
**Radiological Survey of Exposed
Shorelines and Islands of the
Columbia River Between Vernita
and the Snake River Confluence**

M. J. Sula

April 1980

**Prepared for the U.S. Department of Energy
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**Pacific Northwest Laboratory
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RADIOLOGICAL SURVEY OF EXPOSED SHORELINES
AND ISLANDS OF THE COLUMBIA RIVER BETWEEN
VERNITA AND THE SNAKE RIVER CONFLUENCE

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SUMMARY

This document describes a radiological survey which was performed to evaluate the magnitude and distribution of radioactive contamination on the exposed shorelines of the Columbia River along and downstream of the Hanford Site. The area encompassed by the survey includes the low-lying exposed land on both sides of the river from the uppermost point of production reactor discharge into the river at 100-B Area to the confluence of the Snake and Columbia Rivers, almost 60 miles downstream of the starting point. External exposure rate measurements were made at nearly 30,000 locations during the survey - accounting for approximately 60% of the land in the study area.

Measurable radioactive contamination, resulting from past Hanford operations was found to be present on the shorelines of the Columbia River along the study area. The absence of short-lived radionuclides in the shore sediments and the presence of contamination several meters above recent maximum river levels indicate that the material was deposited some years ago.

Contamination on the exposed island and shoreline areas was found to be present in three different distributions:

- 1) A fairly constant, uniformly distributed layer of contamination was observed over the entire study area. The average exposure rate over the survey area measured 11 ± 3 $\mu\text{R/hr}$ compared to a background exposure rate measured along the shoreline upstream of the Hanford project of 7 ± 1 $\mu\text{R/hr}$.
- 2) Ninety-two areas were located in which exposure rate readings exceeded 25 $\mu\text{R/hr}$. These areas of increased radiation levels are attributed to contaminated sediments that have been concentrated in some places by river action and are referred to as "contamination deposits." The areas ranged in size from a few square meters to several thousand square meters and were usually found in areas of dense vegetation. Areas found to contain the highest levels of river-deposited contamination were the White Bluffs Slough area, where exposure rates reached 40 $\mu\text{R/hr}$; the Hanford Townsite Peninsula, in which an area reading 45 $\mu\text{R/hr}$ was identified, and Island-344 near the 300 Area which read 38 $\mu\text{R/hr}$. The

remaining "contamination deposits" were in the 25-30 $\mu\text{R/hr}$ range and appeared to be evenly distributed over the survey area. (Higher exposure rates were measured during the survey along the production reactor areas, but were attributed to radioactive material contained in the production reactor facilities and not to river-deposited contamination.) Samples of soil and vegetation taken at several sites along the river showed the "contamination deposits" to consist of a mixture of ^{60}Co , ^{137}Cs and ^{152}Eu in approximately equal proportions.

- 3) Discrete particles of contamination containing ^{60}Co were found along the river, usually in flat, rocky areas with little or no vegetation. The particles were observed to be metallic flakes, possibly fragments of stainless steel valve and pump components used in the production reactors. Fourteen of the particles were recovered. These particles were found at depths from 0-5" below the surface and contained from 1.7-24 μCi of ^{60}Co activity.

External dose rates from the uniformly distributed contamination and the "contamination deposit" types of contamination are below applicable external radiation protection dose limits for uncontrolled areas. Based on past surveys of river usage, the maximum individual has been established as a member of the public who spends 500 hours per year on the shore of the river. Were that individual to spend the entire 500 hours at the highest measured contamination deposit location (45 $\mu\text{R/hr}$), the resulting whole body dose would be about 20 mrem above the approximately 100 mrem which would normally be received during a year by a local resident due solely to naturally-occurring radiations.

The discrete particles present a somewhat different situation, radiologically. In the event of direct contact with a small source, the beta radiations and the extreme nonuniformity of the radiation field in the exposed tissues become the primary considerations. In such a situation, the usual dose-response relationships become invalid; and in fact, the effectiveness of the radiation in producing damage in the organism is significantly reduced. Although no definite statements can be made without additional data, currently available information on the particle sizes and activities suggest that deleterious health effects due to the particles are most unlikely.

CONTENTS

SUMMARY	v
INTRODUCTION	1
HISTORICAL OVERVIEW	3
PRESENT SURVEY	7
SURVEY AND MEASUREMENT METHODS	9
Survey Locations	9
Survey Techniques	9
Formal Grid Survey	9
Informal Grid Survey	19
Shoreline Track Survey	19
General Survey	21
Measurements	21
RESULTS AND DISCUSSION	23
General	23
Uniformly Distributed Contamination	31
Contamination Deposits	31
Discrete Particulate Contamination	35
Comparison With Aerial Radiological Surveys (ARMS)	38
CONCLUSIONS	39
ACKNOWLEDGMENTS	40
REFERENCES	41
APPENDIX A - DATA - ISLANDS AND BROAD SHORELINES	A.1
APPENDIX B - DATA - NARROW SHORELINES	B.1
APPENDIX C - RADIOLOGICAL SURVEY OF D-ISLAND	C.1
APPENDIX D - FIELD CALIBRATION OF SURVEY INSTRUMENT	D.1
APPENDIX E - ANALYSIS OF DISCRETE PARTICLES	E.1

FIGURES

1	History of Production Reactor Operation at Hanford	1
2	Typical Radionuclide Composition in Surface Sediments Behind McNary Dam	5
3	Hanford Site Showing Columbia River Shoreline and Islands Included in 1979 Survey	8
4	Surveyed Areas from Vernita Bridge to 100-B Area	10
5	Surveyed Areas from 100-B to 100-D Area	11
6	Surveyed Areas from 100-D to 100-F Area	12
7	Surveyed Areas from 100-F Area to Hanford Townsite	13
8	Surveyed Areas from Hanford Townsite to Ringold	14
9	Surveyed Areas from Ringold to Island 347	15
10	Surveyed Areas from Island 347 to Richland	16
11	Surveyed Areas from Richland to Kennewick	17
12	Surveyed Areas of Kennewick and Pasco	18
13	Surveying for Discrete ⁶⁰ Co Particles	20
14	Distribution of River Deposited Contamination on Exposed Shorelines and Islands	30
15	Exposure Rate Due to Uniformly Deposited Contamination over Exposed Shorelines and Islands ($7 \pm 1 \mu\text{R/hr}$ background)	32

TABLES

1	Shoreline Exposure Rate 1968-1974	3
2	Summary of Survey Data: Island and Broad Shorelines	24
3	Summary of Survey Data: Narrow Shorelines	28
4	Concentrations of Man-Made Long-Lived Radionuclides in Soil and Vegetation Samples Collected Along the Columbia River Shoreline	33
5	Discrete ⁶⁰ Co Particles Recovered from Island-377 (D-Island) and Island-355 (Ringold)	37

5012

5013

3

1600	11
1700	12
1800	11
1900	12
2000	11
2100	11
2200	11
2300	11
2400	12
2500	12
2600	13
2700	12
2800	13
2900	13
3000	14
3100	13

$$3.4 \text{ cm} = 800 \text{ m}$$

$$1 \text{ cm} = 235.3 \text{ m}$$

- across from 100 h bar

-

INTRODUCTION

As a result of plutonium production operations at Hanford, large quantities of radioactive material were discharged into the Columbia River. This discharge began in 1944 upon startup of the first of nine production reactors (Figure 1). Eight of the reactors used Columbia River water as a coolant. The water was withdrawn from the river, circulated through the reactor core and, after a few hours holdup time in a retention basin, returned to the river. During passage through the reactor, the cooling water picked up loose debris including radioactive products of corrosion processes within the reactor and small fragments of reactor fuel elements which had failed while in service. Upon discharge to the river, the radioactive material was rapidly dispersed in the river water (Columbia River flowrate averages approximately $2800 \text{ m}^3/\text{s}$) and sorbed onto detritus and inorganic particles, incorporated into the aquatic biota, or in the case of larger particles of insoluble material, deposited on the river bed. (1, 2)

In the years following its deposition on river sediments, periodic increases in river flowrate, caused by operation of large hydroelectric plants

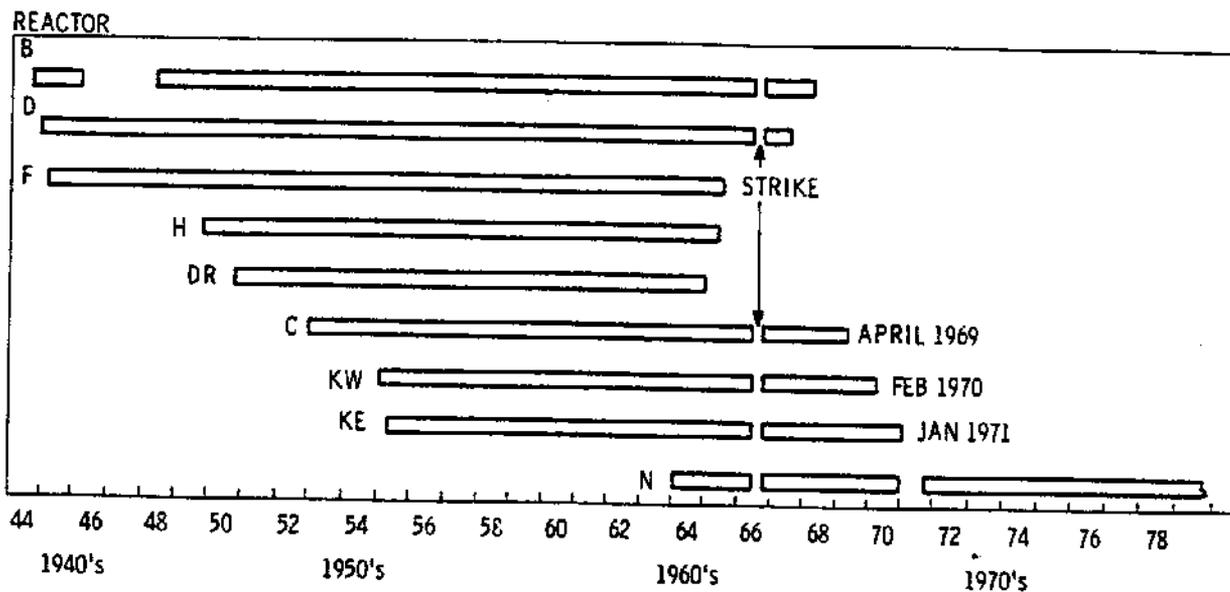


FIGURE 1. History of Production Reactor Operation at Hanford

upstream and downstream of the Hanford site, annual spring freshets, and occasional floods have resulted in the resuspension and subsequent deposition of some of the insoluble radioactive material on river shoreline areas above the current normal river water level. Following the closure in 1971 of the last operating single-pass production reactor (KE), the discharge of radioactive material into the river from plutonium production operations at Hanford decreased to relatively insignificant levels. (The only production reactor which remained in operation, N-Reactor, does not use the single-pass cooling system, but instead uses a closed loop circulating system with system bleeds discharged to radioactive waste treatment facilities.)

Since 1971, the radionuclide burden of the sediments and exposed shoreline areas of the Columbia River downstream of the production reactor sites has been decreasing as the radioactive material deposited in these areas decay. Short-lived radionuclides, which during operation of the single-pass reactors accounted for the majority of the radiation exposure due to the deposited contamination, have since decayed to negligible levels. Radiation exposure levels above background along the shorelines are currently due to a few remaining long-lived radionuclides and unless large increases in river flow-rate in the future result in the redistribution of contamination along exposed shoreline areas, the quantity of deposited radioactive contamination is expected to continue to decrease at a rate characteristic of the half-life of the mixture of remaining radionuclides.

This document describes a radiological survey to evaluate the magnitude and distribution of radioactive contamination on the exposed shorelines of the Columbia River along and downstream of the Hanford Site. Areas considered in the survey include the riverbank, broad flood plains, low lying peninsulas, sloughs and islands from the uppermost point of production reactor discharge at 100-B Area to the confluence of the Snake and Columbia Rivers.

HISTORICAL OVERVIEW

Several radiological surveys of shorelines and islands of the Columbia River have been performed in the past.⁽³⁻⁸⁾ This has included ground surveys, aerial surveys, and soil/sediment analysis. Most of the ground survey work was conducted during operation of the single-pass reactors using G-M survey instruments. The results of these surveys were influenced by immediate reactor operating conditions and river level fluctuations, since many of the higher levels of contamination encountered were due to short-lived radionuclides which had been deposited shortly before the survey.

The decrease in shoreline activity that followed shutdown of the production reactors is shown by routine measurements taken during 1968-1975 (Table 1) at two locations downstream and one location upstream of Hanford.⁽⁹⁻¹³⁾ The exposure rates in Table 1 represent an average of several readings taken during the year at the specified location, one meter above the ground and one meter from the edge of the water.

TABLE 1. Shoreline Exposure Rate 1968-1975

Year	Exposure Rate (μ R/hr)		
	<u>Richland</u>	<u>Sacajawea Park</u>	<u>Vernita Bridge</u> ^(a)
1968	46	28	NR ^(b)
1969	30	25	NR ^(b)
1970	18	22	NR ^(b)
1971	13	13	NR ^(b)
1972	10	11	10
1973	11	12	10
1974	11	11	10
1975	12	13	9

(a) Upstream of Hanford Project - represents natural background radiation levels

(b) NR - Not Reported

In 1976, a more intensive routine shoreline monitoring program was instituted. Thermoluminescent dosimeters (TLD's) were placed at 10 sites along the Hanford shoreline from 100-K Area to Wooded Island.⁽¹³⁾ The dosimeters are changed monthly and results are summarized each year in the Hanford Environmental Surveillance Report. Data from the Environmental Reports for the years 1976-1978 show no discernable trends in shoreline contamination level.⁽¹⁴⁻¹⁶⁾

Aerial surveys of Columbia River shoreline and island areas were performed during 1973-1974 and again in 1978 by EG&G Inc. of Las Vegas, using the Aerial Radiological Monitoring System (ARMS).⁽¹⁷⁾ The surveys covered an area from approximately four km above the Vernita Bridge to approximately 10 km below the confluence of the Snake River with the Columbia River. An additional 20 km downstream of McNary Dam was also surveyed. The surveys were conducted using an array of NaI detectors mounted on a helicopter. Results were reported in terms of net exposure rate above background for ^{60}Co and, where detected, ^{137}Cs . (The average background exposure rate measured in the vicinity of the Hanford Site by the aerial survey was $10 \mu\text{R/hr}$).⁽¹⁷⁾

The highest shoreline activities were observed along the H-Area Slough and on the Hanford Townsite Peninsula. Radiation levels above background up to $14 \mu\text{R/hr}$ from ^{60}Co (corrected to one-meter above surface) and $3 \mu\text{R/hr}$ from ^{137}Cs were measured in the H-Area Slough. Levels up to $22 \mu\text{R/hr}$ from ^{60}Co and $1 \mu\text{R/hr}$ from ^{137}Cs were measured on the Hanford Townsite Peninsula. The highest radiation levels observed on islands occurred in the Ringold area where maximum readings in the range of $9-14 \mu\text{R/hr}$ ^{60}Co were obtained. No ^{137}Cs activity was detected in this area.

Following the 1973-1974 aerial survey, samples of sand were taken from several of the areas along the river reported to have higher radiation levels. Analysis showed that the most prominent radionuclide in the sand was ^{60}Co , along with measurable levels of ^{54}Mn , $^{152-154}\text{Eu}$, ^{65}Zn , $^{106}\text{RuRh}$, and ^{137}Cs .⁽¹¹⁻¹²⁾ These radionuclides appeared to be uniformly distributed in the sand. However, during collection of these sands, seven discrete particles containing only ^{60}Co contamination were found buried 2.5-10 cm (1-4") below the surface.

In 1976, samples of surface sediments in the Columbia River were analyzed to determine both the natural and man-made radionuclide composition. An example of a typical distribution based on samples taken behind McNary Dam (decay corrected to the present) is shown in Figure 2.⁽¹⁾ Since the contamination along the shorelines is considered to be from the same source, the distribution of radionuclides is expected to be similar.

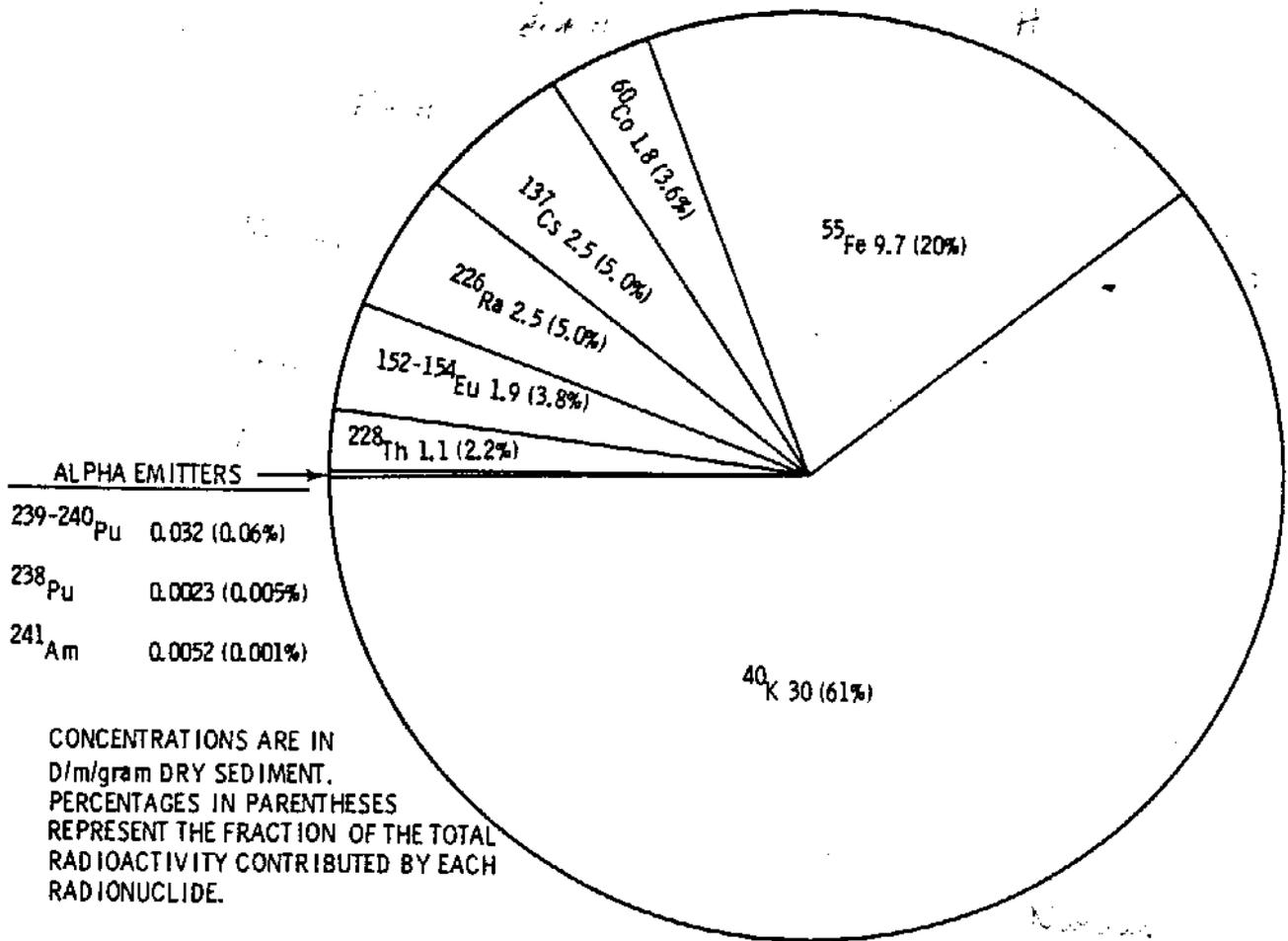


FIGURE 2. Typical Radionuclide Composition in Surface Sediments Behind McNary Dam

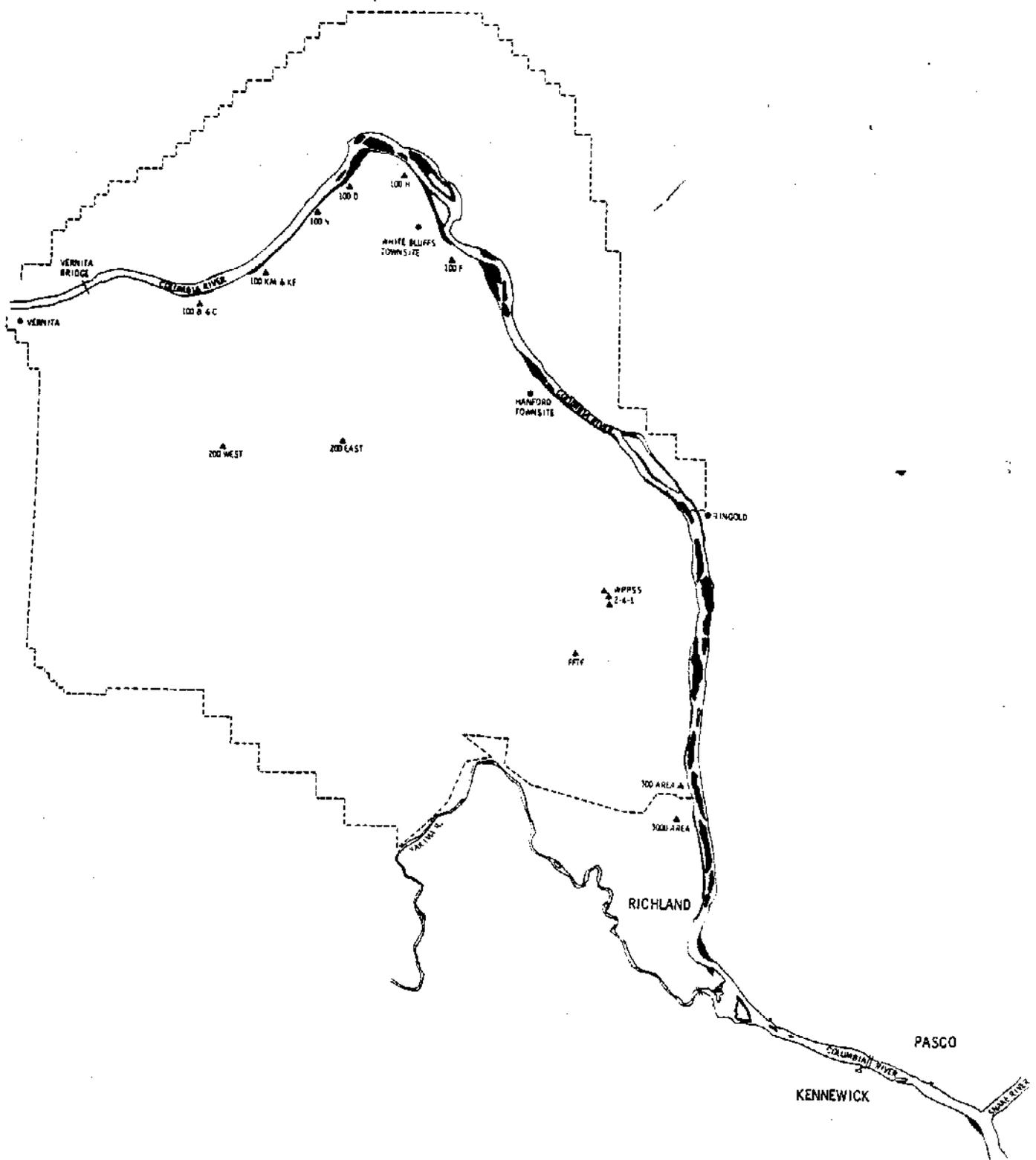


FIGURE 3. Hanford Site Showing Columbia River Shoreline and Islands Included in 1979 Survey (Darkened areas were surveyed. See Figures 4 through 12.)

PRESENT SURVEY

In June 1979, funding was provided to perform a comprehensive ground based survey of islands and shorelines along the Columbia River to determine the status and extent of existing radiation levels and contamination in areas above the water level. Such a comprehensive ground survey of all of these areas had not been performed since the shutdown of the last of the single-pass production reactors in January 1971.

This survey was performed during the period May 13 - July 9, 1979 and included the river islands and shorelines shown in Figure 3 with the exception of Island-377 (across from D-Area), which was surveyed in October 1978, Island-345 (North of the 300 Area), which was surveyed in April 1979, and the Coyote Rapids Peninsula, which was surveyed in August 1979.

It was not physically possible to take exposure rate readings over the entire area under consideration. Therefore, selected locations were chosen based upon results of the 1974 and 1978 ARMS surveys and on the anticipated use of the area by the public (e.g., hunting, fishing, boating, picnicking, and exploring). The ARMS reports (the 1978 report is expected to be issued in mid-1980) provide the best information concerning the contamination status of islands and shoreline areas not specifically covered in this report.

This survey provides a characterization of the external radiation environment only. Contamination found along the river is expressed in terms of $\mu\text{R/hr}$ at one-meter above the ground. Using this approach to specify contamination levels allows direct comparison with external radiation measurements taken elsewhere, and with standards for allowable external radiation levels in uncontrolled areas.

SURVEY AND MEASUREMENT METHODS

Survey Locations

Areas were chosen for survey based upon the anticipated presence of contamination using the 1974 Aerial Radiological Survey Report⁽¹⁷⁾ and preliminary 1978 Aerial Survey data. In addition, several other areas were surveyed based upon their frequent use by the public. These areas include several small beaches north of Richland, Two Rivers Park, Bateman Island, Ringold Sand Dunes, and portions of the Richland shoreline. An exploratory survey was performed along the shoreline of the Columbia River Park; however, there was no indication of the presence of elevated contamination levels and as a result a formal survey was not performed.

Areas which were surveyed are enclosed within the dotted lines in Figures 4-12. Appendix A and B provide descriptions of starting and stopping places for the river shoreline surveys and also provides maps of land areas surveyed using the grid system.

Survey Techniques

All surveys were conducted on foot using portable low-level gamma radiation detectors. The procedure for recording contamination levels remained constant throughout the course of the survey; however, the degree of survey coverage provided for individual areas varied depending on several factors including; the size of the area, anticipated contamination levels, type of area including location and geographical features, and manpower scheduling constraints. Whenever possible, a formal grid was established for the area to insure uniform coverage and to enable relocation of survey points at some time in the future if desired.

Formal Grid Survey

The formal grid was laid out by first establishing a reference point. This location was permanently marked by a 5-cm diameter pipe driven into the ground. Grid points were then established at 90-meter spacings (except for Island-345 for which the spacing was 15 meters). Maps of the gridded areas are included in Appendix B. The grids were oriented from the reference point



FIGURE 4. Surveyed Areas from Vernita Bridge to 100-B Area

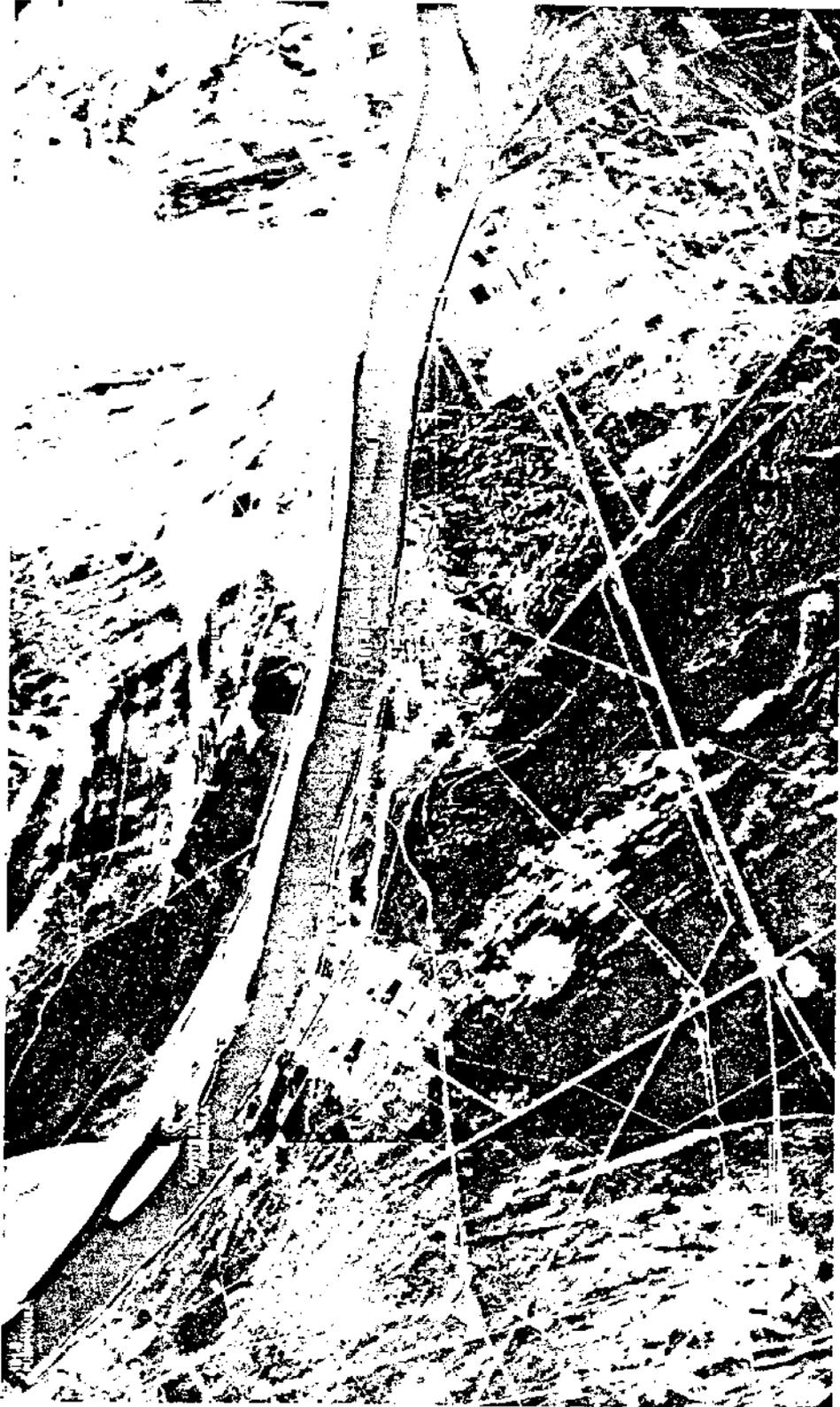


FIGURE 5. Surveyed Areas from 100-B to 100-D Area



FIGURE 6. Surveyed Areas from 100-D to 100-F Area

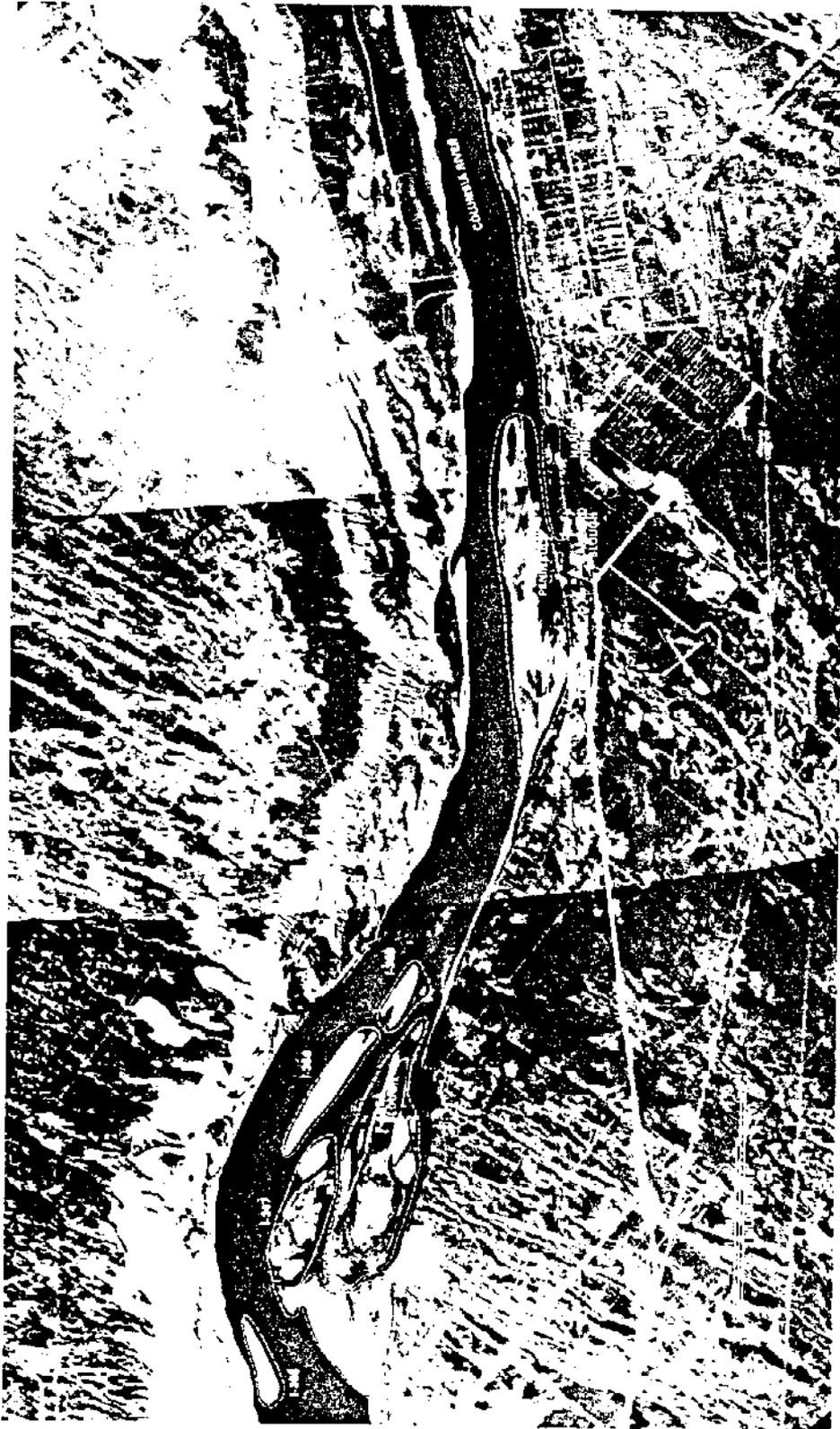


FIGURE 7. Surveyed Areas from 100-F Area to Hanford Townsite



FIGURE 8. Surveyed Areas from Hanford Townsite to Ringold

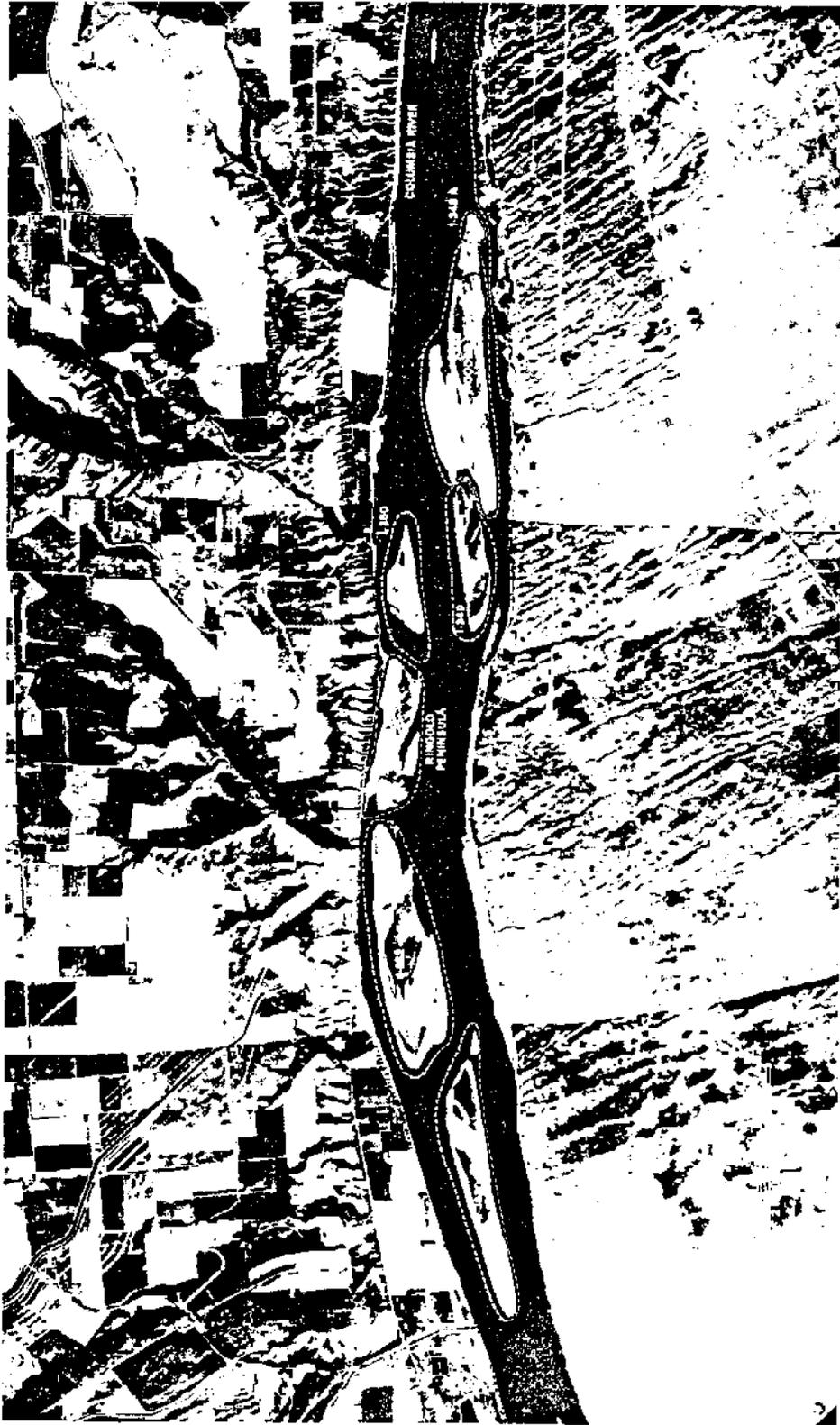


FIGURE 9. Surveyed Areas from Ringold to Island 347



FIGURE 10. Surveyed Areas from Island 347 to Richland



FIGURE 11. Surveyed Areas from Richland to Kennewick



FIGURE 12. Surveyed Areas of Kennewick and Pasco



FIGURE 13. Surveying for Discrete ^{60}Co Particles

by either a compass bearing or a second reference point as shown on the maps. With the exception of the surveys conducted on Islands 375 and 345, gridded areas were surveyed by locating each grid point and arbitrarily choosing three 3 m x 3 m (10' x 10') survey plots within a circle of approximately 30 meters radius from the grid point. On Island 375, the grid points were used to mark corners of 90 m x 90 m sections within which three 3 m x 3 m survey plots were arbitrarily chosen and on Island 345, a .6 m x .6 m (2' x 2') plot was surveyed at each grid point. Two readings were taken for each survey plot: the maximum exposure rate at one-meter above the ground and the maximum ground surface exposure rate (Figure 13). The ground exposure rate was not reported in the data Appendix unless it differed significantly from the reading taken at one-meter (i.e., a discrete radioactive particle was located).

Informal Grid Survey

An informal grid was used when a systematic method was necessary to assure uniform coverage of an area, but a formal grid could not be established (due to time constraints). Methods of establishing informal grids varied from location to location, but assured that coverage was at least as equivalent as that provided by a formal grid, that the survey plots were evenly distributed over the area, and that shoreline areas received special consideration. The informal grid was most often used for long, narrow islands.

