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HW-52803

AEC RESEARCH AND DEVELOPMENT REPORT

HANFORD TECHNICAL RECORD
RADIOACTIVE CONTAMINATION IN THE HANFORD ENVIRONS

FOR THE PERIOD

APRIL, MAY, JUNE

1957

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HW-52803

Health and Safety
(M-3679, 20th Ed., Rev. 1)

This document consists of 46 pages. C[redacted]
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RADIOACTIVE CONTAMINATION IN THE HANFORD ENVIRONS FOR THE PERIOD APRIL, MAY, JUNE 1957

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12-31-71
By [redacted] 4-20-73
J E Savely 6-18-98

By

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Radiation Protection Operation

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October 28, 1957

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

Work performed under Contract No. W-31-109-Eng-52 between the Atomic Energy Commission and General Electric Company

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ABSTRACT

SECTION I: RADIOACTIVE CONTAMINATION IN EFFLUENT GASES

Total average I^{131} emission from A-plant and S-plant stacks this quarter was 0.8 curie per day compared to 1.4 curies per day during the previous quarter. Approximately 80 percent of the I^{131} was emitted from A-plant stack this quarter. Ruthenium emission from the S-plant stack again averaged less than 0.01 curie per day.

C^{14} and S^{35} measurements were generally comparable to previous measurements. Total average tritium oxide emission from all reactor area stacks combined was 3.9 curies per day this quarter, an increase by a factor of 2 over last quarter's value. Maximum tritium oxide measurement was 3.6 curies per day emitted from 100-KE Area in June.

No significant changes were noted in the gross alpha activity density of reactor stack gases this quarter. The gross beta activity density returned to near normal values at 100-D and 100-F Areas this quarter, following unusually high measurements noted last quarter. The decreasing trend in both the activity density of filterable gross beta emitters and the concentrations of radioactive particles noted since October, 1956, in the 100-B reactor stack gases continued into the present quarter.

SECTION II: RADIOACTIVE CONTAMINATION ON VEGETATION

Quarterly averages for radio-iodine deposition on off-project vegetation were (5 to 16) x 10^{-6} μc/gm. Monthly average values above the detection limit of 3 x 10^{-6} μc/gm in June resulted from bomb fallout from nuclear tests.

On-project vegetation samples also showed increased radio-iodine activity density in June, when monthly averages were (3 to 12) x 10^{-5} μc/gm. Quarterly averages were (1 to 4) x 10^{-5} μc/gm.

Increases in non-volatile beta emitter activity density on vegetation during June raised the quarterly average values to (8 to 20) x 10^{-5} μc/gm for off-project vegetation, and (10 to 28) x 10^{-5} μc/gm for on-project vegetation. The radio-iodine deposition patterns for April, May, June are illustrated in Appendix B.

SECTION III: RADIOACTIVE CONTAMINATION IN THE ATMOSPHERE

No significant changes were recorded in the average dosage rates measured in the Tri-City Area this quarter. At 300 Area, average values decreased to levels comparable to those found in the Tri-City Area. Average dose rate measured by Victoreen Integrons was 0.6 mrad/day this quarter in both the Tri-City Area and the 300 Area and Vicinity.

During June, increases in the concentration of radioactive particles and in radio-iodine activity density in the atmosphere reflected fallout of bomb debris from nuclear tests in Nevada.

SECTION IV: RADIOACTIVE CONTAMINATION IN HANFORD WASTES

Gross beta activity in reactor cooling water discharged to the Columbia River averaged 3.4×10^4 curies per day this quarter compared 1.5×10^4 curies per day last quarter. Small changes in average power levels could not account for this increase. A summary of activity in liquid wastes discharged to open swamps and ditches is tabulated. Results of ground surveys on project and in nearby residential areas in April are illustrated in Appendix B.

Ground surveys of the Tri-Cities in April detected no particles in 30,000 square feet surveyed. In June, 14 particles were detected in 64,000 square feet surveyed in Richland.

SECTION V: RADIOACTIVE CONTAMINATION IN THE COLUMBIA RIVER AND RELATED WATERS

General decreases of 40 to 60 percent were noted in the beta emitter activity densities of Columbia River water during the quarter. This reflects the increase in river flow beginning the first few days of May. Mud activity levels were generally lower to a lesser extent. Activity levels of the Snake and Yakima Rivers remained at background concentrations.

SECTION VI: RADIOACTIVE CONTAMINATION IN DRINKING WATER

The Columbia River flow began to increase rapidly during the first week in May bringing the average flow for the second quarter to 1.7×10^6 gps compared to 5.2×10^5 gps during the first quarter. Pasco Filter Plant samples showed decreased beta emitter activities all through the treatment process, probably because of the greater water volume which provides greater dilution of contaminants. Water leaving the plant averaged 1.9×10^{-6} $\mu c/cc$, about 75 percent as high as last quarter.

MPC fractions, based on the continuous occupational limit related to the gastro-intestinal tract, were calculated from analyses of samples from Pasco and 100-F Area.

INTRODUCTION

This document summarizes the results obtained from monitoring the Hanford environs for radioactive contamination during the period April, May, and June, 1957. Samples were collected by Regional Monitoring forces according to procedures previously outlined in documents of this series.[1, 2] These samples were analyzed by Radiological Chemical Analysis forces according to procedures and techniques described in a previously published laboratory manual.[3]

Counting rates obtained from these analyses were corrected for geometry, backscatter, air-window absorption, source size, self-absorption, chemical yield, and collection efficiency by Radiological Chemical Analysis forces using factors described in previous reports.[4, 5, 6] Additional corrections for decay were applied to those samples in which significant amounts of short half-life beta particle emitters were found. The findings obtained from analyzing the direct samples were supplemented with readings obtained from portable and fixed instrumentation.

The results obtained from the described efforts are presented in Sections I through VI. These sections discuss the amounts of active material discharged from plant facilities and their effect on the contamination of vegetation, air, soil, and water.

SECTION I

RADIOACTIVE CONTAMINATION IN EFFLUENT GASES

Radioactive contaminants in the separations and reactor area effluent gases released to the Hanford environs were sampled at the stacks and the stack breechings. Daily filter and scrubber samples from the separations areas were analyzed for I^{131}, $Ru^{103-106}$, and filterable total beta activity. Semi-weekly filter samples and monthly tritium oxide and C^{14}-S^{35} samples were taken from the reactor area stacks. The results obtained are discussed below and summarized in Tables I through V in Appendix A.

SEPARATIONS AREAS

Slight changes in the I^{131} emission rates from the A-plant stack this quarter were within the range of fluctuations normally observed at this facility. Average daily emission of filterable gross beta emitters decreased slightly for the second quarter in a row, although, the present quarter average of 0.008 curie per day is still within the expected range of values (Table I).

A general decrease in the average daily emission rate of I^{131} from the S-plant stack was noted this quarter. Average value last quarter (9) was 0.86 curie per day, average during the present quarterly reporting period was 0.13 curie per day (Table II). Average ruthenium emission rates from the S-plant stack were below the detection limit again this quarter. Maximum measurement was 0.21 curie per day in May (Table II).

Concentrations of filterable radioactive materials discharged from the U-plant stack this quarter remained near low values noted last quarter, when operations were reduced at this facility.

REACTOR AREAS

Tritium oxide emission rates from four reactor areas increased this quarter. Total average emission from the eight reactor areas combined was

3.9 curies per day this quarter, compared to 1.8 curies per day last quarter. Six measurements above 1.0 curie per day were found: 3.6 and 3.4 curies per day at 100-KE Area, 2.1 and 1.1 at 100-KW Area, 1.7 at 100-H Area, and 1.5 at 100-D Area.

No significant changes in C^{14} and S^{35} emission rates were noted this quarter. Average values were near the respective detection limits and only scattered positive measurements were obtained. The maximum C^{14} value occurred at 100-C Area in May, when 2.7×10^{-2} curie per day was emitted. The maximum S^{35} measurement was 3.1×10^{-3} curie per day at 100-B Area in April (See Table IV).

