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RADIOACTIVE CONTAMINATION IN THE ENVIRONS OF THE HANFORD WORKS

FOR THE PERIOD

JANUARY, FEBRUARY, MARCH, 1951

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RADIOACTIVE CONTAMINATION IN THE ENVIRONS OF THE HANFORD WORKS FOR THE PERIOD JANUARY, FEBRUARY, MARCH, 1951

by

H. J. Paas and W. Singlevich
Development Division
Health Instrument Divisions

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June 1, 1951

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RADIOACTIVE CONTAMINATION IN THE ENVIRONS OF THE HANFORD WORKS

FOR THE PERIOD JANUARY, FEBRUARY, MARCH, 1951

ABSTRACT

This report summarizes the results obtained during a three month study of monitoring for radioactive contamination in the environs of the Hanford Works. A summary of the highlights of the results appears below:

SECTION I - METEOROLOGICAL DATA:

During the hours of metal dissolution, the wind prevailed from the northwest direction 35 percent of the time; wind from westerly components which included the southwest, west, and northwest directions accounted for 68 percent of the wind. Meteorological data recorded at each of the 100 Areas indicated considerable variation in wind direction within the confines of the project. Tabular summations and graphic portrayals showing the variation in wind direction at four observation points are included.

SECTION II - RADIOACTIVE CONTAMINATION ON VEGETATION:

The calculated quantity of I-131 estimated in the dissolvers during dissolution of irradiated uranium increased by a factor of 3 when compared with each of the two previous quarterly periods; this increase was a direct result of the continuation of the dissolving of uranium which had been cooled for shorter periods. The installation of silver reactors in the off-gas lines of the dissolver cells was completed during this quarter. Estimations of the quantity of I-131 expelled into the atmosphere via the stacks in 200 West Area indicated an average of about 3.8 curies per day and a maximum of 15.8 curies per day; pre-reactor measurements indicated an average of 10 to 11 curies per day. The activity density of I-131 on vegetation, however, indicated a general decrease throughout the environs. The point of maximum deposition which encompasses an area of about four square miles near the 200 West Area gate indicated an average activity density of 1.5 x 10^{-2} µc/gram. Although the activity density of I-131 on vegetation decreased from the early part of January through the middle of March, a rather significant increase was observed between March 15 and March 25. Maximum measurements for the latter period indicated the activity density of I-131 to be 2.5 x 10^{-4} µc/gram in the vicinity of the Kennewick Highlands. The average activity density of the non-volatile beta emitters during the early part of the quarter was less than 1.0 x 10^{-5} µc/gram at all locations except those in the immediate vicinity of the 200 Areas. Samples collected after February 9 indicated highly significant increases approaching factors of 3 to 10. Increases in airborne activity were simultaneously noted; a critical review of the Hanford monitoring devices indicated that the increase was the result of activity originating at the Las Vegas, Nevada, testing grounds. Tables summarizing the results of these measurements on and off the Hanford project are included. Estimated iso-activity maps for each of the monthly periods and the quarterly average are also included.

SECTION III - RADIOACTIVE CONTAMINATION IN THE ATMOSPHERE:

Dosage rates measured by integrons and "C" type ionization chambers showed no deviation from previous measurements. Highly significant increases in atmospheric contamination were noted on and after February ninth by detachable M and S type ionization chambers, air filter devices and active particle monitoring. These increases were attributed to deposition from a radioactive cloud which originated from the Nevada "A" bomb tests. With the exception of this period in February, the activity density of filterable beta emitters in the atmosphere showed a general decrease by a factor of 2 to 10 at most locations. The maximum values approached 4.0×10^{-11} µc/cc as noted near the 200 West Area. Concentrations at the project perimeter and in residential communities were on the order of 10^{-13} µc/cc. The activity density of I-131 in the air decreased by a factor of about 4 near the separation areas and by a factor of about 2 at many outlying locations. Measurements obtained near the 200 West Area gatehouse indicated a quarterly average of 9.9×10^{-12} µc/cc. Spot samples obtained during periods when the stack gases were observed at ground level indicated maximum concentrations on the order of 10^{-10} µc/cc. Active particles in the atmosphere showed little deviation from past results during January and March; however, shortly after the Nevada atomic explosions, the number of active particles increased by a factor of about 100 at most monitoring locations.

SECTION IV - RADIOACTIVE CONTAMINATION IN HANFORD WASTES:

Measurements for the activity density of beta emitters in the 107 effluent water indicated increases on the order of 1.0×10^{-4} µc/cc to 2.0×10^{-4} µc/cc in all basins. One sample from the 107-F basin indicated an activity density of 8.0×10^{-3} µc/cc. Detailed summaries of the maximum and average values for radioactive contamination in the 100, 200, and 300 Area waste systems are included. The activity density of I-131 discharged into the Columbia River was estimated to be about 7 to 8 mc per day.

SECTION V - RADIOACTIVE CONTAMINATION IN THE COLUMBIA AND YAKIMA RIVERS:

Radiochemical analysis for the activity density for alpha and beta emitters in the Columbia River indicated very little trend or change from previous measurements. The maximum average activity density measured was 3.9×10^{-6} µc/cc at the Hanford Ferry; the maximum individual measurement was 8.2×10^{-6} µc/cc in a sample taken just below the 100-F Area. Extension of the sampling program to McNary Dam and Patterson Ferry showed the average activity density to range from 3.0 to 4.0×10^{-7} µc/cc in this region. Special studies designed to evaluate the effect of the entrance of the Yakima River were completed; detailed discussion and graphic portrayals of these data are included. The results obtained from the mud sampling program were not indicative of any change from previous measurements.