Shoreline Track Survey

The shoreline track survey method was applied to river shoreline surveys where the shorelines were narrow (i.e., all areas except for large low lying shoreline regions on floodplains and peninsulas which were surveyed using the grid method). The shoreline survey usually consisted of three tracks running parallel to the shoreline. Surveys were made on .6 m x .6 m (2' x 2') plots at 15-meter intervals along each track. At each plot, two survey instrument readings were obtained just as in the grid survey. Track 1 was always located closest to the water's edge along a path midway between the water's edge and the daily high water mark. Tracks 2 and 3 were spaced 15-meters and 30-meters, respectively, inland from the track 1 path.

General Survey

General surveys were conducted on very small islands and peninsulas and on the beach areas. The surveys were performed using 3 m x 3 m (10' x 10') survey plots randomly distributed over the area.

Measurements

Field contamination measurements were made using a portable Ludlum micro-R meter Model 12S survey instrument. The micro-R meter is a small hand-held, battery powered device incorporating a 2.5 cm x 2.5 cm NaI(Tl) crystal to detect gamma radiation emitted by the radioactive contamination. The instrument readout is in units of $\mu\text{R/hr}$ based on laboratory calibration using a Ra-226 source. The surveys were performed by the Environmental Monitoring personnel of the Pacific Northwest Laboratory (PNL).

Maintenance and calibration checks were performed throughout the survey by the Instrument Calibrations and Evaluations group at PNL. Calibration and maintenance records are maintained by calibrations personnel. Prior to use each day, each instrument was given an informal battery and background check by the Monitoring personnel.

During the survey, it became apparent that the survey instruments were sensitive to small changes in battery charge, in that during a survey, a gradual decrease in the efficiency of the detector was observed as the batteries weakened. The maximum change in instrument efficiency observed during a survey was 50%; however, in most cases efficiency changes were of the order of only a few percent. This did not affect the capability of the instrument to respond to increases in radiation level associated with the presence of a contamination deposit or discrete particle, although in some cases it caused the instrument reading to be biased low.

The survey instruments were found to be highly sensitive to the low-energy gamma radiations resulting from the scatter of the higher energy source emissions from the contamination with nearby objects such as rocks, vegetation, and the instrument user. A correction factor was established to account for the gamma energy distribution encountered under field conditions

using a Reuter Stokes ionization chamber as the reference. Procedures and results are described in Appendix D. (The field calibration was performed after the survey had begun. All data reported in Appendix A and B were taken directly from the survey instrument without application of the field calibration correction factor.)

RESULTS AND DISCUSSION

GENERAL

A total of nearly 30,000 individual measurements were made during the performance of the survey. It is estimated that 21 million square meters of land, or approximately 60% of the affected area between B-Area and Two Rivers Park in Finley, ^{were} ~~was~~ accounted for by the survey. In all, 64 km (40 miles) of shoreline and 26 islands were surveyed.

Data obtained during the survey are presented in Appendix A for surveys made on islands, peninsulas, sloughs, and flood plains; and in Appendix B for shoreline surveys. This data is summarized in Tables 2 and 3.

Contamination found along the Columbia River shoreline and island areas can be categorized as one of three types with respect to its distribution: 1) "discrete particles" of ^{60}Co contamination, 2) "contamination deposits"; i.e., regions of varying size with contamination levels significantly higher than adjacent areas and 3) a uniform layer of contamination deposited over a large area. For the purpose of definition, the term "discrete particle" was applied to contamination in which the radiation appeared to be emitted by a point source (i.e., the instrument reading would decrease rapidly as the instrument was moved away from the apparent source). Areas designated as "contamination deposits" refer to regions in which the measured exposure rate at one-meter above the ground exceeded an arbitrarily chosen value of 25 $\mu\text{R/hr}$. The level of uniformly distributed contamination is expressed in the tables by the average^(a) of the individual exposure rate readings taken at one-meter

(a) In computing the average exposure rate for island, slough, peninsula, and floodplain areas, all individual survey measurements were included. For shoreline regions, in which the survey was performed by walking tracks parallel to the shoreline, a biased average was used. The biased average was calculated by considering only the maximum of the three instrument readings (one for each track) at a particular location along the shoreline in the calculation of the average exposure rate. The biased average exposure rate was intended to prevent data recorded at survey points located high on the river bluff which had not been exposed to contamination-bearing river water and hence, not a member of the population under study, from being included in the calculation of an average exposure rate for that population. It was frequently the case during the survey, that the river bluff would closely approach the shoreline such that two tracks would be on the bluff, well above the river. This technique results in a slight overestimation of the average exposure rate.

TABLE 2. Summary of Survey Data: Island and Broad Shorelines

Survey Area	Exposure Rate, $\mu\text{R/hr}$ (a) 1 Meter Above Ground		Number 3m x 3m Survey Plots	Number Discrete Particles Found	Particle/ m^2	Location with Elevated Readings(b) (>25 $\mu\text{R/hr}$ @ 1 Meter Above Ground [max $\mu\text{R/hr}$; location; terrain]
	Average $\pm \sigma$	Maximum				
Coyote Rapids Pen.	6 \pm 1	9	34	0		
Island-377 (D-Island)(c)	9 \pm 1	125	14	7	5.4 x 10 ⁻²	(d) 1 25; At Vent Pipes
D-Area Floodplain	12 \pm 4	23	298	1	3.7 x 10 ⁻⁴	
Island-376	10 \pm 3	25	25	9	3.9 x 10 ⁻²	2 25; Interior of down-stream half; rocky, no vegetation
Island-375	9 \pm 3	19	210	30	1.5 x 10 ⁻²	
Island-373 A	15 \pm 3	25	6	1	1.8 x 10 ⁻²	3 25; upstream half of island just above daily high water mark; rocky, sparse vegetation - particles found nearby
Island-373 B	11 \pm 2	25	21	2	1.0 x 10 ⁻²	4 25; Near downstream end of island; rocky, no vegetation, particles found nearby
Upper Island-372 (Locke I)	11 \pm 4	25	142	8	6.0 x 10 ⁻³	5 25; Grid section 3C; Rocky 6 25; Grid section 8C; Rocky 7 25; Grid section 9C; Rocky
Lower Island-372 (Locke I)	12 \pm 2	18	462	4	9.4 x 10 ⁻⁴	
White Bluffs Slough	15 \pm 4	40	219	2	9.8 x 10 ⁻⁴	8 29; Grid section 4A; Cheatgrass 9 28; Grid section 5A; Cheatgrass 10 25; Grid section 6A; Cheatgrass 11 40; Grid section 22A; Low, grassy area 12 38; Grid section 23A; Low grassy area 13 26; Grid section 68; Grass and dirt 14 25; Grid section 10B; Rocky 15 25; Grid section 11B; Rocky 16 25; Grid section 17B; Rocky 17 25; Grid section 20; Rocky 18 25; Grid section 40; Rocky 19 28; Grid section 50; Rocky
Island-368	9 \pm 2	13	62	6	1.0 x 10 ⁻²	
F-Area Floodplain	11 \pm 4	31	225	10	4.7 x 10 ⁻³	20 25; Grid section 3I; Grassy 21 31; Grid section 11J; Rocky with grass; 2 particles found nearby

TABLE 2. Summary of Survey Data: Island and Broad Shorelines (contd)

Survey Area	Exposure Rate, $\mu\text{R/hr}$ (a) 1 Meter Above Ground		Number 3m x 3m Survey Plots	Number Discrete Particles Found	Particle/ m^2	Location, with Elevated Readings (b) ($>25 \mu\text{R/hr}$ @ 1 Meter Above Ground [max $\mu\text{R/hr}$; location; terrain]
	Average $\pm \sigma$	Maximum				
Hanford Townsite Pen.	12 ± 5	38	483	2	4.4×10^{-4}	<p>35: 25; Grid section 13E; Brushy</p> <p>36: 25; Grid section 14E; Brushy</p> <p>37: 25; Grid section 15E; Brushy</p> <p>38: 25; Grid section 16E; Brushy</p> <p>39: 25; Grid section 17E; Brushy</p> <p>40: 28; Grid section 18E; Brushy with willows</p> <p>41: 30; Grid section 19E; Brushy with willows</p> <p>42: 25; Grid section 26E; on shoreline, particles found at waters edge nearby</p> <p>43: 25; Grid section 13F; Rocky with medium vegetation</p> <p>44: 25; Grid section 14F; Dead trees nearby</p> <p>45: 38; Grid section 15F; Dead trees nearby</p> <p>46: 25; Grid section 20F; High vegetation</p> <p>47: 25; Grid section 21F; High vegetation</p> <p>48: 25; Grid section 16G; High vegetation</p>
Savage Island Slough (Upstream end)	14 ± 4	35	117	4	3.7×10^{-3}	49: 35; Grid section 3C; Rocks and weeds
Savage Island Slough (Gravel Bars)	11 ± 2	15	20	1	5.4×10^{-3}	-
Island-355 (Ringold I)	10 ± 2	25	153	13	3.9×10^{-3}	50: 25; On West bank, 550m S. of N. tip of Island near boat Landing beach; Rocky With low vegetation
Island-353	11 ± 2	20	253	8	3.4×10^{-3}	-
Island-352	10 ± 2	15	740	7	1.0×10^{-3}	-
Ringold Peninsula	11 ± 3	20	216	3	1.5×10^{-3}	-
Island-350	11 ± 2	18	202	12	6.5×10^{-3}	-
Island-349 (N. Wooded Island)	10 ± 3	15	129	0	-	-
Island-348 (S. Wooded Island)	12 ± 4	23	303	2	7.1×10^{-4}	-
Island 348 A	15 ± 3	23	34	2	6.4×10^{-3}	-

TABLE 2. Summary of Survey Data: Island and Broad Shorelines (contd)

Survey Area	Exposure Rate, $\mu\text{R/hr}$ (a)		Number 3m x 3m Survey Plots	Number Discrete Particles Found	Particle/ m^2	Location with Elevated Readings(b) ($>25 \mu\text{R/hr}$ @ 1 Meter Above Ground [max $\mu\text{R/hr}$; location; terrain]
	Average $\pm \sigma$	Maximum				
Island-367	13 \pm 3	25	181	13	7.8×10^{-3}	[22] 25; Region(3);-
Island-367 A	4 \pm 1	4	7	0	-	[23] 25; Region(3);-
F-Area Slough	11 \pm 4	26	725	8	1.2×10^{-3}	[24] 26; Interior of Region (1); - [25] 26; Region (1) near water; [26] 25; Region (2) near water; High vegetation [27] 25; Region (4); Grassy [28] 25; Region (4); Grassy [29] 28; Region (5), near shoreline, approx. 730m South of N.E. Corner; - [30] 28; Region (5), near shoreline, approx. 830m South of N.E. Corner; Grassy bank - particles found nearby [31] 25; Region (5), approx. 750m South of N.E. Corner and 15m above daily high water mark;- [32] 25; Region (5), approx. 830m South of N.E. Corner and 15m above daily high water mark;- [33] 28; Region (5), approx. 920m South of N.E. Corner and 15m above daily high water mark;- [34] 25; Region (5), approx. 920m counter clockwis from North Point, along shoreline;-
Island-366	10 \pm 3	18	153	15	1.1×10^{-2}	-
Island-365	10 \pm 1	13	38	2	5.7×10^{-3}	-

TABLE 2. Summary of Survey Data: Island and Broad Shorelines (contd)

Survey Area	Exposure Rate, $\mu R/hr$ ^(a) 1 Meter Above Ground		Number 3m x 3m Survey Plots	Number Discrete Particles Found	Particle/m ²	Location with Elevated Readings ^(b) (>25 $\mu R/hr$ @ 1 Meter Above Ground [max $\mu R/hr$; location; terrain]
	Average $\pm \sigma$	Maximum				
Island-345	13 \pm 5		736 ^(e)	0	-	<p>[51] 26; N.E. Quadrant, Track 1, 15m from Starting point; -</p> <p>[52] 26; N.E. Quadrant, Track 1, 30m from Starting point; -</p> <p>[53] 29; N.E. Quadrant, Track 1, 75m from Starting point; -</p> <p>[54] 26; N.E. Quadrant, Track 1, 150m from Starting point; -</p> <p>[55] 25; N.E. Quadrant, Track 1, 200m from Starting point</p> <p>[56] 26; S.W. Quadrant, Track 3, 170-210m</p> <p>[59] From starting point</p> <p>[60] 25; S.W. Quadrant, Track 5, 380-410m</p> <p>[61] From starting point</p>
Island-344	8 \pm 2	38	102	1	1.1 x 10 ⁻³	[62] 38; Section 20 on W. Side of Island; particles found nearby
Island-342 (Third Island) Beaches North of Richland	11 \pm 3 10 ^(f)	23 25	523 -	3 0	6.1 x 10 ⁻⁴ -	[63] 25; On upper reaches sandy beach on lower E. side of Third Is. Where black silty Material was deposited in Bands parallel to waters edge; -
Island-340	11 \pm 2	15	126	0	-	-
Island-339 (Nelson I)	15 \pm 5	24	102	2	2.2 x 10 ⁻³	-
Richland Marina	12 \pm 3	13	136	0	-	-
Columbia Pt., 4 WD-Track Area	11 \pm 2	15	24	0	-	-
Bateman Island Beaches	11 \pm 2	15	17	0	-	-
Island-333	13 \pm 5	38	50	1	2.2 x 10 ⁻³	[64] 38; S. side of Is., Approximately 30m From upstream end; Sandy with willows
Island-332	13 \pm 4	20	14	0	-	-
Two Rivers Park	11 \pm 3	18	22	1	5.0 x 10 ⁻³	-

- (a) Corrected for field calibration
 (b) Refer to maps in Appendix A to locate
 (c) Surveyed 10-30-79 (See Appendix C)
 (d) Numbers in correspond to further information in Appendix
 (e) Survey plots were 0.6 x 0.6m (2' x 2')
 (f) Complete coverage (plots not used)

TABLE 3. Summary of Survey Data: Narrow Shorelines

Survey Location	Exposure Rate, $\mu\text{R/hr}$ (a) 1 Meter Above Ground		Number of 0.6m x 0.6m (2' x 2') Survey Plots	Number of Discrete Particles Found	Particles/ m^2	Areas with Elevated Readings (c) (>25 $\mu\text{R/hr}$ 1 Meter Above Ground) [max $\mu\text{R/hr}$; length of deposit; location]
	Average Biased \pm	Maximum				
Vernita Bridge	7 \pm 1	7	30 ^(b)	0 ^(c)	-	
S-Area	9 \pm 2	125	135	0	-	1 125; 110m, below 107-B Retention basin
N-Area to K-Area	11 \pm 2	250	363	0	-	2 28; 60m; approx. 2km Upstream of starting point
N-Area to D-Area	8 \pm 2	380	612	0	-	3 250; 150m; below 107-K Retention basin 4 880; 1250m; Shine from reactor facilities. Region extends from starting point at 100-N outfall and extends downstream for 1250m. Levels increase as bank is climbed
D-Area to D-Floodplain	7 \pm 2	63	228	0	-	5 63; 60m; 730m downstream of starting point
H-Area	10 \pm 3	25	1229	4	8.8×10^{-3}	6 25; 15m; Approx. 1.8km downstream of 181-H 7 25; 30m; Approx. 310m downstream of sawed off telephone pole which is located approx. 3.4km downstream of 181-H Area. Higher activity appears to be associated with 3 particles found in this area. A fourth particle was found approx. 180m upstream
H-Slough to F-Area	11 \pm 4	30	306	0	-	8 30; 490m; Approx. 490m downstream of starting point 9 26; 150m; Just upstream of power line crossing

TABLE 3. Summary of Survey Data: Narrow Shorelines (contd)

Survey Location	Exposure Rate, $\mu\text{R/hr}$ (a) 1 Meter Above Ground		Number of 0.6m x 0.6m (2' x 2') Survey Plots	Number of Discrete Particles Found	Particles/ m^2	Areas with Elevated Readings (c) (>25 $\mu\text{R/hr}$ 1 Meter Above Ground) [max $\mu\text{R/hr}$; length of deposit; location]
	Average Biased \pm	Maximum				
Hanford Townsite Slough	12 \pm 3	24	219	0	-	-
Hanford Townsite	11 \pm 3	30	876	0	-	<p>10 28; 30m; Approx. 1530m downstream of starting point</p> <p>11 30; 140m; Approx. 1710m downstream of starting point</p> <p>12 28; 46m; Approx. 2450m downstream of starting point</p> <p>13 25; 46m; Approx. 2600m downstream of starting point</p> <p>14 30; 92m; Approx. 2750m downstream of starting point</p> <p>15 25; 30m; Approx. 3060m downstream of starting point</p> <p>16 29; 60m; Approx. 3500m downstream of starting point</p> <p>17 28; 60m; Approx. 3850m downstream of starting point</p> <p>18 25; 46m; Approx. 4130m downstream of starting point</p> <p>19 25; 30m; Approx. 4200m downstream of starting point</p>
Savage Island	11 \pm 2	24	441 ⁽²⁾	1	2.4 x 10 ⁻⁴	-
Ringold Sand Dunes	10 \pm 2	26	120 ⁽²⁾	0	-	<p>20 26; 240m; Approx. 670m downstream of starting point in thick grass</p> <p>21 25; 30m; Approx. 1530m downstream of starting point in sand dunes</p> <p>22 25; 30m; Approx. 1600m downstream of starting point in sand dunes and willows</p>
East Bank Across from Ringold Island	10 \pm 1	19	483	0	-	-
West Bank Across from Wooded Island - 1	12 \pm 3	26	582	0	-	<p>23 26; 110m; Approx. 795m upstream of starting point</p> <p>24 25; 15m; Approx. 2200m upstream of starting point</p>
West Bank Across from Wooded Island - 2	14 \pm 3	29	99	0	-	<p>25 29; 46m; Approx. 210m downstream of starting point</p>

TABLE 3. Summary of Survey Data: Narrow Shorelines (contd)

Survey Location	Exposure Rate, $\mu\text{R/hr}$ (a)		Number of 0.6m x 0.6m (2' x 2') Survey Plots	Number of Discrete Particles Found	Particles/m ²	Areas with Elevated Readings (c) (>25 $\mu\text{R/hr}$ 1 Meter Above Ground) [max $\mu\text{R/hr}$; length of deposit; location]
	Average Biased $\pm \sigma$	Maximum				
North of 300 Area	13 \pm 2	26	92	0 ^(c)	-	$\triangle 26$ 25; 15m; Approx. 370m upstream of starting point $\triangle 27$ 25; 15m; Approx. 460m upstream of starting point
North of Graduate Center	11 \pm 3	19	264	0	-	
North of Richland Pumpouse	11 \pm 4	25	171	0	-	$\triangle 28$ 25; 46m; Approx. 460m upstream of starting point
Saint to Snyder St. (Richland)	7 \pm 1	10	51	0	-	
Thomas to Park St. (Richland)	10 \pm 2	18	375	0	-	
East Shore Across from Hanford House	12 \pm 2	19	378	0	-	

- (a) Corrected for field calibration
- (b) Survey plots measured 3m x 3m
- (c) Appendix B
- (d) Numbers in \triangle correspond to further information in the Appendix

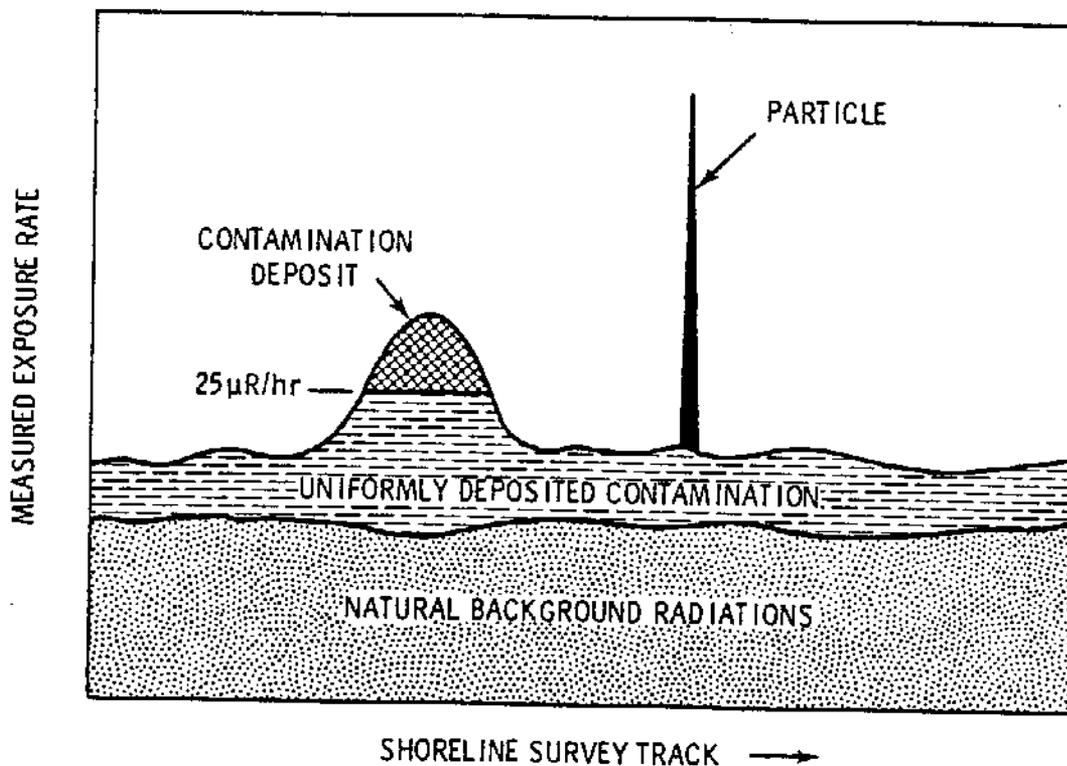


FIGURE 14. Distribution of River Deposited Contamination on Exposed Shorelines and Islands

above the ground within a designated survey area, but excluding any readings indicative of the presence of a "contamination deposit" or "discrete particle". Figure 14 pictorially represents the three categories of contamination reported in the tables.

UNIFORMLY DISTRIBUTED CONTAMINATION

The uniformly distributed layer of contamination appears to remain at a fairly constant level slightly above background over the stretch of exposed riverbank shoreline extending from B-Area to the endpoint of the survey at the Snake River confluence (see Figure 15). An average exposure rate for this stretch of the river based on the portable survey instrument readings is 11 ± 3 $\mu\text{R/hr}$ (96 mR/yr). A background exposure rate based on 30 readings taken along a 300 m section of shoreline upstream of the Vernita Bridge (i.e., upstream of any potential sources of Hanford introduced contamination) indicates a background of 7 ± 1 $\mu\text{R/hr}$ (61 mR/yr). This measured background exposure rate agrees favorably with background external radiation measurements reported in the 1978 Hanford Environmental Surveillance report.⁽¹⁶⁾

Samples of soil and vegetation were collected at six sites along the shoreline at which contamination levels below 25 $\mu\text{R/hr}$ at one meter above the ground were recorded. Table 4 shows the concentrations of the predominant long-lived man-made radionuclides found in the samples. Naturally occurring radionuclides were present at normal concentrations and accounted for the majority of the gamma-radiation emitted by the samples. With the exception of the soil samples taken at N-Area and the Hanford Townsite Peninsula, ^{137}Cs concentrations were at levels attributable to world-wide fallout as reported in the 1978 Hanford Environmental Surveillance Report.⁽¹⁶⁾ Cobalt-60 and Europium-152 were not identified in samples of soil and vegetation taken off-site and away from the river as part of the routine Hanford environmental surveillance program and thus are associated with Hanford operations.⁽¹⁶⁾

CONTAMINATION DEPOSITS

Twenty-eight areas with measured exposures rates of 25 $\mu\text{R/hr}$ or greater were identified along the riverbank shoreline and 64 areas were identified on

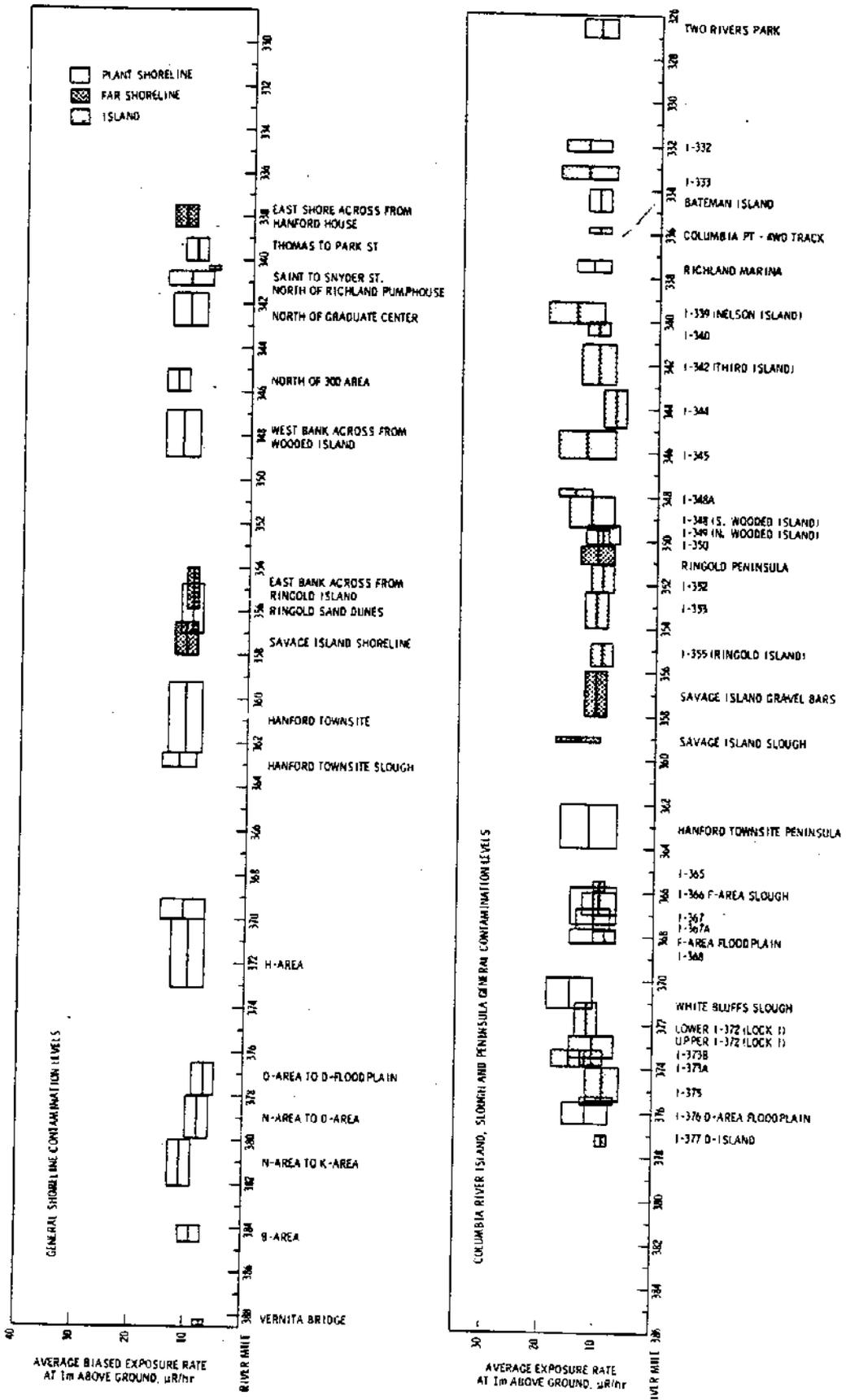


TABLE 4. Concentrations of Man-Made Long-Lived Radionuclides in Soil and Vegetation Samples Collected Along the Columbia River Shoreline

Location	Concentration pCi/gram (wet wt.)		
	Co-60	Cs-137	Eu-152
<u>Exposure Rate <25 μR/hr</u>			
N-Area Shore			
Vegetation	1.0	0.09	ND
Soil	7.4	2.9	ND
F-Area Slough			
Vegetation	ND	0.04	ND
Soil	0.29	0.52	0.33
Hanford Townsite Peninsula			
Vegetation	ND	ND	ND
Soil	1.5	1.3	3.0
Plant Shore Across from Wooded Island			
Vegetation	ND	ND	ND
Soil	0.20	0.23	ND
Richland Marina			
Vegetation	ND	0.099	ND
Soil	1.0	0.52	1.6
McMurray St. Shoreline			
Vegetation	0.13	0.10	ND
Soil	0.88	0.44	0.65
<u>Exposure Rate >25 μR/hr</u>			
H Area Slough			
Vegetation	.11	4.1	.24
Soil	6.0	19.	9.5
Hanford Townsite Slough			
Vegetation	.064	.64	.21
Soil	7.3	7.3	12.0

NOTE: Shorter lived radionuclides were also present in the N-Area Shoreline sample. Naturally occurring radionuclides were present in normal concentrations. Only gamma-emitting radionuclides were considered.
 ND - Not Detected

islands, peninsulas, sloughs and floodplains. A total of 3,450 m of shoreline or 5% of the distance along the shoreline surveyed by the track method was found to exceed 25 $\mu\text{R/hr}$ at one meter above the ground. These areas ranged from a few feet to 1,250 m in length. On islands and other land areas surveyed by the grid systems, contamination deposits varied in area from less than 10 m^2 to areas covering several adjacent 90 m x 90 m grid sections. Approximately $5 \times 10^5 \text{ m}^2$ or 2.4% of the area surveyed by the grid system was found to contain contamination deposits.

The highest exposure rates at one meter above the ground on the river shoreline were measured along the B, K, N, and D Reactor areas. Exposure rates as high as 800 $\mu\text{R/hr}$ were recorded along the shoreline in a region which extended from just below to approximately 1,250 m downstream of N Reactor. All exposure rate readings taken in this area increased as the survey instruments were raised away from the ground and as the high riverbank bluff in this area was ascended towards the reactor facility; therefore, the high radiation level in this area was determined to be due to scattered gamma rays (skyshine) from several of the N Reactor radwaste storage and transfer facilities and not to surface contamination. The highest radiation levels found along B, K, and D areas, 125, 250 and 63 $\mu\text{R/hr}$ respectively, were measured below the now inoperative reactor effluent retention basins and as such were also probably not the result of river deposited contamination.

The highest exposure rate measured on an island was 125 $\mu\text{R/hr}$ on Island-377 (D-Island). This reading was taken where vent pipes for the D and DR reactor cooling systems penetrate the ground surface near the upstream end of the island. As in the previously mentioned areas with high exposure rates, the radiation levels measured were not due to river deposited contamination.

Areas found to contain the highest levels of river deposited contamination were in the While Bluff Slough, where exposure rates at one meter above ground reached 40 $\mu\text{R/hr}$ in one location and 38 $\mu\text{R/hr}$ in another; on the Hanford Townsite Peninsula in which an area reading 45 $\mu\text{R/hr}$ was located; and on Island-344 (near the 300 Area) at 38 $\mu\text{R/hr}$. The remaining contamination

With the exception of 14 particles recovered from D-Island and Ringold Island for special study, none of the discrete particles were removed from their original location. Laboratory analysis of these discrete 14 particles with a NaI(Tl) multichannel analyzer identified the gamma radiations emitted to be entirely due to ^{60}Co at activities ranging from 1.7-24 μCi (see Table 5).

When isolated, the particles were barely visible to the naked eye, appearing as small, dark colored chips or flakes of roughly equal size. Microscopic examination of three particles showed them to be metallic appearing flakes with diameters of approximately 0.1 mm (see Figure E-1). The particles were found to vary in elemental composition, but all contained significant proportions of chromium, iron, and cobalt (see Appendix D) characteristic of the alloy stellite, used in valve and pump components in all of the production reactors.

Nine of eleven particles were found above the daily high water level, indicating deposition occurred during a period of extremely high river flow. Particles were found at depths up to 5" below the surface, mostly in the sandy interstices between rocks, although one was found to have been deposited within a small crack on the side of a rock (see Table 5).

The particles were more heavily concentrated on islands, especially those with large rocky, unvegetated areas. Fewer particles (37 as compared to 151) were found on shorelines, sloughs, floodplains, and peninsulas where there was more vegetation. The small number of particles found in many of the areas precludes an accurate quantification of particle distribution. It does, however, appear that the number of particles found per square meter of ground surveyed decreases as one travels downstream from the reactor areas.

The highest concentration of discrete particle contamination was found on the group of islands between D-Area and Locke Island. These islands are all characterized by large, level, rocky areas with little or no vegetation. Comparable concentrations of discrete particles were found on Island-368 and Island-366 near F-Area and on Island-339 (Nelson Island) near North Richland. These islands are also characterized by large, flat, rocky areas.

deposits were in the 25-30 $\mu\text{R/hr}$ range and appeared to be rather evenly distributed as far downriver as the survey was conducted.

In general, contamination deposits were most frequently found in flat, densely vegetated areas at an elevation several feet above the daily high-water level. Field measurements using a Reuter Stokes ionization chamber were made in a heavily vegetated area on the Hanford Townsite Peninsula to determine if the increased readings were due to the uptake and concentration of radionuclides by the vegetation. The measurements showed only a 15% reduction in the exposure rate following the removal of all vegetation flush with the ground within a 3 m radius circle around the instrument.

Samples of soil and vegetation taken from two areas classified as "contamination deposits" show the same radionuclides found in areas with lower contamination levels, but at greater concentrations (see Table 4). The concentrations of all radionuclides identified in these samples are above levels associated with worldwide fallout. (16)

DISCRETE PARTICULATE CONTAMINATION

Discrete particles of contamination were found in 188 places between B-Area and Two Rivers Park near the confluence of the Snake and Columbia Rivers. Unlike areas with contamination deposits, which were more frequently located in areas of dense vegetation, the majority of the discrete particles were found in rocky, flat areas with little or no vegetation. The two types of contamination therefore appear to have been distributed along the river in a mutually exclusive manner.

The number of discrete particles found in each survey region is given in Tables 2 and 3. Information pertaining to the specific location of each particle is provided in Appendix A and B. Instrument readings were recorded at the ground in addition to one meter above the ground at each particle location. These readings, which are given in the data Appendices, should be considered only an approximation of the actual exposure rate at the ground surface since the depth of the particle, and hence the gamma energy distribution and source-to-detector geometry were unknown, and a valid correction factor could thus not be determined.

TABLE 5. Discrete ⁶⁰Co Particles Recovered from Island-377
(D-Island and Island-355 (Ringold))

Particle Location	Description of Area	Micro-R Meter Readings, μ R/hr			Depth Below Surface	⁶⁰ Co Activity (μ Ci)
		General Background in Area	1m above ground at Particle Location	Surface of ground above Particle		
1 Upper end of D-Island 30' above DHWL	Rocks 1-6" dia. sparse weeds in area, gradual slope	10	14	210	NR	NR
2 Upper end of D-Island 25' above DHWL	Sand, rock 1-5" dia. flat	10	13	500	NR	16
3 Upper end of D-Island 30' above DHWL	Rocks 1-6" dia. sparse weeds	10	18	1400	2"	14
4 Cove at upper end of D-Island, below DHWL	Rocky, gradual slope	9	12	100	3"	1.7
5 50 yds downstream of cove 40' below DHWL	Rocks to 6" dia.	8	15	1000	3 1/2"	6.6, 23
6 D-Island 75' above DHWL	Sand, rocks, low vegetation	14	26	700	5"	21
7 D-Island 60' above DHWL	Large rocks	10	20	1000	Surface	9.9
8 Upper end of Ringold Island, 80' above DHWL near center of Island	Small rocks, sand	8	12	800	1 1/2"	13
9 Upper end of Ringold Island 30' in from DHWL (~2' verticle above DHWL)	Rocks 2-6" dia.	9	110	580	1 1/2"	12
10 Upper end of Ringold Island 20' in from DHWL (~2' verticle above DHWL)	Rock to 1", sand, sparse vegetation	NR	8	180	NR	6.5
11 Upper third of Ringold Island 13' above DHWL	Small rocks 1", sand	10	12	300	NR	2.5
12 Ringold Island	Rocky	NR	NR	NR	NR	9.7
13 Ringold Island	Rocky	NR	NR	NR	NR	1.7
14 Ringold Island	Rocky	NR	NR	NR	NR	24

DHWL - Daily High Water Level

NR - Not Recorded

COMPARISON WITH AERIAL RADIOLOGICAL SURVEYS (ARMS)

In general, the present survey showed good agreement with the 1974 ARMS report and with preliminary results for the 1978 aerial survey. Both surveys indicated that the areas containing the maximum levels of river deposited contamination were located along the H-Area Slough and on the Hanford Townsite Peninsula.⁽¹⁷⁾ It is felt that the use of the Aerial survey as a basis for choosing the particular areas to be included in the ground survey was appropriate.

Two aspects regarding the use of aerial monitoring techniques for performing a definitive contamination survey of the Columbia River shoreline areas should be noted. First, the loss of spatial resolution by locating the detector well above the ground surface (45 m) prevented the detection of discrete particulate contamination. Second, the presence of water within the detector 'field of view' greatly complicated the measurement of background terrestrial radiations along the shoreline and prevented the measurement of the net gross activity due to Hanford produced contamination. For this reason, the 1974 survey reported only ^{60}Co , and where detectable, ^{137}Cs concentrations. Europium-152 could not be measured with the NaI detectors used in the survey due to spectrum interference and; as a result, the actual radiation level due to the contributions of all the individual radionuclides present could not be determined.

CONCLUSIONS

Measurable radionuclide contamination resulting from past Hanford operations is still present along the shore of the Columbia River downstream from the 100-B Area. The absence of short-lived radionuclides in the shore sediments and the presence of contamination several meters above current maximum river levels indicate that the material was deposited some years ago. The predominant radionuclides present in the sediments are ^{60}Co , ^{152}Eu and ^{137}Cs .

Contamination on the exposed shore and island surfaces is present in three types of distributions:

- A fairly constant, uniform distribution of contamination, producing an exposure rate reading of about $11\ \mu\text{R/hr}$ (including approximately $7\ \mu\text{R/hr}$ background) exists over much of the study area.
- Localized areas of concentrated contamination or "contamination deposits" producing exposure rates in excess of $25\ \mu\text{R/hr}$ were observed at 92 locations, primarily in areas of heavier vegetation.
- Discrete particles containing ^{60}Co were observed in a number of areas, primarily in flat, rocky areas devoid of vegetation.

External dose rate from the uniformly distributed contamination and the "contamination deposit" types of contamination are below applicable external radiation protection dose limits for uncontrolled areas. Based on past surveys of river usage, the maximum individual has been established as a member of the public who spends 500 hours per year on the shore of the river. Were that individual to spend the entire 500 hours at the highest measured contamination deposit location ($45\ \mu\text{R/hr}$), the resulting whole body dose would be about 20 mrem above the approximately 100 mrem which would normally be received during a year by a local resident due solely to naturally-occurring radiations.

The discrete particles present a somewhat different situation, radiologically. In the event of direct contact with a small source, the beta radiations and the extreme nonuniformity of the radiation field in the exposed tissues become the primary considerations. In such a situation, the

usual dose-response relationships become invalid; and in fact, the effectiveness of the radiation in producing damage in the organism is significantly reduced. Although no definite statements can be made without additional data, currently available information on the particle sizes and activities suggest that deleterious health effects due to the particles are most unlikely.