The activity density of alpha particle emitters discharged from the reactor area stacks was below the newly defined detection limit of 6×10^{-8} curie per day this quarter (Table V). Gross beta particle emitter activity density and the concentration of radioactive particles in the stack gases discharged from 100-B reactor continued to decrease for the third consecutive quarter. Average values at other reactor areas for these two types of measurements were near normal throughout the quarter.

300 AREA - 327 BUILDING

Weekly filter and scrubber samples collected from the plenum of the 327 Building stack were analyzed for gross beta particle emitters. Monthly average values for April, May, June, and the quarterly average value were all less than 5×10^{-5} curie per day. The maximum measurement was 6×10^{-5} curie per day in May.

SECTION II

RADIOACTIVE CONTAMINATION ON VEGETATION

Determination of the radioactive contamination of vegetation in the environs was made by radiochemical analysis of over 2500 samples. More than 2100 of these samples were from the immediate environs and the remainder from off-area locations in eastern and southern Washington and northern Oregon. All samples were analyzed for I^{131}; 1400 were analyzed for non-volatile beta particle emitters. Forty samples from selected locations were analyzed for alpha particle emitters. The results of these measurements are discussed below and are summarized in Tables VI through IX in Appendix A.

Vegetation measurements for I^{131} and non-volatile beta emitters during April and May were near levels found during the previous quarter.(9) During June, a ten-fold increase in radio-iodine, and a three-fold increase in non-volatile beta emitter activity densities of vegetation were noted. These increases were the result of bomb fallout from nuclear test explosions in Nevada. Radio-iodine deposition on off-project vegetation averaged ($\leq$3 to 5) x 10^{-6} μc/gm during April and May, and (1 to 5) x 10^{-5} μc/gm during June. Quarterly averages were (4 to 16) x 10^{-6} μc/gm. On-project vegetation I^{131} deposition during April and May averaged (< 3 to 15) x 10^{-6} μc/gm; during June the average was (3 to 12) x 10^{-5} μc/gm. Quarterly average values ranged from (0.4 to 4.3) x 10^{-5} μc/gm.

Non-volatile beta emitter activity density on off-project vegetation averaged (4 to 12) x 10^{-5} μc/gm during the first two months of the quarter and (1 to 5) x 10^{-4} μc/gm during June. Quarterly average values were (5 to 10) x 10^{-5} μc/gm.

On-project vegetation measurements for this type of activity averaged (5 to 13) x 10^{-5} μc/gm during the first part of the quarter and (3 to 5) x 10^{-4} μc/gm during periods of fallout. Quarterly average values were

(6 to 11) x 10^{-5} μc/gm. The maximum measurement of 4.0 x 10^{-4} μc/gm was obtained at Route 4-S, Mile 6, near 200 East Area, on June 14, 1957.

Continuation of research work on gamma ray spectroscopy methods for vegetation analyses has resulted in a satisfactory procedure for routine use. This method employes counting 150 grams of chopped vegetation in a 9 ounce jar mounted on top of a 3" x 3" NaI crystal and analysis of the gamma energy spectrum with a 100-channel analyzer.

Starting in July, the vegetation results reported will be from the use of the new method, although wet chemistry analyses will continue for a short time to compare the two types of measurements.

Average alpha emitter activity density on vegetation this quarter was comparable to last quarter's measurements for all seven locations sampled. These data represent an interruption of the increasing trend noted during the previous two quarters. (8 and 9) A new detection limit, 3 x 10^{-8} μc/gm, based on the use of alpha scintillation counting was calculated in April; the limit previously used was 1 x 10^{-7} μc/gm.

SECTION III

RADIOACTIVE CONTAMINATION IN THE ATMOSPHERE

The magnitude and extent of airborne contamination in the Hanford environs were determined from analyses of filter and scrubber samples and from data recorded in the operation of Victoreen Integrons, H. M. Chambers, and Detachable Ionization Chambers. The results obtained by each of these monitoring methods are summarized in Tables X through XII in Appendix A.

The quarterly average dosage rates in the vicinity of 300 Area decreased by a factor or 2 to 3 this quarter [9], as measured by both integrons and detachable chambers. The victoreen measurements average 0.6 mrad/day, which is the same dosage rate as was measured in the Tri-City Area for this period. The Benton City integron was out of service this quarter and no readings were available to compare with the unusually high average obtained last quarter. Other fluctuations noted were within the range of expected values.

As in the past, measurements for alpha particle emitter activity density in the atmosphere were below 6×10^{-15} μc/cc at all locations monitored. However, a new detection limit of 2×10^{-15} μc/cc was established during April, based upon the use of alpha scintillation counting techniques. Locations where the air-borne alpha emitter activity density was above the new detection limit were 100-K Area, 3.3×10^{-15} μc/cc; 100-D Area, 2.2×10^{-15} μc/cc; Gable Mountain, 4.3×10^{-15} μc/cc; and 300 Area, 4.9×10^{-15} μc/cc. 100-H Area, 200 Area locations, and residential areas were all below 2×10^{-15} μc/cc. The maximum value was 1.8×10^{-14} μc/cc at 100-K Area on April 10, 1957.

Filterable beta particle emitters and radioactive particle concentrations in the atmosphere increased, coincident with the resumption of nuclear tests in Nevada during the quarter. During June, a monthly average of 0.35 particle/m^3 was obtained at Boise, Idaho, and 0.20 particle/m^3 at Richland, Washington.

Radio-iodine activity density in the atmosphere also increased during the periods of fallout from nuclear tests. A maximum value of 7.2×10^{-12} μc/cc was obtained on a weekly sample operated in 200 West Area from May 27 to June 3, 1957.

SECTION IV

RADIOACTIVE CONTAMINATION IN HANFORD WASTES

The magnitude and extent of radioactive contamination in Hanford wastes were determined from the results of over 2700 measurements. Solid and liquid samples obtained from open waste areas analyzed radiochemically for gross alpha and beta particle emitters. Specific isotopic analyses were also performed for certain other contaminants. These measurements were supplemented with data obtained from portable instrument surveys at various locations on the plant.

100 AREA WASTES

Radioactive contamination discharged to the Columbia River from the reactor areas was determined by analyzing samples collected daily from the outlets of the effluent water retention basins and correcting the results for decay. A summary of the activity of beta particle emitters discharged to the river per unit of time, not corrected for periods of reactor outage (when no samples were taken) is given in Table XIII in Appendix A.

The average total beta activity in cooling water discharged to the river from all reactors increased from 1.5×10^4 curies per day last quarter[9] to 3.4×10^4 curies per day during the current quarter. Increases in average reactor power levels, and reduced downtime this quarter could account for only a fraction of this increase. River water turbidity, which is at its highest during the spring run-off, may be partly responsible for the higher cooling water activity density.

The activity density of I^{131} in waste discharged to the Columbia River from the Biology Farm at 100-F Area was measured by analyzing composite samples collected from the sump in the waste discharge line. An average of 85 μc/day was discharged to the river during the quarter, compared to last quarter's average of 83 μc/day.

200 AREA WASTES

Liquid and solid samples collected from waste sources in the separations areas are summarized in Tables XIV and XV in Appendix A. The changes in alpha and beta particle emitter activity density noted when this quarter's results were compared with those of past quarters were generally within the range of fluctuations expected. Decreases noted in activity density in liquid samples from the T-plant ditch and swamp are a continuation of long-term trends resulting from shutdown of T-plant facility. Increased alpha particle emitter activity density in the Laundry Ditch water and decreased alpha particle emitter activity density in U-ditch inlet water (Table XIV) were both confirmed by uranium analyses on these samples (Table XV).

The newly established Redox swamp at 200 West Area was added to the locations routinely sampled for mud and water activity densities. Quarterly averages shown in Table XIV represent several increases by factors of 2 to 4 over initial measurements made in March, 1957.

