130	130	70	27	26
Ba-La ¹⁴⁰	53	90	58	19	9.7
Co ⁶⁰	13	24	21	69	5.6
Cr ⁵¹	380	820	660	170	100
Cs ¹³⁷	51	110	92	27	19
Kp ⁴⁰	150	250	140	61	54
Zn ⁶⁵	310	880	610	210	170

There was considerable variability in the dose rate between different locations which, from a practical standpoint, negates any minor decrease which might be expected with distance downriver. Even though an appreciable fraction of the radiation measured in the water originates from short-lived gamma emitters, the time required for the water to travel through this twelve-mile section of the river is only about three and one-half hours. Radioactive decay is thus of comparatively minor importance. The dose rates measured in the Ringold to 300 Area section were not sufficiently different from those measured in the vicinity of Richland to warrant the conclusion that significantly greater exposures would result from recreational use of the river upstream to Ringold.

In comparison with the dose rates of 0.05 to 0.2 mr/hr measured at a height of three feet above the beaches, similar measurements over land near the center of the Hanford reservation are in the range of 0.01 to 0.02 mr/hr.⁽⁴⁾

ABSTRACT

Radioactive materials released with the effluent of the Hanford production reactors can provide measurable radiation exposure to persons who use the river downstream. Dose rates measured on beaches in the Ringold to 300 Area section of the river were in the range of 0.05 to 1.1 mr/hr with maximum values near the water's edge. Dose rates in the water were in the range of 0.05 to 0.2 mr/hr. March and October values, obtained at a river flow of 50,000 cfs and 60,000 cfs, respectively, were about twice those observed in July at a river flow of 175,000 cfs. In general, the levels of contamination found in the Ringold to 300 Area section were not appreciably different from those which exist in the vicinity of Richland where the river is now used extensively for recreational purposes.

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