ACKNOWLEDGMENT

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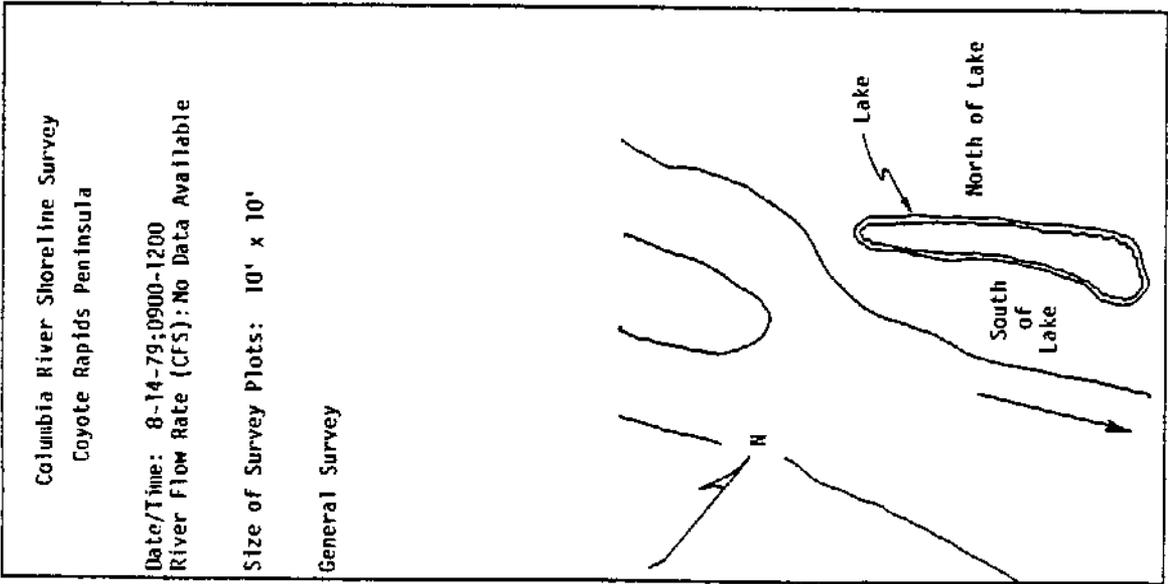
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APPENDIX A
DATA - ISLANDS AND BROAD SHORELINES

Uncorrected IR Meter Reading @ 1m Above Ground
(µR/hr)

North of Lake	South of Lake
6, 7, 7	4, 5, 5
7, 7, 6	4, 4, 5
7, 6, 7	4, 5, 4
7	5, 5, 4
	4, 4, 4
	5, 4, 4
	5, 5, 5
	4, 4, 5



Columbia River Shoreline Survey
D-Area Floodplain

Date/Time: 6-16-79; 0830-1330
River Flow Rate (CFS): 57,800-89,000

Size of Survey Plots: 10' x 10'

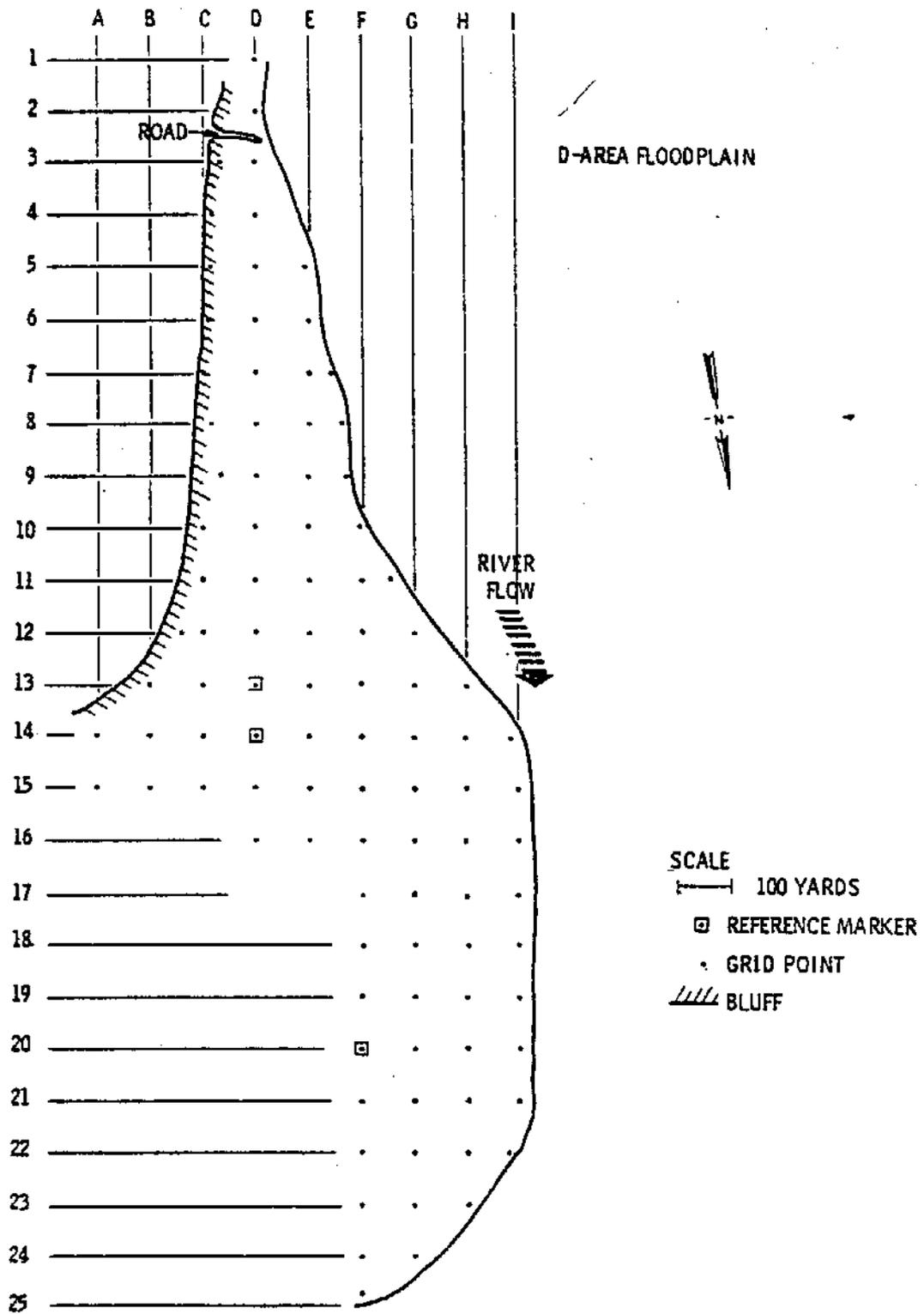
Formal Grid: See Map - Next page

Discrete Particulate Contamination ($\mu\text{R/hr}$ at ground surface):

(a) 90 Grass

Uncorrected μR Meter Reading @ 1m Above Ground
($\mu\text{R/hr}$)

	A	B	C
1			
2			
3			
4			10, 10, 8
5			10, 10, 10
6			12, 12, 12
7			10, 12, 12
8			8, 10, 8
9			8, 8, 8
10			8, 8, 10
11			8, 8, 8
12			10, 12, 10
13		12	10, 10, 10
14	10, 8, 11	14, 9, 10	10, 10, 10
15	10, 9, 9	12, 11, 12	12, 12, 10
16		9, 10, 10	12, 14, 12
17			
18			
19			
20			
21			
22			
23			
24			
25			



D-Area Floodplain Continued

Uncorrected μR Meter Reading @ 1m Above Ground
($\mu\text{R}/\text{hr}$)

	D	E	F	G	H	I
1	7, 7, 8 Rocks					
2	8, 7, 10					
3	6, 8, 7					
4	7, 7, 7	10, 8, 10 Rocks				
5	7, 7, 10	10, 10, 8				
6	8, 10, 11	8, 8, 8				
7	12, 10, 10 Soft	6, 8, 8 Sand,				
8	9, 10, 11	10, 10, 10 Grass	4, 4, 4 Rocks			
9	10, 11, 13		4, 4, 4			
10	11, 10, 10		4, 4, 4			
11	12, 13, 12		4, 4, 4			
12	12, 12, 12		10, 11, 9 High Grass	7, 8, 8 Rocks		
13	10, 10, 11		10, 10, 10	8, 7, 7		
14	12, 11, 11		10, 10, 10	17, 10, 8	10, 8, 10	
15	10, 14, 12		10, 10, 10	10, 17, 16	10, 8, 10	
16	12, 10, 8		8, 8, 8 Sand,	9, 9, 9	8, 10, 10	
17	10		7, 7, 7 Rocks	10, 9, 10	8, 10, 10	9, 9, 9 Rocks
18			6, 6, 6	13, 13, 11	8, 8, 8	8, 9, 8
19			6, 6, 6	9, 9, 9	10, 10, 8	9, 9, 11 Grass
20			6, 6, 6	9, 9, 8	8, 8, 10	14, 15, 14
21			6, 6, 6	10, 9, 9	8, 8, 10	14, 15, 14
22			5, 5, 5	11, 11, 9	10, 8, 10	15, 16, 18 (a)
23			7, 7, 7	9, 10, 11	11, 10, 10	14, 8, 9
24			8, 8, 8	13, 12, 13	10, 8, 10	9, 9, 8 Rocks
25			7, 7, 7	13, 13, 13	10, 10, 8	8, 8, 7

Columbia River Shoreline Survey
Island-376

Date/Time: Lower Half: 5-17-79; 1300-2000
River Flow Rate (CFS): Lower Half: 07,000-124,000
Date/Time: Upper Half: 6-27-79; 0800-1100
River Flow Rate (CFS): Upper Half: 54,700-83,100

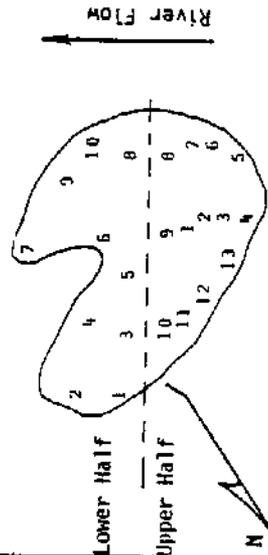
Size of Survey Plots: 10' x 10'

General Survey - Approximate survey locations shown on sketch below.

Discrete Particulate Contamination ($\mu\text{R/hr}$ at ground surface):

- (a) 1000
- (b) 1000
- (c) 900
- (d) 30
- (e) 1000
- (f) 45
- (g) 3000
- (h) 500
- (i) 200

Areas with general contamination $> 25 \mu\text{R/hr}$ indicated by the symbol \square .



Uncorrected μR Meter Reading @ 1m Above Ground
($\mu\text{R/hr}$)

	Lower Half	Upper Half
1	4	11
2	4	10
3	4	9
4	5 (a)	9 (h, i)
5	5, 15, 20 \square (b)	9
6	5	9
7	5	10
8	8	8
9	9 (c)	11
10	10 (d, e, f, g)	9
		11
		12
		9
		8

Columbia River Shoreline Survey
Island-375

Date/Time: 5-19-79;0900-1600
River Flow Rate (CFS): 110,400-170,100

Size of Survey Plots: 10' x 10'

Formal Grid: See map - next page

Discrete Particulate Contamination ($\mu\text{R/hr}$ at ground surface):

(a) 2000,2500	(o) 1500
(b) 3000	(p) 1400
(c) 400	(q) 140
(d) 80	(r) 800
(e) 1000	(s) 200
(f) >3000	(t) 800
(g) 3000	(u) 600
(h) 600	(v) 700
(i) 400	(w) 600
(j) 1500	(x) 2500
(k) 1000	(y) 400
(l) 3000	(z) 300
(m) 800	(AA) 2000
(n) 1800	(BB) 700
	(CC) 600

Uncorrected μR Meter Reading @ 1m Above Ground
($\mu\text{R/hr}$)

Section	Section	Section	Section
1 9, 9, 9	27 5, 5, 6	53 8, 8, 8 (v)	79 4, 4, 4
2 9, 9,10 (a)	28 6, 7, 7 (q,r)	54 6, 8,12 (w,x)	80 4, 4, 4
3 10,10,11	29 6, 6, 6	55 8, 8, 8	81 10,10,10
4 8, 8, 9	30 5, 6, 6	56 4, 4, 5	
5 8, 8,12 (b)	31 5, 6, 8 (s)	57 6, 6, 6	
6 10,10,10	32 4, 4, 5 (t)	58 8, 8, 9	
7 11,11,11 (c)	33 7, 8, 8	59 5, 6, 8 (y)	
8 8, 8, 8 (d)	34 8, 8, 8	60 6, 6, 6 (z)	
9 8, 8, 8	35 8, 8, 8	61 8, 8, 8	
10 8,10,10 (e)	36 8, 8, 8	62 6, 8, 8	
11 10,10,10	37 8, 8, 9	63 6, 6, 6	
12 8, 8, 8	38 9, 9, 9	64 8, 8, 9	
13 7, 7,13 (f)	39 4, 5, 5	65 - , - , -	
14 8, 8,15 (g)	40 4, 4, 5	66 7, 7,12 (AA)	
15 8, 8, 8 (h)	41 4, 4, 4 (u)	67 8, 8, 8	
16 7, 8, 8 (i)	42 4, 4, 4	68 - , - , -	
17 10,11,13 (j,k,l)	43 4, 4, 4	69 6, 6, 7 (BB)	
18 8, 8,14 (m)	44 4, 4, 4	70 8, 8, 8	
19 10,10,10	45 - , - , -	71 - , - , -	
20 7, 7,10 (n)	46 - , - , -	72 4, 4, 5	
21 10,10,12	47 - , - , -	73 6, 6, 6	
22 6, 6, 7	48 - , - , -	74 6, 6, 6	
23 - , - , -	49 - , - , -	75 4, 5, 5	
24 6, 6, 6	50 - , - , -	76 5, 6, 5 (CC)	
25 8, 8,10 (o)	51 8, 8, 8	77 6, 6, 6	
26 6, 6, 8 (p)	52 4, 4, 4	78 6, 6, 6	

Columbia River Shoreline Survey
Island-373-A

Date/Time: 5-18-79; 1130-1330
River Flow Rate (CFS): 149,100-154,700

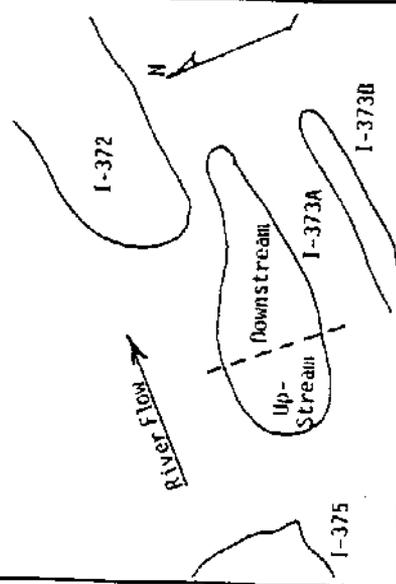
Size of Survey Plots: 10' x 10'

General Survey.

Discrete Particulate Contamination ($\mu\text{R/hr}$ at ground surface):

(a) 1500 Rock-gravel, just above daily high water mark.

Areas with general contamination $\geq 25 \mu\text{R/hr}$ indicated by the symbol \square .



Uncorrected μR Meter Reading @ 1m Above Ground
($\mu\text{R/hr}$)

Upstream
14
12
20 (a) \square

Downstream
9
10
14

Uncorrected μR Meter Reading ϕ in Above Ground
($\mu\text{R}/\text{hr}$)

1	9, 10, 11
2	8, 9, 10
3	5, 10, 10 (a)
4	10, 10, 10
5	10, 10, 10
6	6, 8, 9
7	8, 9, 20 (b) \square

Columbia River Shoreline Survey
Island-373-B

Date/Time: 5-18-79; 0900-1200
River Flow Rate (CFS): 143,900-149,100

Size of Survey Plots: 10' x 10'

Informal Grid: Marrow Island marked off from West to East in 100 yd sections.

Discrete Particulate Contamination ($\mu\text{R}/\text{hr}$ at ground surface):
(a) 3000 Rocky
(b) 2000 Rocky

Areas with general contamination $\geq 25 \mu\text{R}/\text{hr}$ indicated by the symbol \square .

The diagram shows an elongated island with a grid of seven sections numbered 1 to 7 from west to east. A north arrow is located above the island, and an arrow labeled 'River Flow' points to the right below the island. Section 7 is marked with a square symbol, indicating general contamination.

Columbia River Shoreline Survey
Upper Island-372
(Upper Locke Island)

Date/Time: 6-27-79; 1500-2100
River Flow Rate (CFS): 151,900-154,700

Size of Survey Plots: 10' x 10'

Formal Grid: See Map - Next Page.

Discrete Particulate Contamination ($\mu\text{R/hr}$ at ground surface):

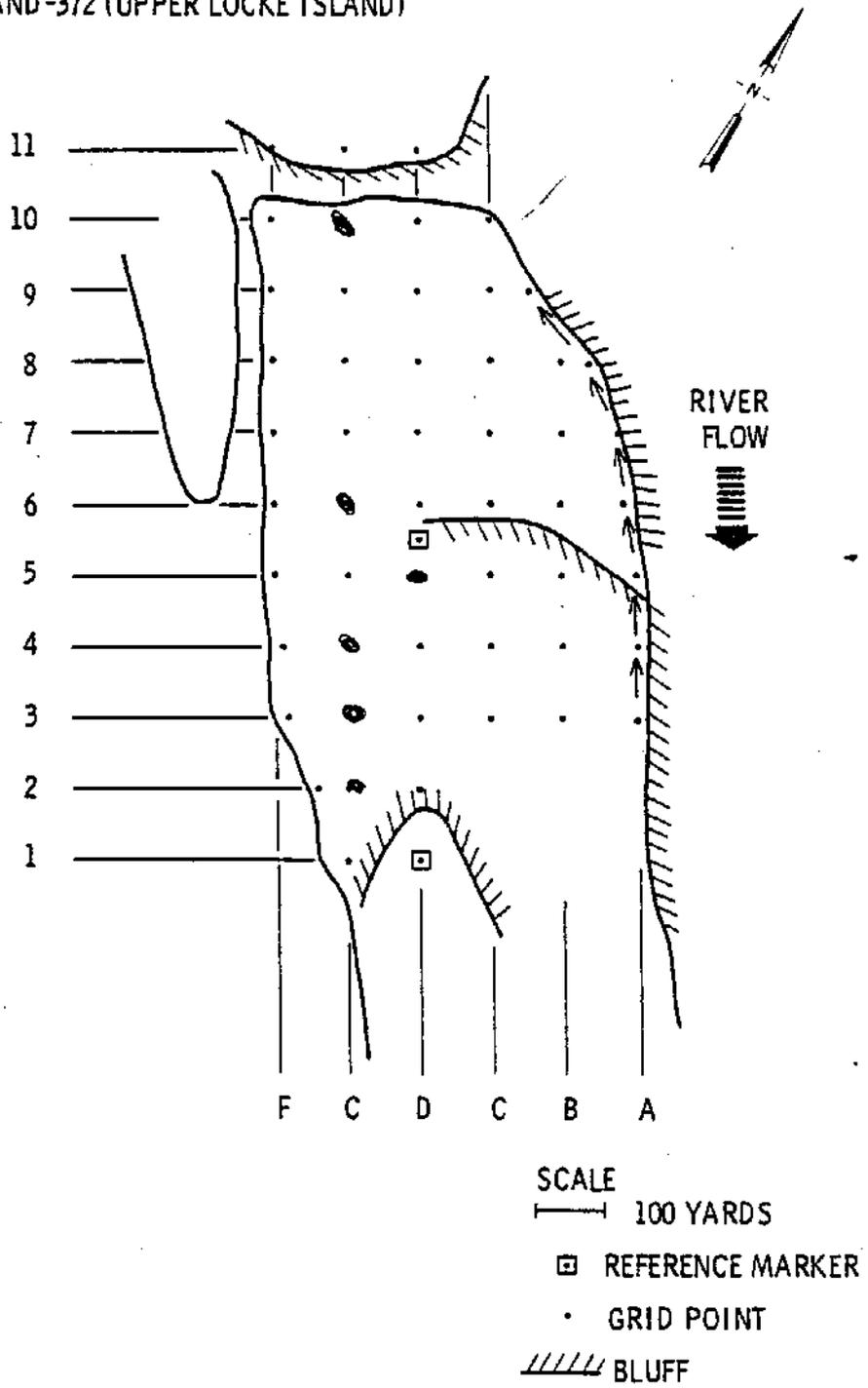
- {a} 1200
- {b} 260
- {c} 180
- {d} 80
- {e} 120
- {f} 300
- {g} 600
- {h} 60

Areas with general contamination $\geq 25 \mu\text{R/hr}$ are indicated by the symbol \square .

Uncorrected μR Meter Reading @ 1m Above Ground ($\mu\text{R/hr}$)

	A	B	C	B	F
1	10,12,13 Grass, Dirt				
2	12,11,11	6, 8, 6 Rocks,	20,18,16	6,7,7	6,6,7
3	12,12,11	10,10,10 Weeds	16,18,16	7,8,7	7,7,6 (b)
4	10,10,10	10,10,10	16,18,12	7,8,7	8,7,7 (c,d,e)
5	11,11,10	10,10,10	14,16,14	7,9,7 (a)	8,8,7 (f)
6	9,10,9	10,10,8	14,16,14	6,8,10	7,8,7
7	10,10,10	10,10,10	20,18,18	8,8,7	7,7,8 (g)
8			20,16,18	8,8,7	6,7,8
9				6,6,6	7,7,6
10				5,5,5	6,7,6 (h)
11				6,6,4	7,8,7
12					

I SLAND-372 (UPPER LOCKE ISLAND)



Lower Locke Island Continued

Uncorrected μR Meter Reading @ 1m Above Ground
($\mu R/hr$)

Track 1		North Shore		Track 3	
8, 6, 7	Mud	10, 11, 11	Sand	10, 8, 8	High
7, 6, 7		9, 10, 10		8, 8, 9	Needs
7, 7, 7		11, 11, 14		8, 9, 9	↓
8, 8, 8	Mulberry Tree	13, 14, 11		8, 10, 9	
7, 8, 7		10, 11, 12		9, 8, 8	
8, 8, 8		11, 12, 12		7, 7, 6	
8, 8, 8		12, 12, 12		8, 9, 9	
8, 8, 7 (c)		11, 11, 11		7, 8, 7	
8, 7, 8		11, 12, 11		7, 7, 8	
8, 8, 8		11, 11, 11		10, 10, 10	
8, 8, 8		10, 9, 9		10, 10, 9	
8, 8, 8		9, 10, 9		10, 10, 10	
8, 8, 8	Trees	10, 9, 9 (d)		9, 10, 10	
8, 8, 8		9, 11, 11		10, 9, 10	
8, 8, 8		10, 11, 9		9, 9, 9	
6, 8, 8		9, 9, 9		10, 9, 9	
7, 7, 7		10, 9, 9		10, 10, 9	
7, 7, 7		9, 9, 8		9, 9, 8	
7, 7, 8		8, 9, 9		8, 7, 9	
7, 7, 9		9, 9, 9		10, 8, 9	
11, 10, 9		9, 9, 9		8, 10, 9	
8, 6, 6	Mud, Sand	9, 9, 9		10, 10, 10	
6, 6, 7	↓	9, 9, 9		10, 10, 10	
6, - -		9, 9 -		9, 10, 10	
				9, 9, 9	

90
200
150
00-000517-20

Columbia River Shoreline Survey
White Bluffs Slough

Date/Time: 6-12-79; 1900-2100
River Flow Rate (CFS): 147,800

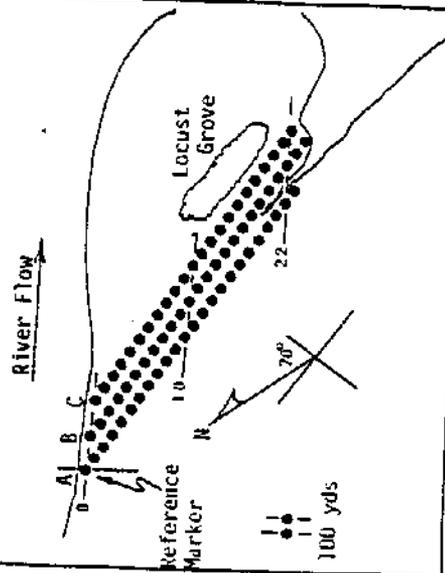
Size of Survey Plots: 10' x 10'

Formal Grid: See map.

Discrete Particulate Contamination ($\mu\text{R/hr}$ at ground surface):

- (a) 1400
- (b) 400

Areas with general contamination $> 25 \mu\text{R/hr}$ indicated by the symbol \square .



Uncorrected μR Meter Reading @ 1m Above Ground
($\mu\text{R/hr}$)

	A	B	C
0	10, 9, 8		
1	12, 13, 12	13, 13, 13	6, 7, 5
2	16, 15, 14	12, 11, 12	7, 8, 6
3	17, 14, 14	14, 13, 11	20, 12, 14
4	23, 14, 22	15, 15, 13	14, 12, 13
5	19, 14, 22	15, 17, 15	10, 20, 20
6	20, 17, 12	17, 18, 18	10, 22, 11
7	10, 11, 14	21, 15, 17	18, 11, 12 (a)
8	10, 10, 10	13, 13, 14	10, 8, 10
9	10, 9, 9	12, 13, 12	11, 15, 10
10	9, 10, 10	13, 17, 13	13, 13, 13
11	9, 9, 10	18, 19, 20	11, 12, 14
12	9, 9, 10	19, 20, 19	11, 11, 11
13	10, 10, 9	13, 12, 19	10, 10, 12
14	10, 8, 9	13, 13, 12	11, 11, 10 (b)
15	10, 10, 9	17, 18, 18	11, 10, 10
16	10, 10, 10	13, 17, 18	11, 10, 10
17	10, 10, 10	17, 12, 13	12, 12, 12
18	10, 10, 10	16, 20, 17	12, 12, 12
19	10, 10, 10	15, 17, 18	9, 8, 7
20	8, 8, 8	11, 8, 15	12, 12, 9
21	9, 8, 8	15, 7, 14	8, 10, 9
22	7, 32, 28	11, 9, 11	9, 7, 8
23	23, 9, 30	9, 8, 8	7, 10, 9
24		9, 7, 9	
25		6, 7, 10	
26			

Columbia River Shoreline Survey
[Stand-368

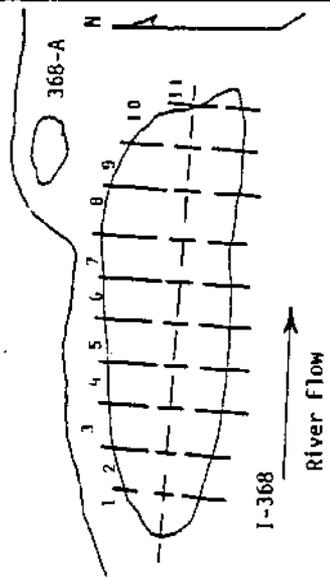
Date/Time: 6-14-79; 1500-1700
River Flow Rate (CFS): 127,200-145,200

Size of Survey Plots: 10' x 10'

Informal Grid: Island divided into North and South halves. Three plots within 100 yd. sections starting at upstream end. General survey made on I-368-A.

Discrete Particulate Contamination ($\mu\text{R/hr}$ at ground surface):

- (a) 100 Rocky (d) 95 Rocks
- (b) 100 Beach (e) 3000 Rocks
- (c) 500 Beach (f) 420 Grave



Uncorrected μR Meter Reading @ 1m Above Ground
($\mu\text{R/hr}$)

	I-368		I-368-A	
	North	South	North	South
1	6,5,6 (a)	9,9, 8 (d)	9 (f)	
2	5,6,6	8,8,10 (e)		
3	5,6,6	8,8, 9		
4	6,-,-	9,8, 9		
5	6,7,5 (b)	9,9, 8		
6	6,6,6 (c)	9,7, 8		
7	6,5,6	8,8, 7		
8	6,6,6	9,9, 8		
9	6,6,7	8,9, 9		
10	6,6,6	9,9, 9		
11		8,9, 9		

Columbia River Shoreline Survey
F-Area Floodplain

Date/Time: 6-23-79; 0800-1500
River Flow Rate (CFS): 43,000-56,200

Size of Survey Plots: 10' x 10'

Formal Grid: See map - next page.

Discrete Particulate Contamination ($\mu\text{R/hr}$ at ground surface):

- (a) 300
- (b) 120
- (c) 400
- (d) 1000
- (e) 3000
- (f) 400
- (g) 425
- (h) 120
- (i) 110
- (j) 750

Areas with general contamination $\geq 25 \mu\text{R/hr}$ indicated by the symbol \square .

Uncorrected μR Meter Reading @ 1m Above Ground
($\mu\text{R/hr}$)

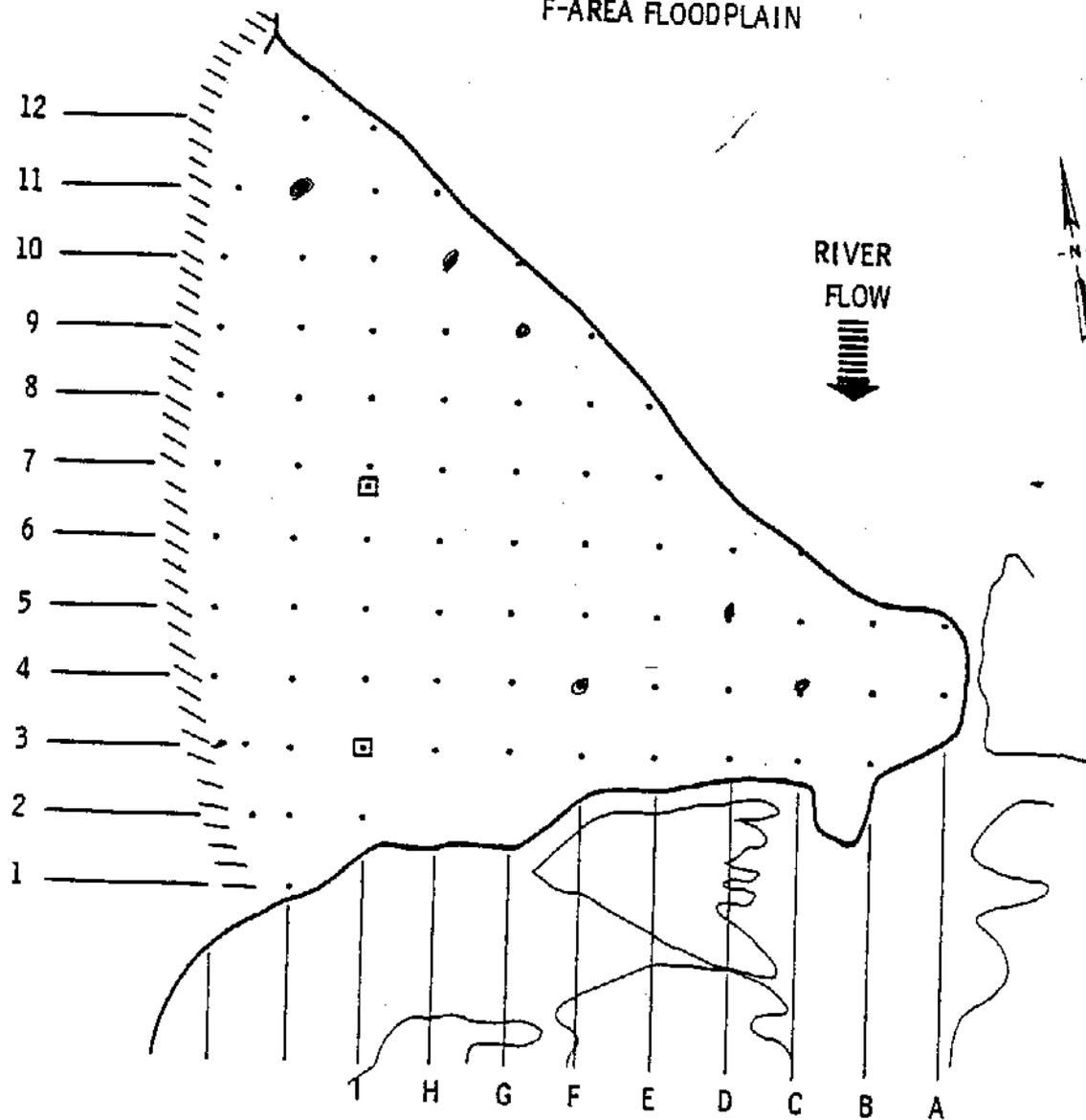
	A	B	C	D
1				
2				
3	7, 7, 7	7, 7, 7	7, 7, 7	7, 7, 7
4	7, 7, 7	7, 7, 7	6, 7, 7 (b)	7, 7, 7
5		7, 7, 7	7, 7, 7	8, 7, 7 (a)
6			7, 7, 7	6, 6, 6
7				
8				
9				
10				
11				
12				

F-Area Floodplain Continued

Uncorrected μR Meter Reading @ 1m Above Ground
($\mu\text{R}/\text{hr}$)

	E	F	G	H	I	J	K
1		10,11,12			14,14,14	4, - , -	6, 7, 7
2	8, 8, 8	11,11,10	11,11,11	14,12,10	12,15,20 ²⁰	5, 4, 4	12,12,17 (c)
3	8, 8, 6	11,11,11	12,13,14	12,12,12	18,18,19	6, 6, 6	11,12,10
4	7, 7, 7	10,10,10 (j)	14,14,14	12,14,12	16,15,10	6,12, 8	
5	7, 7, 7	10, 9,10	12,11,10	10,12,12	10,12,12	6, 6, 5	9, 9, 6
6	7, 7, 7	8, 8,10	8, 9, 8	12,12,12	12,12,12	6, 6, 5	5, 8, 7
7	7, 7, 7	7, 8, 7	9, 9, 8	10,10,10	10,10, 8	5, 4, 6	4, 6, 5
8	7, 7, 7		9, 9, 7 (g)	10,10, 8	8,10, 8	5, 4, 5	5, 5, 5
9			7, 8, 7 (h,i)	9, 8,10	8, 8, 6	4, 5, 6	5, 4, 4
10				8, 8,10	8, 8, 8	4, 4, 6	4, 4, 4
11					6, 8, 8	25, 6,14 (d,e,f)	4, 6, 6
12					6, 8, 8	4, 4, 5 ²¹	

F-AREA FLOODPLAIN



SCALE

— 100 YARDS

☐ REFERENCE MARKER

• GRID POINT

Columbia River Shoreline Survey
Island-367

Date/Time: 6-19-79;0800-1400
River Flow Rate (CFS): 60,900-118,800

Size of Survey Plots: 10' x 10'

General Survey: Areas were gridded formally. However, grid orientation was confused subsequent to the survey. Establishment of grid did insure that measurements were made at equally spaced points. See following map.

Discrete Particulate Contamination ($\mu\text{R/hr}$ at ground surface):

367-(1): (a) 80
(b) 150

367-(2): (a) 60
(b) 150

367-(3): (a) 1400
(b) 2600
(c) 2200
(d) 400

367-(4): (a) 190
(b) 800
(c) 1000
(d) 450
(e) 220
(f) 600
(g) 150

Areas with general contamination $\geq 25 \mu\text{R/hr}$ indicated by the symbol \square .

Uncorrected μR Meter Reading @ 1m Above Ground ($\mu\text{R/hr}$)	
I-367-(1)	5, 5, 6 6, 7, 9 9, 10, 8 8, 9, 9 9, 8, 8 7, 8, 8 8, 8
I-367-(2)	10, 10, 10 8, 10, 10 10, 10, 10 8, 10, 10 10, 8, 10 10, 8, 10 8, 9, 9 9, 9, 9 12, 12, 12 12, 12, 12 12, 12, 12 13, 14, 14 14, 14, 14 12, 12, 12 12, 12, 12 12, 12, 12 10, 12, 12 10, 12, 10 14, 12, 12 10, 10, 10 10, 10, 10 10, 12, 12 10, 11, 11 12, 14, 14 14, 16, 16 12, 44, 18
I-367-(3)	8, 8, 10 7, 8, 8 10, 8, 8 8, 8, 7 8, 10, 8 11, 10, 9 12, 11, 9 12, 6, 7 12, 14, 16 11, 10, 14 10, 16, 18 12, 14, 20 \square 9, 15, 8 10, 10, 9 14, 15, 16 20, 10, 9 \square 10, 9, 12 16, 12, 10 6, 7, 6 8, 6, 5
I-367-(4)	9, 9, 9 10, 10, 11 10, 10, 11 9, 10, 10 11, 11, 11 9, 8, 8 8, 8
I-367-A	3, 4, 3 3, 4, 4 4

Columbia River Shoreline Survey
 F-Area Slough

Date/Time: 6-23-79;0800-1500
 River Flow Rate (CFS): 43,000-56,200

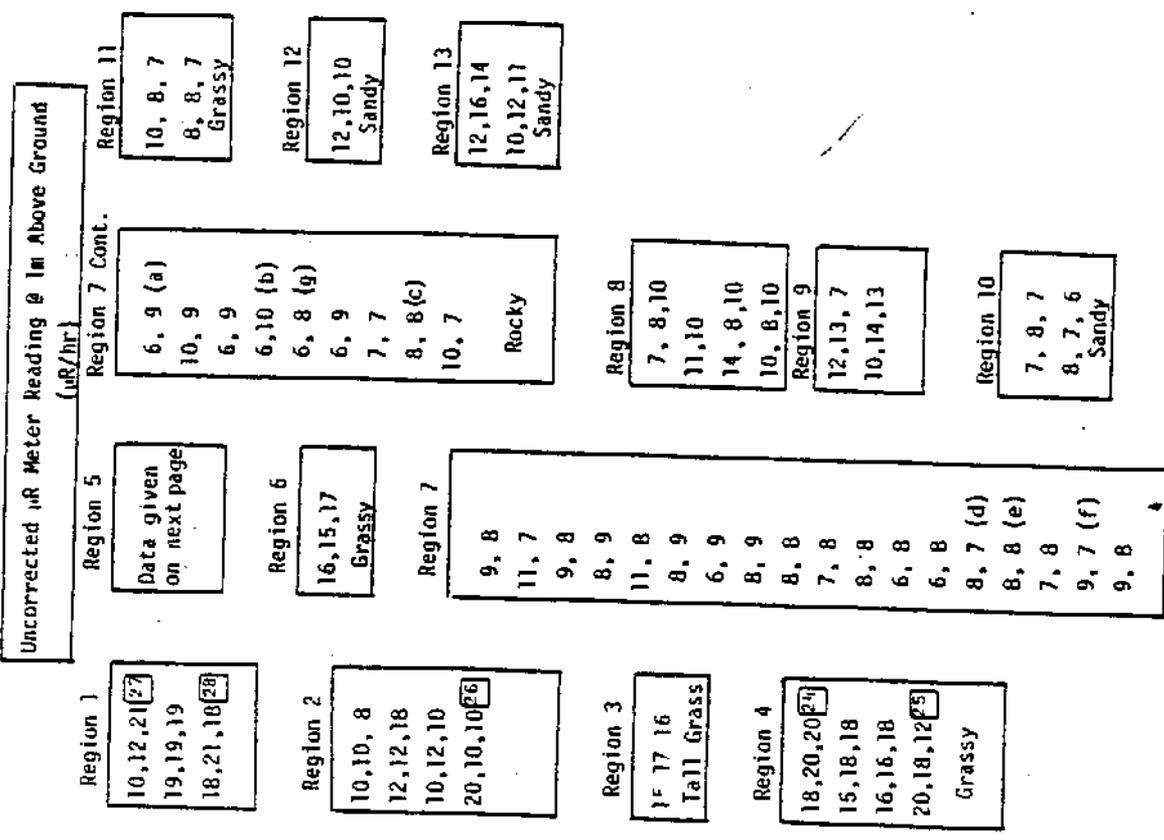
Size of Survey Plots: 10' x 10'

General Survey: See following map for location of regions.