Portable instrument surveys using G. M. and C. P. meters were performed at the perimeter of all open waste zones in the separation areas. Counting rates obtained over mud and water at the B-ditch and B-swamp in 200 East Area this quarter were from 50 to 500 c/m above background, about one-half of the values noted last quarter. Counting rates observed at the T-swamp and T-ditch generally decreased throughout the quarter as these waste zones gradually dried up. Maximum readings were 35,000 c/m over the ditch and 40,000 c/m over the swamp in April. Laundry ditch readings continued to range from a background of 200 c/m up to a few thousand c/m. Maximum measurements were again obtained at the U-swamp inlet, where dosage rates of 10 to 40 mrad/hr were found throughout the quarter.

300 AREA WASTES

Radioactive contamination in waste water entering the 300 Area North pond was measured in bi-weekly composite samples collected by Fuels Preparation Department personnel (Table XVI). Gross beta particle emitter

activity discharged to this pond decreased this quarter to 45 per cent of last quarter's average. This is a valid decrease and was not related to the new sampling and analysis techniques adopted. Periods when both the new methods and the previous daily grab and/or composite samples were employed showed comparable results for monthly and quarterly averages. The change in plutonium detection limit from the previous value of 1×10^{-9} μc/cc to about 1×10^{-7} μc/cc was due to a change in the volume of sample used for this analysis.

ENVIRONS - GROUND CONTAMINATION

Spot ground surveys with portable instruments were made in the Tri-City Area in April. No radioactive particles were detected when 21,000 square feet were surveyed in Richland, 5,000 square feet in Kennewick, and 4,000 square feet in Pasco. During June, 14 particles were detected on the ground in Richland during a survey of 64,000 square feet. Average and maximum instrument readings, taken at the surface of individual particles, were 5,000 c/m and 20,000 c/m, respectively. Maximum reading at three feet above the ground on a Thyac G. M. with the beta shield open was 300 c/m.

Surveys of areas adjacent to the project roadways and inside of the reactor areas revealed 0 to 1 particle per 1000 square feet surveyed, except in the vicinity of 100-B Area. Higher particle deposition at 100-B Area resulted from the "wind-blown" spread of contamination from the 107-CW basin during April. Surveys revealed deposition to be in a south southwest direction over an area of 12 square miles. Route 1 and the cut-off roads from 100-B Area to Route 4N showed particle concentrations of 3 to 8 particles per 1000 square feet along the roadways. Average instrument reading per particle at ground level was 15,000 c/m, and at 3 feet above the ground, it was 200 c/m. Maximum measurement at ground level was 40 mrad/hr.

During a survey of 16 locations on Wahluke Slope on April 26, 1957, one particle was located at each of three adjacent locations at the county-line road directly north of 100-B Area. Particle activities were 6,000 c/m,

10,000 c/m, and 30,000 c/m (15 mrad/hr at ground level).

Surveys of 400 square foot plots around Redox indicated an increased deposition near the end of May. One plot at the southeast corner of the 200 West Area had 68 particles per 400 square feet in May, compared to 11 particles in March and 3 in July. Purex plot survey results were comparable to those obtained last quarter. Average and maximum concentrations were 0.2 and 3 particles per plot, respectively. The particle deposition on the project and nearby residential areas during April, 1957, is illustrated in Appendix B.

SECTION V

RADIOACTIVE CONTAMINATION IN THE COLUMBIA RIVER AND RELATED WATERS

Approximately 500 samples of water were collected from the Columbia, Yakima, and Snake Rivers to determine the concentration of their radioactive contaminants. Alpha particle emitters averaged below the reporting limit of 5×10^{-9} μc/cc for all river locations sampled this quarter.

General decreases of 40 - 60 percent in the beta particle emitter activity density of the Columbia River water (Table XVII) were noted this quarter.

The monthly one-liter samples collected from the Columbia River between NcNary Dam and Portland revealed gross beta activity densities ranging from 2×10^{-7} to 7×10^{-7} μc/cc, generally 20 - 30 percent lower than those of last quarter.(9) The maximum value, 7×10^{-7} μc/cc occurred at McNary and Paterson in late April.

Thirteen water samples collected from the south bank of the Columbia River at the Hanford Ferry Landing were analyzed for the activity density of I^{131}. Average and maximum results for this quarter were 5×10^{-8} and 1.8×10^{-7} μc/cc, respectively, compared to 1.0×10^{-7} and 1.6×10^{-7} μc/cc, respectively, in the previous quarter.

Approximately 200 river mud samples were collected from the Columbia River and nearby tributaries for measurement of gross alpha and beta particle emitters. All alpha particle emitter concentrations were below the reporting limit of 3×10^{-6} μc/gm.

The activity density of beta particle emitters in Columbia River mud increased this quarter at most locations along with river water activity. River mud samples collected within the project ranged from 2.4×10^{-5} μc/gm to a maximum of 7.0×10^{-4} μc/gm obtained at 100-F Area. Off-project mud samples collected from the Columbia, Snake,

and Yakima Rivers ranged from 2×10^{-5} μc/gm to 5×10^{-5} μc/gm.

More than 150 samples of raw water were collected from the 183 and 283 Buildings in the reactor and separations areas for gross alpha and beta analysis (Table XVIII). The activity density from gross alpha emitters was below the detection limit for all samples.

The raw water samples represent water prior to purification for drinking; the activity density of beta particle emitters in raw water this quarter was generally one-half that of the previous quarter and reflects the increase in Columbia River water flow. The highest activity density of 1.3×10^{-5} μc/cc was found at 183-H Building on April 4, 1957.

SECTION VI

RADIOACTIVE CONTAMINATION IN DRINKING WATER

The results of 617 samples of drinking water analyzed for gross alpha and beta particle emitters are presented in Table XIX in Appendix A. Drinking water derived from the Columbia River was generally lower in beta emitter activity densities than that of last quarter.[9] Results ranged from 30 to 60 percent of last quarter's values, except for the beta emitter average activity density at Pasco which increased by about 50 percent. The average was probably raised by high maximum values during April before higher river flow rates and greater dilution of beta emitters began in May. The beta emitter activity density of drinking water at the White Bluffs Fire Hall was decreased to one-half of it's previous value.

Columbia River flow averaged 1.7×10^6 gps compared with 5.2×10^5 gps in the first quarter of 1957.

Fractions of continuous occupational MPC's for the gastro-intestinal tract were calculated from isotopic analyses of raw water. A summary of the results is presented below:

Month	Pasco
April	0.51 percent of MPC_{GI}
May	0.64 percent of MPC_{GI}
June	0.23 percent of MPC_{GI}

The samples from which these were calculated actually cover from the middle of one month to the middle of the next. The decrease in MPC for June actually represents the period of increasing river flow between the middle of May and the middle of June.

The results of 90 samples analyzed for alpha emitters and uranium are compared in Table XX. There are no significant changes in these figures from previous measurements.

The results of samples collected from successive stages of the water treatment process of the Pasco Filter Plant are shown in Table XXI. All of the values for beta particle emitters were lower by 20 to 80 percent, reflecting the increase in flow and higher dilution of the Columbia River during May and June.

APPENDIX A

Table I through XXI

TABLE I

IODINE-131 AND FILTERABLE BETA PARTICLE EMITTERS DISCHARGED FROM THE A - PLANT STACK APRIL, MAY, JUNE 1957

Units of Curies Per Day

Month	I-131		Filterable Total Beta	
	Maximum	Average	Maximum	Average
April	2.5	0.93	0.056	0.012
May	1.9	0.63	0.021	0.008
June	1.1	0.52	0.006	0.005
Quarter	2.5	0.69	0.056	0.008
Last Quarter	3.0	0.44	0.69	0.018

TABLE II

IODINE-131 AND RUTHENIUM DISCHARGED FROM THE S - PLANT STACK APRIL, MAY, JUNE 1957

Units of Curies Per Day

Month	I-131		Ruthenium	
	Maximum	Average	Maximum	Average
April	2.5	0.26	0.04	<0.01
May	1.3	0.13	0.21	<0.01
June	0.06	< 0.02	<0.02	<0.01
Quarter	2.5	0.13	0.21	<0.01
Last Quarter	23	0.86	<0.01	<0.01

TABLE III

RADIOACTIVE PARTICULATE MATERIALS DISCHARGED FROM THE U-PLANT STACK

APRIL, MAY, JUNE

1957

Month	Alpha Partical Emitters, Units of 10^{-8} curie/day		Beta Particle Emitters, Units of 10^{-5} curie/day		Radioactive Particle Concentrations, Units of 10^{4} Particles/day	
	Max.	Avg.	Max.	Avg.	Max.	Avg.
April	0.5	0.3	0.07	0.04	2.5	0.46
May	0.6	0.3	0.12	0.05	2.5	0.81
June	0.6	0.2	0.13	0.05	7.7	1.4
Quarter	0.6	0.3	0.13	0.05	7.7	0.86
Last Quarter	0.8	0.3	0.14	0.04	3.5	0.63

TABLE IV

QUARTERLY SUMMARY OF TRITIUM OXIDE, CARBON-14, SULFUR-35 DISCHARGED FROM REACTOR STACKS

APRIL, MAY, JUNE

1957

Stack	Tritium Oxide, Units of curie/day		Carbon-14, Units of 10^{-3} curie/day		Sulfur-35, Units of 10^{-4} curie/day	
	Maximum	Average	Maximum	Average	Maximum	Average
100-B	0.3	0.2	< 6	< 6	31	11
100-C	1.6	0.4	27	18	< 6	< 6
100-KW	2.2	0.6	< 6	< 6	< 6	< 6
100-KE	3.6	1.2	< 6	< 6	24	10
100-D	1.1	0.7	6	< 6	< 6	< 6
100-DR	< 0.1	< 0.1	< 6	< 6	< 6	< 6
100-H	1.7	0.6	13	< 6	7	< 6
100-F	0.2	0.1	12	< 6	9	< 6

TABLE V

QUARTERLY SUMMARY OF
RADIOACTIVE PARTICULATE MATERIALS DISCHARGED
FROM THE REACTOR STACKS
APRIL, MAY, JUNE
1957

Stack	Alpha Particle Emitters, Units of 10^{-7} curie/day		Beta Particle Emitters, Units of 10^{-5} curie/day		Radioactive Particle Concentrations, Units of 10^{5} Particles/day	
	Maximum	Average	Maximum	Average	Maximum	Average
100-B	0.6	< 0.6	8.7	0.6	1.7	0.2
100-C	1.8	< 0.6	69	5.8	28	4.2
100-KW	1.2	< 0.6	20	6.4	14	1.0
100-KE	2.4	< 0.6	18	6.9	4.5	0.4
100-D	1.3	< 0.6	230	10	50	2.5
100-DR	1.8	< 0.6	22	4.7	2.6	0.4
100-H	1.9	< 0.6	56	11	10	1.0
100-F	1.7	< 0.6	160	11	6.9	1.1

TABLE VI

RADIOACTIVE CONTAMINATION ON VEGETATION

APRIL, MAY, JUNE

1957

Units of 10^{-6} μc/gm

Location Project	No. Samples	Iodine-131 Max.	Iodine-131 Avg.	Iodine-131 Avg. Last Qtr.	Non-Volatile Beta Emitters Max.	Non-Volatile Beta Emitters Avg.	Non-Volatile Beta Emitters Avg. Last Qtr.
200 West Area	78	150	16	15	630	170	110
200 West - Redox	26	92	13	20	540	140	110
200 West - Gate	58	130	12	8	570	140	79
Route 3	13	120	19	6	---	---	---
Meteorology Tower	13	63	12	7	570	170	68
Batch Plant	13	110	18	5	590	170	74
200 East Area	52	240	26	11	1600	220	110
200 East - Purex	44	40	10	10	730	96	83
Near 200 Areas	347	2280	43	6	4030	200	84
North of 200 Areas	235	290	28	<3	1040	200	76
South of 200 Areas	382	470	19	5	1740	180	74
PSN 50-51-61	39	290	25	15	850	210	60
Goose Egg Hill	116	180	12	12	940	140	60
Wahluke Slope	144	260	20	3	1250	160	69
Rattlesnake Mountain	42	41	4*	--	520	160*	---
Off Project							
Pasco to Ringold	117	210	15	<3	1160	130	69
Richland	126	210	16	<3	1120	200	50
Benton City - Kiona	26	110	9	3	600	130	60
Richland "Y"	13	66	9	4	----	---	--
Kennewick Environs	178	150	10	<3	630	120	63
Pasco Environs	126	130	10	<3	750	110	92
Prosser to Paterson-McNary	66	47	5	<3	630	84	66
Eastern Washington	132	24	4	<3	510	100	98
So. Washington and No. Oregon	122	170	14	<3	1120	130	65

* No samples were collected in June from this location.

TABLE VII

RADIOACTIVE CONTAMINATION FROM IODINE ON VEGETATION

APRIL, MAY, JUNE

1957

Units of 10^{-6} μc/gm

Location	April		May		June	
Project	Max.	Avg.	Max.	Avg.	Max.	Avg.
200 West Area	43	8	14	3	150	38
200 West - Redox	8	4	8	< 3	92	32
200 West - Gate	30	6	10	< 3	130	27
Route 3	12	7	11	< 3	120	48
Meteorology Tower	7	< 3	12	< 3	63	31
Batch	8	4	7	3	110	47
200 East Area	41	15	32	7	240	55
200 East - Purex	40	11	16	10	---	--
Near 200 Areas	38	4	27	4	2280	120
North of 200 Areas	18	3	16	< 3	290	80
South of 200 Areas	31	3	27	< 3	470	52
PSN 50-51-61	12	< 3	9	< 3	290	71
Goose Egg Hill	21	3	7	< 3	180	33
Wahluke Slope	10	< 3	11	< 3	260	55
Rattlesnake Mountain	13	5	41	< 3	---	--
Off Project						
Pasco to Ringold	8	< 3	79	5	210	39
Richland	10	< 3	15	< 3	210	46
Benton City - Kiona	8	< 3	< 3	< 3	110	26
Richland "Y"	< 3	< 3	7	< 3	66	25
Kennewick Environs	38	< 3	10	< 3	150	25
Pasco Environs	10	< 3	8	< 3	130	27
Prosser to Paterson McNary	10	< 3	12	< 3	47	11
Eastern Washington	8	< 3	7	< 3	24	10
So. Washington and No. Oregon	< 3	< 3	8	< 3	170	40

TABLE VIII

RADIOACTIVE CONTAMINATION FROM NON-VOLATILE BETA PARTICLE EMITTERS ON VEGETATION

APRIL, MAY, JUNE

1957

Units of 10^{-6} μc/gm

Location	April		May		June	
Project	Max.	Avg.	Max.	Avg.	Max.	Avg.
200 West Area	200	75	330	70	630	360
200 West - Redox	740	54	160	91	540	270
200 West - Gate	220	62	170	64	570	280
Meteorology Tower	100	67	490	130	570	320
Batch Plant	140	74	140	76	590	370
200 East Area	410	92	340	91	1600	480
200 East - Purex	730	110	530	85	----	---
Near 200 Areas	1140	94	610	86	4030	420
North of 200 Areas	400	100	400	95	1040	410
South of 200 Areas	340	56	980	80	1740	400
PSN 50-51-61	140	68	280	130	850	420
Goose Egg Hill	130	56	490	88	940	270
Wahluke Slope	130	65	160	66	1250	360
Rattlesnake Mountain	520	250	180	69	----	---
Off Project						
Pasco to Ringold	1160	110	430	71	730	220
Richland	110	53	310	55	1120	500
Benton City - Kiona	48	34	63	35	600	310
Kennewick Environs	88	50	340	68	630	240
Pasco Environs	93	51	270	62	750	230
Prosser to Paterson-McNary	120	43	440	59	630	150
Eastern Washington	300	120	160	41	500	150
So. Washington and No. Oregon	100	55	520	60	1120	260