Discrete Particulate Contamination ($\mu\text{R/hr}$ at ground surface):

Region 7: (a) 300* (e) 110
 (b) 3000** (f) 120
 (c) 300* (g) 310
 (d) 2200

*Particle at surface
 **Reading 3/4" above surface



Columbia River Shoreline Survey

F--Area Slough
(Region-5)

Date/Time: 6-19-79; 1500-2000
River Flow Rate (CFS): 122,400-129,600

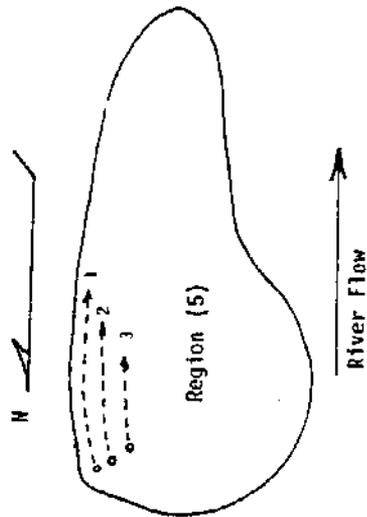
Size of Survey Plots: 10' x 10'

Informal Grid: Perimeter of region surveyed using shoreline track methods, starting at Notheast corner and continuing clockwise around the region. See sketch below. Three plots surveyed every 100 yds. Following map gives location of region.

Discrete Particulate Contamination ($\mu\text{R/hr}$ at ground surface):

(a) 250 Grass bank

Areas with general contamination $\geq 25 \mu\text{R/hr}$ indicated by the symbol \square .



**Uncorrected μR Meter Reading @ 1m Above Ground
($\mu\text{R/hr}$)**

Region (5)

Track 1
6, 6, 5
6, 7, 6
6, 6, 6
6, 6, 6
7, 8, 6
6, 7, 6
7, 8, 12
7, 20, 22 \square 29
20, 22, 10 (a) \square 10
14, 16, 14
16, 10, 8
14, 12, 10
8, 8, 10
8, 7, 7
7, 10, 6
10, 8, 12
9, 8, 9
10, 6, 6
8, 6, 6
6, 4, 4
4, 5, 4
5, 5, 4
5, 5, 4
5, 4, 4
5, 5, 4
5, 4, 5

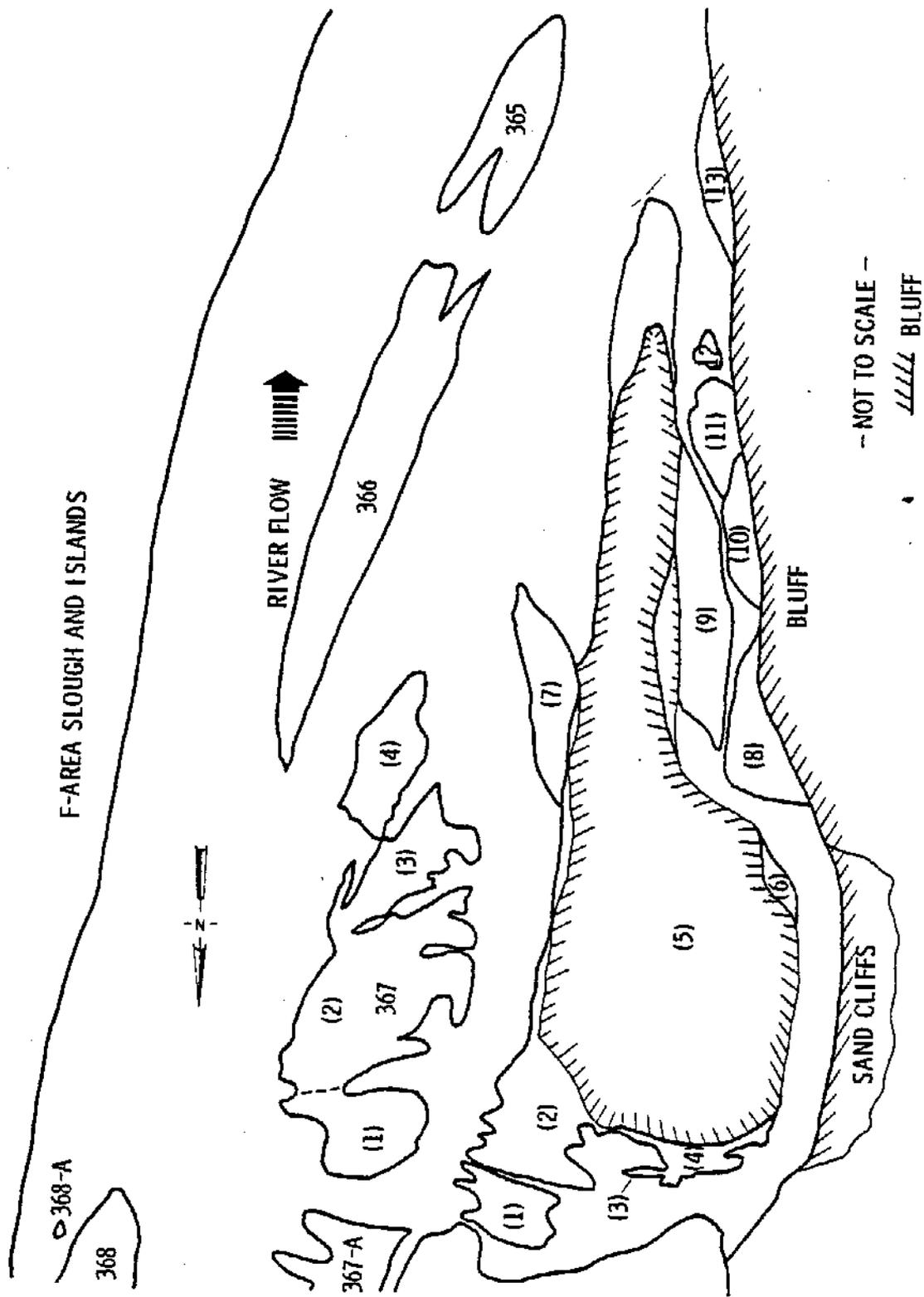
Track 2
9, 14, 14
10, 14, 13
13, 11, 9
10, 11, 11
11, 10, 17
16, 16, 18
16, 18, 14
15, 20, 18 \square 31
20, 16, 20 \square 22
22, 20, 12 \square 33
11, 10, 10
10, 12, 10
9, 9, 10
10, 8, 13
16, 17, 17
16, 17, 15
17, 13, 16
16, 15, 17
16, 18, 18
16, 15, 12
12, 13, 12
8, 11, 10
12, 11, 10
10, 8, 8
11, 9, 10
8, 9, 12

Track 3
9, 8, 7
7, 8, 7
5, 5, 5
5, 5, 5
5, 6, 5
5, 5, 6
6, 5, 4
5, 5, 4
6, 6, 5
5, 5, 4
5, 5, 5
5, 5, 5
5, 6, 5
5, 5, 5
5, 5, 6
5, 5, 5
5, 5, 5
5, 4, 5
5, 5, 4
5, 5, 5
5, 5, 5
5, 5, 5
5, 5, 5

I-Area Slough Region-5 Continued

Uncorrected μ R Meter Reading @ 1m Above Ground
(μ R/hr)

Track 1	Track 2	Track 3	Track 1	Track 2	Track 3
4, 5, 5	8, 8, 8	5, 5, 5	8, 8, 10	10, 10, 10	5, 5, 5
5, 4, 5	8, 8, 8	6, 5, 6	10, 10, 8	10, 10, 11	5, 5, 5
5, 5, 5	8, 10, 8	6, 6, 4	10, 11, 9	10, 11, 11	4, 5, 5
4, 5, 4	8, 8, 8	5, 5, 6	11, 12, 9	10, 10, 10	5, 5, 5
5, 5, 5	8, 8, 8	6, 5, 5	8, 8, 8	10, 10, 10	5, 5, 5
4, 5, 5	8, 8, 8	4, 4, 7	8, 8, 8	10, 8, 10	5, 5, 5
5, 4, 6 S. Point	8, 6, 8 S. Point	8, 8, 8 S. Point	8, 8, 8	10, 10, 10	5, 5, 5
4, 5, 4	7, 8, 8	11, 11, 10	7, 8, 8	10, 10, 10	5, 5, 5
5, 5, 7	8, 8, 8	10, 12, 11	8, 8, 8	10, 10, 10	5, 5, 5
8, 8, 8	8, 8, 8	9, 9, 9	6, 7, 6	11, 10, 10	5, 5, 5
8, 7, 8	10, 10, 8	5, 5, 4	8, 7, 8	10, 10, 12	5, 5, 5
9, 8, 8	9, 10, 8	4, 4, 5	8, 8, 8	10, 10, 10	5, 5, 5
8, 8, 8	10, 10, 8	5, 4, 4	8, 8, 8	10, 10, 14	5, 5, 5
8, 8, 9	11, 10, 9	4, 5, 4	8, 8, 8	10, 10, 10 N. Point	5, 5, 5
8, 9, 9	8, 9, 9	4, 4, 4	8, 8, 8 N. Point		
9, 12, 14	9, 10, 9	5, 4, 4			
12, 14, 16	9, 10, 7	5, 4, 4			
12, 12, 12	10, 10, 10	5, 5, 5			
10, 10, 14	10, 10, 10	5, 5, 5			
10, 10, 12	11, 10, 10	4, 5, 5			
12, 11, 11	10, 10, 10	5, 5, 5			
11, 12, 10	10, 10, 10	5, 5, 4			
8, 10, 9	10, 10, 10	5, 5, 5			
9, 9, 18	10, 10, 10	5, 5, 5			
20, 18, 19	10, 10, 9	5, 5, 5			
14, 14, 12	10, 10, 10	5, 4, 5			
		5, 5, 5			



Columbia River Shoreline Survey
Island-366

Date/Time: 6-19-79; 1600-2000
River Flow Rate (CFS): 122,400-129,600

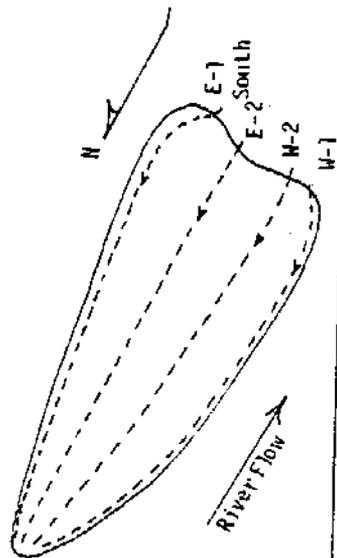
Size of Survey Plots: 10' x 10'

Informal Grid: Four paths walked from downstream end to upstream end. Grid point established approximately every 100 yds along path and three plots chosen within circle of 30 yds radius about grid point.

Discrete Particulate Contamination ($\mu\text{R/hr}$ at ground surface):

(a)	1200	(l)	700
(b)	350	(j)	1800
(c)	1600	(k)	180
(d)	3000	(i)	900
(e)	3000	(m)	1600
(f)	3000	(n)	380
(g)	150	(o)	440
(h)	390		

North



Uncorrected μR Meter Reading @ 1m Above Ground
($\mu\text{R/hr}$)

West #1	West #2	East #2	East #1*
7,7,7	10,11,10	10, 8,10	10,10,-
6,7,7	10,11,11	10,10,10	10,10,10
7,7,7	14,10,12	10,11,11	8,10,10
7,7,6	11,11,10	11,14,10	10,10, 8 (g)
7,7,6	12,10,10	10,10,10	10,10,10 (h)
7,6,6	10,13,11	10, 9,11	8, 8, 8 (i,j)
6,5,6	10, 9,10	10,10,11	8, 8, 8 (k)
5,5,4 (a)	10, -, - (c,d)	10, 7,12 (e)	10,10,10 (l,m,n)
4,4,4	8,13, 9	10,10, 7 (f)	10,10,10 (o)
4,4,4	7, 7, 8	10,10,11	10,10,10
5,4,5	10,11,10	10,10,11	10,10,10
4,5,5	10, 7, 9	9,11,10	10,10,10
4,4,- (b)	10,10,10	10,10, 8	10,10,10
-, -, -	8, -, -	-, -, -	-, -, -

S. End

N. End

* Calibration check showed that the instrument used for these readings (5012) was low by a factor of 2. Data in this column and associated data in 'particles' column have been corrected for this.

Columbia River Shoreline Survey
Island-365

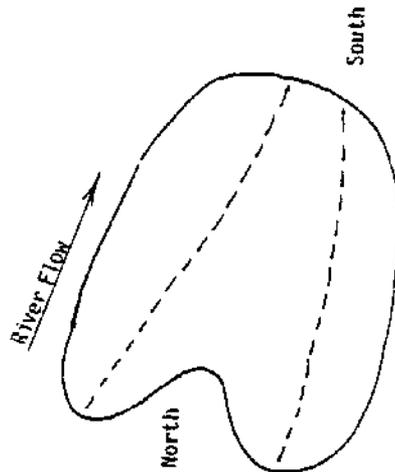
Date/Time: 6-19-79; 1200-1300
River Flow Rate (CFS): 83,100-118,800

Size of Survey Plots: 10' x 10'

Informal Grid: Island walked from North to South, with two paths dividing it lengthwise into thirds. Three plots surveyed in vicinity of path every 100 yds walked.

Discrete Particulate Contamination ($\mu\text{R/hr}$ at ground surface):

- (a) 180
- (b) 140



Uncorrected μR Meter Reading @ 1m Above Ground
($\mu\text{R/hr}$)

West Side
9, 9, 9
9, 9, 9
9, 8, 8 (a)
9, 8, 8
8, 8, 8
9, 9, 9
8, 8, -

South End

North End

East Side
7, 7, 8 (b)
6, 7, 10
6, 7, 7
8, 8, 8
8, 9, 9
9, 6, 8

Columbia River Shoreline Survey
Hanford Townsite Peninsula

Date/Time: 6-06-79; 1800-2000

6-12-79; 1300-1700

River Flow Rate (CFS): 92,000-140,000

Size of Survey Plots: 10' x 10'

Formal Grid: See map - next page.

Discrete Particulate Contamination ($\mu\text{R/hr}$ at ground surface):

(a) 60 At waters edge

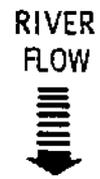
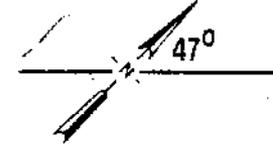
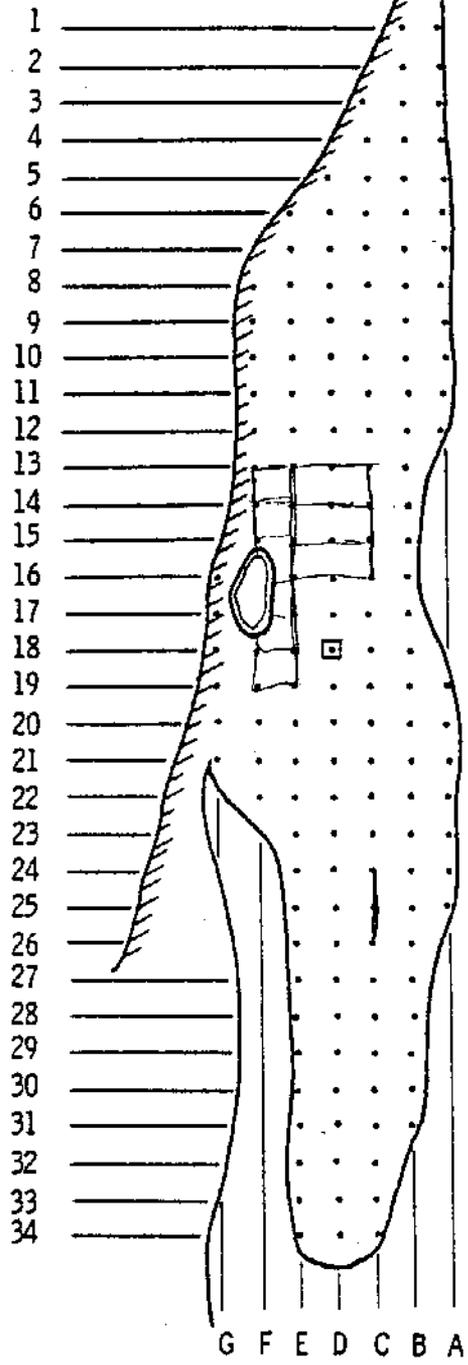
(b) 1400 6' above high water line

Areas with general contamination $> 25 \mu\text{R/hr}$ indicated by the symbol \square .

Uncorrected μR Meter Reading @ 1m Above Ground
($\mu\text{R/hr}$)

	Track A	Track B	Track C	Track D
1	8, 8, 10	7, 8, 8		
2	7, 8, 9	6, 7, 8		
3	8, 8, 10	6, 7, 7	9, 9, 9	
4	8, 10, 10	6, 6, 7	9, 9, 9	
5	7, 8, 10	5, 7, 7	7, 8, 8	12, 12, 13
6	8, 9, 10	5, 5, 7	7, 7, 8	14, 14, 14
7	8, 8, 9	5, 5, 5	7, 7, 7	7, 8, 8
8	8, 8, 9	5, 5, 5	7, 7, 8	12, 12, 12
9	9, 10, 10	4, 5, 5	7, 7, 7	13, 14, 14
10	8, 9, 10	5, 5, 5	7, 7, 7	13, 14, 14
11	9, 9, 10	6, 6, 7	8, 8, 9	10, 11, 12
12	9, 10, 10	9, 10, 12	9, 10, 10	14, 14, 14
13		5, 6, 6	11, 11, 11	12, 13, 14
14		6, 7, 10	10, 10, 11	12, 13, 14
15		6, 10, 10	12, 12, 12	14, 14, 14
16		6, 13, 13	12, 12, 12	13, 13, 14
17		6, 7, 7	10, 10, 12	12, 12, 14
18		6, 6, 7	8, 8, 8	8, 9, 9
19	7, 7, 8	5, 5, 5	8, 8, 9	8, 8, 9
20	7, 8, 8	5, 6, 6	8, 8, 9	8, 8, 9
21	8, 8, 9	5, 6, 6	8, 8, 8	6, 7, 7
22	7, 8, 8	5, 6, 6	8, 8, 8	7, 8, 15
23	6, 7, 7	5, 6, 6	8, 9, 9	10, 11, 13
24	7, 8, 9	6, 6, 7	12, 14, 16	11, 11, 12
25	6, 7, 8	6, 8, 10	11, 12, 16	13, 15, 15
26		5, 5, 8	10, 12, 12	11, 12, 13

HANFORD TOWNSITE
PENINSULA



- SCALE
→ 100 YARDS
- ☐ REFERENCE MARKER
- GRID POINT
- /// BLUFF

Continued

Uncorrected μR Meter Reading @ 1m Above Ground
($\mu\text{R}/\text{hr}$)

	Track E	Track F	Track G	Track B	Track C	Track D	Track E
1							
2				4, 6, 6	8, 9, 9	9, 10, 11	14, 14, 14
3				5, 5, 5 (b)	8, 8, 9	8, 8, 9	12, 12, 12
4				4, 5, 5	8, 9, 10	9, 9, 9	10, 12, 13
5				5, 5, 5	8, 8, 9	5, 6, 7	10, 11, 14
6	10, 10, 10			5, 5, 5	7, 8, 8	6, 7, 7	11, 13, 16
7	8, 10, 10				7, 8, 8	6, 6, 7	12, 14, 18
8	10, 10, 12	11, 12, 14			6, 6, 6	6, 7, 7	10, 14, 14
9	8, 10, 11	10, 10, 12			6, 6, 6	6, 6, 6	10, 10, 10
10	8, 8, 10	8, 12, 14					
11	8, 8, 10	10, 10, 11					
12	10, 12, 12	9, 10, 11					
13	14, 16, 20 (a)	18, 10, 20 (a)					
14	14, 18, 20 (a)	17, 18, 20 (a)					
15	17, 20, 20 (a)	24, 25, 30 (a)					
16	16, 16, 20 (a)						
17	18, 18, 20 (a)		18, 20, 20 (a)				
18	18, 20, 22 (a)		10, 11, 12 (a)				
19	23, 24, 24 (a)	14, 14, 15	9, 10, 10				
20	12, 14, 18	15, 16, 19	13, 14, 15				
21	14, 15, 16	12, 14, 20 (a)	9, 10, 11				
22	12, 12, 12	14, 15, 20 (a)	10, 10, 11				
23	16, 16, 17	10, 14, 15					
24	16, 16, 16						
25	17, 18, 18						
26	12, 12, 20 (a)						

Columbia River Shoreline Survey
Savage Island Slough - Upstream End

Date/Time: 7-3-79; 0900-1400
River Flow Rate (CFS): 66,700-87,000

Size of Survey Plots: 10' x 10'

Formal Grid: See map - next page.

Discrete Particulate Contamination ($\mu\text{R/hr}$ at ground surface):

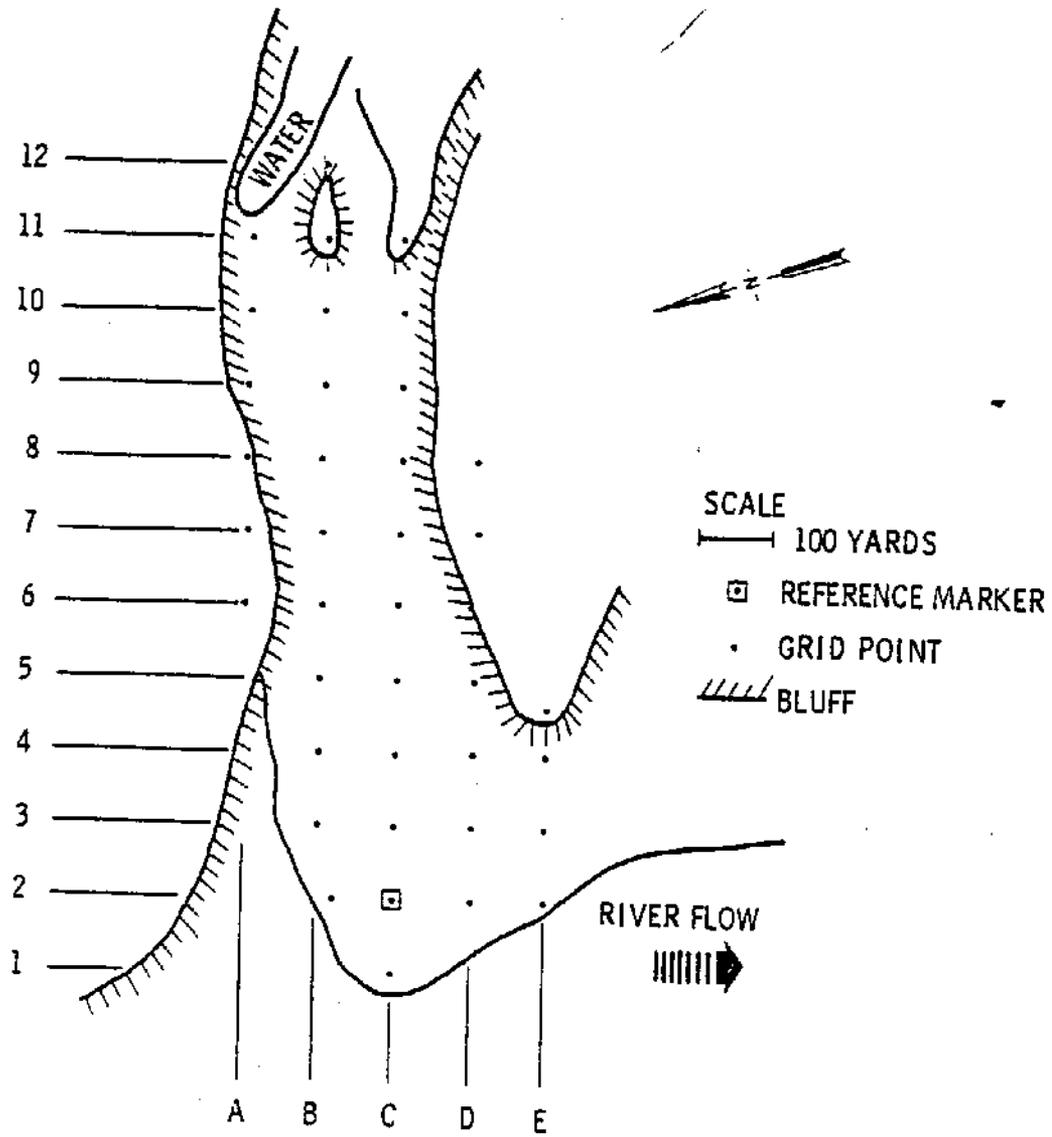
- (a) 100
- (b) 150
- (c) 100 Willows
- (d) 40

Areas with general contamination $\geq 25 \mu\text{R/hr}$ indicated by the symbol \square .

Uncorrected μR Meter Reading @ 1m Above Ground
($\mu\text{R/hr}$)

	A	B	C	D	E
1	6, 6, 6		7, 8, 9		
2	5, 5, 6	10, 12, 14(b)	13, 19, 19	11, 11, 11	10, 10, 10(a)
3		10, 10, 11	20, 20, 28 \square	12, 12, 12	10, 10, 10
4		10, 10, 16	18, 18, 18	12, 12, 12	12, 12, 12
5		15, 10, 10	15, 16, 14	15, 15, 15	14, 12, 12
6	6, 6, 6	14, 10, 14(c)	15, 16, 16	14, 14, 14	
7	5, 5, 6	10, 10, 12	13, 13, 13	10, 10, 10	
8	6, 5, 5	8, 10, 12	13, 13, 13	10, 10, 10	
9	9, 12, 12	8, 8, 10	12, 12, 12		
10	11, 10, 11	10, 8, 8(d)	12, 12, 12		
11	8, 8, 8	8, 10, 10	12, 12, 12		
12		8, 10, 8			

SAVAGE ISLAND SLOUGH - UPSTREAM END



Columbia River Shoreline Survey
Savage Island Slough Gravel Bars

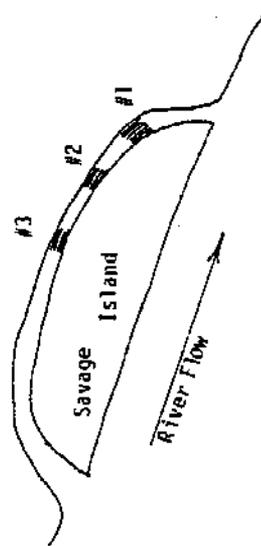
Date/Time: 6-10-79; 0800-1300
River Flow Rate (CFS): 75,500-81,200

Size of Survey Plots: 10' x 10'

General Survey.

Discrete Particulate Contamination ($\mu R/hr$ at ground surface):

(a) 900



Uncorrected μR Meter Reading @ 1m Above Ground
($\mu R/hr$)

Gravel Bar #1
9, 10, 10
10, 9, 10
9

Gravel Bar #2
11, 12, 9
11, 7, 9
7

Gravel Bar #3
8, 8, 7
7, 7, 11 (a)

Columbia River Shoreline Survey
Island-355 (Ringold Island)

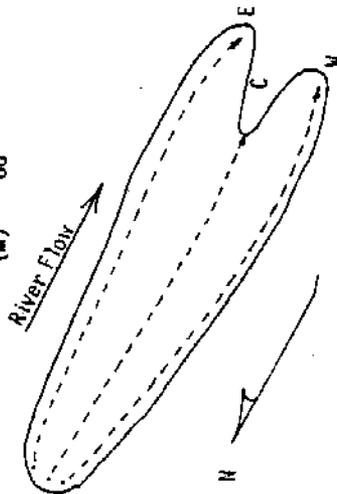
Date/Time: 6-6-79; 0830-1330
River Flow Rate (CFS): 74,600-115,200

Size of Survey Plots: 10' x 10'

Informal Grid: Three tracks walked from North to South. Three plots surveyed every 100 yd interval.

Discrete Particulate Contamination ($\mu\text{R/hr}$ at ground surface):

- (a) 3000
- (b) 1000
- (c) 150
- (d) 800
- (e) 350
- (f) 3000
- (g) 300
- (h) 100
- (i) 100
- (j) 130
- (k) 100
- (l) 200
- (m) 60



Uncorrected μR Meter Reading @ 1m Above Ground
($\mu\text{R/hr}$)

West Bank	Center	East Bank
8, 8, 8	9, 9, 10	6, 6, 8 (1, J)
8, 8, 8 (a)†	9, 10, 9 (d, e)	6, 6, 7 Rocks
9, 8, 8	8, 8, 8 Willows	8, 6, 6 †
9, 7, 8	8, 9, 9	6, 6, 6
8, 9, 9	8, 8, 8 Rocks, Weeds	6, 6, 6
20, 15, 10 50	8, 8, 9	6, 6, 6
8, 10, 10 (b)	8, 8, 8	6, 6, 6
12, 10, 9 (c)	8, 9, 10	6, 6, 6
9, 8, 10	11, 9, 10	6, 6, 6 (k)
10, 9, 11	8, 6, 7	6, 6, 6 (l)
10, 12, 10	7, 6, 9 (f)	6, 6, 6
10, 9, 10	10, 9, 10 (g, h)	6, 6, 6
10, 9, 10	11, 10, 10	8, 8, 8
10, 9, 8	11, 11, 11	8, 8, 8
8, 7, 7	10, 9, 8	8, 8, 8
7, 8, 9	10, 9, 11	8, 8, 8
8, 7, 7	- , - , -	8, 8, 8
- , - , -	- , - , -	8, 8, 8 (m)

North

South

Columbia River Shoreline Survey
Island-353

Date/Time: 7-3-79; 1500-200
River Flow Rate (CFS): 118,000-124,800

Size of Survey Plots: 10' x 10'

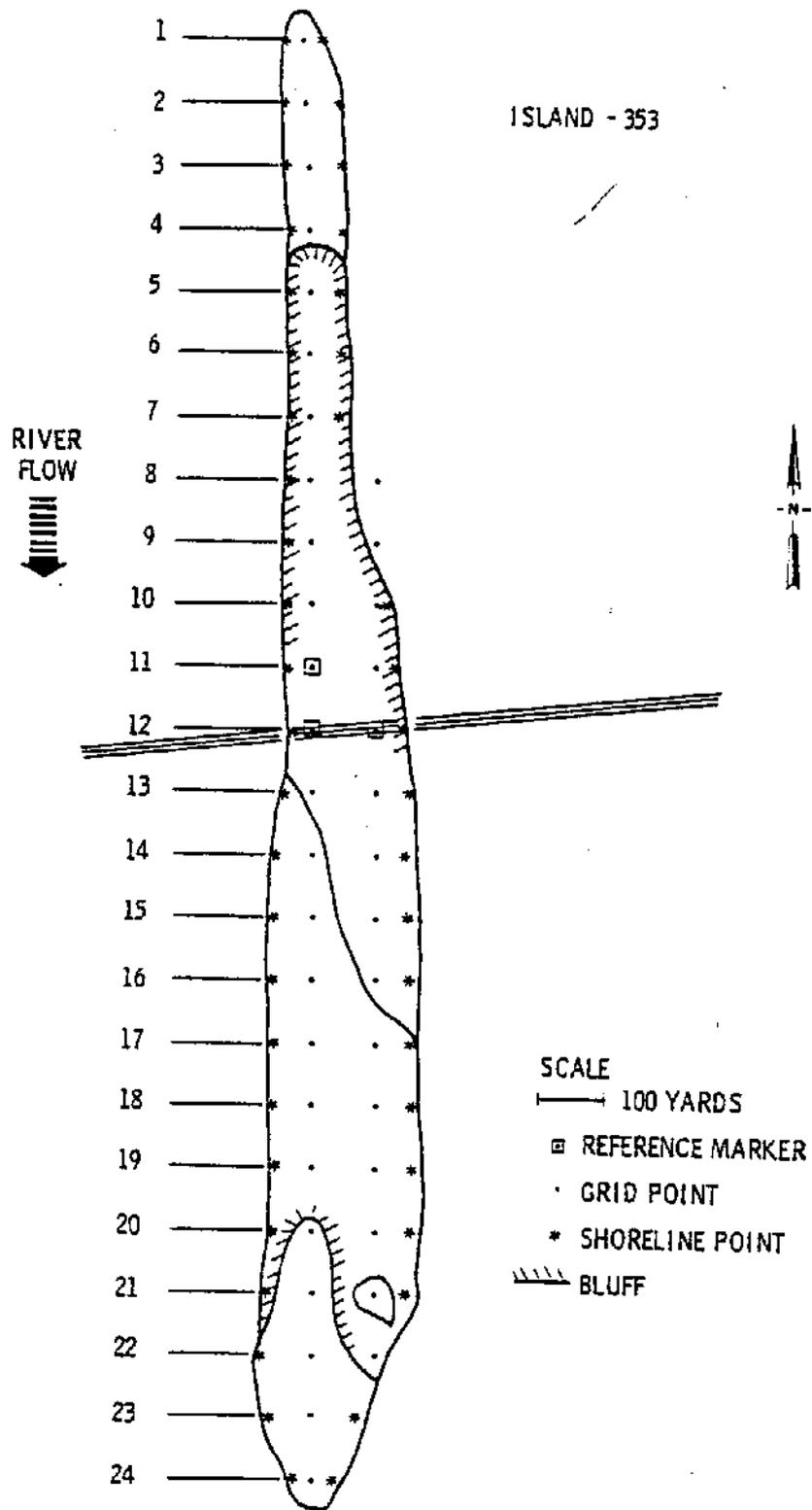
Formal Grid: See map - next page

Discrete Particulate Contamination ($\mu\text{R/hr}$ at ground surface):

- (a) 140
- (b) 1800
- (c) 220
- (d) 150
- (e) 280
- (f) 1000
- (g) 200
- (h) 160

Uncorrected μR Meter Reading @ 1m Above Ground
($\mu\text{R/hr}$)

	West Shore	West Inland	East Inland	East Shore
1	8,10, 8	7, 7, 7	5, 4, 4	
2	8,10, 8	8, 8, 7	5, 6, 5	
3	10, 8,10	8, 8, 8	5, 5, 5	
4	10,10, 8(a)	9, 9, 9	5, 5, 5	
5	10,10, 6(b)	9, 9, 9	5, 5, 6	
6	10,10,10	9, 9, 9	6, 5, 6	
7	10, 6, 6	9, 9, 9	7, 8, 7(f)	
8	8,10,10	8, 9, 9	8, 8, 7(g)	
9	10, 8,10	9, 9, 8	7, 8, 7	
10	8,10, 8	9, 9, 9	6, 7, 7	8, 7, 7
11	8,10,10	9, 9, 9	7, 7, 8	7, 7, 7
12	10, 6,10	8, 8, 9	8, 8, 7	8, 7, 7
13	8,10, 8	10,10,11	8, 7, 8	8, 7, 7
14	8, 8,10	11,16,16	8, 8, 8	7, 8, 8
15	10,10, 6	14,14,14	9, 8,11	8, 7, 7
16	10, 6,10	11,11,10	9, 9, 9	7, 7, 8
17	8, 6, 8	10,10,10(d)	9, 9, 8	8, 9, 9
18	8, 6, 8	11,11,11(e)	8, 8, 9	8, 9, 8
19	8, 6, 6	10,10,11	8, 9, 9	9, 9, 8
20	8, 8, 6	12,12,11	9,14, 7	9, 9, 8
21	8, 8, 8	11,11,11	8, 8, 8	9, 9, 8
22	10,10, 8	10,10,10	8, 8, 8	9, 9, 8
23	10,10,10	10,10,10	8, 8, 8	-
24	10,10, 8	10, 9, 9	8, 8, 7	-
25				8, (h)



Columbia River Shoreline Survey
Island-352

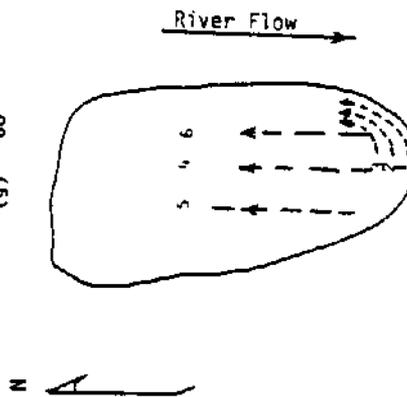
Date/Time: 6-21-79; 1500-2000
River Flow Rate (CFS): 116,400-120,000

Size of Survey Plots: 10' x 10'

Informal Grid: Paths walked as shown. Three plots surveyed every 100 yds. Spacing between shoreline tracks was 50'.

Discrete Particulate Contamination ($\mu\text{R/hr}$ at ground surface):

- (a) 250
- (b) 250
- (c) 180
- (d) 200
- (e) 600
- (f) 1200
- (g) 60



Uncorrected μR Meter Reading @ 1m Above Ground
($\mu\text{R/hr}$)

Track 1	Track 2	Track 3
9, 8, 9 Rocky	11, 12, 12 Rocky	9, 8, 9 Rocky
8, 8, 8	12, 8, 9	9, 8, 8
8, 8, 8	10, 9, 7	8, 10, 10
8, 8, 8	8, 12, 11	10, 10, 10 (a)
8, 8, 8	9, 10, 10	10, 10, 9
8, 8, 8	8, 11, 8	10, 9, 10
8, 8, 9	8, 9, 8	9, 10, 9
8, 8, 8	10, 7, 8	9, 9, 9
8, 9, 8	9, 8, 8	10, 9, 9
8, 8, 8	10, 7, 8	10, 10, 9
8, 8, 9	7, 6, 8	9, 9, 10
9, 9, 8	8, 9, 6	9, 10, 9 (b)
8, 8, 8	8, 9, 9	9, 9, 9 (c)
8, 8, 8	8, 7, 7	10, 11, 10
9, 8, 8	7, 6, 8	12, 11, 11 (d)
8, 8, 8	7, 7, 7	10, 10, 11
8, 8, 8	7, 7, 7	11, 12, 10 Sand
8, 8, 8	8, 8, 8	10, 12, 12
8, 8, 8	10, 10, 10 Sandy	11, 11, 11
8, 8, 10	12, 12, 10	13, 11, 12
9, 8, 8	8, 8, 8 Rocky	11, 11, 11
9, 9, 8	8, 8, 8	10, 13, 12
8, 8, 8	7, 7, 7	10, 10, 10
8, 8, 8	6, 6, 6	9, 9, 10 Rocky
8, 8, 9	6, 6, 6	9, 8, 8
8, 8, 8	6, 6, 6	8, 8, 8

South End

Uncorrected μ R Meter Reading θ in Above Ground
(μ R/hr)

Inland		Track 4	Track 5 *	Track 6	Track 1	Track 2	Track 3
South End		5, 5, 6	8, 8, 8	10, 8, 9 Rocky, Grass	8, 8, 8	7, 7, 7	8, 8, 8
		5, 5, 4	8, 10, 8	8, 10, 9 Grass	8, 8, 8	7, 7, 7	8, 9, 8
		5, 5, 5	6, 8, 8	9, 8, 8 (g) †	8, 8, 8	6, 6, 6	8, 8, 8
		5, 6, 5	8, 8, 8	10, 8, 9	8, 8, 8	6, 6, 6	9, 8, 8
		6, 6, 6	8, 8, 10	8, 10, 10	8, 8, 8	6, 6, 6	8, 8, 8
		5, 5, 6	8, 6, 8	10, 10, 10	8, 8, 8	6, 6, 6	7, 8, 7
		6, 5, 5	8, 8, 10	10, 10, 12	8, 8, 9	6, 6, 6	7, 8, 7
		5, 5, 6	6, 6, 6	8, 8, 10 Willows	8, 8, 8	6, 6, 6	7, 8, 8
		6, 6, 7 Mulberry Tree	8, 8, 6	10, 10, 10	8, 7, 8	6, 6, 6	9, 8, 8
		5, 5, 5	8, 8, 8	10, 10, 10 Low Veg.	7, 8, 8	7, 6, 7	9, 8, 9
		5, 5, 5	10, 8, 8	10, 10, 10	8, 8, 8	5, 7, 6	9, 9, 9
		5, 5, 5 Flume	8, 10, 8	10, 10, 10 Trees	8, 8, 8	6, 6, 6	8, 8, 7
		6, 5, 5	8, 10, 10	10, 10, 8 Grass	8, 8, 8	7, 6, 6	8, 9, 8
		4, 4, 5	8, 12, 8	8, 8, 10 †	8, 8, 7	6, 6, 6	8, 8, 8
		5, 4, 6	8, 6, 8	9, 10, 10	8, 8, 8	6, 6, 6	8, 8, 9
		6, 6, 5	6, 10, 8	10, 10, 10	8, 8, 8	6, 6, 6	9, 8, 8
		5, 6, 5	6, 8, 8 (f)	9, 10, 10	8, 8, 8	6, 6, 6	7, 9, 7 Sand Dunes
		4, 4, 3		10, 10, 10	8, 8, 8	6, 6, 6	7, 10, 8
		4, 4, 3		9, 10, 8	8, 8, 8	6, 6, 6	8, 8, 9
				10, 8, 8	8, 8, 8	6, 6, 6	9, 9, 9
				6, 8, 10	9, 8, 9	6, 6, 6	9, 8, 9
				8, 8, 8	8, 9, 9	6, 6, 6 Sand, Weeds	8, 9, 8
					7, 8, 8 Beach	7, 7, 7	8, 9, 8 Rocks
					8, 8, 7 †	7, 7, 7	8, 8, 9 †
					8, 8, 8	7, 7, 7	9, 9, 10
					8, 8, 8 Rocks	8, 8, 8	10, 9, 8

(Cont.)