TABLE IX

RADIOACTIVE CONTAMINATION FROM ALPHA PARTICLE EMITTERS ON VEGETATION

APRIL, MAY, JUNE

1957

Units of 10^{-7} μc/gm

Location	April Average	May Average	June Average	Quarter Maximum	Quarter Average
Near 200 Areas					
200 West Gate	9.2	22	6.8	55	12
Meteorology Tower	9.5	0.6	1.6	16	3.9
Batch Plant	5.1	1.9	7.7	9.8	4.8
Rt. 4S, Mi. 4	3.4	1.1	1.6	3.9	2.0
Rt. 4S, Mi. 6	1.5	0.5	0.4	2.0	0.8
Outlying					
Pasco	< 0.3	< 0.3	< 0.3	0.3	< 0.3
Benton City	< 0.3	< 0.3	< 0.3	0.5	< 0.3

TABLE X

AVERAGE DOSE RATES MEASURED BY IONIZATION CHAMBERS

APRIL, MAY, JUNE

1957

Units of mrad per day

Location	Integrons and HM Chambers		Detachable Chambers	
	Quarterly Average	Average Last Quarter	Quarterly Average	Average Last Quarter
100 Areas and Vicinity	2.7	5.1	1.2	1.3
200 Areas and Vicinity	5.8	3.4	1.3	1.4
300 - 3000 Areas and Vicinity	0.6	2.1	1.1	2.0
Benton City	---	5.8	---	---
Tri-City Area	0.6	0.7	---	---

TABLE XI

RADIOACTIVE PARTICULATE MATERIALS FILTERED FROM AIR

APRIL, MAY, JUNE

1957

Location	Beta Particle Emitters Units of 10^{-14} µc/cc		Concentration of Radioactive Particles Units of 10^{-3} Partcles/m^3	
	Quarterly Average	Average Last Quarter	Quarterly Average	Average Last Quarter
100 Areas and Vicinity	70	28	56	9
200 Areas and Vicinity	92	33	52	16
300 - 3000 Areas and Vicinity	77	28	39	18
Benton City	85	23	26	8
Tri-City Area	35	14	53	13
Seattle, Washington	--	--	30	17
Spokane, Washington	--	--	57	23
Walla Walla, Washington	--	--	88	33
Yakima, Washington	--	--	73	20
Boise, Idaho	--	--	160	34
Lewiston, Idaho	--	--	80	12
Great Falls, Montana	--	--	58	43
Meacham, Oregon	--	--	11	8
Klamath Falls, Oregon	--	--	88	41

TABLE XII

CONCENTRATIONS OF IODINE DETECTED BY AIR SCRUBBERS

APRIL, MAY, JUNE

1957

Units of 10^{-12} µc/cc

Location	April	May	June	Qtrly. Avg.	Wkly. Max.	Avg. Last Qtr.
100 Areas and Vicinity	< 0.1	0.1	0.7	0.3	3.3	< 0.1
200 Areas and Vicinity	0.3	0.3	1.1	0.6	7.2	0.2
300 Area and Vicinity	0.1	0.1	0.4	0.2	1.2	< 0.1
Benton City	< 0.1	< 0.1	0.6	0.2	1.7	< 0.1
Tri-City Area	< 0.1	< 0.1	0.7	0.3	2.5	< 0.1

TABLE XIII

BETA PARTICLE EMITTERS DISCHARGED TO RIVER

IN REACTOR EFFLUENT WATER

APRIL, MAY, JUNE

1957

Units of 10^{3} µc/sec

Location	No. Samples	April Max.	April Avg.	May Max.	May Avg.	June Max.	June Avg.	Quarterly Max.	Quarterly Avg.
100-B	61	68	46	57	34	44	23	68	34
100-C	46	130	75	120	82	76	45	130	67
100-KW	50	170	90	300	150	70	50	300	96
100-KE	54	150	75	340	150	70	49	340	92
100-D	54	34	20	41	19	36	17	41	19
100-DR	60	120	62	83	45	36	12	120	40
100-H	36	86	40	71	39	.06	.03	86	26
100-F	25	31	22	13	12	37	21	37	18

TABLE XIV

RADIOACTIVE CONTAMINATION IN 200 AREA WASTE SYSTEMS

APRIL, MAY, JUNE

1957

Liquid Samples

Location	Alpha Particle Emitters Units of 10^{-8} μc/cc			Beta Particle Emitters Units of 10^{-7} μc/cc		
	Maximum	Average	Average Last Quarter	Maximum	Average	Average Last Quarter
T-Ditch	< 0.5	< 0.5	< 0.5	24	< 5.0	9.0
T-Swamp	< 0.5	< 0.5	< 0.5	26	11	19
Laundry Ditch	80	9.3	0.9	8.0	< 5.0	< 5.0
U-Ditch Inlet	5.0	0.8	4.7	< 5.0	< 5.0	< 5.0
231 Ditch	10	2.9	2.9	< 5.0	< 5.0	< 5.0
234-5 Ditch	4.9	0.8	< 0.5	< 5.0	< 5.0	< 5.0
U-Swamp	280	58	34	62	20	74
B-Ditch	< 0.5	< 0.5	< 0.5	< 5.0	< 5.0	< 5.0
B-Swamp	3.4	< 0.5	< 0.5	< 5.0	< 5.0	< 5.0
Purex	1.2	< 0.5	0.8	6.7	< 5.0	< 5.0
222-S Swamp	79	15	14	7.0	< 5.0	6.8
Redox Swamp	15	3.9	1.6	47	22	4.5

Solid Samples

	Units of 10^{-6} μc/gm			Units of 10^{-5} μc/gm		
T-Ditch	16	8.7	9.6	4100	1910	2700
Laundry Ditch	15	9.5	5.8	40	19	25
234-5 Ditch	1270	420	380	5.8	4.1	2.8
B-Swamp	8.4	1.6	0.6	28	5.5	3.7
Purex	2420	770	830	19	6.2	5.3
222-S Swamp	200	150	160	130	86	100
Redox Swamp	6040	800	120	38800	4980	1300

TABLE XV

RADIOACTIVE CONTAMINATION IN 200 AREA WASTE SYSTEMS

APRIL, MAY, JUNE

1957

Liquid Samples

	Uranium Units of 10^{-9} µc/cc		
Location	Maximum	Average	Average Last Quarter
U-Swamp	2400	640	310
Laundry Ditch	650	88	6.8
U-Ditch	29	4.6	34
222-S Swamp	400	100	97

Solid Samples

	Units of 10^{-6} µc/gm		
Laundry Ditch	24	8.3	20
222-S Swamp	200	70	78

TABLE XVI

RADIOACTIVE CONTAMINATION IN 300 AREA POND INLET

APRIL, MAY, JUNE

1957

Units of 10^{-8} µc/cc

Liquid Samples	Maximum	Average	Average Last Quarter
Beta Particle Emitters	160	56	120
Strontium	< 16	< 13	< 7
Uranium	180	71	78
Plutonium	< 15	< 12	0.32

TABLE XVII

CONCENTRATIONS OF BETA PARTICLE EMITTERS IN RIVER WATER

APRIL, MAY, JUNE

1957

Units of 10^{-8} μc/cc

Location	April Average	May Average	June Average	Quarter Average	Average Last Quarter
Columbia River					
Will's Ranch	< 5	< 5	< 5	< 5	< 5
181-B	< 5	< 5	< 5	< 5	< 5
181-C	< 5	< 5	< 5	< 5	< 5
181-KW	530	240	32	270	540
181-KE	590	310	42	310	660
181-D	3230	1340	330	1630	2290
181-H	2610	1430	670	1570	2350
Below 100-H	4010	2340	530	2290	2230
181-F	3780	2400	410	2200	3530
Below 100-F	2350	1460	750	1520	3130
Hanford	2200	1520	760	1490	4020
300 Area	1360	970	490	940	1680
Byer's Landing	880	470	200	520	1070
Richland	900	670	400	660	1080
Kennewick Highlands Pumping Station	610	490	270	460	780
Pasco Bridge (Kennewick side)	490	370	240	370	640
Pasco Bridge (Pasco side)	670	400	240	440	710
Pasco Filter Plant Pumping Station	540	400	270	400	990
Sacajawea Park	470	300	170	310	470
Below McNary Dam	83	72	51	69	87
Paterson	99	51	53	68	100
Snake River					
Mouth	< 5	< 5	5	< 5	< 5
Yakima River					
Prosser	< 5	< 5	< 5	< 5	< 5
Shore	5	< 5	< 5	< 5	6
Horn	< 5	< 5	6	< 5	< 5

TABLE XVIII

CONCENTRATIONS OF BETA PARTICLE EMITTERS IN RAW WATER

RIVER EXPORT LINE

APRIL, MAY, JUNE

1957

Units of 10^{-8} μc/cc

Location	April Average	May Average	June Average	Quarter Average	Average Last Quarter
183-B	< 5	< 5	< 5	< 5	7
183-C	< 5	5	< 5	< 5	8
183-KW	530	230	25	260	500
183-KE	560	190	31	260	560
183-D	1780	720	170	890	1780
183-DR	1710	740	130	860	1840
183-H	2620	990	360	1330	2530
183-F	910	700	440	680	2600
283-East	23	76	17	39	18
283-West	25	9	10	15	13

TABLE XIX

CONCENTRATIONS OF ALPHA AND BETA PARTICLE EMITTERS IN WATER SUPPLIES
APRIL, MAY, JUNE
1957

Location	No. Samples	Alpha Particle Emitters Units of 10^{-9} µc/cc Max.	Alpha Particle Emitters Units of 10^{-9} µc/cc Avg.	Beta Particle Emitters Units of 10^{-8} µc/cc Max.	Beta Particle Emitters Units of 10^{-8} µc/cc Avg.
Mattawa Chev. Station	11	< 5	< 5	< 5	< 5
Midway and Vicinity	20	< 5	< 5	6	< 5
100-B Area	13	< 5	< 5	11	6
100-C Area	13	< 5	< 5	13	7
100-K Area	21	< 5	< 5	500	64
100-D Area	11	< 5	< 5	1090	320
100-DR Area	13	< 5	< 5	700	290
100-H Area	13	< 5	< 5	570	230
100-F Area	13	< 5	< 5	710	280
White Bluffs' Fire Hall	13	< 5	< 5	78	19
PSN-21	12	9	8	< 5	< 5
B-Y Well	13	6	< 5	< 5	< 5
251 Building	13	< 5	< 5	11	< 5
200 East Area	39	< 5	< 5	31	9
200 West Area	52	< 5	< 5	27	6
300 Area, 3000 Area (San)	18	< 5	< 5	< 5	< 5
Byer's Landing Pump Station	13	< 5	< 5	7	< 5
Larson Farm	13	6	< 5	< 5	< 5
Richland	24	6	< 5	< 5	< 5
Prosser	13	< 5	< 5	< 5	< 5
Benton City	37	16	8	< 5	< 5
Headgate Well	14	< 5	< 5	< 5	< 5
Enterprise	12	< 5	< 5	< 5	< 5
Kennewick	100	< 5	< 5	590	120
Pasco	51	< 5	< 5	860	130
Sacajawea	13	8	7	5	< 5
McNary	26	< 5	< 5	7	< 5
Paterson Store	13	< 5	< 5	< 5	< 5

TABLE XX

CONCENTRATIONS OF ALPHA PARTICLE EMITTERS
IN DRINKING WATER
APRIL, MAY, JUNE, 1957

Location	Alpha Particle Emitters Units of 10^{-9} µc/cc			Uranium Units of 10^{-9} µc/cc		
	No. Samples	Max.	Avg.	No. Samples	Max.	Avg.
Columbia Field (San)	8	< 5	< 5	8	2	2
B-Y Well	13	6	< 5	13	6	3
PSN-21	12	9	8	12	11	8
Lee Blvd. (San)	8	6	< 5	8	5	4
Benton City Store	13	14	12	13	12	10
Benton City Water Company	10	16	12	10	18	11
Sacajawea	13	8	7	13	8	7
Paterson Store	13	< 5	< 5	12	6	2