North End

* Presurvey calibration check showed this instrument to read low by a factor of 2. Values reported here have been corrected.

Uncorrected μR Meter Reading @ 1m Above Ground
($\mu\text{R}/\text{hr}$)

Track 1	Track 2	Track 3
8, 8, 8	7, 7, 7	8, 9, 9
9, 9, 8	6, 6, 6	9, 9, 10
7, 7, 7	8, 8, 8	9, 9, 9 (e)
8, 8, 8	8, 8, 8	10, 10, 10
8, 8, 8	11, 11, 11	10, 9, 8 Sand
8, 8, 8	8, 8, 8	8, 8, 8
7, 7, 7	10, 10, 10	8, 7, -
8, 8, 8	8, 8, 8	
9, 8, 9 Beach	9, 9, 9	
9, 9, 10	8, 8, 8	
9, 9, 9	7, 7, 7	
8, 8, 7	7, 7, 7	
	8, 8, 8	

(Cont.)

Columbia River Shoreline Survey
Ringold Peninsula

Date/Time: 7-5-79; 1600-2000
River Flow Rate (CFS): 74,000-103,800

Size of Survey Plots: 10' x 10'

Formal Grid: See map - next page.

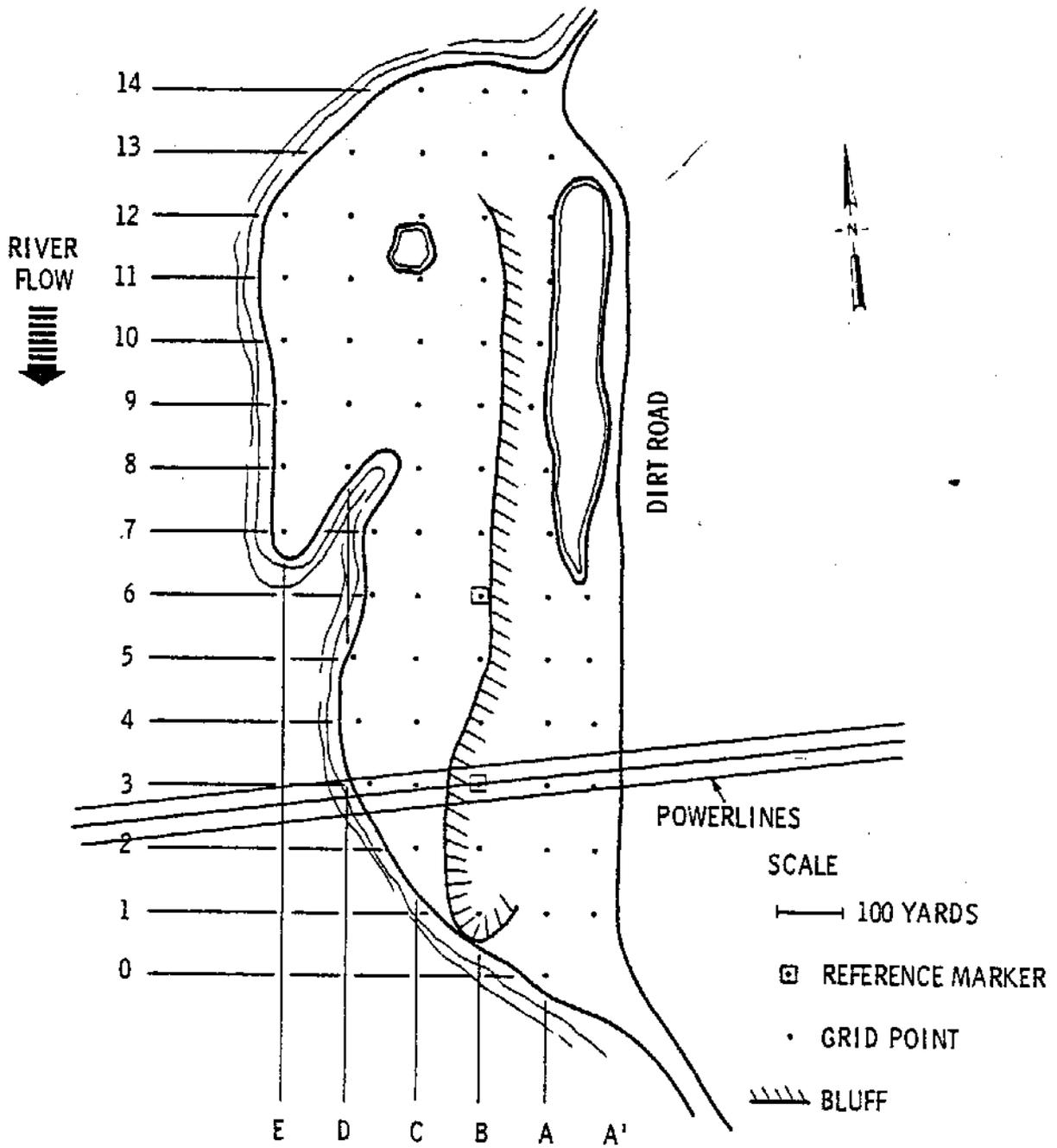
Discrete Particulate Contamination ($\mu\text{R/hr}$) at ground surface:

- (a) 200 Rocks and Sand
- (b) 625 Found in sandy washout
- (c) 1600 Rocks

Uncorrected μR Meter Reading @ 1m Above Ground
($\mu\text{R/hr}$)

East of A	Track A	Track B	Track C	Track D	Track E
0	10,10,11	10,10,15			
1	8, 8,10	10,10,15			
2	8, 8,10	14,14,15	9, 9, 9		
3	10,12,12	12,13,13(b)	8, 8, 8	6, 6, 6	
4	8,11,13	10,12,12	8, 8, 8	4, 6, 6(c)	
5	11,12,12	8, 9,10	8, 8, 8	6, 6, 6	
6	10,11,11	11,11,12	8, 8,10	4, 6, 6	
7	10,10,12	9,12,12	8,10,10	4, 6, 6	4, 4, 6
8		9,14,14	8, 8, 8	4, 6, 6	4, 4, 6
9		9,10,10	8, 8, 8	6, 6, 6	6, 6, 6
10		9,10,12	8, 8, 8	6, 6, 8	4, 4, 6
11		10,10,10	8, 8, 8	6, 8, 8	4, 4, 6
12		8,11,12	10,10,10	6, 6, 8	4, 4, 6
13		8, 9,10	10,10,10	6, 6, 8	4, 4, 6
14		11,11,13	8, 8, 8	6, 6, 8	
15		10,10,12	8, 8, 8	6, 6, 8	

RINGOLD PENINSULA



Columbia River Shoreline Survey
Island-350

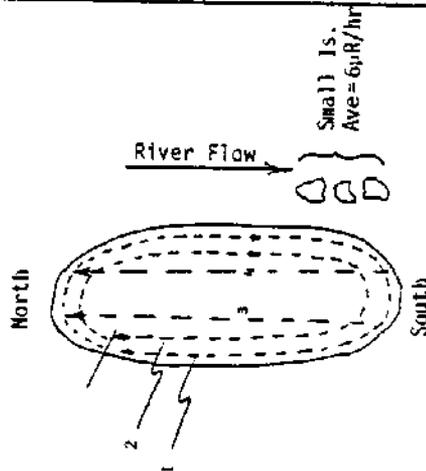
Date/Time: 6-21-79;0800-1300
River Flow Rate (CFS): 71,900-77,400

Size of Survey Plots: 10' x 10'

Informal Grid: Four paths walked as shown.
Three plots surveyed every 100 yd interval.

Discrete Particulate Contamination ($\mu\text{R/hr}$ at ground surface):

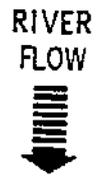
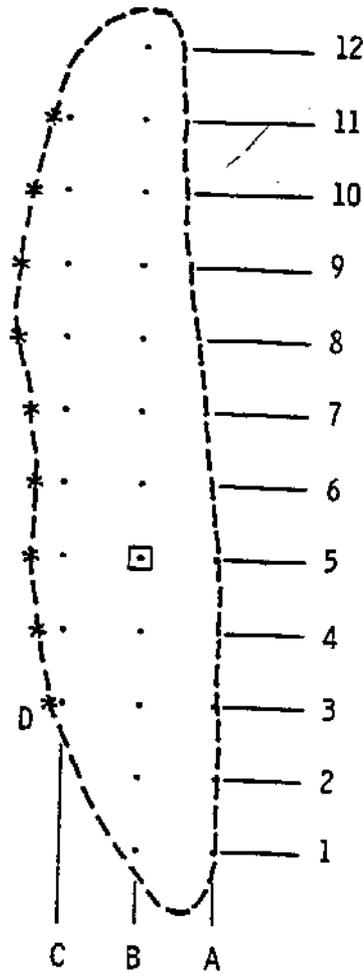
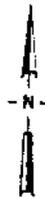
(a)	400	(f)	95
(b)	3000	(g)	60
(c)	120	(h)	200
(d)	100	(i)	280
(e)	120	(j)	450
		(k)	325
		(l)	150



Uncorrected μR Meter Reading @ 1m Above Ground
($\mu\text{R/hr}$)

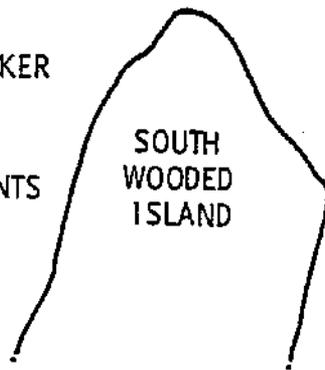
Shoreline 1	Shoreline 2	Track 3	Track 4
9, 11, 10 (a)	9, 10, 11	8, 9, 10	7, 8, 9
9, 9, 9	10, 9, 9	10, 10, 10	8, 8, 9
9, 9, 9	10, 10, 11	10, 10, 10	9, 9, 9
8, 8, 8	10, 9, 9	10, 11, 11	9, 10, 11
8, 7, 7 S. End	8, 8, 8 S. End	12, 12, 12	13, 14, 12
7, 7, 6	7, 8, 8	12, 12, 10	11, 11, 10
12, 8, 7 (b)	8, 8, 8	10, 10, 10	12, 12, 11
8, 8, 8	8, 9, 8 (f)	8, 10, 10	11, 13, 9 (1)
8, 8, 8 (c)	8, 9, 9	- , - , -	- , - , -
8, 8, 8	9, 9, 9	- , - , -	- , - , -
8, 8, 8	9, 9, 10	- , - , -	- , - , -
8, 8, 8	9, 9, 9	- , - , -	- , - , -
8, 8, 8	9, 9, 9	- , - , -	- , - , -
7, 6, 6	10, 11, 8 (g)		
8, 8, 8 (d)	7, 8, 8		
8, 8, 8	8, 7, 9		
8, 7, 7	9, 8, 8 (h)		
6, - , - N. End	9, 8, 8 N. End		
7, 8, 7	7, 8, 8		
8, 8, 8	9, 8, 9		
8, 8, 10	9, 10, 10 (i)		
10, 8, 9 (e)	11, 11, 11		
9, 9, 9	10, 10, 9 (j)		
9, 9, 9	10, 9, 9		
9, 9, 10	10, 9, 11 (k)		
9, 9, 10	10, 9, 10		

ISLAND - 349
(NORTH WOODED ISLAND)



SCALE
 100 YARDS

-  REFERENCE MARKER
-  GRID POINT
-  SHORELINE POINTS



Uncorrected μ R Meter Reading @ 1m Above Ground
(μ R/hr)

A	B	C	D
9, 9, 9 Rocky	4, 5, 6 Rocky	12, 12, 12 Rocky	9, 11, 8 Rocky
9, 8, 9 ↓	7, 6, 4 ↓	12, 12, 12 ↓	10, 8, 9 ↓
8, 7, 9	6, 5, 7	12, 12, 12	9, 8, 10
8, 7, 8	7, 8, 7	8, 8, 8	10, 12, 10
8, 8, 8	7, 5, 8	8, 8, 8	9, 8, 9
8, 8, 8	7, 7, 5	8, 8, 8	10, 9, 11
8, 8, 8	6, 5, 6	8, 8, 8	8, 10, 11
8, 8, 8	4, 3, 6	8, 8, 8	10, 9, 11
9, 8, 8	5, 4, 3	8, 8, 8	11, 9, 10
8, 8, 8	3, 3, 3	8, 8, 8	
8, 8, 8	3, 3, 3	8, 8, 8	
8, 8, 8	4, 3, 3	8, 8, 8	

Columbia River Shoreline Survey
Island-349
(North Wooded Island)

Date/Time: 6-9-79; 1145-1345
River Flow Rate (CFS): 79,200-97,200

Size of Survey Plots: 10' x 10'

Formal Grid: See following map.

Columbia River Shoreline Survey
Island-348
(South Wooded Island)

Date/Time: 6-9-79:0800-1700
River Flow Rate (CFS): 183,000

Size of Survey Plots: 10' x 10'

Formal Grid: See following map.

Discrete Particulate Contamination ($\mu\text{R/hr}$ at ground surface):

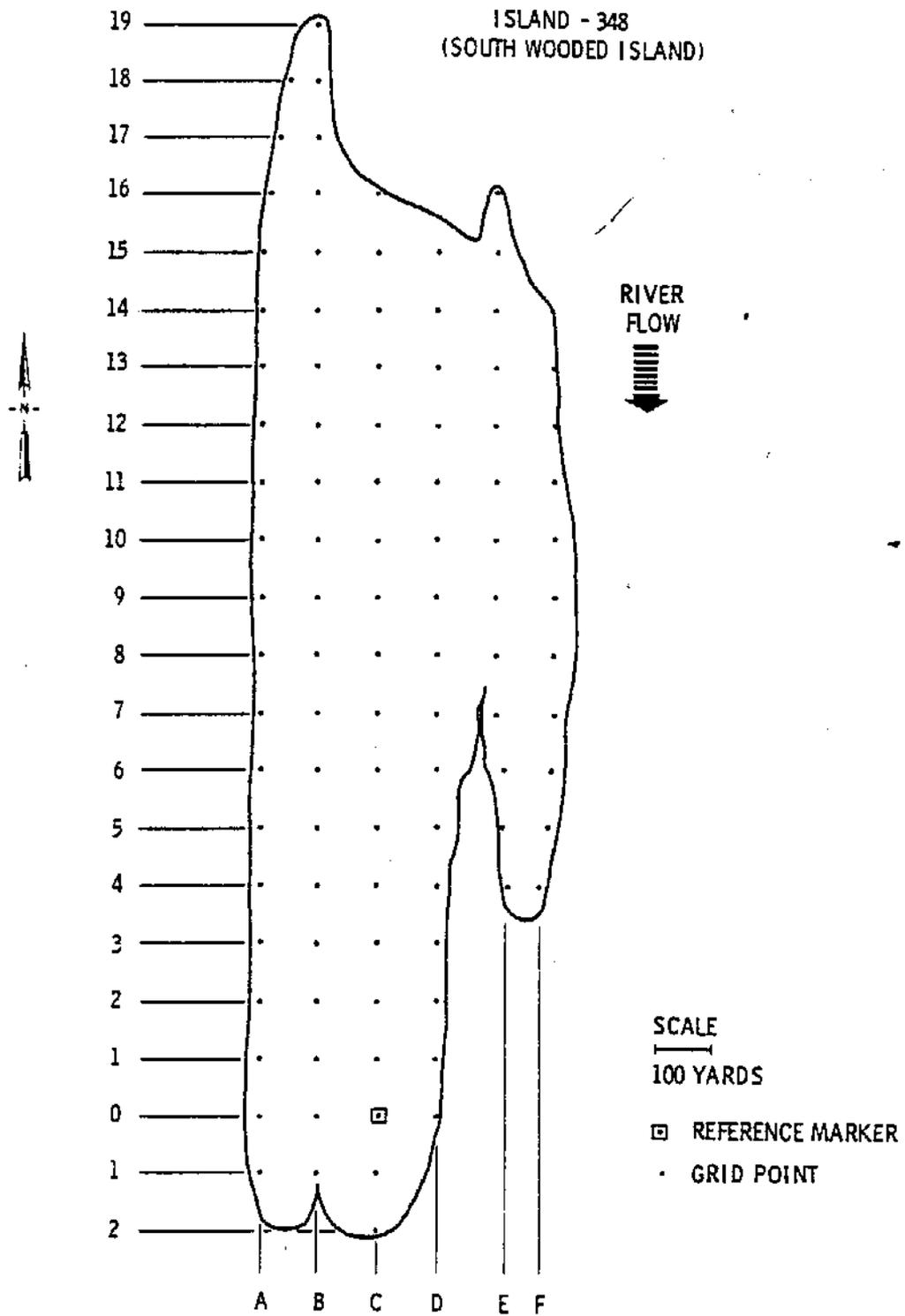
- (a) 180
- (b) 400

Uncorrected μR Meter Reading @ 1m Above Ground
($\mu\text{R/hr}$)

	A	B	C
-2	11,13,11	10,12,13	11,11,9
-1	13,11,12	13,12,15	15,10,10
0	15,11,10	14,19,18	9,9,9
1	6,7,6	15,18,18	8,8,8
2	5,8,6	16,16,16	8,8,8
3	6,8,7	12,10,10	8,8,8
4	8,11,15	10,10,10	8,8,8
5	6,10,12	12,10,10	8,8,8
6	7,8,7	11,11,11	8,8,8
7	5,6,7	11,11,11	8,8,8
8	6,6,6	11,11,10	8,8,8
9	6,6,8	13,13,12	8,8,12
10	6,5,6	12,12,14	12,12,12
11	7,4,4	13,15,14	12,12,12
12	5,6,6	14,14,15	12,12,12
13	5,4,7	15,14,14	8,8,8
14	5,9,8 On Bluff	16,15,15	8,8,8
15	5,8,8	15,13,14	8,8,8
16	7,4,5	14,13,13	8,8,8
17	5,5,5	14,10,13 Rocks	8,8,8
18	5,4,7	14,12,13	8,8,8
19		12,12,13	

Uncorrected μR Meter Reading @ 1m Above Ground
($\mu\text{R}/\text{hr}$)

	D	E	F
-2			
-1	8, 12, 13		
0	9, 11, 13 Veg ↓		
1	10, 9, 11 ↓		
2	10, 9, 10		
3	10, 9, 10		
4	10, 9, 11		
5	9, 18, 14 Weeds ↓		
6	9, 16, 11 ↓	9, 9, 9 Rocks ↓	8, 8, 8 Rocks
7	10, 10, 11 Rocks ↓	9, 9, 9	8, 8, 8 ↓
8	12, 10, 10 ↓	9, 10, 10	11, 9, 9
9	18, 14, 15 Veg	10, 12, 11	9, 9, 9 (a)
10	9, 10, 10 Rocks	11, 10, 11	9, 9, 9 (b)
11	11, 10, 11 Veg	11, 11, 11	9, 9, 9
12	9, 8, 9 Rocks	9, 9, 9	8, 8, 9
13	10, 9, 8 ↓	9, 9, 8	7, 7, 7
14	12, 11, 10	12, 9, 9	7, 7, 7
15	12, 13, 18 Veg ↓	9, 9, 8	7, 7, 8
16			8, 8, 8
17			
18			
19			



Columbia River Shoreline Survey
Island-348-A

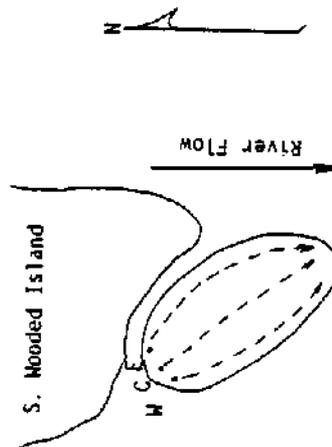
Date/Time: 6-8-79; 1300-1400
River Flow Rate (CFS): 133,500

Size of Survey Plots: 10' x 10'

Informal Grid: Three paths walked from North to South as shown. Three plots surveyed every 100 yd interval.

Discrete Particulate Contamination ($\mu\text{R/hr}$ at ground surface):

- (a) 150
- (b) 220



Uncorrected μR Meter Reading @ 1m Above Ground
($\mu\text{R/hr}$)

West Bank (W)
8, 8, 12
10, 11, 15
11, 14, 10 (a, b)
12

Center (C)
10, 12, 15 High Veg
12, 14, 15
11, 12, 15
18, 15, 14

East Bank (E)
9, 12, 12
11, 12, 12
10, 10, 10
12, 12, 12

Columbia River Shoreline Survey
Island-345

Date/Time: 4-27-79;0800-1600
5-03-79;0800-1600
River Flow Rate (CFS): 76,400-106,000
79,200-134,800

Size of Survey Plots: 10' x 10'

Formal Grid: See following map.

Areas with general contamination > 25 µR/hr
indicated by the symbol □.

Uncorrected µR Meter Reading @ 1m Above Ground
(µR/hr)

NW Quadrant						NE Quadrant					
1	2	3	4	5	6	1	2	3	4	5	6
10	12	18	11	12	10	18	15	11	13	7	7
8	13	17	10	12	11	21	16	13	14	5	6
8	12	18	11	12	8	21	17	11	14	7	5
6	12	15	12	11	9	19	15	13	13	7	5
7	13	14	10	14	4	23	14	12	13	9	4
9	12	15	11	14	6	16	15	10	11	10	5
10	11	15	11	15	4	19	13	12	15	7	6
8	14	15	11	15	4	18	14	12	15	7	5
9	11	13	11	11	4	18	17	13	17	7	6
10	5	11	11	11	4	21	16	12	14	8	6
7	9	15	9	11	4	17	13	12	13	6	7
7	10	14	9	10	4	17	9	14	13	7	7
6	11	13	7	10	4	20	17	12	12	7	5
6	10	13	9	14	5	19	19	12	10	7	6
7	9	11	9	13	4	17	17	11	11	7	7
7	9	13	9	12	5	18	16	10	11	7	7
7	10	13	7	13	5	17	14	10	11	-	-
6	9	11	7	12	9	17	13	10	11	-	-
6	9	12	8	-	-	15	11	11	11	-	-
7	9	12	7	-	-	14	13	10	8	-	-
7	7	12	8	-	-	16	13	12	10	-	-
7	8	12	7	-	-	13	12	10	11	-	-
6	9	13	8	-	-	15	13	8	10	-	-
7	9	13	8	-	-	14	13	8	11	-	-
6	8	10	8	-	-	15	12	9	9	-	-
7	8	11	7	-	-	15	11	9	10	-	-

Uncorrected μR Meter Reading @ 1m Above Ground
($\mu\text{R}/\text{hr}$)

NW Quadrant					
1	2	3	4	5	6
7	7	11	7	-	-
7	7	11	8	-	-

NE Quadrant					
1	2	3	4	5	6
13	11	7	10	-	-
13	11	7	10	-	-

SW Quadrant

1	2	3	4	5	6	7	8
11	8	16	12	10	6	5	6
12	8	16	11	11	6	4	6
12	7	19	11	14	7	6	6
12	7	16	13	12	7	6	7
13	7	15	12	14	6	5	6
12	6	18	12	12	7	6	6
12	5	18	10	13	7	6	6
12	6	17	11	14	7	6	7
12	6	18	13	14	7	6	6
12	7	19	12	16	7	4	6
12	6	21 ⁵⁶	11	15	7	5	6
11	6	20 ⁵⁷	14	14	6	5	6
11	5	20 ⁵⁸	15	14	7	5	6

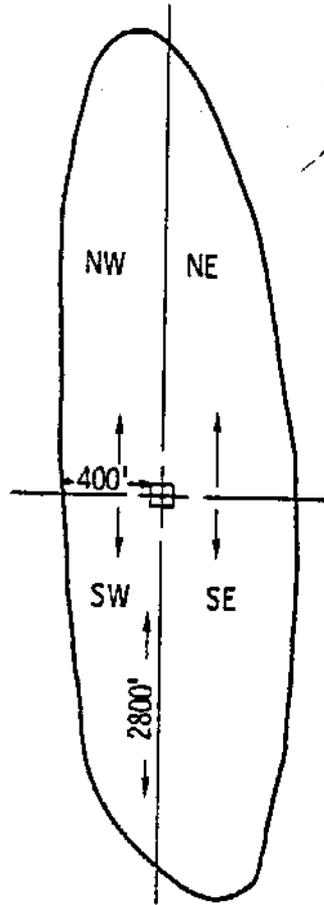
SE Quadrant

1	2	3	4	5	6	7	8
18	18	12	15	14	6	6	6
19	19	10	13	12	6	6	6
19	19	10	14	9	4	5	6
17	17	10	15	11	3	7	5
15	17	11	12	9	3	7	6
15	16	10	12	13	5	5	5
15	17	10	12	10	6	7	6
14	16	10	14	10	6	6	5
16	16	8	14	10	7	6	6
17	15	9	13	9	6	6	5
14	15	8	12	10	6	6	5
16	15	8	13	11	6	5	4
14	15	8	14	10	7	5	-

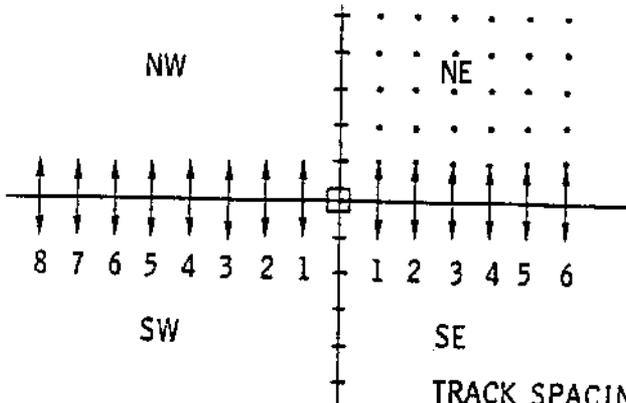
Uncorrected μR Meter Reading @ 1m Above Ground
($\mu\text{R}/\text{hr}$)

SW Quadrant								SE Quadrant							
1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
9	4	20 ⁵⁹	15	14	8	7	5	14	16	8	11	10	6	6	-
10	6	16	14	17	8	5	5	15	14	8	11	12	7	6	
9	5	17	13	17	9	6	6	14	14	8	10	11	7	5	
9	4	17	15	18	9	6	6	15	14	8	11	10	6	7	
9	5	17	13	18	9	7	6	15	13	8	9	10	7	5	
9	10	17	12	17	9	7	5	14	13	8	12	10	6	6	
8	10	14	12	19	9	7	6	13	13	7	10	11	6	4	
9	9	14	12	17	8	7	6	13	13	7	9	11			
8	9	15	13	18	9	5	7	13	15	8	9	14			
8	9	15	12	17	9	5	5	12	11	8	10	12			
9	5	15	11	17	9	7	6	15	8	7	9	14			
9	4	16	13	20 ⁶⁰	10	5	7	13	13	7	9	12			
8	5	16	13	18 ⁶¹	10	7	6	13	9	7	10	13			
8	4	15	11	20	10	7	6	11	9	8	9	14			
9	9	16	10	18	9	6	5	11	8	7	10	14			
				19	5	7	6								
				18	4	7	6								
				18	4	8	6								
				17	4	7	6								
				15	9	7	7								
				17	4	7	6								
				16	5	8	7								
				15	4	7	6								

ISLAND - 345



SURVEY GRID



TRACK SPACING - 50'

SURVEY POINT SPACING - 50'

• GRID POINT

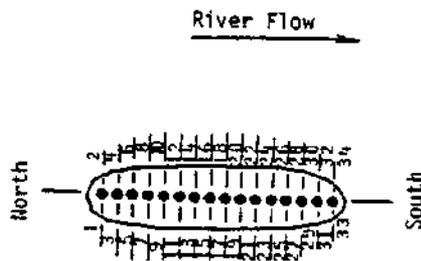
Columbia River Shoreline Survey
Island-344

Date/Time: 5-24-79; 0900-1200
River Flow Rate (CFS): 120,000-133,500

Size of Survey Plots: 10' x 10'

Informal Grid: Island divided lengthwise into East and West halves, then into 100 yds segments from North to South as shown. Three plots surveyed in each section.

Discrete Particulate Contamination ($\mu\text{R/hr}$ at ground surface): (a) 400
Areas with general contamination $\geq 25 \mu\text{R/hr}$ indicated by the symbol \square .



Uncorrected μR Meter Reading @ 1m Above Ground
($\mu\text{R/hr}$)

1	7, 8, 7	18	6, 6, 6
2	4, 4, 4	19	7, 8, 8
3	8, 7, 7	20	30, 6, 6 (a) \square 30
4	5, 4, 5	21	7, 8, 9
5	7, 7, 7	22	6, 7, 7
6	5, 5, 5	23	8, 7, 8
7	7, 7, 7	24	6, 7, 7
8	6, 10, 6	25	7, 7, 8
9	8, 7, 7	26	6, 7, 7
10	6, 6, 6	27	8, 14, 8
11	7, 7, 7	28	10, 10, 9
12	6, 6, 6	29	7, 7, 7
13	6, 8, 7	30	6, 6, 8
14	6, 5, 6	31	7, 7, 8
15	7, 7, 7	32	4, 5, 4
16	8, 8, 6	33	8, 7, 8
17	8, 8, 7	34	4, 4, 4

Columbia River Shoreline Survey
Island-342
(Third Island)

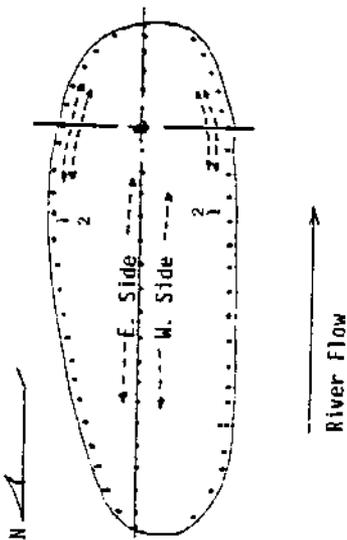
Date/Time: 6-28-79; 1500-2000
River Flow Rate (CFS): 137,400-156,100

Size of Survey Plots: 10' x 10'

Informal Grid: Island staked as shown on map. Stakers used to orient surveyors as paths walked to North and South of reference stake. Three plots surveyed every 100 yds. Shoreline tracks spaced 50 ft. apart with outside track between water and dally high water mark

Discrete Particulate Contamination ($\mu\text{R/hr}$ at ground surface):

- (a) 220
- (b) 100 Sandy
- (c) 300 Rocky



Uncorrected μR Meter Reading @ 1m Above Ground
($\mu\text{R/hr}$)

	West Shore Track 1	West Shore Track 2	West Side
N 23	12, 12, 10	11, 10, 9	6, 6, 8
22	11, 10, 12	6, 10, 9	6, 8, 8
21	9, 10, 10	8, 9, 11	6, 6, 8
20	8, 9, 9	7, 9, 8	6, 6, 8
19	8, 8, 8	7, 8, 8	8, 6, 6
18	8, 8, 8	9, 8, 8	6, 8, 10
17	8, 8, 8	6, 6, 8	6, 6, 6
16	8, 8, 8	9, 9, 8	8, 8, 6 (c)
15	9, 8, 8	9, 9, 8	8, 8, 10
14	8, 9, 8	11, 8, 8	8, 8, 8

	East Side	East Shore Track 2	East Shore Track 1
N 23	6, 7, 6	9, 9, 8	9, 8, 8
22	5, 6, 6	10, 10, 9	8, 7, 6
21	6, 5, 5	9, 9, 8 (a)	7, 7, 6
20	5, 5, 6	9, 8, 8	7, 8, 7
19	6, 6, 6	9, 9, 10	8, 8, 8
18	7, 6, 6	10, 11, 10	7, 8, 8
17	6, 6, 6	10, 10, 10	7, 7, 8
16	8, 7, 6	9, 9, 10	8, 7, 9
15	7, 7, 6	11, 10, 10	8, 9, 8
14	7, 8, 7	12, 12, 12	9, 9, 8

Island-342 (Third Island) Cont.

Uncorrected μR Meter Reading @ 1m Above Ground
($\mu R/hr$)

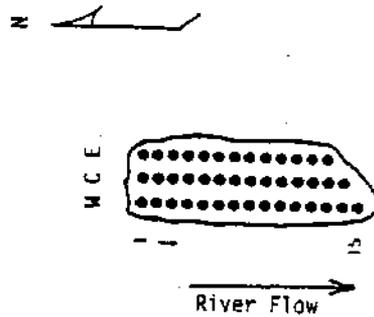
	West Shore Track 1	West Shore Track 2	West Side	East Side	East Shore Track 2	East Shore Track 1
13	8, 8, 8	8, 10, 8	10, 8, 8	8, 8, 8	11, 12, 11	9, 9, 9
12	7, 8, 8	10, 12, 8	10, 8, 10	7, 8, 8	12, 11, 12	8, 8, 8
11	8, 8, 7	7, 11, 10	8, 10, 8	8, 8, 8	11, 11, 12	9, 9, 8
10	10 - , -	11, 8, 8	8, 6, 6	8, 8, 7	10, 12, 11	8, 8, 8
9	11, 10, 10	10, 11, 10	6, 8, 9	7, 7, 8	10, 11, 10	8, 8, 8
8	14, 14, 12	8, 12, 11	6, 10, 10 (b) Sandy ↓	10, 9, 8	12, 10, 10	8, 9, 8 Steep bank
7	13, 11, 11	9, 10, 9	6, 8, 8	10, 8, 8	12, 13, 13	8, 8, 9
6	13, 12, 12	8, 9, 7	8, 6, 8	9, 8, 8	11, 10, 11	8, 9, 8
5	13, 13, 13	7, 9, 11	6, 6, 8	10, 9, 8	15, 12, 11	9, 9, 8
4	13, 14, 12	10, 9, 10	6, 8, 6	10, 10, 10	16, 16, 16	9, 9, 9
3	12, 13, 13	7, 10, 8	8, 6, 8	9, 10, 10	14, 15, 15	9, 9, 8
2	13, 14, 12	6, 9, 8	6, 6, 10	8, 8, 8	14, 13, 15	8, 8, 8
1	10, 10, 11	10, 10, 8	6, 6, 10 Rocky	8, 7, 7	12, 12, 13	8, 8, 8 Sandy Beach ↓
0	- , - , -	8, 8, 8	6, 6, 8 ↓	11, 8, 7 Grass & Sand ↓	13, 16, 18 Grass & Sand ↓	7, 8, 8
1	10, 10, 11	7, 10, 11	6, 6, 8	7, 8, 8	15, 15, 16	10, 10, 10
2	13, 14, 12	9, 10, 11	8, 8, 10 Low Veg. ↓	7, 11, 8	12, 11, 10	8, 8, 8
3	13, 14, 13	9, 9, 8	8, 10, 10 ↓	7, 7, 7	11, 12, 13	8, 8, 6
4	13, 14, 13	10, 12, 10	8, 8, 8	7, 7, 7	11, 11, 11	6, 7, 6
5	13, 11, 11	10, 7, 12	6, 6, 6 Willows	7, 7, 5	15, 15, 10	6, 6, 6
6	13, 11, 11					

Columbia River Shoreline Survey
Island-340

Date/Time: 6-1-79; 0800-1100
River Flow Rate (CFS): 106,000-109,300

Size of Survey Plots: 10' x 10'

Informal Grid: Island gridded as shown in diagram. 100 yds between grid points.



Uncorrected μR Meter Reading @ 1m Above Ground
($\mu R/hr$)

	West Shore	Center Track	East Shore
1	8, 10, 6	10, 11, 10 Low Veg.	9, 9, 10
2	10, 6, 8	9, 10, 12	9, 10, 9
3	8, 6, 6	10, 12, 11	10, 10, 10
4	8, 8, 8	11, 10, 9	9, 11, 10
5	6, 6, 8	9, 10, 12	10, 11, 12
6	6, 8, 8	10, 10, 11	10, 10, 15
7	8, 8, 8	8, 9, 10	10, 9, 10
8	6, 8, 8	9, 10, 10	8, 9, 8
9	6, 8, 8	5, 8, 8	8, 10, 9
10	8, 8, 8	9, 7, 6	8, 9, 8
11	8, 8, 8	9, 8, 9	9, 9, 8
12	8, 6, 8	10, 10, 9	9, 9, 8
13	6, 8, 6	6, 8, 10	7, 8, 7
14	8, 8, 8	6, 8, 9	
15	8, 8, 8		

Columbia River Shoreline Survey
Island-339
(Nelson Island)

Date/Time: 6-28-79; 1500-1700
River Flow Rate (CFS): 137,400-147,800

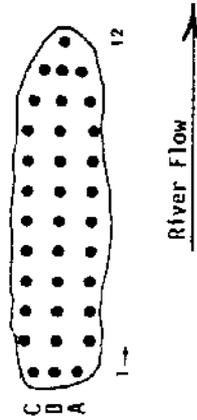
Size of Survey Plots: 10' x 10'

Informal Grid: Island gridded as shown on diagram. 100 yd. spacing between points.

Discrete Particulate Contamination ($\mu\text{R/hr}$ at ground surface):

- (a) 180
- (b) 110

N

Uncorrected μR Meter Reading @ 1m Above Ground

	A	B	C
1	7, 6, 6 Sand, Rocks	18, 17, 16	12, 11, 12 Rocks
2	7, 7, 9	14, 12, 12 Rocks, Sand	17, 15, 14
3	10, 10, 10	14, 15, 15 Sand	19, 18, 19 High Grass
4	10, 10, 10 Grass	15, 17, 17	18, 17, 19
5	12, 11, 12	16, 16, 16 (a)	16, 17, 18
6	13, 12, 10	14, 14, 14 (b)	12, 13, 13 Rocks
7	10, 10, 10	16, 17, 16 Grass	11, 11, 11
8	10, 7, 7	17, 16, 17 Rocks	9, 10, 9
9	6, 6, 6 Sand, Rocks	14, 18, 12	10, 10, 11
10	7, 6, 7	11, 10, 12	10, 11, 10
11	7, 7, 7	12, 10, 11	9, 9, 10
12		10, 10, 10	

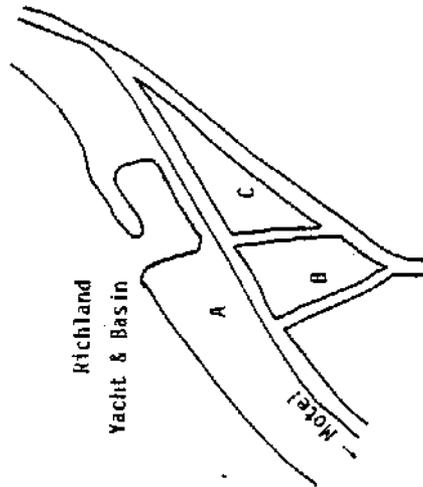
Columbia River Shoreline Survey
Richland Marina

Date/Time: Section A & B 6-14-79;0600-0900
Section C 6-20-79;0600-0900
River Flow Rate (CFS): 90,000-92,000

Size of Survey Plots: 10' x 10'

General Survey.