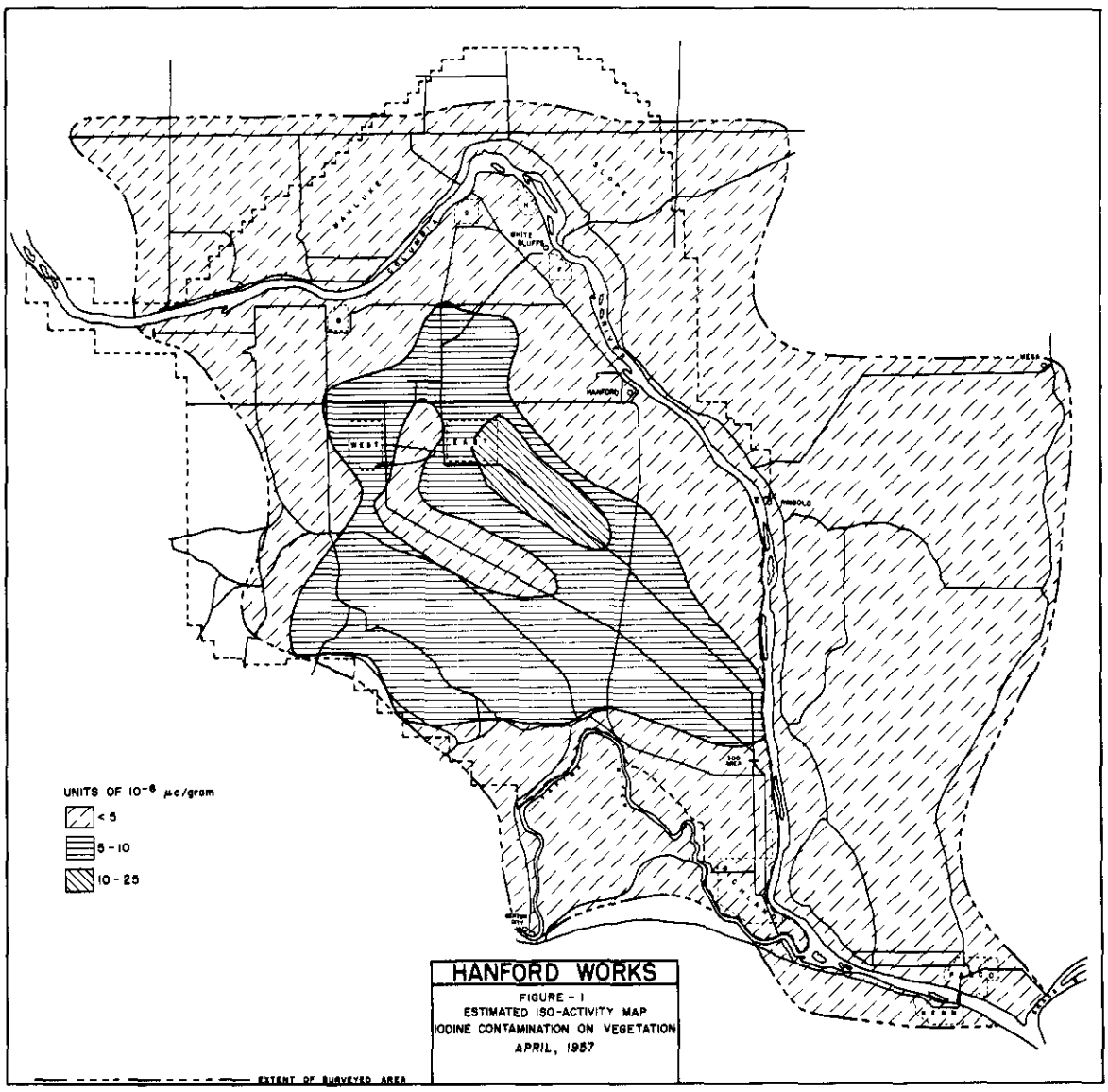
TABLE XXI

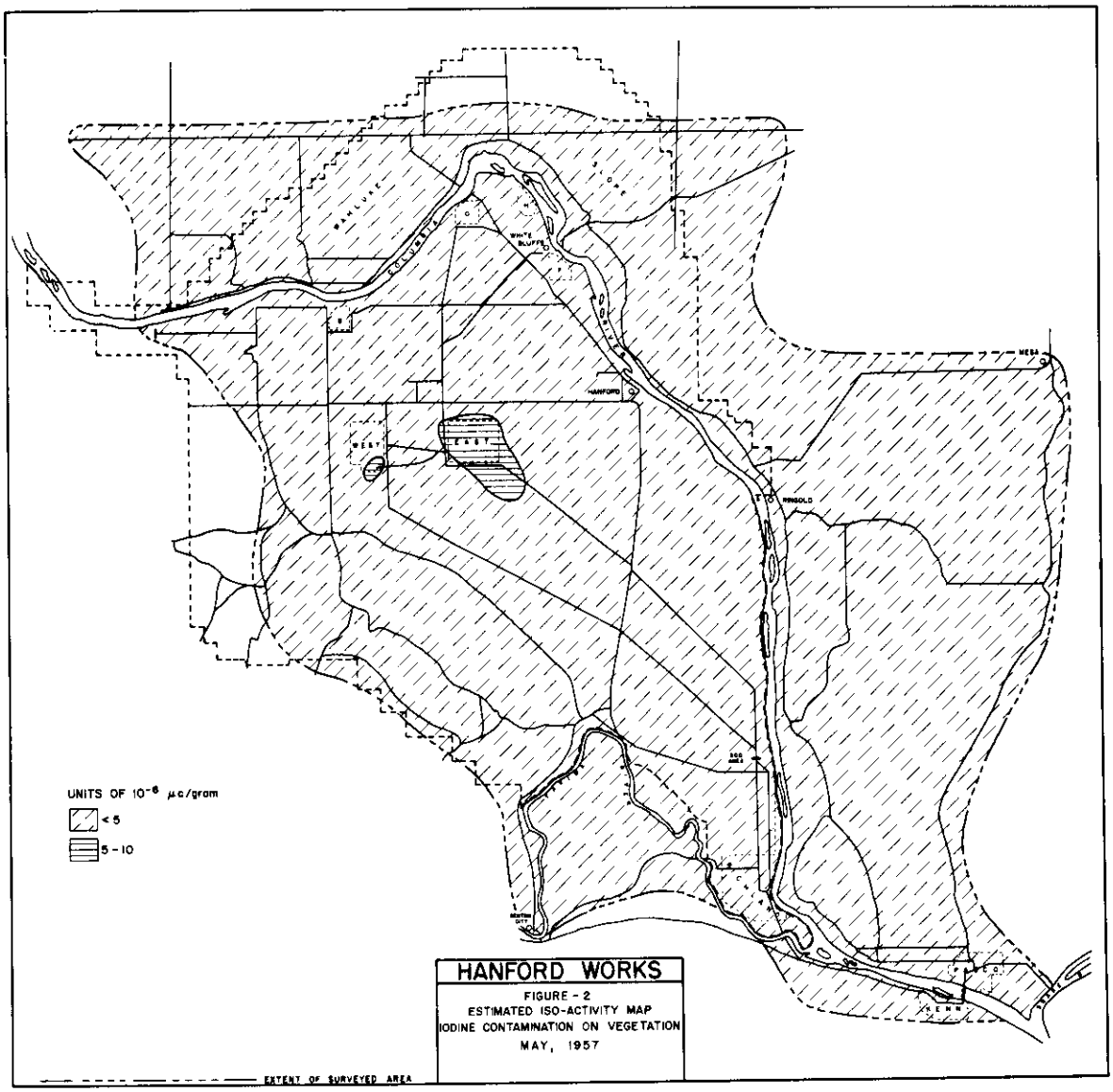
CONCENTRATIONS OF BETA PARTICLE EMITTERS
AT THE PASCO FILTER PLANT
APRIL, MAY, JUNE, 1957

Type Sample	No. Samples	Maximum	Average
Water Entering Plant From River	37	1.1×10^{-5} µc/cc	4.0×10^{-6} µc/cc
Filter Bed Material	13	2.1×10^{-4} µc/gm	9.8×10^{-5} µc/gm
Backwash Activity (Soluble)	13	4.4×10^{-6} µc/cc	2.2×10^{-6} µc/cc
Backwash Activity (Insoluble)	13	6.0×10^{-1} µc/gm	9.6×10^{-2} µc/gm
Foam From Filter Beds	1	0.9×10^{-3} µc/gm	0.9×10^{-3} µc/gm
Water Leaving Plant	38	8.6×10^{-6} µc/cc	1.9×10^{-6} µc/cc

APPENDIX B

Figures 1 through 5





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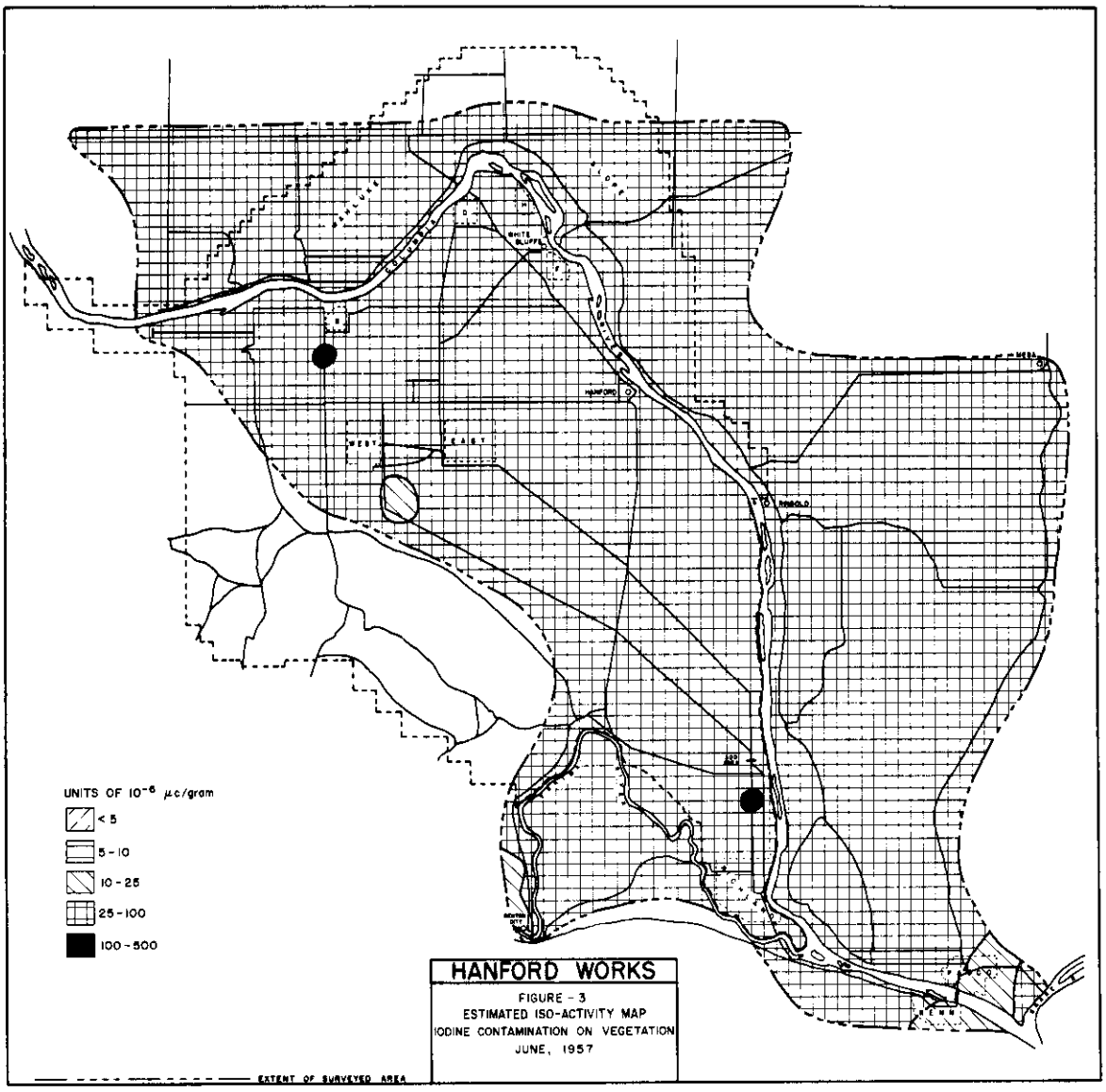