No particles found: Heavy Vegetation



Uncorrected μR Meter Reading @ 1m Above Ground
($\mu R/hr$)

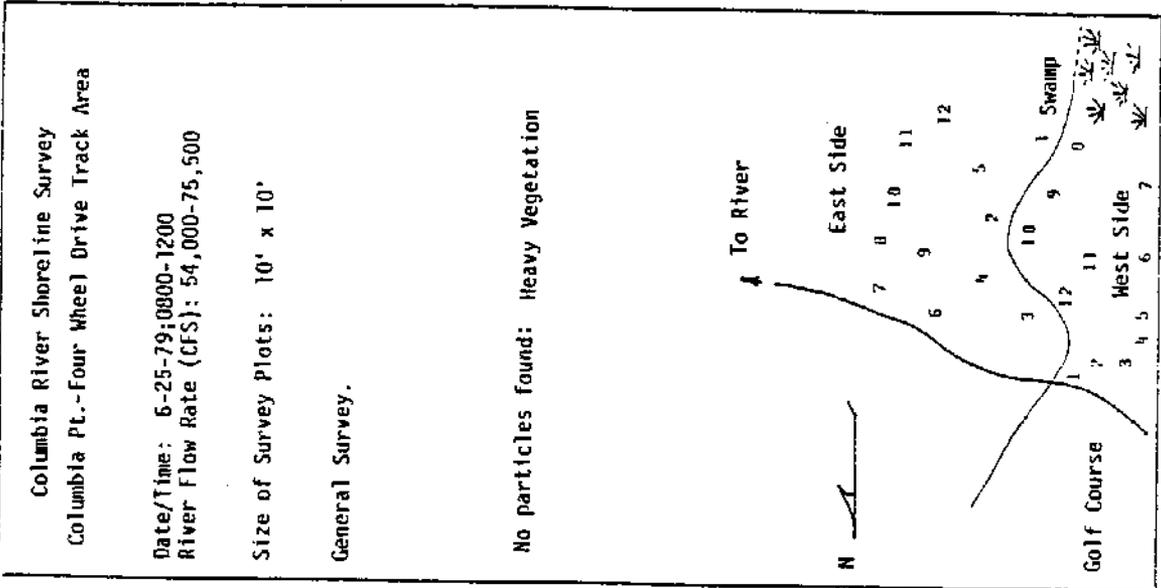
Section A
14, 8, 8
14, 8, 8
14, 8, 8
14, 8, 0
14, 8, 8
14, 8, 8
14, 8, 8
10, 10, 12
8, 12, 10
8, 8, 10

Section B
8, 8, 8
10, 10, 14
10, 10, 14
6, 10, 14
8, 10, 10
8, 10, 8
10, 12, 8
15, 10, 12
12, 12, 10
10, 10, 10
12, 10, 10
14, 12, 12
12, 8, 8
8, 7, 9
8, 11, 11
11, 12, 8
10, 10, 8
10, 10, 10

Section C
10, 10, 10
10, 14, 9
10, 8, 9
9, 10, 10
10, 10, 10
8, 8, 8
8, 8, 8
8, 8, 7
9, 9, 9
7, 8, 8
8, 8
12, 10, 8
8, 8, 9
8, 11, 8
14, 8, 7
6, 5, 5
5, 4, 5
6, 4

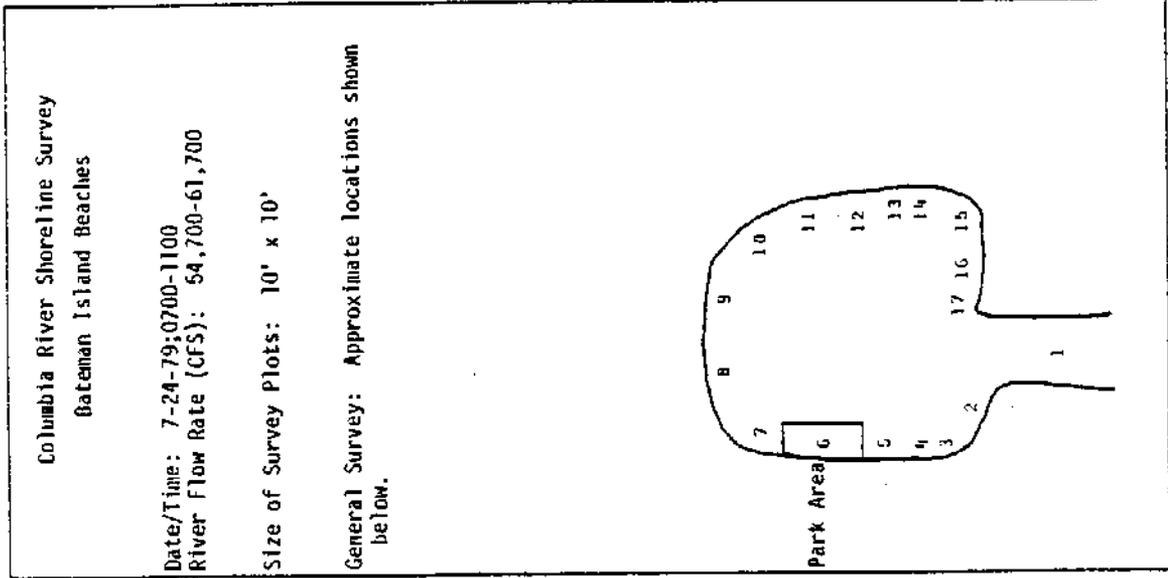
Uncorrected μR Meter Reading @ 1m Above Ground
[$\mu\text{R}/\text{hr}$]

	East Side	West Side
1	11	12
2	10	10
3	10	8
4	8	8
5	8	5
6	9	7
7	6	7
8	10	8
9	9	11
10	10	10
11	10	9
12	11	10



**Uncorrected μR Meter Reading @ 1m Above Ground
($\mu R/hr$)**

1	8	Rocks, sand, weeds
2	7	
3	7	
4	8	
5	8	
6	8	Rocks
7	7	
8	8	Rocks, sand
9	8	
10	8	
11	12	Grass, mud
12	10	
13	10	
14	12	Tall weeds
15	10	
16	10	Rocks, weeds
17	8	



Columbia River Shoreline Survey
Island-333
(Downstream of Bateman Island)

Date/Time: 6-14-79; 0600-0900
River flow Rate (CFS): 90,000-92,000

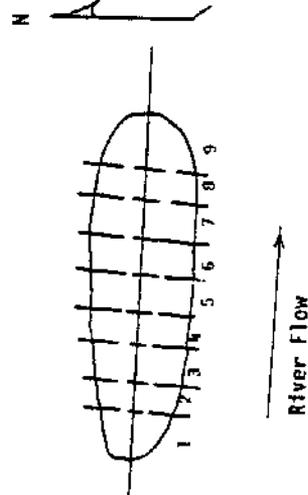
Size of Survey Plots: 10' x 10'

Informal Grid: Island divided lengthwise into North and South halves, then each half walked from West to East. Three plots surveyed every 100 yds.

Discrete Particulate Contamination ($\mu\text{R/hr}$ at ground surface):

(a) 400

Areas with general contamination $\geq 25 \mu\text{R/hr}$ indicated by the symbol \square .



Uncorrected μR Meter Reading @ 1m Above Ground
($\mu\text{R/hr}$)

North	
1	5, 6, 6
2	7, 7, 12
3	6, 11, 6
4	9, 8, 8
5	6, 7, 6
6	6, 6, 7
7	6, 5, 10
8	7, 6, 8
9	6

South	
10, 12, 16	
16, 30, 20 (a)	\square
15, 16, 14	
17, 17, 17	
15, 13, 12	
16, 15, 12	
16, 12, 10	
11, 11, 11	
9	

Uncorrected μ R Meter Reading @ 1m Above Ground
(μ R/hr)

1	6, 8, 9 Grassy
2	12, 10, 10
3	9, 10, 5
4	10, 16, 16
5	6
6	14

Columbia River Shoreline Survey
Island-332

Date/Time: 6-14-79; 0600-0900
River Flow Rate (CFS): 90,000-92,000

Size of Survey Plots: 10' x 10'

Informal Grid: Island divided lengthwise into North and South halves, and West to East in 100 yd sections, beginning on West end.

Columbia River Shoreline Survey
Two Rivers Park

Date/Time: 6-20-79; 1600-2000
River Flow Rate (CFS): 126,000-128,400

Size of Survey Plots: 10' x 10'

General Survey.

Discrete Particulate Contamination ($\mu\text{R/hr}$ at ground surface):

(a) 25 At edge of weeds in rocks.

Uncorrected μR Meter Reading @ 1m Above Ground
($\mu\text{R/hr}$)

	Upsream	Beach	Downstream
1	14 (a)	12	10
2	12	12	12
3	12	11	14
4	10	10	10
5	10	10	10
6	8	10	11
7	8	10	8
8	6	10	9
9	9	10	8
10	10	6	10
11	10	6	7
12	10	6	6
13			8
14			7
15			8
16			6
17			7
18			7
19			7
20			7

APPENDIX B
DATA - NARROW SHORELINES

Columbia River Shoreline Contamination Survey
 Vernita Bridge Area

Date/Time: 8-9-79; 1600-1800
 River Flow Rate (CFS): 127,200-145,200

Starting Point: 3/4 mile upstream of Vernita Bridge.

Stopping Point: Approximately 1000' upstream of starting point.

Size of Survey Plots: 10' x 10'
 No. of Plots per track: 45
 Distance between plots: 150'
 Distance between tracks: 50'

Discrete Particulate Contamination: None found

Areas with general contamination ≥ 25 $\mu\text{R/hr}$ are indicated by the symbol Δ .

Uncorrected μR Meter Reading @ 1m Above Ground ($\mu\text{R/hr}$)						
Track	Track 1	Track 2	Track 3	Continued		
	1	2	3	Track 1	Track 2	Track 3
	5	6	6			
	5	6	6			
	5	6	5			
	6	6	5			
	5	5	5			
	5	6	6			
	5	6	5			
	5	6	6			
	5	6	6			
	5	6	6			

Columbia River Shoreline Contamination Survey
B-Area Shoreline

Date/Time: 6-14-79; 1600-1800
River Flow Rate (CFS): 127,200-145,200

Starting Point: 181-B Pumphouse

Stopping Point: 1904-B Outfall Structure

Size of Survey Plots: 2' x 2'
No. Plots per track: 45
Distance between plots: ~ 50'
Distance between tracks: ~ 50'

Discrete Particulate Contamination: None found.

Areas with general contamination
≥ 25 µR/hr are indicated by the symbol Δ.

Uncorrected µR Meter Reading @ 1m Above Ground (µR/hr)										
Track	1	2	3	Track	1	2	3	Continued		
								Track	1	2
5	6	6	6	6	5	8	6			
5	8	6	6	6	5	6	6			
5	8	8	6	6	5	8	6			
5	8	8	8	8	5	8	6			
5	8	8	8	8	5	8	6			
5	10	8	8	8	6	8	6			
5	8	8	8	8	6	8	6			
5	8	8	8	8	6	8	6			
5	8	8	8	8	6	15	10			
5	8	8	8	8	6	15	10			
5	8	8	6	6	8	20	10			
5	8	8	6	6	8	20	30			
5	10	6	6	6	8	50	60			
5	8	6	6	6	8	50	100			
5	8	6	6	6	8	50	100			
5	10	6	6	6	10	50	50			
5	10	6	6	6	10	-	20			
5	8	6	6	6	12	-	20			
5	8	6	6	6	12	-	10			
5	8	6	6	6	14	-	-			
5	8	6	6	6	16	-	-			
5	8	6	6	6						

Columbia River Shoreline Contamination Survey
M-Area to K-Area

Date/Time: 6/13/79; 1500-2100
River flow Rate (CFS): 122,400-156,100

Starting Point: MPPSS Power Lines
Stopping Point: 101-KE Pumphouse

Size of Survey Plots: 2' x 2'
No. Plots per track: 121
Distance between plots: ~ 50'
Distance between tracks: ~ 50'

Discrete Particulate Contamination: None found.

Areas with general contamination
> 25 $\mu\text{R/hr}$ are indicated by the symbol Δ .

Uncorrected μR Meter Reading @ 1m Above Ground ($\mu\text{R/hr}$)									
Track	Track	Track	Continued						
1	2	3	1	2	3	1	2	3	1
6	10	8	4	10	10	4	10	10	4
6	8	10	4	8	9	3	8	9	4
6	12	8	3	8	9	3	10	10	4
4	10	8	3	10	10	4	10	10	4
5	14	8	4	10	10	4	10	10	4
5	10	8	4	10	10	4	10	10	4
5	14	8	4	10	10	5	12	10	4
4	12	8	6	10	10	6	10	10	4
6	12	8	6	10	8	6	10	8	4
5	10	8	6	12	10	4	8	9	4
4	10	10	4	10	10	4	12	8	4
4	12	10	4	12	10	5	8	8	4
4	10	10	5	10	8	5	10	8	4
4	10	10	5	10	8	5	10	8	4
4	10	10	4	10	8	4	10	8	4
4	10	10	4	10	8	4	10	8	3
3	10	10	3	8	8	3	8	8	4
4	10	10	3	8	8	4	10	10	4
4	8	10	4	8	10	4	8	10	4
4	10	10	4	10	10	5	10	8	4
3	8	10	3	10	8	3	10	8	3

N-Area to K-Area Continued

Uncorrected μm Meter Reading @ 1m Above Ground

Track																	
1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
5	10	8	6	10	6	4	8	10	4	8	10	4	8	10	6	10	14
4	12	8	4	10	10	4	10	10	4	8	10	4	8	10	6	8	14
5	14	6	6	10	10	4	10	10	4	8	10	4	8	10	6	10	12
5	10	8	4	10	10	4	10	10	4	8	10	4	8	10	4	10	10
4	12	9	4	10	10	4	10	10	4	8	10	4	8	10	4	10	10
4	10	10	4	10	10	4	10	10	4	8	10	4	8	10	4	10	10
4	12	10	4	10	10	4	10	10	4	8	10	4	8	10	4	10	10
6	10	10	4	10	10	4	10	10	4	8	10	4	8	10	4	10	10
6	10	10	4	10	10	4	10	10	4	8	10	4	8	10	4	10	10
5	10	10	4	10	10	4	10	10	4	8	10	4	8	10	4	10	10
6	12	10	5	10	10	5	10	10	5	8	10	5	8	10	4	10	10
6	10	10	4	10	10	4	10	10	4	10	10	4	10	10	4	10	10
6	12	10	4	10	10	4	10	10	4	14	12	4	14	12	4	10	10
6	12	10	4	10	10	4	10	10	4	14	14	4	14	14	4	10	10
5	10	10	4	10	10	4	10	10	4	12	16	4	12	16	4	8	10
5	10	10	4	10	10	4	10	10	4	10	14	4	10	14	5	10	10
5	8	10	4	10	10	4	10	10	4	10	14	4	10	14	4	12	10
6	10	10	4	10	10	4	10	10	4	10	14	4	10	14	6	12	10
5	8	8	4	10	10	4	10	10	4	10	16	4	10	16	6	10	10
6	10	6	4	10	10	4	10	10	4	10	20	4	10	20	6	10	10
6	8	8	4	10	10	4	10	10	4	14	20	4	14	20	6	10	10
6	8	8	4	10	10	4	10	10	4	12	22	4	12	22	6	10	10
6	8	8	4	10	10	4	10	10	4	10	22	4	10	22	6	10	10
5	8	6	4	10	10	4	10	10	4	12	20	4	12	20	6	10	10



N-Area to K-Area Continued

Uncorrected μ R Meter Reading & In Above Ground											
Track			Track			Track			Track		
1	2	3	1	2	3	1	2	3	1	2	3
5	8	10	6	10	10						
4	10	10	6	12	10						
4	10	10	6	8	12						
4	10	9	6	10	12						
4	10	10	5	10	12						
4	10	10	4	10	12						
4	8	10	4	10	14						
4	10	10	4	8	14						
4	10	10	4	10	14						
4	8	12	4	10	14						
5	10	12	4	10	14						
4	8	14	4	10	14						
4	10	14	4	10	80						
4	10	14	4	8	80						
4	10	14	4	8	100						
4	10	14	4	10	120						
4	6	14	4	10	200						
4	10	14	4	10	80						
4	10	14	4	10	60						
4	8	14	4	10	60						
4	10	14	4	8	30						
4	12	14	4	10	25						
4	10	14									
5	10	10									
6	10	10									

Columbia River Shoreline Contamination Survey
N-Area to D-Area

Date/Time: 6-7-79; 1530-2000
 River Flow Rate (CFS): 128,400-140,000

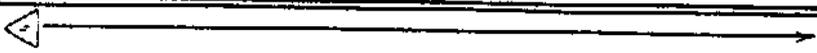
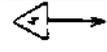
Starting Point: 181-N Pumphouse
 Stopping Point: 181-D Pumphouse

Size of Survey Plots: 2' x 2'
 No. Plots per track: 204
 Distance between plots: 50'
 Distance between tracks: 50'

Areas with general contamination > 25 µR/hr
 Indicated by the symbol Δ.

Uncorrected µR Meter Reading @ 1m Above Ground (µR/hr)						
Track 1	Track 2	Track 3	Continued			Trench
			Track 1	Track 2	Track 3	
90	120	120	95	205	20	
85	110	40	90	210	40	
50	80	30	125	240	50	
44	80	100	140	240	60	
44	80	80	145	230	60	
44	80	80	140	280	62	
43	90	90	150	400	40	
45	80	24	160	350	40	
45	100	20	170	350	600	
60	110	20	175	400	625	
61	110	60	155	400	700	
61	115	30	170	275	600	
65	120	18	160	280	600	
70	130	24	160	280	500	
75	180	22	155	280	500	
75	210	28	150	280	600	
85	230	40	150	300	600	
83	230	30	160	400	700	
83	275	40	155	400	600	
90	260	40	160	400	600	
85	225	30	160	400	600	
80	210	30	155	280	600	
82	215	30	145	240	500	
97	210	40	140	225	500	
98	210	30	135	220	500	
100	205	35	115	210	500	
85	205	30	120	200	400	

Uncorrected μR Meter Reading @ 1m Above Ground ($\mu R/hr$)												
Track 1	Track			Track 1	Track 2	Track 3	Track 1	Track 2	Track 3	Track 1	Track 2	Track 3
	1	2	3									
120	190	400	400	10	16	24	7	6	8	7	6	6
110	180	400	400	10	14	22	7	7	8	7	6	6
110	180	300	300	10	15	20	8	7	8	7	6	6
105	120	300	300	10	12	18	6	6	7	7	6	6
100	140	240	240	9	14	18	7	6	8	7	6	6
90	120	150	150	9	12	16	7	7	7	7	6	7
85	100	130	130	9	12	18	7	6	7	7	6	6
75	100	150	150	8	12	14	7	7	7	7	6	6
65	100	140	140	8	10	14	7	6	7	7	6	6
50	90	140	140	8	10	14	8	6	7	6	5	7
42	80	100	100	8	9	12	8	7	7	7	5	5
40	75	110	110	7	10	13	7	7	6	7	5	5
40	65	110	110	7	9	11	7	7	7	7	6	6
42	60	100	100	7	9	11	7	7	6	7	6	5
50	80	80	80	8	9	11	7	6	7	7	6	5
55	40	70	70	8	9	10	7	6	6	7	6	5
50	40	70	70	8	9	9	7	6	6	7	6	5
60	40	60	60	6	9	10	7	7	7	7	6	5
55	30	50	50	7	9	9	7	6	6	7	6	5
50	25	60	60	7	7	8	7	6	6	7	5	5
50	25	40	40	7	7	7	7	5	6	7	6	5
15	25	40	40	7	7	8	7	5	7	7	6	5
14	20	40	40	7	8	8	7	6	7	7	6	5
12	20	28	28	7	7	8	7	6	6	7	6	5
11	14	26	26	7	7	8	7	5	6	7	6	5



N-Springs

EMO 379
Marker

Uncorrected μ R Meter Reading @ 1m Above Ground

(μ R/hr)

Track																	
1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
7	6	5	7	6	6	7	6	6	7	6	6	7	6	6	7	6	6
7	6	5	7	6	6	7	6	6	7	6	6	7	6	6	7	6	6
7	6	5	7	6	5	7	6	5	7	6	5	7	6	5	7	6	5
7	6	6	7	6	6	7	5	4	7	5	4	7	5	4	7	5	4
7	6	5	7	6	5	7	5	5	7	5	5	7	5	5	7	5	5
7	6	5	7	6	5	7	5	5	7	6	5	7	6	5	7	6	5
7	6	6	7	6	6	7	6	5	7	6	5	7	6	5	7	6	5
7	6	5	7	5	5	7	6	5	7	6	5	7	6	5	7	6	5
7	6	4	7	6	4	7	6	4	7	6	4	7	6	4	7	6	4
7	6	5	7	6	5	7	6	5	7	6	5	7	6	5	7	6	5
7	6	5	7	6	5	7	6	5	7	6	5	7	6	5	7	6	5
7	6	4	7	6	4	7	6	4	7	6	4	7	6	4	7	6	4
7	6	5	7	6	5	7	6	5	7	6	5	7	6	5	7	6	5
7	6	4	7	6	4	7	6	4	7	6	4	7	6	4	7	6	4
7	6	6	7	6	6	7	6	6	7	6	6	7	6	6	7	6	6
7	6	5	7	6	5	7	6	5	7	6	5	7	6	5	7	6	5
7	6	5	7	6	5	7	6	5	7	6	5	7	6	5	7	6	5

EMO 378
Marker

D-Area to D-Floodplain Continued

Track	Uncorrected pR Meter Reading @ 1m Above Ground		
	Track 1	Track 2	Track 3
6	6	6	5
6	10	5	5
8	6	5	5
10	6	5	5
10	6	5	5
6	6	5	5
6	6	5	5
6	6	5	5
6	10	5	5
6	6	5	5
6	6	5	5
6	6	5	5
6	6	5	5
6	8	5	5
6	8	5	5
6	6	5	5
6	8	5	5
6	8	5	5
6	8	5	5
6	10	8	8
-	12	8	8
-	10	8	8

Columbia River Shoreline Contamination Survey
II-Area Shoreline

Date/Time: 6-5-79; 1530-2030
River Flow Rate (CFS): 140,000-149,100

Starting Point: 181-II building downstream

Stopping Point: North end of East shoreline of Whitebluffs Slough Inlet.

Size of Survey Plots: 2' x 2'
No. Plots per track: 337
Distance between plots: 50'
Distance between tracks: 50'

Discrete Particulate Contamination:
(a) 100
(b) 200
(c) 1000
(d) 350

Areas with general contamination ≥ 25 $\mu\text{R/hr}$ are indicated by the symbol Δ .

Uncorrected μR Meter Reading @ 1m Above Ground ($\mu\text{R/hr}$)												
Track	Track	Track	Track	Track	Track	Continued						
						Track	Track	Track	Track	Track	Track	
8	9	9	9	9	9	3	1	2	3	4	7	
5	9	8	8	6	6				5	5	5	
5	9	7	5	5	5				6	6	6	
6	9	6	5	5	5				5	5	5	
4	9	10	5	5	5				4	4	5	
4	13	8	6	6	6				4	5	6	
4	10	8	6	6	6				6	6	-	
4	10	7	7	7	7				5	7	5	
4	10	7	7	7	7				6	7	5	
4	10	6	6	6	6				5	7	5	
4	6	6	6	6	6				5	7	5	
4	6	5	6	6	6				5	7	5	
4	7	5	5	5	5				6	6	5	
4	6	6	6	5	5				5	6	5	
3	6	5	5	5	5				4	6	-	
3	6	5	5	5	5				5	-	5	
4	7	6	5	5	5				6	-	5	
3	6	6	6	6	6				6	-	5	
5	6	5	5	5	5				6	-	5	
4	6	6	5	5	5				6	-	5	
5	-	-	6	5	5				5	-	5	
5	-	-	5	5	5				6	-	5	
5	-	-	6	6	6				4	-	6	
6	-	-	7	7	7				4	-	7	
5	-	-	6	6	6				6	-	6	
4	-	-	7	7	7				5	-	5	
4	-	-	6	6	6				4	-	6	

Uncorrected μR Meter Reading @ 1m Above Ground
(B/H/E)

Track	Track				Track				Track				Track			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
4	-	-	-	5	5	8	12	10	5	7	8	8	6	8	8	8
6	-	-	-	4	4	16	11	10	4	7	8	9	6	9	8	8
7	-	-	-	5	5	16	11	10	6	7	9	8	5	9	8	7
5	-	-	6	6	6	12	10	10	5	7	11	8	6	8	8	8
4	-	-	8	4	5	12	11	9	5	7	9	8	6	8	8	8
4	-	-	7	5	5	12	11	10	4	7	12	9	5	7	8	8
4	-	-	8	6	6	12	10	8	5	7	11	8	6	8	8	9
4	-	-	9	5	6	14	12	9	4	6	8	11	7	7	8	8
5	-	-	10	7	5	12	10	9	5	7	8	10	6	9	8	6
4	7	10	8	4	4	12	13	9	4	7	7	11	6	8	8	8
5	7	9	7	5	5	12	11	10	4	6	8	10	6	9	8	8
5	7	8	8	4	4	14	9	10	4	7	7	9	5	8	8	7
4	-	-	8	4	4	12	8	9	5	7	7	15	6	9	8	8
6	-	-	8	7	5	12	8	8	6	8	7	20	6	8	8	8
5	-	-	8	8	5	8	8	8	5	7	7	12	6	8	8	8
4	-	-	6	8	5	10	7	9	5	9	7	12	5	9	8	7
5	-	-	7	7	4	9	7	8	6	8	6	10	5	8	8	7
5	-	-	7	6	5	8	7	8	5	7	8	8	5	8	8	8
6	-	-	14	12	4	8	7	7	5	7	8	8	6	8	8	8
5	-	-	14	15	4	8	7	8	5	7	8	9	7	8	8	9
6	6	14	16	4	4	8	7	8	4	7	9	7	7	8	7	8
6	6	14	10	5	5	8	7	8	6	8	8	7	7	8	8	7
6	6	14	12	4	4	7	8	8	6	8	7	8	6	8	8	8
5	7	14	10	5	5	7	7	8	5	8	7	7	6	8	8	8
5	7	13	11	4	4	8	8	7	5	8	8	7	5	9	8	9



4

Track			Track			Track			Track			Track		
1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
7	10	6	6	8	7	5	14	9	4	12	-	4	12	-
6	10	8	4	9	8	5	14	10	4	12	-	4	12	-
6	12	6	5	9	8	5	14	11	6	10	-	7	12	-
7	10	7	4	10	8	5	14	9	7	12	-	-	12	-
6	10	8	4	9	8	5	14	10	-	12	-	-	12	-
7	12	8	5	10	8	6	14	11	-	12	-	-	12	-
7	12	8	5	8	9	4	14	9	-	12	-	-	12	-
7	12	8	6	8	8	5	14	9	-	12	-	-	12	-
7	12	6	6	8	9	6	14	9	-	12	-	-	12	-
7	12	6	6	10	8	5	12	10	-	12	-	-	10	-
8	10	8	5	12	8	4	12	11	-	12	-	-	10	-
7	12	8	6	10	8	5	12	11	-	12	-	-	10	-
7	12	8	6	10	7	5	14	11	-	12	-	-	10	-
7	14	8	6	12	8	5	12	10	-	12	-	-	10	-
7	10	-	5	12	9	5	14	11	-	12	-	-	10	-
7	10	-	6	12	8	3	14	9	-	12	-	-	10	-
7	10	-	5	14	8	4	12	8	-	12	-	-	10	-
7	11	-	4	14	9	4	10	8	-	12	-	-	10	-
6	12	-	4	18	8	4	10	8	-	12	-	-	10	-
6	10	-	7	14	9	4	10	9	-	12	-	-	10	-
6	10	-	4	12	9	4	10	-	-	12	-	-	10	-
4	9	7	5	10	9	6	12	-	-	12	-	-	10	-
4	9	7	6	15	9	4	10	-	-	12	-	-	10	-
6	10	8	6	18	9	5	12	-	-	12	-	-	10	-

Columbia River Shoreline Contamination Survey

II-Slough to F-Area

Date/Time: 6-20-79; 1500-2100
 River Flow Rate (CFS): 126,000-130,000

Starting Point: North end of West shoreline of
 White Bluffs slough inlet.

Stopping Point: Dead tree approximately 1000'
 downstream of power line crossing.

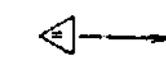
Size of Survey Plots: 2' x 2'
 No. Plots per track: 102
 Distance between plots: ~ 50'
 Distance between tracks: ~ 50'

Discrete Particulate Contamination: (a) 500 µR/hr
 at surface, 5 µR/hr at 1m.

Areas with general contamination
 > 25 µR/hr are indicated by the symbol Δ.

Uncorrected µR Meter Reading @ 1m Above Ground (µR/hr)										
Track	Track	Track	Continued			Track	Track	Track	Track	Track
			1	2	3					
11	20	6	15	20	5	15	20	5	15	20
9	-	6	14	16	5	14	16	5	14	16
9	-	6	15	18	3	15	18	3	15	18
10	-	6	8	20	5	8	20	5	8	20
8	-	7	7	-	4	7	-	4	7	-
8	22	6	7	-	4	7	-	4	7	-
9	24	5	8	-	4	8	-	4	8	-
8	22	5	7	-	4	7	-	4	7	-
9	20	4	7	-	4	7	-	4	7	-
10	20	4	7	-	4	7	-	4	7	-
10	18	4	-	10	4	-	10	4	-	10
11	18	5	-	-	5	-	-	5	-	-
9	20	4	-	-	4	-	-	4	-	-
10	-	4	7	10	4	7	10	4	7	10
9	-	4	7	12	4	7	12	4	7	12
9	-	4	8	10	4	8	10	4	8	10
9	-	5	9	18	4	9	18	4	9	18
9	-	4	15	10	4	15	10	4	15	10
11	20	5	13	8	4	13	8	4	13	8
12	20	4	14	18	4	14	18	4	14	18
11	14	4	15	14	4	15	14	4	15	14
11	20	4	13	16	4	13	16	4	13	16
10	18	4	15	14	5	15	14	5	15	14
10	16	5	15	14	4	15	14	4	15	14
8	14	5	17	14	5	17	14	5	17	14
10	16	6	17	12	4	17	12	4	17	12
10	16	5	9	14	5	9	14	5	9	14
11	20	5								

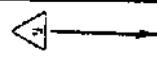
River Sign '13'



H-Slough to F-Area Continued

			Uncorrected μ Meter Reading # In Above Ground					
Track	Track	Track	Track	Track	Track	Track	Track	Track
1	2	3	1	2	3	1	2	3
9	16	5	18	15	5			
9	14	4	18	16	6			
9	10	5	8	18	5			
9	10	3	7	19	5			
6	10	4	7	16	4			
8	8	4	6	16	5			
7	10	4	6	16	4			
11	10	5	7	18	5			
7	10	4	6	18	4			
7	9	5	6	10	5			
6	8	5	6	6	4			
7	8	4	5	6	4			
8	8	4	6	6	5			
7	14	4	5	6	5			
9	8	4	5	5	5			
9	10	4	6	5	4			
9	12	4	5(a)	4	3			
9	-	4	5	5	3			
8	12	4	5	4	4			
17	18	4	6	5	3			
18	20	4	5	6	4			
17	18	4	5	6	3			
17	14	5						
20	16	5						
21	18	5						

Boat Ramp



Columbia River Shoreline Contamination Survey
Hanford Townsite Slough

Date/Time: 5-29-79, 1500-1800
River Flow Rate (CFS): 142,600-156,100

Starting Point: Hanford Pump House.

Stopping Point: Northwest end of Hanford Townsite Slough.

Size of Survey Plots: 2' x 2'
No. Plots per track: 73
Distance between plots: ~ 50'
Distance between tracks: ~ 50'

Discrete Particulate Contamination: None found.

Areas with general contamination ≥ 25 $\mu\text{R/hr}$ are indicated by the symbol Δ .

Uncorrected μR Meter Reading @ 1m Above Ground ($\mu\text{R/hr}$)										
Track 1	Track 2	Track 3	Continued			Track 1	Track 2	Track 3		
-	7	9	10	12	10	10	12	10		
-	7	8	12	16	9	12	16	9		
-	7	7	13	13	8	13	13	8		
-	7	6	12	12	10	12	12	10		
-	8	7	14	12	10	14	12	10		
-	8	8	13	13	9	13	13	9		
-	7	7	12	13	10	12	13	10		
-	8	8	10	5	10	10	5	10		
-	8	7	11	5	9	11	5	9		
-	8	8	10	5	8	10	5	8		
-	8	7	11	5	10	11	5	10		
9	9	18	12	5	8	12	5	8		
12	11	18	14	6	9	14	6	9		
10	9	19	12	5	10	12	5	10		
10	8	17	10	5	8	10	5	8		
12	10	14	14	5	9	14	5	9		
12	7	11	14	5	10	14	5	10		
12	12	11	12	4	9	12	4	9		
12	9	10	16	5	10	16	5	10		
10	5	9	12	4	9	12	4	9	1/2 Mile	
10	7	10	12	5	8	12	5	8		
10	6	10	11	6	9	11	6	9		
13	5	9	14	5	9	14	5	9		
12	6	10	14	5	9	14	5	9		
12	5	9	12	6	8	12	6	8		
12	5	10	12	6	8	12	6	8		

Hanford Townsite Slough Continued											
Uncorrected pH Meter Reading @ 1m Above Ground											
Track	Track	Track	Track	Track	Track	Track	Track	Track	Track	Track	Track
1	2	3	1	2	3	1	2	3	1	2	3
13	5	8									
10	5	8									
12	6	9									
14	5	8									
13	6	9									
12	5	9									
14	7	9									
10	6	9									
12	7	10									
9	6	10									
10	6	10									
13	5	10									
12	5	11									
9	6	11									
10	5	10									
12	6	11									
12	7	12									
14	6	12									
10	5	-									
12	6	-									

Dead Trees
3/4 mile

Columbia River Shoreline Contamination Survey
Manford Townsite

Date/Time: 5-30-79; 1500-2000
River flow Rate (CFS): 145,200-156,100

Starting Point: Manford Pump House

Stopping Point: Just before bluffs sand dunes area, 3/4 mile downstream of starting point

Size of Survey Plots: 2' x 2'
No. Plots per track: 292
Distance between plots: ~ 50'
Distance between tracks: ~ 50'

Discrete Particulate Contamination: None found.

Areas with general contamination ≥ 25 $\mu\text{R/hr}$ are indicated by the symbol Δ .

Uncorrected μR Meter Reading @ 1m Above Ground ($\mu\text{R/hr}$)						
Track	Track	Track	Cont. Inud			
			Track	Track	Track	
1	2	3	1	2	3	
4	2	8	11	6	9	
4	6	6	12	9	9	
4	5	8	8	6	8	
4	5	8	11	5	9	
4	5	6	11	4	8	
12	4	7	9	4	7	
8	5	6	7	4	8	
6	7	5	6	3	7	
8	7	6	7	4	9	
9	7	7	7	5	7	
8	6	8	7	4	8	
4	6	8	10	5	6	
4	7	7	6	4	8	
8	7	8	6	6	9	
10	9	9	8	5	9	
10	6	8	7	5	8	
6	4	8	9	5	9	
10	4	8	7	4	9	
12	4	8	6	4	9	
12	7	8	4	5	9	
12	9	7	5	16	8	
13	11	8	6	9	9	
12	12	10	9	6	7	
10	13	6	17	4	9	
10	12	9	7	5	8	
12	6	9	5	7	8	

Hanford Townsite Continued

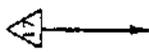
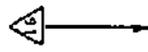
			Uncorrected pH Meter Reading 8' In Above Ground													
Track	Track	Track	Track	Track	Track	Track	Track	Track	Track	Track	Track	Track	Track	Track	Track	
1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	3	
5	10	7	6	7	8											
4	6	9	8	5	9											
14	6	8	6	8	8											
6	6	7	6	9	8											
5	5	8	6	6	9											
4	4	7	6	6	8											
4	5	9	5	6	8											
6	4	8	6	7	8											
6	4	9	12	9	8											
6	4	9	15	12	8											
7	5	8	15	15	9											
4	4	8	15	10	8											
5	4	8	6	6	9											
8	4	9	13	9	8											
9	6	8	12	8	9											
8	4	9	18	16	8											
7	6	8	22	17	9											
7	4	9	10	14	8											
6	8	8	15	8	8											
7	8	9	7	6	8											
6	7	8	5	8	8											
5	7	9	12	10	6											
6	4	8	10	7	7											
5	4	7	19	7	8											
6	6	8	16	5	7											

			Track			Track			Track		
1	2	3	1	2	3	1	2	3	1	2	3
5	6	7	17	5	6						
8	7	6	12	6	5						
6	6	7	19	6	7						
6	5	7	19	6	7						
8	15	7	20	6	7						
5	8	7	21	6	7						
7	6	7	24	5	7						
5	8	7	19	6	7						
6	7	8	14	5	7						
6	5	8	18	6	7						
4	7	7	19	7	6						
6	5	7	13	6	6						
7	6	7	9	5	7						
6	6	7	8	6	7						
10	15	7	6	5	7						
19	13	7	7	5	7						
9	9	8	7	6	7						
18	11	7	8	7	7						
19	12	8	12	9	7						
14	16	7	9	18	7						
15	15	7	8	16	7						
15	11	6	6	10	7						
12	13	8	8	13	7						
13	13	7	8	5	6						
13	11	7	6	7	7						

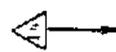
1 1/2 mile

Hanford Townsite Continued											
Uncorrected μM Meter Reading @ 1m Above Ground											
Track	Track	Track	Track	Track	Track	Track	Track	Track	Track	Track	Track
1	2	3	1	2	3	1	2	3	1	2	3
15	11	9	24	14	8	ΔA	6	15	9	12	9
18	12	12	15	11	8		8	6	9	8	8
22	15	11	10	16	9		6	5	8	10	9
18	13	11	8	11	8		7	5	8	8	8
10	16	12	10	11	8		7	5	9	10	7
15	15	11	9	8	8		6	6	8	9	6
12	12	9	9	6	8		6	6	9	8	8
8	17	10	8	8	8		6	4	10	8	8
15	16	10	11	12	8		6	5	9	7	7
20	14	8	9	14	8		20	5	10	9	7
18	16	7	10	15	11		23	6	9	12	8
19	18	8	8	8	8		20	5	8	13	8
8	18	8	15	7	8		20	5	9	12	7
7	14	8	20	12	10	ΔA	8	7	8	8	7
15	4	7	18	13	11		12	7	9	7	7
10	5	8	17	8	11		14	5	8	6	7
8	5	8	15	7	11		14	6	7	6	7
8	5	8	8	7	12	2 miles	14	6	9	7	7
15	6	8	8	14	10		21	10	8	15	9
18	7	8	6	11	10		22	9	9	16	8
19	12	8	7	13	9		22	7	10	15	8
22	16	8	8	12	10		22	6	9	15	8
24	15	8	8	10	9		15	6	8	16	8
22	16	8	8	17	8		12	6	9	15	8

2 1/2 miles



2 miles



Columbia River Shoreline Contamination Survey
Savage Island

Date/Time: 6/17/79; 0830-1330
River Flow Rate (CFS): 40,500-53,200

Starting Point: Survey marker at North end of
dry slough which runs West to
East through Savage Island.