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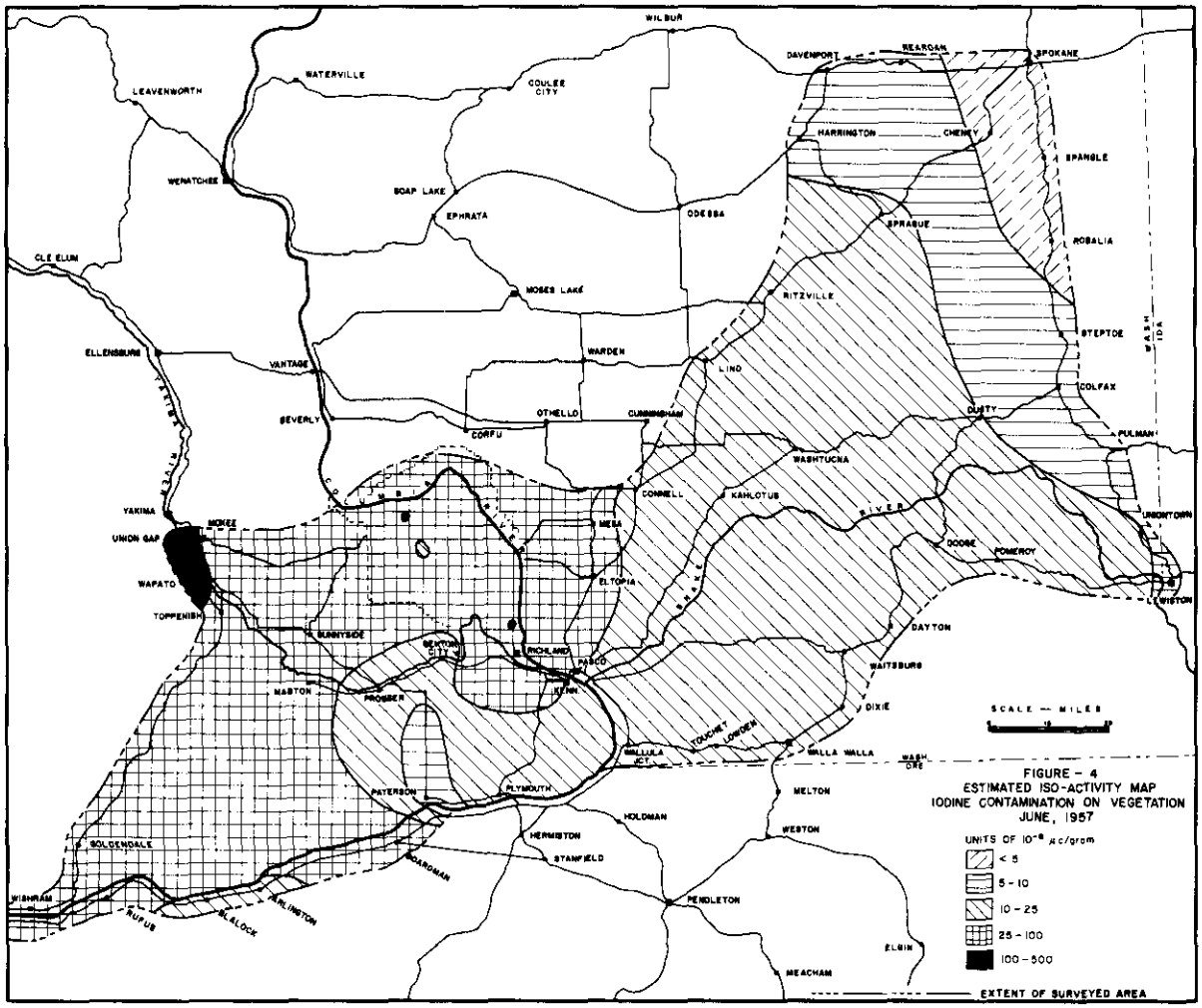

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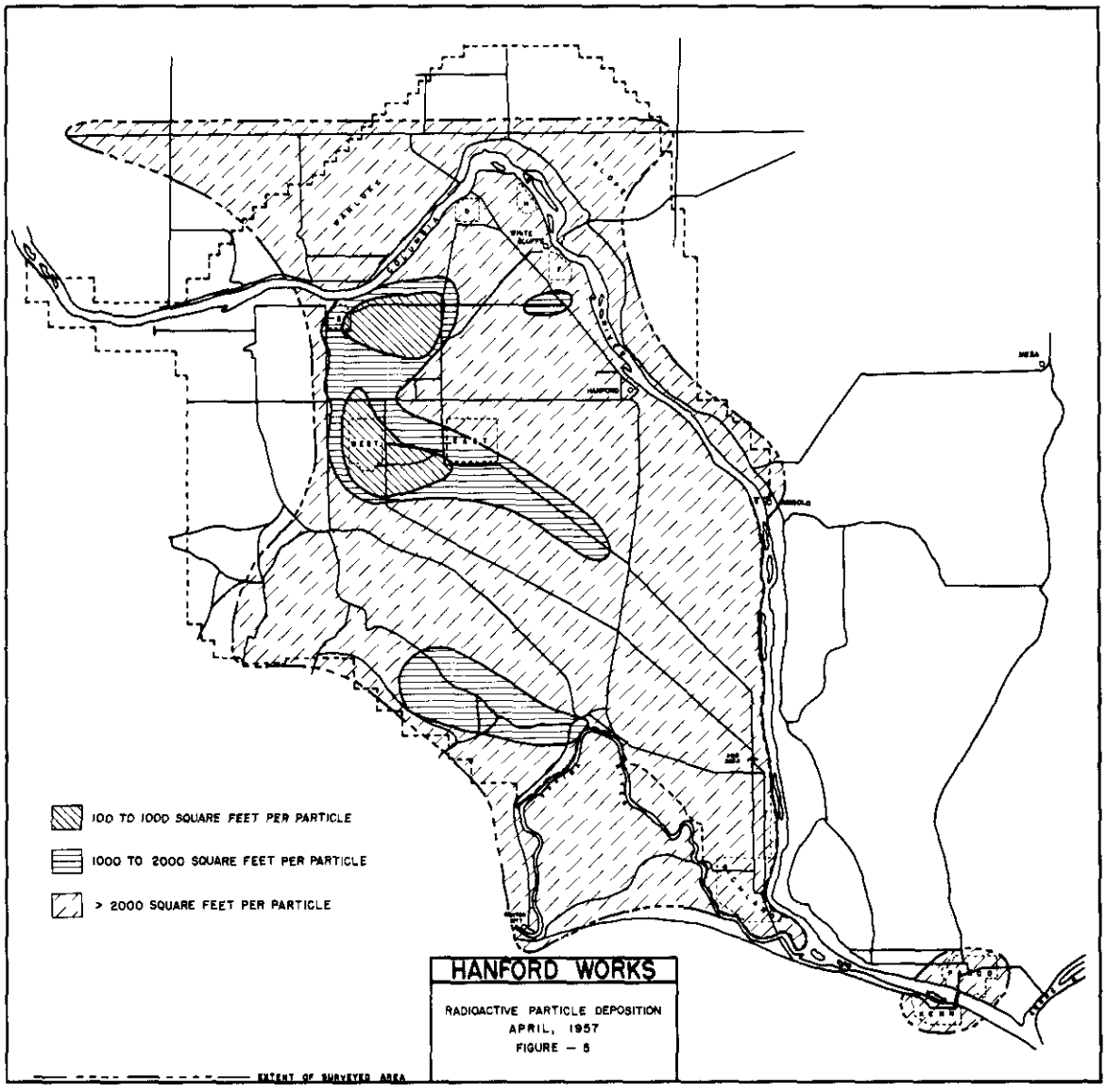

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