Stopping Point: Sturgeon hole, old bed springs
on bank.

Size of Survey Plots: 2' x 2'
No. Plots per track: 147
Distance between plots: ~ 50'
Distance between tracks: ~ 50'

Discrete Particulate Contamination:
(a) 100 (17) Sandy area in dry grassy region.

Areas with general contamination
≥ 25 µR/hr are indicated by the symbol Δ.

Uncorrected µR Meter Reading @ 1m Above Ground (µR/hr)						
Track	Track	Track	Track	Track	Track	Track
1	2	3	1	2	3	1
8	9	7	8	14	8	8
8	9	7	8	14	8	8
8	12	7	8	14	8	8
9	9	8	8	13	9	8
8	9	8	8	13	9	8
9	9	9	8	11	8	8
8	13	8	8	11	8	8
8	9	8	8	11	10	8
10	14	8	9	10	8	8
8	14	8	9	8	10	8
8	14	10	9	8	8	8
8	14	10	8	8	8	8
8	14	10	9	8	8	8
8	14	9	9	8	8	8
8	14	9	8	8	8	8
0	16	8	9	8	8	8
8	16	8	9	8	8	8
8	13	9	8	8	8	8
8	12	10	8	8	8	8
8	14	9	8	8	8	8
8	14	9	8	8	8	8
8	14	9	8	8	8	8
8	12	8	8	10	8	8
8	14	8	8	12	8	8
8	15	8	8	12	8	8
8	17(a)	8	8	12	8	8

Savage Island Continued											
Track			Uncorrected μR Meter Reading @ 1m Above Ground			Track			Track		
1	2	3	1	2	3	1	2	3	1	2	3
9	12	8	8	11	8	9	11	9	8	12	11
9	12	9	8	12	8	9	11	9	9	12	12
8	12	9	8	12	8	10	12	8	8	12	12
8	12	8	9	12	9	8	12	8	9	12	12
8	11	9	9	12	9	8	11	9	9	12	12
9	11	12	8	12	9	9	12	10	9	12	12
9	10	14	10	12	9	8	12	9	8	12	11
8	12	10	10	12	9	9	12	9	9	12	12
8	12	10	8	10	9	10	11	10	9	11	12
9	12	10	8	10	9	10	11	10	8	11	11
9	12	10	8	10	8	10	11	9	8	11	10
9	12	10	9	11	8	9	11	11	8	11	10
9	11	8	10	11	9	10	11	12	8	11	11
8	11	9	12	12	9	9	11	11	8	11	11
8	11	9	10	12	9	10	12	12	-	-	10
9	10	8	10	12	8	10	12	11	-	-	10
9	11	8	10	12	9	10	12	11	-	-	9
8	10	9	10	12	9	8	12	11	-	-	-
10	10	8	10	11	9	8	10	12	-	-	-
10	10	9	9	11	8	9	10	12	-	-	-
8	10	8	9	12	8	10	11	10	-	-	-
8	11	8	10	12	9	9	11	10	-	-	-
9	12	8	10	10	9	10	11	11	-	-	-
8	12	8	9	10	8	9	12	11	-	-	-
8	12	8	10	11	9	8	11	11	-	-	-

Columbia River Shoreline Contamination Survey
Ringold Sand Dunes

Date/Time: 6/17/79; 0830-1330
River Flow Rate (CFS): 40,500-53,200

Starting Point: Across river from Sturgeon hole.

Stopping Point: Across from North end of I-355 (Ringold Island).

Size of Survey Plots: 2' x 2'
No. Plots per track: 60
Distance between plots: ~ 50'
Distance between tracks: ~ 50'

Discrete Particulate Contamination: (a) 400 (19).

Areas with general contamination ≥ 25 $\mu\text{g}/\text{hr}$ are indicated by the symbol Δ .

Uncorrected μR Meter Reading @ 1m Above Ground ($\mu\text{g}/\text{hr}$)						
Track	Track	Track	Continued			Track
			Track	Track	Track	
7	7	7	8	21	-	-
7	7	8	8	20	-	-
7	6	-	17	21	-	-
7	6	-	9	11	-	-
8	8	-	9	12	-	-
7	7	-	9	10	-	-
8	8	-	8	10	-	-
8	10	-	8	10	-	-
7	8	-	6	10	-	-
8	14	-	7	11	-	-
9	12	-	9	15	-	-
9	12	-	9	13	-	-
8	12	-	9	10	-	-
7	6	-	7	10	-	-
9	7	-	7	10	-	-
8	11	-	7	9	-	-
8	12	-	6	10	-	-
14	11	-	7	9	-	-
14	12	-	7	8	-	-
10	11	-	7	12	-	-
15	11	-	8	12	-	-
18	10	-	9	10	-	-
19	11	-	10	9	-	-
18	12	-	20	8	-	-
19(a)	18	-	9	9	-	-
20	18	-	-	-	-	-



Columbia River Shoreline Contamination Survey
East Bank Across from Ringold Island

Date/Time: 6-10-79/0900-1230
River Flow Rate (CFS): 78,300-81,200

Starting Point: Large flume across from North tip of Island-353.

Stopping Point: South entrance to Savage Island slough.

Size of Survey Plots: 2' x 2'
No. of Plot per track: 161
Distance between plots: ~ 50'
Distance between tracks: ~ 50'

Discrete Particulate Contamination: None found.

Areas with general contamination $\geq 25 \mu\text{R/hr}$ are indicated by the symbol Δ .

Uncorrected μR Meter Reading @ 1m Above Ground ($\mu\text{R/hr}$)										
Track	Track	Track	Track	Track	Track	Track	Track	Continued		
								Track	Track	Track
8	8	8	8	8	8	8	8	1	2	3
10	9	7	7	7	7	7	7	9	6	10
9	6	7	7	7	7	7	7	10	6	8
9	4	6	6	6	6	6	6	10	6	8
9	6	5	5	5	5	5	5	8	6	8
10	5	5	5	5	5	5	5	8	7	8
10	4	5	5	5	5	5	5	8	6	8
10	4	4	4	4	4	4	4	8	5	12
10	5	4	4	4	4	4	4	8	6	15
10	5	4	4	4	4	4	4	8	4	10
10	4	4	4	4	4	4	4	8	4	8
10	5	4	4	4	4	4	4	8	6	8
10	5	4	4	4	4	4	4	8	6	8
9	6	5	5	5	5	5	5	8	6	8
9	6	5	5	5	5	5	5	8	6	8
10	4	4	4	4	4	4	4	8	5	8
10	4	4	4	4	4	4	4	8	6	8
9	4	4	4	4	4	4	4	10	6	9
10	5	5	5	5	5	5	5	8	8	9
9	4	4	4	4	4	4	4	8	7	10
9	6	6	6	6	6	6	6	8	6	10
10	8	8	8	8	8	8	8	8	8	9
10	5	10	10	10	10	10	10	8	5	8
10	6	8	8	8	8	8	8	8	6	8
9	7	9	9	9	9	9	9	8	8	8
10	6	10	10	10	10	10	10	9	8	8
10	6	10	10	10	10	10	10	8	6	8

East Bank Across from Ringold Island Continued														
Track			Unconnected			1m Above Ground			Track			Track		
1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
10	6	8	9	9	13	8	8	11	8	8	11	8	9	4
8	7	9	10	10	11	8	8	10	8	8	10	8	9	4
8	6	8	9	10	11	8	8	10	8	8	10	8	10	4
10	8	8	8	10	11	8	8	10	8	8	10	8	10	4
9	8	7	8	9	12	9	8	10	9	8	10	8	10	5
10	8	7	8	8	12	8	8	9	8	8	9	9	10	4
8	9	8	8	8	12	9	8	9	8	8	9	8	10	6
8	9	8	8	8	10	8	8	9	8	8	9	8	10	5
8	9	9	8	9	11	8	9	10	8	9	10	8	10	5
8	10	9	8	10	11	8	9	10	9	8	10	8	9	4
10	10	9	9	10	11	9	8	10	9	8	10	8	9	4
12	10	10	10	11	12	10	8	9	10	8	9	10	9	4
10	12	10	8	10	12	10	8	9	10	8	9	10	9	4
10	10	10	8	9	10	10	8	8	10	8	8	11	10	4
8	10	10	8	8	9	8	8	8	8	9	8	10	10	4
9	10	11	8	8	9	8	8	8	8	9	8	8	10	4
10	9	11	8	8	9	8	8	8	8	9	8	8	9	5
11	10	11	8	8	9	8	8	8	8	9	8	8	9	5
8	11	11	8	8	10	8	8	8	8	9	8	8	9	5
8	12	12	9	8	11	8	8	8	8	9	8	8	9	6
8	8	12	10	9	11	10	9	9	8	9	8	8	9	6
8	8	12	11	9	11	10	9	11	10	9	9	8	9	6
9	8	12	11	9	10	10	8	10	10	10	4	9	9	6
8	9	13	10	8	10	8	8	10	8	10	4	10	10	6
8	9		9	9	11	9	9	9	9	9	4	10	10	6

East Bank Across from Ringold Island Continued											
Uncorrected μ R Meter Reading @ 1m Above Ground											
Track	Track	Track	Track	Track	Track	Track	Track	Track	Track	Track	Track
1	2	3	1	2	3	1	2	3	1	2	3
8	10	6									
8	10	6									
8	10	6									
8	11	6									
8	10	4									
8	10	4									
8	9	4									
8	9	4									
9	9	4									
10	10	4									
10	10	5									
9	10	6									

Columbia River Shoreline Contamination Survey
West Bank Across From Wounded Island-1

Date/Time: 5-22-79; 1530-1700
5-23-79; 1530-2000
River Flow Rate (CFS): 137,400
Starting Point: Dirt road intersects Bluff, across from center of Island-347. (Heading upstream).

Stopping Point: Approximately 1/2 mile upstream of gravel pit water pump.

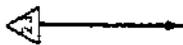
Size of Survey Plots: 2' x 2'
No. of Plot per track: 194
Distance between plots: ~ 50'
Distance between tracks: ~ 50'

Discrete Particulate Contamination: None found.

Areas with general contamination \leq 25 μ R/hr are indicated by the symbol Δ .

Uncorrected μ R Meter Reading @ 1m Above Ground (μ R/hr)											
Track 1			Track 2			Track 3			Continued		
1	2	3	1	2	3	1	2	3	1	2	3
6	8	13				14	10	13			
10	8	12				10	8	12			
10	6	9				7	6	10			
6	7	10				8	7	8			
6	8	9				6	6	8			
6	6	9				6	7	8			
10	8	10				10	8	10			
6	10	9				10	10	8			
10	12	11				6	6	8			
8	9	9				8	6	9			
10	8	11				7	6	8			
6	9	11				6	6	8			
8	8	10				6	6	8			
6	8	10				6	6	8			
6	10	12				6	6	9			
4	11	10				10	8	9			
5	10	11				10	7	8			
5	10	10				6	6	8			
4	8	12				6	7	10			
6	7	12				4	6	10			
6	9	11				5	6	8			
10	9	8				4	4	11			
6	6	8				4	2	8			
6	8	14				5	6	8			
8	8	12				17	8	8			
7	6	13				15	10	8			
12	12	11				18	9	8			

West Bank Across From Wooded Island-1 Continued															
Uncorrected pR Meter Reading @ In Above Ground															
Track	Track			Track			Track			Track			Track		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
19	12	8	8	18	10	7	14	9	7	8	8	7	8	8	7
21	15	8	8	15	11	6	14	10	7	10	10	7	10	10	5
20	16	10	10	11	9	6	12	12	8	12	12	8	10	9	6
21	18	10	10	12	8	6	9	15	7	9	10	18	10	10	6
16	12	10	10	9	8	6	9	10	18	10	8	15	9	9	7
21	10	10	10	8	7	6	10	8	15	10	8	15	10	8	7
9	6	8	8	11	8	8	7	8	9	7	8	9	11	10	6
10	10	14	14	15	9	7	8	8	13	8	8	13	8	9	7
15	14	14	14	14	6	7	7	9	14	7	9	14	8	9	7
15	12	10	10	15	9	6	7	18	10	7	18	10	11	6	7
16	10	10	10	12	8	7	7	11	18	7	11	18	8	8	6
16	14	10	10	5	7	7	7	8	15	7	8	15	10	3	7
18	6	10	10	14	8	7	7	15	13	7	15	13	14	2	7
8	2	6	6	16	8	6	10	10	10	10	10	10	6	2	7
8	2	5	5	12	7	6	9	10	11	9	10	11	6	2	6
7	3	5	5	15	8	7	10	9	9	10	9	9	8	3	7
8	6	5	5	14	9	6	8	10	9	8	10	9	10	2	7
7	8	7	7	14	8	7	10	10	8	10	10	8	14	20	13
7	9	18	18	15	7	7	8	9	15	8	9	15	16	10	16
7	10	17	17	14	6	6	8	8	7	8	8	7	10	19	17
8	12	14	14	10	6	6	10	10	6	10	10	6	12	11	14
13	11	15	15	10	6	5	8	12	7	8	12	7	11	10	19
13	13	10	10	11	10	5	8	10	6	8	10	6	14	14	13
16	11	7	7	7	10	5	10	11	6	10	11	6	13	12	15



5-23-79



West Bank Across from Wooded Island-1 ContInued											
Uncorrected μ l Meter Reading @ 1m Above Ground											
Track	Track	Track	Track	Track	Track	Track	Track	Track	Track	Track	Track
1	2	3	1	2	3	1	2	3	1	2	3
14	11	14	7	11	8						
14	15	17	9	10	9						
10	18	16	11	11	9						
14	18	15	11	10	9						
12	12	15	12	10	9						
13	11	16	12	9	6						
14	9	17	13	10	5						
10	17	15	12	11	5						
7	11	14	12	9	5						
10	8	17	10	9	6						
7	10	16	9	11	6						
8	8	15	8	10	5						
9	11	10	6	9	5						
11	10	10	8	10	6						
11	10	9	6	9	6						
11	10	10	7	10	5						
9	9	9	6	8	5						
11	10	8	6	7	5						
12	10	8	8	8	5						
12	10	7	8	7	-						
12	9	7	6	6	-						
10	8	9									
8	7	8									
7	10	9									
8	8	8									

Columbia River Shoreline Contamination Survey
West Bank Across from Hooded Island-2

Date/Time: 5-24-79/1530-1700
River Flow Rate (CFS): 140,000

Starting Point: Dirt road intersects Bluff, across from center of Island-347 (Heading downstream)
Stopping Point: Sign pole w/o sign (old barrel on Bluff above)

Size of Survey Plots: 2' x 2'
No. Plots per track: 33
Distance between plots: ~ 50'
Distance between tracks: ~ 50'

Discrete Particulate Contamination: None found.

Areas with general contamination ≥ 25 $\mu\text{R/hr}$ are indicated by the symbol Δ .

Uncorrected μR Meter Reading @ 1m Above Ground ($\mu\text{R/hr}$)					
Track 1	Track 2	Track 3	Continued		
			Track 1	Track 2	Track 3
8	12	11	7	9	9
7	9	11	9	11	9
7	11	11	7	11	11
8	17	11	8	10	11
8	17	13	9	11	9
16	17	13			
17	16	14			
15	12	10			
16	13	10			
18	13	8			
18	11	7			
15	14	8			
15	15	8			
23	17	8			
21	12	8			
19	10	8			
15	8	7			
11	12	7			
15	9	8			
17	11	7			
17	12	9			
11	11	10			
11	11	-			
8	12	10			
8	13	11			
8	10	11			
8	9	8			

Columbia River Shoreline Contamination Survey
North of 300 Area

Date/Time: 5-23-79/1500-1700
River Flow Rate (CFS): 127,200

Starting Point: Across from South tip of Island-345.

Stopping Point: Yellow "No Trespassing" sign just before dip in bluff, near upper 1/3 of Island-345.

Size of Survey Plots: 2' x 2'
No. Plots per track: 46
Distance between plots: ~ 50'
Distance between tracks: ~ 50'

Discrete Particulate Contamination: None found.

Areas with general contamination \leq 25 μ R/hr are indicated by the symbol Δ .

Uncorrected μ R Meter Reading @ 1m Above Ground (μ R/hr.)									
Track 1	Track 2	Track 3	Continued			Track 1	Track 2	Track 3	
12	4	-	-	-	-	10	6	-	
10	3	-	-	-	-	12	6	-	
12	4	-	-	-	-	20	8	-	
15	3	-	-	-	-	12	4	-	Δ
12	3	-	-	-	-	12	2	-	
12	2	-	-	-	-	10	2	-	
12	2	-	-	-	-	18	2	-	
10	2	-	-	-	-	16	2	-	
10	3	-	-	-	-	12	2	-	
-	3	-	-	-	-	13	2	-	
12	3	-	-	-	-	15	3	-	
10	8	-	-	-	-	18	3	-	
16	6	-	-	-	-	18	2	-	
16	4	-	-	-	-	14	3	-	
12	4	-	-	-	-	18	3	-	
12	4	-	-	-	-	12	3	-	
14	4	-	-	-	-	10	2	-	
14	4	-	-	-	-	10	3	-	
14	4	-	-	-	-	12	-	-	
15	4	-	-	-	-	-	-	-	
14	4	-	-	-	-	-	-	-	
21	3	-	-	-	-	-	-	-	Δ
12	3	-	-	-	-	-	-	-	
15	3	-	-	-	-	-	-	-	
15	5	-	-	-	-	-	-	-	
10	4	-	-	-	-	-	-	-	

North of Graduate Center Continued											
Uncorrected μR Meter Reading @ 1m Above Ground											
Track	Track	Track	Track	Track	Track	Track	Track	Track	Track	Track	Track
1	2	3	1	2	3	1	2	3	1	2	3
-	-	-	-	-	-	-	-	-	-	-	-
-	6	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	7	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	6	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	5	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	6	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-
11	5	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	5	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	7	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	6	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	13	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	6	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	6	-	-	-	-	-	-	-	-	-	-
10	6	-	-	-	-	-	-	-	-	-	-
11	12	-	-	-	-	-	-	-	-	-	-

pts. spaced approx. every 100 ft.

Columbia River Shoreline Contamination Survey
North of Richland Pumpouse

Date/Time: 5-22-79/1530-2000
River Flow Rate (CFS): 137,480-147,800

Starting Point: Richland Water Plant water intake structure.

Stopping Point: Start of houses on high bluff.

Size of Survey Plots: 2' x 2'

No. Plots per track: 57

Distance between plots: ~ 50'

Distance between tracks: ~ 50'

Discrete Particulate Contamination: None found.

Areas with general contamination > 25 µR/hr are indicated by the symbol Δ.

Uncorrected µR Meter Reading @ 1m Above Ground (µR/hr)					
Track 1	Track 2	Track 3	Continued		
			Track 1	Track 2	Track 3
8	8	8	15	10	15
8	6	10	15	12	19
6	8	10	20	18	20
6	6	10	10	14	18
10	6	10	10	8	12
12	7	10	8	10	8
10	9	9	6	8	10
10	10	8	6	8	8
10	10	8	8	8	7
10	12	10	6	6	8
8	8	11	-	-	7
8	10	10			
8	10	8			
10	8	12			
10	10	10			
11	8	15			
12	10	16			
12	10	17			
8	10	14			
12	12	19			
11	16	17			
16	10	17			
8	14	17			
10	14	15			
12	12	14			
10	13	14			
12	18	13			

Columbia River Shoreline Contamination Survey
 Saint to Snyder St. (Richland)

Date/Time: 5-22-79/1400-1430
 River Flow Rate (CFS): 153,300

Starting Point: Saint Street Richland.

Stopping Point: Snyder Street at South end of parking lot.

Size of Survey Plots: 2' x 2'
 No. Plots per track: 17
 Distance between plots: ~ 50'
 Distance between tracks: ~ 50'

Discrete Particulate Contamination: None found.

Areas with general contamination $\geq 25 \mu R/lr$ are indicated by the symbol Δ .

Uncorrected μR Meter Reading @ 1m Above Ground ($\mu R/hr$)				
Track	Track	Track	Continued	
1	2	3	Track	Track
			1	2
8	7	4	1	3
7	6	5	2	
7	7	4		
6	6	4		
7	5	4		
7	6	5		
6	6	4		
6	6	3		
6	7	3		
7	7	4		
8	6	4		
6	6	3		
6	8	4		
6	7	3		
6	7	4		
6	6	4		
6	4			

Columbia River Shoreline Contamination Survey
 Thomas to Park St. (Richland)

Date/Time: 5-22-79/1000-1345
 River Flow Rate (CFS): 126,000-153,300

Starting Point: Thomas Street Richland.

Stopping Point: Park Street Richland.

Size of Survey Plots: 2' x 2'
 No. Plots per track: 125
 Distance between plots: ~ 50'
 Distance between tracks: ~ 50'

Discrete Particulate Contamination: None found.

Areas with general contamination
 > 25 µR/hr are indicated by the symbol Δ

Uncorrected µR Meter Reading @ 1m Above Ground (µR/hr)						
Track 1	Track 2	Track 3	Continued			Track 3
			Track 1	Track 2	Track 3	
7	4	10	13	6	4	4
7	3	8	10	8	4	4
9	8	7	9	9	4	4
10	5	8	10	9	4	4
9	4	7	11	6	4	4
10	6	8	10	7	4	4
10	6	4	12	7	4	4
11	7	8	9	8	6	6
11	6	8	9	5	4	4
9	6	8	8	5	4	4
10	4	8	8	5	4	4
7	4	8	7	6	16	16
7	7	4	7	4	12	12
9	4	8	6	5	4	4
11	5	4	6	6	4	4
10	5	4	7	6	4	4
14	6	8	7	6	6	6
13	12	8	6	5	4	4
13	9	4	7	5	4	4
14	6	4	5	6	4	4
13	6	4	5	6	4	4
11	5	6	5	6	4	4
14	7	6	6	5	4	4
11	8	4	7	7	4	4
13	8	4	6	6	4	4
10	6	4	7	6	6	6
13	8	4	9	6	4	4

Thomas to Park Street Continued											
Uncorrected RR Meter Reading 0' In Above Ground											
Track	Track	Track	Track	Track	Track	Track	Track	Track	Track	Track	Track
1	2	3	1	2	3	1	2	3	1	2	3
8	7	4	12	5	6	10	5	7	1	2	3
9	7	6	12	7	8	14	5	7			
10	6	4	12	7	7	12	4	7			
9	5	4	11	7	8	12	5	8			
9	4	4	12	7	9	12	5	6			
7	6	8	10	6	8	11	5	6			
8	5	6	12	7	8	9	4	4			
8	6	8	10	7	9	9	7	4			
8	6	7	10	6	10	9	6	4			
9	6	8	9	5	8	9	5	4			
11	6	8	11	5	8	10	5	7			
9	5	8	10	5	8	12	4	7			
9	7	8	10	7	8	10	6	8			
10	4	8	10	6	8	10	6	6			
10	5	8	10	7	6	11	6	6			
9	5	6	10	5	8	13	5	7			
8	6	7	10	7	8	12	5	6			
8	5	9	9	5	8	13	5	7			
9	6	7	10	5	9	11	6	6			
11	5	8	10	7	8	12	5	6			
8	5	7	11	7	8	9	5	6			
10	4	6	11	5	8	7	4	5			
8	5	8	8	4	9	-	4	-			
9	5	8	12	4	8						
12	5	8	12	6	11						

Columbia River Shoreline Contamination Survey
 Eastern Shoreline Across From Hanford House

Date/Time: 5/25/79; 0900-1700
 River Flow (CFS): 127,200-132,200

Starting Point: Dirt piles next to rectangular inlet.

Stopping Point: Across from gravel pit.

Size of Survey Plots: 2' x 2'
 No. Plots per track: 126
 Distance between plots: ~ 50'
 Distance between tracks: ~ 50'

Discrete Particulate Contamination: None found.

Areas with general contamination ≥ 25 $\mu\text{R/hr}$ are indicated by the symbol Δ .

Uncorrected μR Meter Reading @ 1m Above Ground ($\mu\text{R/hr}$)									
Track	Track	Track	Continued						
			Track	Track	Track				
1	2	3	1	2	3				
6	10	-	9	-	-				
8	14	11	-	14	-				
-	11	15	9	11	15				
-	13	14	-	-	-				
-	12	14	-	-	-				
9	12	13	-	-	11				
8	11	-	-	-	-				
10	12	13	-	-	-				
-	-	11	-	-	-				
10	12	13	-	-	14				
-	-	-	-	-	-				
6	9	9	-	-	10				
8	10	11	-	-	-				
-	-	14	-	-	11				
-	12	13	-	-	-				
-	-	-	-	-	10				
-	13	-	-	-	10				
-	-	13	-	-	9				
-	-	13	-	-	10				
-	11	13	-	-	9				
-	-	12	-	-	10				
-	-	12	-	-	10				
-	-	13	-	-	9				
-	-	13	-	-	9				
-	-	14	-	-	11				
-	-	14	-	-	11				
-	-	13	-	-	-				
-	12	-	-	-	-				

APPENDIX C
RADIOLOGICAL SURVEY OF D-ISLAND

APPENDIX C

RADIOLOGICAL SURVEY OF "D" ISLAND^(a)

A survey of "D" Island was performed on October 25, 1978 to determine its current radiological status. Some of the results of the survey were higher than had been expected, and a resurvey was conducted on October 30, 1978, to determine the distribution and density of the radioactive particles, to take exposure readings more amenable to interpretation, and to collect several particles for radionuclide identification and quantification.

The water level of the river at the start of the resurvey (October 30) was 381 feet at D Reactor water intake. This was approximately the same as the level at the start of the October 25 survey, although no gauge reading was taken during the October 25 survey.

The shore of "D" Island is characterized by a surface covering of smooth rocks 1 to 6 inches in diameter over a layer of mixed pea gravel to sandy-silty material. Three of the most radioactive particles that could be found were found in the top 1/4 to 1/2 inch of the pea gravel/sandy-silty layer. The microscopic particles could not be differentiated from the matrix in which they were found except by the radiation they emitted. Laboratory analysis of the particles using a GeLi detector and a multichannel analyzer showed that the particles were 100% ^{60}Co . No trace of any other radionuclide was observed, confirming that the particles are not of recent origin. Activities of 2.8 to 22 μCi ^{60}Co were measured on these particles.

Most of the radioactive particles located had contact exposure rates of 50 to 150 $\mu\text{R/hr}$. At a distance of one meter exposure rates of background (6-8 $\mu\text{R/hr}$) to 13 $\mu\text{R/hr}$ were noted for most particles. A small fraction of the particles, perhaps 1 or 2% contained more activity and exhibited exposure rates up to 60 $\mu\text{R/hr}$ at one meter. One particle was found that read about 750 $\mu\text{R/hr}$ at one meter, but was not recovered due to the rapidly rising water late in the morning. Based on the two surveys, it is estimated that the average radioactive particle on the island contains about 0.5 μCi ^{60}Co .

To gain some information on the distribution and density of the radioactive particles on the island, fourteen, 100 ft² areas were selected at random along the north shore, some near the water line and some twenty to thirty feet inland. Each plot was carefully surveyed, noting the number of particles and the contact exposure rate of each particle. A total of seven particles were located in the 14 areas, yielding a density of 5×10^{-3} particles per square foot.

The island is about 2000 feet in length and has an estimated shoreline perimeter of 5000 feet. The wetted area or area where particles may have been deposited in the past and that may be exposed during low flow periods is estimated to average 30 ft in width. Thus, the total number of radioactive particles exposed on the shore during low river flow is estimated to be about 750 ($.005 \times 5000 \times 30$). An upper limit estimate of the total activity associated with all the particles on the island is 1000 μCi . This corresponds to an average shoreline surface concentration of about $0.06 \mu\text{Ci}/\text{m}^2$, which agrees reasonably well with the E.G.G. aerial survey of 1973.

In general, background exposure rates at one meter over the shoreline are 6 to 8 $\mu\text{R}/\text{hr}$. Above the radioactive particles are small areas that exceed background, ranging in size from a few inches in diameter at contact to a foot or two in diameter at a meter above the surface.

In addition to the discrete particles, elevated radiation levels were found at vent pipes that penetrate the D and DR Reactor cooling water discharge lines at the upstream end of the island. These are small diameter pipes extending several feet above the surface with a "T" on top and are only visible during low river flow conditions. Contact exposure rates on these vents are 80 to 100 $\mu\text{R}/\text{hr}$.

(a) Letter from J. R. Houston, Environmental Evaluations, Occupational and Environmental Protection Department, Pacific Northwest Laboratory, Richland, WA, to P. F. X. Dunigan, Safety and Environmental Protection Division, U.S. Department of Energy, Richland Operations Office, Richland, WA, "Radiological Survey of "D" Island, Dated November 1, 1978.

APPENDIX D
FIELD CALIBRATION OF SURVEY INSTRUMENT

APPENDIX D

FIELD CALIBRATION OF SURVEY INSTRUMENT

A correction factor was applied to all survey data, based upon a comparison of exposure rate measurements made using a Ludlum μ R survey meter and a Reuter Stokes Ionization Chamber under field conditions. The correction factor accounts for errors in the survey meter readings resulting from the different gamma-energy distributions and source to detector geometries encountered in the field versus the calibration laboratory.

Exposure rate readings were taken at seven locations along the Columbia River shoreline from the Vernita Bridge to the 300 Area. The comparison was made at several locations to account for changes in contamination level, local variations in energy distributions, and difference in scatter due to the type of ground cover. Both instruments were located one-meter above the ground about six feet apart, the ionization chamber on a tripod and the survey meter hand held. A preliminary survey using the μ R meter was performed at each calibration site to insure that contamination levels were uniform in the vicinity.

Each calibration test was run for one hour during which an integrated reading was obtained from the ionization chamber and several equally spaced readings were taken with the μ R meter. Table D-1 shows the data obtained from the measurements. Error bars represent the $\pm 2\sigma$ distribution about the mean of the several μ R meter readings.

Both instruments had been tested and calibrated (using a Ra-226 source), by the Instrument Evaluation and Calibrations group at PNL just prior to the tests.

The Reuter Stokes ionization chamber is not as sensitive to the energy distribution of the gamma field as is the survey instrument, which uses a NaI crystal for radiation detection. It is estimated that errors due to laboratory calibration of the Reuter Stokes chamber are less than 5% (Operational Manual RSS-111 Area Monitoring Systems, Reuter Stokes Instruments, Inc., April 1977).

The correction factor was determined by graphing the readings obtained from the two instruments (Figure D-1). A straight line was drawn through the

data points using the least squares approximation. The slope of the line was calculated to be 1.25, and with a coefficient of determination of $r^2 = .97$, the fit of the line to the data was judged to be adequate.

Corrected values were then obtained by multiplying the μR meter readings by 1.25.

TABLE D-1. Comparison of Reuter Stokes Ionization Chamber and Ludium μR Survey Meter Readings

<u>Shoreline Location</u>	<u>Indicated Exposure Rate ($\mu\text{R}/\text{hr}$) Ionization Chamber</u>	<u>μR Survey Meter $\pm 2\sigma$</u>
Near Vernita Bridge	9.2	5.4 \pm .8
H-Area Slough	16.5	13.8 \pm 2.4
Richland Marina	13.9	12.1 \pm .4
Hanford Townsite Peninsula	19.1	18.8 \pm .6
F-Area Slough	13.6	11.6 \pm .4
Across from Wooded Is.	19.2	17 \pm 0
Park Street, Richland	13.7	11.3 \pm 1.0

$$\bar{x} = 15.03$$

$$s = 3.54$$

$$12.36$$

$$4.5$$

$$LLM \ 1.17 = R-E$$

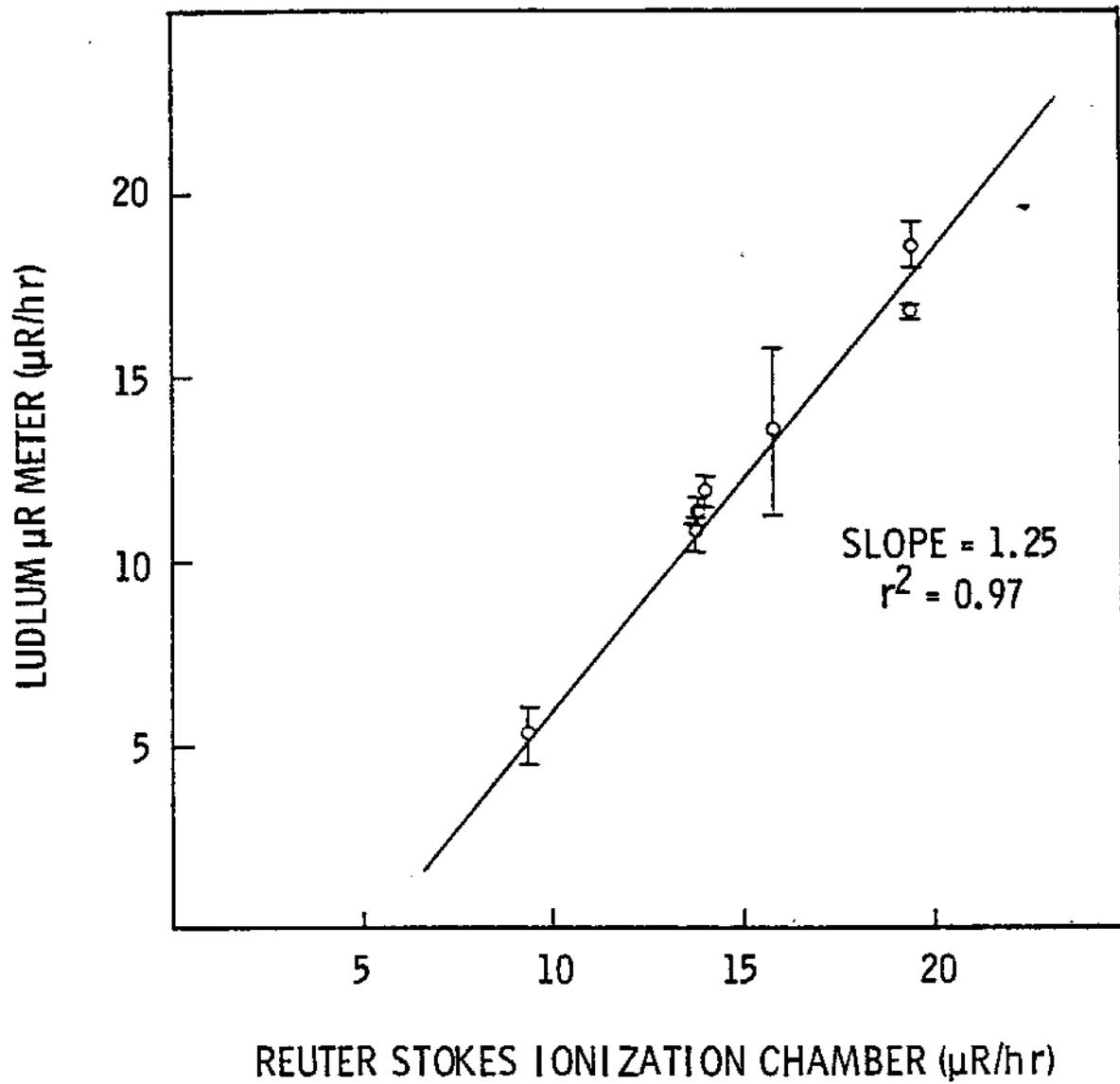


FIGURE D-1. Field Calibration of the Ludlum μR Meter

APPENDIX E
ANALYSIS OF DISCRETE PARTICLES

APPENDIX E

ANALYSIS OF DISCRETE PARTICLES

Three "Discrete Particles", recovered from D-Island, were analyzed by the Physical Science group at PNL. The three particles were randomly chosen from a set of 14 particles retrieved for radionuclide analysis. The particles were visible to the naked eye - appearing as dark colored flakes and were of similar size and shape when viewed through a microscope (Figure E-1). Radionuclide analysis of each particle by the Radiation Monitoring group at PNL using a NaI detector coupled to a multi-channel analyzer showed gamma emissions to be purely due to ^{60}Co . No attempt was made to determine the existence of trace quantities of other radionuclides.

Composition of the particles was determined by energy dispersive analysis using a Materials Analysis Electron Microprobe Model 4005 and an EDAX Li-drifted silicon x-ray detector. The elemental composition of the three particles varied; however, each particle contained significant fractions of chromium, iron, and cobalt, in ratios reasonably close to the range of distribution of these elements in the alloy, stellite.

Particle	Analysis of Particles							
	Dimensions (mm)		Elemental Composition (%)					
	Major Axis	Minor Axis	Cr	Fe	Co	Si	Mn	Zr
1	0.16	0.10	41	21	12	3	-	-
2	0.16	0.08	38	7	32	2	2	1
3	0.11	0.08	25	10	29	3	1	1



FIGURE E-1. Micro-photograph of a Discrete ^{60}Co Particle Recovered From Ringold Island (magnified 500 x)

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SURVEY AND MEASUREMENT METHODS

Survey Locations

Areas were chosen for survey based upon the anticipated presence of contamination using the 1974 Aerial Radiological Survey Report⁽¹⁷⁾ and preliminary 1978 Aerial Survey data. In addition, several other areas were surveyed based upon their frequent use by the public. These areas include several small beaches north of Richland, Two Rivers Park, Bateman Island, Ringold Sand Dunes, and portions of the Richland shoreline. An exploratory survey was performed along the shoreline of the Columbia River Park; however, there was no indication of the presence of elevated contamination levels and as a result a formal survey was not performed.

Areas which were surveyed are enclosed within the dotted lines in Figures 4-12. Appendix A and B provide descriptions of starting and stopping places for the river shoreline surveys and also provides maps of land areas surveyed using the grid system.

Survey Techniques

All surveys were conducted on foot using portable low-level gamma radiation detectors. The procedure for recording contamination levels remained constant throughout the course of the survey; however, the degree of survey coverage provided for individual areas varied depending on several factors including; the size of the area, anticipated contamination levels, type of area including location and geographical features, and manpower scheduling constraints. Whenever possible, a formal grid was established for the area to insure uniform coverage and to enable relocation of survey points at some time in the future if desired.

Formal Grid Survey

The formal grid was laid out by first establishing a reference point. This location was permanently marked by a 5-cm diameter pipe driven into the ground. Grid points were then established at 90-meter spacings (except for Island-345 for which the spacing was 15 meters). Maps of the gridded areas are included in Appendix B. The grids were oriented from the reference point

by either a compass bearing or a second reference point as shown on the maps. With the exception of the surveys conducted on Islands 375 and 345, gridded areas were surveyed by locating each grid point and arbitrarily choosing three 3 m x 3 m (10' x 10') survey plots within a circle of approximately 30 meters radius from the grid point. On Island 375, the grid points were used to mark corners of 90 m x 90 m sections within which three 3 m x 3 m survey plots were arbitrarily chosen and on Island 345, a .6 m x .6 m (2' x 2') plot was surveyed at each grid point. Two readings were taken for each survey plot: the maximum exposure rate at one-meter above the ground and the maximum ground surface exposure rate (Figure 13). The ground exposure rate was not reported in the data Appendix unless it differed significantly from the reading taken at one-meter (i.e., a discrete radioactive particle was located).

Informal Grid Survey

An informal grid was used when a systematic method was necessary to assure uniform coverage of an area, but a formal grid could not be established (due to time constraints). Methods of establishing informal grids varied from location to location, but assured that coverage was at least as equivalent as that provided by a formal grid, that the survey plots were evenly distributed over the area, and that shoreline areas received special consideration. The informal grid was most often used for long, narrow islands.

Shoreline Track Survey

The shoreline track survey method was applied to river shoreline surveys where the shorelines were narrow (i.e., all areas except for large low lying shoreline regions on floodplains and peninsulas which were surveyed using the grid method). The shoreline survey usually consisted of three tracks running parallel to the shoreline. Surveys were made on .6 m x .6 m (2' x 2') plots at 15-meter intervals along each track. At each plot, two survey instrument readings were obtained just as in the grid survey. Track 1 was always located closest to the water's edge along a path midway between the water's edge and the daily high water mark. Tracks 2 and 3 were spaced 15-meters and 30-meters, respectively, inland from the track 1 path.

General Survey

General surveys were conducted on very small islands and peninsulas and on the beach areas. The surveys were performed using 3 m x 3 m (10' x 10') survey plots randomly distributed over the area.

Measurements

Field contamination measurements were made using a portable Ludlum micro-R meter Model 125 survey instrument. The micro-R meter is a small hand-held, battery powered device incorporating a 2.5 cm x 2.5 cm NaI(Tl) crystal to detect gamma radiation emitted by the radioactive contamination. The instrument readout is in units of $\mu\text{R/hr}$ based on laboratory calibration using a Ra-226 source. The surveys were performed by the Environmental Monitoring personnel of the Pacific Northwest Laboratory (PNL).

Maintenance and calibration checks were performed throughout the survey by the Instrument Calibrations and Evaluations group at PNL. Calibration and maintenance records are maintained by calibrations personnel. Prior to use each day, each instrument was given an informal battery and background check by the Monitoring personnel.

During the survey, it became apparent that the survey instruments were sensitive to small changes in battery charge, in that during a survey, a gradual decrease in the efficiency of the detector was observed as the batteries weakened. The maximum change in instrument efficiency observed during a survey was 50%; however, in most cases efficiency changes were of the order of only a few percent. This did not affect the capability of the instrument to respond to increases in radiation level associated with the presence of a contamination deposit or discrete particle, although in some cases it caused the instrument reading to be biased low.

The survey instruments were found to be highly sensitive to the low-energy gamma radiations resulting from the scatter of the higher energy source emissions from the contamination with nearby objects such as rocks, vegetation, and the instrument user. A correction factor was established to account for the gamma energy distribution encountered under field conditions

RESULTS AND DISCUSSION

GENERAL

A total of nearly 30,000 individual measurements were made during the performance of the survey. It is estimated that 21 million square meters of land, or approximately 60% of the affected area between B-Area and Two Rivers Park in Finley, ^{were} ~~was~~ accounted for by the survey. In all, 64 km (40 miles) of shoreline and 26 islands were surveyed.

Data obtained during the survey are presented in Appendix A for surveys made on islands, peninsulas, sloughs, and flood plains; and in Appendix B for shoreline surveys. This data is summarized in Tables 2 and 3.

Contamination found along the Columbia River shoreline and island areas can be categorized as one of three types with respect to its distribution: 1) "discrete particles" of ^{60}Co contamination, 2) "contamination deposits"; i.e., regions of varying size with contamination levels significantly higher than adjacent areas and 3) a uniform layer of contamination deposited over a large area. For the purpose of definition, the term "discrete particle" was applied to contamination in which the radiation appeared to be emitted by a point source (i.e., the instrument reading would decrease rapidly as the instrument was moved away from the apparent source). Areas designated as "contamination deposits" refer to regions in which the measured exposure rate at one-meter above the ground exceeded an arbitrarily chosen value of $25 \mu\text{R/hr}$. The level of uniformly distributed contamination is expressed in the tables by the average^(a) of the individual exposure rate readings taken at one-meter

(a) In computing the average exposure rate for island, slough, peninsula, and floodplain areas, all individual survey measurements were included. For shoreline regions, in which the survey was performed by walking tracks parallel to the shoreline, a biased average was used. The biased average was calculated by considering only the maximum of the three instrument readings (one for each track) at a particular location along the shoreline in the calculation of the average exposure rate. The biased average exposure rate was intended to prevent data recorded at survey points located high on the river bluff which had not been exposed to contamination-bearing river water and hence, not a member of the population under study, from being included in the calculation of an average exposure rate for that population. It was frequently the case during the survey, that the river bluff would closely approach the shoreline such that two tracks would be on the bluff, well above the river. This technique results in a slight overestimation of the average exposure rate.

TABLE 2. Summary of Survey Data: Island and Broad Shorelines

Survey Area	Exposure Rate, $\mu\text{R/hr}$ (a)		Number 3m x 3m Survey Plots	Number Discrete Particles Found	Particle/ m^2	Location with Elevated Readings(b) ($>25 \mu\text{R/hr}$ @ 1 Meter Above Ground [max $\mu\text{R/hr}$; location; terrain]
	Average $\pm \sigma$	Maximum				
Coyote Rapids Pen.	6 \pm 1	9	34	0		(d) -
Island-377 (D-Island) ^(c)	9 \pm 1	125	14	1	5.4×10^{-2}	1 25; At Vent Pipes
D-Area Floodplain	12 \pm 4	23	298	1	3.7×10^{-4}	-
Island-376	10 \pm 3	25	25	9	3.9×10^{-2}	2 25; Interior of down-stream half; rocky, no vegetation
Island-375	9 \pm 3	19	210	30	1.5×10^{-2}	-
Island-373 A	15 \pm 3	25	6	1	1.8×10^{-2}	3 25; upstream half of island just above daily high water mark; rocky, sparse vegetation - particles found nearby
Island-373 B	11 \pm 2	25	21	2	1.0×10^{-2}	4 25; Near downstream end of island; rocky, no vegetation, particles found nearby
Upper Island-372 (Locke I)	11 \pm 4	25	142	8	6.0×10^{-3}	5 25; Grid section 3C; Rocky 6 25; Grid section 8C; Rocky 7 25; Grid section 9C; Rocky
Lower Island-372 (Locke I)	12 \pm 2	18	462	4	9.4×10^{-4}	-
White Bluffs Slough	15 \pm 4	40	219	2	9.8×10^{-4}	8 29; Grid section 4A; Cheatgrass 9 28; Grid section 5A; Cheatgrass 10 25; Grid section 6A; Cheatgrass 11 40; Grid section 22A; Low, grassy area 12 38; Grid section 23A; Low grassy area 13 26; Grid section 6B; Grass and dirt 14 25; Grid section 10B; Rocky 15 25; Grid section 11B; Rocky 16 25; Grid section 17B; Rocky 17 25; Grid section 2C; Rocky 18 25; Grid section 4C; Rocky 19 28; Grid section 5C; Rocky
Island-368	9 \pm 2	13	62	6	1.0×10^{-2}	-
F-Area Floodplain	11 \pm 4	31	225	10	4.7×10^{-1}	20 25; Grid section 3I; Grassy 21 31; Grid section 11J; Rocky with grass; 2 particles found nearby

TABLE 2. Summary of Survey Data: Island and Broad Shorelines (contd)

Survey Area	Exposure Rate, $\mu\text{R/hr}$ (a) 1 Meter Above Ground		Number 3m x 3m Survey Plots	Number Discrete Particles Found	Particle/ m^2	Location with Elevated Readings(b) ($>25 \mu\text{R/hr}$ @ 1 Meter Above Ground [max $\mu\text{R/hr}$; location; terrain]
	Average $\pm \sigma$	Maximum				
Island-367	13 \pm 3	25	181	13	7.8×10^{-3}	22 25; Region (3);-
Island-367 A	4 \pm 1	4	7			23 25; Region (3);-
F-Area Slough	11 \pm 4	26	725	8	1.2×10^{-3}	24 26; Interior of Region (1); - 25 26; Region (1) near water; 26 25; Region (2) near water; High vegetation 27 25; Region (4); Grassy 28 25; Region (4); Grassy 29 28; Region (5), near shoreline, approx. 730m South of N.E. Corner; - 30 28; Region (5), near shoreline, approx. 830m South of N.E. Corner; Grassy bank - particles found nearby 31 25; Region (5), approx. 750m South of N.E. Corner and 15m above daily high water mark;- 32 25; Region (5), approx. 830m South of N.E. Corner and 15m above daily high water mark;- 33 28; Region (5), approx. 920m South of N.E. Corner and 15m above daily high water mark;- 34 25; Region (5), approx. 920m counter clockwis from North Point, along shoreline;-
Island-366	10 \pm 3	18	153	15	1.1×10^{-2}	-
Island-365	10 \pm 1	13	38	2	5.7×10^{-3}	-

TABLE 2. Summary of Survey Data: Island and Broad Shorelines (contd)

Survey Area	Exposure Rate, $\mu\text{R/hr}$ (a)		Number 3m x 3m Survey Plots	Number Discrete Particles Found	Particle/ m^2	Location with Elevated Readings (b) ($>25 \mu\text{R/hr}$ @ 1 Meter Above Ground [max $\mu\text{R/hr}$; location; terrain]
	Average $\pm \sigma$	Maximum				
Hanford Townsite Pen.	12 \pm 5	38	483	2	4.4×10^{-4}	<p>35] 25; Grid section 13E; Brushy</p> <p>36] 25; Grid section 14E; Brushy</p> <p>37] 25; Grid section 15E; Brushy</p> <p>38] 25; Grid section 16E; Brushy</p> <p>39] 25; Grid section 17E; Brushy</p> <p>40] 28; Grid section 18E; Brushy with willows</p> <p>41] 30; Grid section 19E; Brushy with willows</p> <p>42] 25; Grid section 26E; on shoreline, particles found at waters edge nearby</p> <p>43] 25; Grid section 13F; Rocky with medium vegetation</p> <p>44] 25; Grid section 14F; Dead trees nearby</p> <p>45] 38; Grid section 15F; Dead trees nearby</p> <p>46] 25; Grid section 20F; High vegetation</p> <p>47] 25; Grid section 21F; High vegetation</p> <p>48] 25; Grid section 16G; High vegetation</p>
Savage Island Slough (Upstream end)	14 \pm 4	35	117	4	3.7×10^{-3}	49] 35; Grid section 3C; Rocks and weeds
Savage Island Slough (Gravel Bars)	11 \pm 2	15	20	1	5.4×10^{-3}	-
Island-355 (Ringold I)	10 \pm 2	25	153	13	8.9×10^{-3}	50] 25; On West bank, 550m S. of N. tip of Island near boat Landing beach; Rocky with low vegetation
Island-353	11 \pm 2	20	253	8	3.4×10^{-3}	-
Island-352	10 \pm 2	15	740	7	1.0×10^{-3}	-
Ringold Peninsula	11 \pm 3	20	216	3	1.5×10^{-3}	-
Island-350	11 \pm 2	18	202	12	6.5×10^{-3}	-
Island-349 (N. Wooded Island)	10 \pm 3	15	129	0	-	-
Island-348 (S. Wooded Island)	12 \pm 4	23	303	2	7.1×10^{-4}	-
Island 348 A	15 \pm 3	23	34	2	6.4×10^{-3}	-

TABLE 2. Summary of Survey Data: Island and Broad Shorelines (contd)

Survey Area	Exposure Rate, $\mu\text{R/hr}$ (a)		Number 3m x 3m Survey Plots	Number Discrete Particles Found	Particle/m ²	Location with Elevated Readings(b) (>25 $\mu\text{R/hr}$ @ 1 Meter Above Ground [max $\mu\text{R/hr}$; location; terrain]
	Average = \bar{x}	Maximum				
Island-345	13 ± 5		736 ^(e)	0	-	[51] 26; N.E. Quadrant, Track 1, 15m from Starting point; - [52] 26; N.E. Quadrant, Track 1, 30m from Starting point; - [53] 29; N.E. Quadrant, Track 1, 75m from Starting point; - [54] 26; N.E. Quadrant, Track 1, 150m from Starting point; - [55] 25; N.E. Quadrant, Track 1, 200m from Starting point [56] 26; S.W. Quadrant, Track 3, 170-210m [59] From starting point; [60] 25; S.W. Quadrant, Track 5, 380-410m [61] From starting point [62] 38; Section 20 on W. Side of Island; particles found nearby
Island-344	8 ± 2	38	102	1	1.1×10^{-3}	
Island-342 (Third Island) Beaches North of Richland	11 ± 3 $10^{(f)}$	23 25	523 -	3 0	6.1×10^{-4} -	[63] 25; On upper reaches sandy beach on lower E. side of Third Is. Where black silty Material was deposited in Bands parallel to waters edge; -
Island-340	11 ± 2	15	126	0	-	
Island-339 (Nelson I)	15 ± 5	24	102	2	2.2×10^{-3}	
Richland Marina	12 ± 3	19	136	0	-	
Columbia Pt., 4 WD-Track Area	11 ± 2	15	24	0	-	
Bateman Island Beaches	11 ± 2	15	17	0	-	
Island-333	13 ± 5	38	50	1	2.2×10^{-3}	[64] 38; S. side of Is., Approximately 30m From upstream end; Sandy with willows
Island-332	13 ± 4	20	14	0	-	
Two Rivers Park	11 ± 3	18	22	1	5.0×10^{-3}	

- (a) Corrected for field calibration
 (b) Refer to maps in Appendix A to locate
 (c) Surveyed 10-30-79 (See Appendix C)
 (d) Numbers in correspond to further information
 in Appendix
 (e) Survey plots were 0.6 x 0.6m (2' x 2')
 (f) Complete coverage (plots not used)

TABLE 3. Summary of Survey Data: Narrow Shorelines

Survey Location	Exposure Rate, $\mu\text{R/hr}$ (a) 1 Meter Above Ground		Number of 0.6m x 0.6m (2' x 2') Survey Plots	Number of Discrete Particles Found	Particles/m ²	Areas with Elevated Readings (c) (>25 $\mu\text{R/hr}$ 1 Meter Above Ground) [max $\mu\text{R/hr}$; length of deposit; location]
	Average Biased to	Maximum				
Vernita Bridge	7 ± 1	7	30 ^(b)	0 ^(c)	-	-
B-Area	9 ± 2	125	135	0	-	1 125; 110m, below 107-B Retention basin
N-Area to K-Area	11 ± 2	250	363	0	-	2 28; 60m; approx. 2km Upstream of starting point
N-Area to O-Area	8 ± 2	380	612	0	-	3 250; 150m; below 107-K Retention basin
D-Area to D-Floodplain	7 ± 2	63	228	0	-	4 380; 1250m; Shine from reactor facilities. Region extends from starting point at 100-N outfall and extends downstream for 1250m. Levels increase as bank is climbed
H-Area	10 ± 3	25	1229	4	8.8 x 10 ⁻³	5 63; 60m; 730m downstream of starting point
H-Slough to F-Area	11 ± 4	30	306	0	-	6 25; 15m; Approx. 1.8km downstream of 181-H
						7 25; 30m; Approx. 310m downstream of sawed off telephone pole which is located approx. 3.4km downstream of 181-H Area. Higher activity appears to be associated with 3 particles found in this area. A fourth particle was found approx. 180m upstream
						8 30; 490m; Approx. 490m downstream of starting point
						9 26; 150m; Just upstream of power line crossing

TABLE 3. Summary of Survey Data: Narrow Shorelines (contd)

Survey Location	Exposure Rate, $\mu\text{R/hr}$ (a) 1 Meter Above Ground		Number of 0.6m x 0.6m (2' x 2') Survey Plots	Number of Discrete Particles Found	Particles/ m^2	Areas with Elevated Readings (C) ($>25 \mu\text{R/hr}$ 1 Meter Above Ground) [max $\mu\text{R/hr}$; length of deposit; location]
	Average Biased $\pm \sigma$	Maximum				
Hanford Townsite Slough	12 \pm 3	24	219	0	-	
Hanford Townsite	11 \pm 3	30	876	0	-	<p> 28; 30m; Approx. 1530m downstream of starting point</p> <p> 30; 140m; Approx. 1710m downstream of starting point</p> <p> 28; 46m; Approx. 2450m downstream of starting point</p> <p> 25; 46m; Approx. 2600m downstream of starting point</p> <p> 30; 92m; Approx. 2750m downstream of starting point</p> <p> 25; 30m; Approx. 3060m downstream of starting point</p> <p> 29; 60m; Approx. 3500m downstream of starting point</p> <p> 28; 60m; Approx. 3850m downstream of starting point</p> <p> 25; 46m; Approx. 4130m downstream of starting point</p> <p> 25; 30m; Approx. 4200m downstream of starting point</p>
Savage Island	11 \pm 2	24	441(2)	1	2.4 x 10 ⁻⁶	
Ringold Sand Dunes	10 \pm 2	26	120(2)	0	-	<p> 26; 240m; Approx. 670m downstream of starting point in thick grass</p> <p> 25; 30m; Approx. 1530m downstream of starting point in sand dunes</p> <p> 25; 30m; Approx. 1600m downstream of starting point in sand dunes and willows</p>
East Bank Across from Ringold Island	10 \pm 1	19	483	0	-	
West Bank Across from Wooded Island - 1	12 \pm 3	26	582	0	-	<p> 26; 110m; Approx. 795m upstream of starting point</p> <p> 25; 15m; Approx. 2200m upstream of starting point</p>
West Bank Across from Wooded Island - 2	14 \pm 3	29	99	0	-	<p> 29; 46m; Approx. 210m downstream of starting point</p>

TABLE 3. Summary of Survey Data: Narrow Shorelines (contd)

Survey Location	Exposure Rate, $\mu\text{R/hr}$ (a)		Number of 0.6m x 0.6m (2' x 2') Survey Plots	Number of Discrete Particles Found	Particles/ m^2	Areas with Elevated Readings (c) ($>25 \mu\text{R/hr}$ 1 Meter Above Ground) [max $\mu\text{R/hr}$; length of deposit; location]
	Average Biased \pm	Maximum				
North of 300 Area	13 ± 2	26	92	0 (c)	-	$\triangle 26$ 25; 15m; Approx. 370m upstream of starting point $\triangle 27$ 25; 15m; Approx. 460m upstream of starting point
North of Graduate Center	11 ± 3	19	264	0	-	-
North of Richland Pumpouse	11 ± 4	25	171	0	-	$\triangle 28$ 25; 46m; Approx. 460m upstream of starting point
Saint to Snyder St. (Richland)	7 ± 1	10	51	0	-	-
Thomas to Park St. (Richland)	10 ± 2	18	375	0	-	-
East Shore Across from Hanford House	12 ± 2	19	378	0	-	-

- (a) Corrected for field calibration
 (b) Survey plots measured 3m x 3m
 (c) Appendix B
 (d) Numbers in \triangle correspond to further information in the Appendix

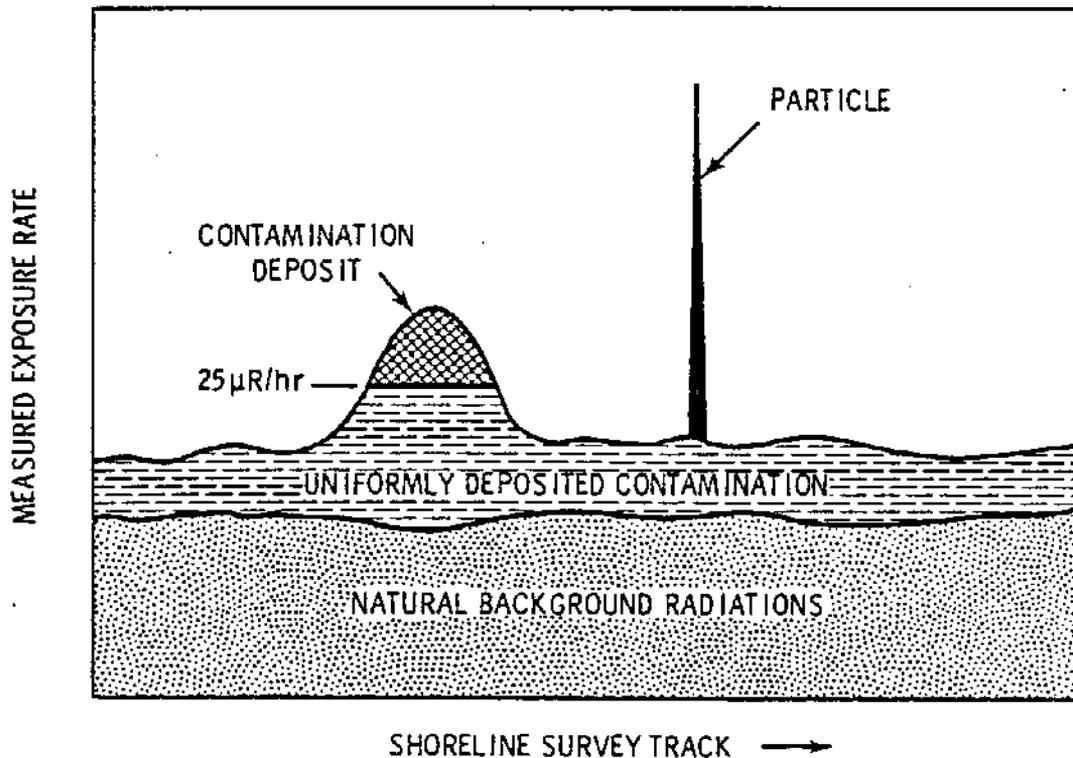


FIGURE 14. Distribution of River Deposited Contamination on Exposed Shorelines and Islands

above the ground within a designated survey area, but excluding any readings indicative of the presence of a "contamination deposit" or "discrete particle". Figure 14 pictorially represents the three categories of contamination reported in the tables.

UNIFORMLY DISTRIBUTED CONTAMINATION

The uniformly distributed layer of contamination appears to remain at a fairly constant level slightly above background over the stretch of exposed riverbank shoreline extending from B-Area to the endpoint of the survey at the Snake River confluence (see Figure 15). An average exposure rate for this stretch of the river based on the portable survey instrument readings is 11 ± 3 $\mu\text{R/hr}$ (96 mR/yr). A background exposure rate based on 30 readings taken along a 300 m section of shoreline upstream of the Vernita Bridge (i.e., upstream of any potential sources of Hanford introduced contamination) indicates a background of 7 ± 1 $\mu\text{R/hr}$ (61 mR/yr). This measured background exposure rate agrees favorably with background external radiation measurements reported in the 1978 Hanford Environmental Surveillance report.⁽¹⁶⁾

Samples of soil and vegetation were collected at six sites along the shoreline at which contamination levels below 25 $\mu\text{R/hr}$ at one meter above the ground were recorded. Table 4 shows the concentrations of the predominant long-lived man-made radionuclides found in the samples. Naturally occurring radionuclides were present at normal concentrations and accounted for the majority of the gamma-radiation emitted by the samples. With the exception of the soil samples taken at N-Area and the Hanford Townsite Peninsula, ^{137}Cs concentrations were at levels attributable to world-wide fallout as reported in the 1978 Hanford Environmental Surveillance Report.⁽¹⁶⁾ Cobalt-60 and Europium-152 were not identified in samples of soil and vegetation taken off-site and away from the river as part of the routine Hanford environmental surveillance program and thus are associated with Hanford operations.⁽¹⁶⁾

CONTAMINATION DEPOSITS

Twenty-eight areas with measured exposures rates of 25 $\mu\text{R/hr}$ or greater were identified along the riverbank shoreline and 64 areas were identified on

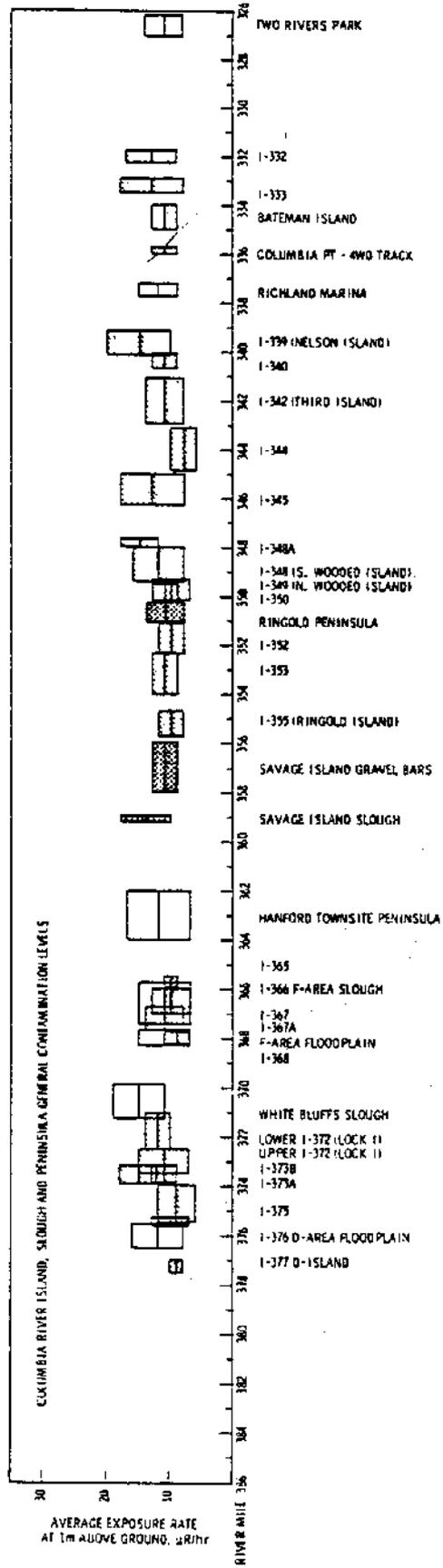
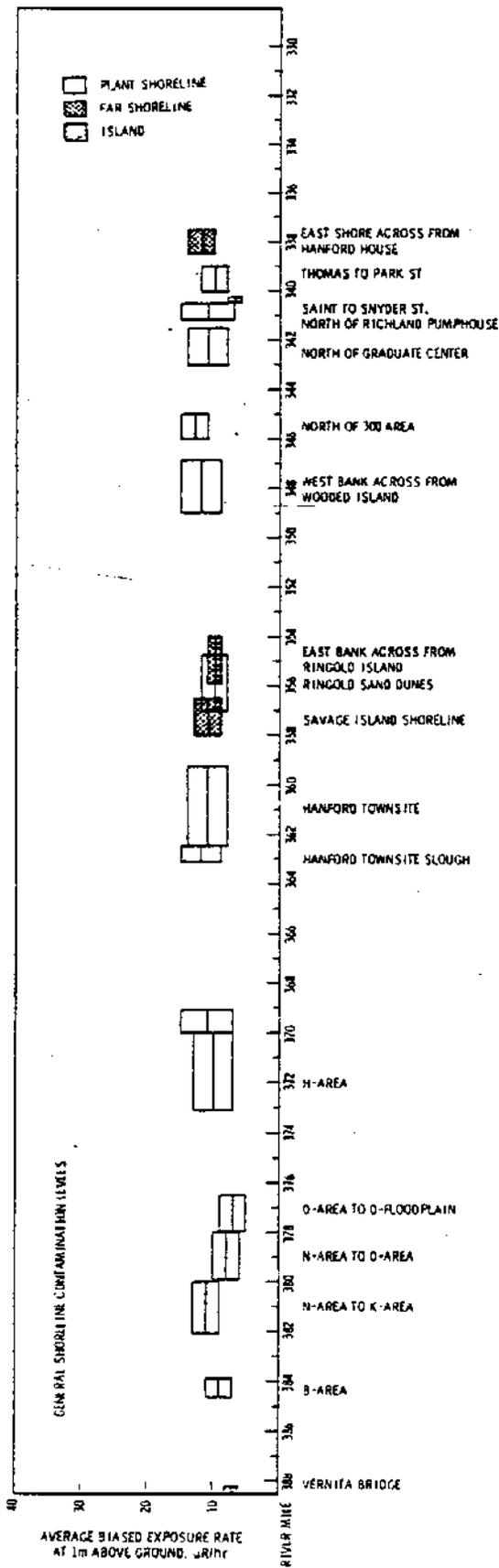


FIGURE 15. Exposure Rate Due to Uniformly Deposited Contamination over Exposed Shorelines and Islands ($7 \pm 1 \mu R/hr$ background)

TABLE 4. Concentrations of Man-Made Long-Lived Radionuclides in Soil and Vegetation Samples Collected Along the Columbia River Shoreline

Location	Concentration pCi/gram (wet wt.)		
	Co-60	Cs-137	Eu-152
<u>Exposure Rate <25 μR/hr</u>			
N-Area Shore			
Vegetation	1.0	0.09	ND
Soil	7.4	2.9	ND
F-Area Slough			
Vegetation	ND	0.04	ND
Soil	0.29	0.52	0.33
Hanford Townsite Peninsula			
Vegetation	ND	ND	ND
Soil	1.5	1.3	3.0
Plant Shore Across from Wooded Island			
Vegetation	ND	ND	ND
Soil	0.20	0.23	ND
Richland Marina			
Vegetation	ND	0.099	ND
Soil	1.0	0.52	1.6
McMurray St. Shoreline			
Vegetation	0.13	0.10	ND
Soil	0.88	0.44	0.65
<u>Exposure Rate >25 μR/hr</u>			
H Area Slough			
Vegetation	.11	4.1	.24
Soil	6.0	19.	9.5
Hanford Townsite Slough			
Vegetation	.064	.64	.21
Soil	7.3	7.3	12.0

NOTE: Shorter lived radionuclides were also present in the N-Area Shoreline sample. Naturally occurring radionuclides were present in normal concentrations. Only gamma-emitting radionuclides were considered.
 ND - Not Detected

islands, peninsulas, sloughs and floodplains. A total of 3,450 m of shoreline or 5% of the distance along the shoreline surveyed by the track method was found to exceed 25 $\mu\text{R/hr}$ at one meter above the ground. These areas ranged from a few feet to 1,250 m in length. On islands and other land areas surveyed by the grid systems, contamination deposits varied in area from less than 10 m^2 to areas covering several adjacent 90 m x 90 m grid sections. Approximately $5 \times 10^5 \text{ m}^2$ or 2.4% of the area surveyed by the grid system was found to contain contamination deposits.

The highest exposure rates at one meter above the ground on the river shoreline were measured along the B, K, N, and D Reactor areas. Exposure rates as high as 800 $\mu\text{R/hr}$ were recorded along the shoreline in a region which extended from just below to approximately 1,250 m downstream of N Reactor. All exposure rate readings taken in this area increased as the survey instruments were raised away from the ground and as the high riverbank bluff in this area was ascended towards the reactor facility; therefore, the high radiation level in this area was determined to be due to scattered gamma rays (skyshine) from several of the N Reactor radwaste storage and transfer facilities and not to surface contamination. The highest radiation levels found along B, K, and D areas, 125, 250 and 63 $\mu\text{R/hr}$ respectively, were measured below the now inoperative reactor effluent retention basins and as such were also probably not the result of river deposited contamination.

The highest exposure rate measured on an island was 125 $\mu\text{R/hr}$ on Island-377 (D-Island). This reading was taken where vent pipes for the D and DR reactor cooling systems penetrate the ground surface near the upstream end of the island. As in the previously mentioned areas with high exposure rates, the radiation levels measured were not due to river deposited contamination.

Areas found to contain the highest levels of river deposited contamination were in the While Bluff Slough, where exposure rates at one meter above ground reached 40 $\mu\text{R/hr}$ in one location and 38 $\mu\text{R/hr}$ in another; on the Hanford Townsite Peninsula in which an area reading 45 $\mu\text{R/hr}$ was located; and on Island-344 (near the 300 Area) at 38 $\mu\text{R/hr}$. The remaining contamination

deposits were in the 25-30 $\mu\text{R/hr}$ range and appeared to be rather evenly distributed as far downriver as the survey was conducted.

In general, contamination deposits were most frequently found in flat, densely vegetated areas at an elevation several feet above the daily high-water level. Field measurements using a Reuter Stokes ionization chamber were made in a heavily vegetated area on the Hanford Townsite Peninsula to determine if the increased readings were due to the uptake and concentration of radionuclides by the vegetation. The measurements showed only a 15% reduction in the exposure rate following the removal of all vegetation flush with the ground within a 3 m radius circle around the instrument.

Samples of soil and vegetation taken from two areas classified as "contamination deposits" show the same radionuclides found in areas with lower contamination levels, but at greater concentrations (see Table 4). The concentrations of all radionuclides identified in these samples are above levels associated with worldwide fallout.⁽¹⁶⁾

DISCRETE PARTICULATE CONTAMINATION

Discrete particles of contamination were found in 188 places between B-Area and Two Rivers Park near the confluence of the Snake and Columbia Rivers. Unlike areas with contamination deposits, which were more frequently located in areas of dense vegetation, the majority of the discrete particles were found in rocky, flat areas with little or no vegetation. The two types of contamination therefore appear to have been distributed along the river in a mutually exclusive manner.

The number of discrete particles found in each survey region is given in Tables 2 and 3. Information pertaining to the specific location of each particle is provided in Appendix A and B. Instrument readings were recorded at the ground in addition to one meter above the ground at each particle location. These readings, which are given in the data Appendices, should be considered only an approximation of the actual exposure rate at the ground surface since the depth of the particle, and hence the gamma energy distribution and source-to-detector geometry were unknown, and a valid correction factor could thus not be determined.

With the exception of 14 particles recovered from D-Island and Ringold Island for special study, none of the discrete particles were removed from their original location. Laboratory analysis of these discrete 14 particles with a NaI(Tl) multichannel analyzer identified the gamma radiations emitted to be entirely due to ^{60}Co at activities ranging from 1.7-24 μCi (see Table 5).

When isolated, the particles were barely visible to the naked eye, appearing as small, dark colored chips or flakes of roughly equal size. Microscopic examination of three particles showed them to be metallic appearing flakes with diameters of approximately 0.1 mm (see Figure E-1). The particles were found to vary in elemental composition, but all contained significant proportions of chromium, iron, and cobalt (see Appendix D) characteristic of the alloy stellite, used in valve and pump components in all of the production reactors.

Nine of eleven particles were found above the daily high water level, indicating deposition occurred during a period of extremely high river flow. Particles were found at depths up to 5" below the surface, mostly in the sandy interstices between rocks, although one was found to have been deposited within a small crack on the side of a rock (see Table 5).

The particles were more heavily concentrated on islands, especially those with large rocky, unvegetated areas. Fewer particles (37 as compared to 151) were found on shorelines, sloughs, floodplains, and peninsulas where there was more vegetation. The small number of particles found in many of the areas precludes an accurate quantification of particle distribution. It does, however, appear that the number of particles found per square meter of ground surveyed decreases as one travels downstream from the reactor areas.

The highest concentration of discrete particle contamination was found on the group of islands between D-Area and Locke Island. These islands are all characterized by large, level, rocky areas with little or no vegetation. Comparable concentrations of discrete particles were found on Island-368 and Island-366 near F-Area and on Island-339 (Nelson Island) near North Richland. These islands are also characterized by large, flat, rocky areas.

TABLE 5. Discrete ⁶⁰Co Particles Recovered from Island-377
(D-Island and Island-355 (Ringold))

Particle Location	Description of Area	Micro-R Meter Readings, μ R/hr			Depth Below Surface	⁶⁰ Co Activity (μ CI)
		General Background in Area	1m above ground at Particle Location	Surface of ground above Particle		
1 Upper end of D-Island 30' above DHWL	Rocks 1-6" dia. sparse weeds in area, gradual slope	10	14	210	NR	NR
2 Upper end of D-Island 25' above DHWL	Sand, rock 1-5" dia. flat	10	13	500	NR	16
3 Upper end of D-Island 30' above DHWL	Rocks 1-6" dia. sparse weeds	10	18	1400	2"	14
4 Cove at upper end of D-Island, below DHWL	Rocky, gradual slope	9	12	100	3"	1.7
5 50 yds downstream of cove 40' below DHWL	Rocks to 6" dia.	8	15	1000	3 1/2"	6.6, 23
6 D-Island 75' above DHWL	Sand, rocks, low vegetation	14	26	700	5"	21
7 D-Island 60' above DHWL	Large rocks	10	20	1000	Surface	9.9
8 Upper end of Ringold Island, 80' above DHWL near center of Island	Small rocks, sand	8	12	800	1 1/2"	13
9 Upper end of Ringold Island 30' in from DHWL (~2' verticle above DHWL)	Rocks 2-6" dia.	9	110	580	1 1/2"	12
10 Upper end of Ringold Island 20' in from DHWL (~2' verticle above DHWL)	Rock to 1", sand, sparse vegetation	NR	8	180	NR	6.5
11 Upper third of Ringold Island 13' above DHWL	Small rocks 1", sand	10	12	300	NR	2.5
12 Ringold Island	Rocky	NR	NR	NR	NR	9.7
13 Ringold Island	Rocky	NR	NR	NR	NR	1.7
14 Ringold Island	Rocky	NR	NR	NR	NR	24

DHWL - Daily High Water Level
NR - Not Recorded

COMPARISON WITH AERIAL RADIOLOGICAL SURVEYS (ARMS)

In general, the present survey showed good agreement with the 1974 ARMS report and with preliminary results for the 1978 aerial survey. Both surveys indicated that the areas containing the maximum levels of river deposited contamination were located along the H-Area Slough and on the Hanford Townsite Peninsula.⁽¹⁷⁾ It is felt that the use of the Aerial survey as a basis for choosing the particular areas to be included in the ground survey was appropriate.

Two aspects regarding the use of aerial monitoring techniques for performing a definitive contamination survey of the Columbia River shoreline areas should be noted. First, the loss of spatial resolution by locating the detector well above the ground surface (45 m) prevented the detection of discrete particulate contamination. Second, the presence of water within the detector 'field of view' greatly complicated the measurement of background terrestrial radiations along the shoreline and prevented the measurement of the net gross activity due to Hanford produced contamination. For this reason, the 1974 survey reported only ^{60}Co , and where detectable, ^{137}Cs concentrations. Europium-152 could not be measured with the NaI detectors used in the survey due to spectrum interference and; as a result, the actual radiation level due to the contributions of all the individual radionuclides present could not be determined.

CONCLUSIONS

Measurable radionuclide contamination resulting from past Hanford operations is still present along the shore of the Columbia River downstream from the 100-B Area. The absence of short-lived radionuclides in the shore sediments and the presence of contamination several meters above current maximum river levels indicate that the material was deposited some years ago. The predominant radionuclides present in the sediments are ^{60}Co , ^{152}Eu and ^{137}Cs .

Contamination on the exposed shore and island surfaces is present in three types of distributions:

- A fairly constant, uniform distribution of contamination, producing an exposure rate reading of about 11 $\mu\text{R/hr}$ (including approximately 7 $\mu\text{R/hr}$ background) exists over much of the study area.
- Localized areas of concentrated contamination or "contamination deposits" producing exposure rates in excess of 25 $\mu\text{R/hr}$ were observed at 92 locations, primarily in areas of heavier vegetation.
- Discrete particles containing ^{60}Co were observed in a number of areas, primarily in flat, rocky areas devoid of vegetation.

External dose rate from the uniformly distributed contamination and the "contamination deposit" types of contamination are below applicable external radiation protection dose limits for uncontrolled areas. Based on past surveys of river usage, the maximum individual has been established as a member of the public who spends 500 hours per year on the shore of the river. Were that individual to spend the entire 500 hours at the highest measured contamination deposit location (45 $\mu\text{R/hr}$), the resulting whole body dose would be about 20 mrem above the approximately 100 mrem which would normally be received during a year by a local resident due solely to naturally-occurring radiations.

The discrete particles present a somewhat different situation, radiologically. In the event of direct contact with a small source, the beta radiations and the extreme nonuniformity of the radiation field in the exposed tissues become the primary considerations. In such a situation, the

usual dose-response relationships become invalid; and in fact, the effectiveness of the radiation in producing damage in the organism is significantly reduced. Although no definite statements can be made without additional data, currently available information on the particle sizes and activities suggest that deleterious health effects due to the particles are most unlikely.

ACKNOWLEDGMENT

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APPENDIX A
DATA - ISLANDS AND BROAD SHORELINES