SECTION VI - RADIOACTIVE CONTAMINATION IN RAIN:

A total rainfall of 1.81 inches represented normal precipitation for the three month period. In general, the average activity density of beta emitters measured in rain samples was less than 1.0×10^{-6} µc/cc at locations along and outside the project perimeter; the average activity density measured in samples collected inside the separations areas ranged from 3.0×10^{-6} μc/cc to 3.0×10^{-5} μc/cc.

SECTION VII- RADIOACTIVE CONTAMINATION IN THE DRINKING WATER AND TEST WELLS:

Radiochemical analysis indicated the activity density of uranium in the wells of the Richland and Benton City systems to average 5 and 15 μg U/liter, respectively. The average activity density of the gross beta emitters did not exceed 1.5×10^{-7} μc/cc at any location; most of the measured values were below the detectable limit of 5×10^{-8} μc/cc. Samples of backwash material from the Pasco Filter Plant showed an average of 3.6×10^{-3} μc/gram; drinking water leaving the filter plant averaged 1.5×10^{-7} μc/cc. Tables are included which summarize in detail the results of all measurements in the wells sampled during this quarterly period.

SECTION I

METEOROLOGICAL DATA--HANFORD WORKS AREA

Meteorological observations were recorded at the Meteorology Tower near the 200 West Area and at several perimeter locations in the vicinity of the 100 Areas and Richland. Observations which represented the time that irradiated metal was dissolved in the 200 Areas were extracted from the daily meteorological recordings. The data obtained at the Meteorology Tower represented recorded observations obtained at an elevation of 200', which represents the elevation of the effluent stacks in the 200 Areas. Measurements obtained from perimeter locations represented the recordings from instruments which were located about 50' above ground level.

The meteorological data summarized in the following discussion represents the accumulated observations for 1552 hours during which dissolving of uranium was in progress. The dissolvers were used approximately 72 percent of the time during the period January, February, and March, 1951.

A review of the wind direction data indicated that the prevailing wind conditions during January, February, and March of 1951 were nearly identical to similar measurements recorded for the same period during 1950. The prevailing wind direction was northwest which accounted for 35 percent of the wind; winds from westerly components which included the southwest, west, and northwest directions accounted for 68 percent of the wind; these three directions also accounted for 68 percent of the wind d ring the same period in 1950. With the exception of the north direction which prevailed 11 percent of the time, the amount of wind from the remaining directions was negligible. Consistent with previous evaluations of meteorological data, the accumulated effect of wind prevailing from directions other than those involving westerly components appeared negligible in the over-all deposition pattern. Figure 1 is an eight point wind rose for the three month average wind direction data as recorded at the 200' level of the Meteorology Tower.

[redacted]

A graphic portrayal showing the month to month variation in wind direction as recorded at the Meteorology Tower is presented in Figure 2 . A comparison of these data with measurements for similar periods during earlier years indicates that very little variation occurred within the three months involved. The only observation approaching significance was the prevalence of the northwest direction 44 percent of the time during the month of February in contrast to 29 and 33 percent during January and March, respectively. As in the past, the calm condition was practically non-existent at the Meteorology Station.

The consistency of the wind direction data observed at the Meteorology Tower was in direct contrast to similar observations recorded at perimeter locations. Table I summarizes the prevailing wind direction data recorded at all stations operated during the period January, February and March, 1951.

TABLE I
PREVAILING WIND DIRECTIONS AT METEOROLOGY STATIONS*
HANFORD WORKS
JANUARY, FEBRUARY, MARCH
1 9 5 1

units in percent of time observed

LOCATION	WIND DIRECTION								
	N	NE	E	SE	S	SW	W	NW	CALM
200 West	11	4	4	5	7	16	17	35	1
100-B	12	4	5	6	12	15	32	8	6
100-D	12	3	8	1	14	9	18	3	32
100-F	10	4	8	10	7	10	15	8	28

* The observations representing recordings at the Richland Station were not used during this period due to faulty instrumentation.

A review of the data summarized above again indicated that the variation in wind direction within the confines of the Hanford Works was highly significant. The large variations noted above tend to minimize the significance of the minor deviations noted when reviewing the month to month variation in wind direction as recorded at the Meteorology Tower near the 200 West Area. Among the more significant observations noted when comparing wind directions at various locations on the site were the following:

 [redacted]

1. The amount of wind from the northwest direction did not exceed 8 percent at any 100 Area location, whereas this direction was the prevailing component throughout the entire period at the 200 West Area station.

2. The most prevailing wind condition at the 100-D and 100-F Areas was calm which occurred on the order of 30 percent of the time in contrast to only 1 and 6 percent of the time at the 200 West and 100-F stations, respectively.

3. Except for the calm condition, the wind prevailed from the west at each of the 100 Areas whereas the northwest direction prevailed at the 200 Areas.

4. The amount of wind from the easterly components including northeast, east, and southeast was negligible at all stations.

5. Winds originating from the north tended to prevail about the same amount of time (10 to 12 percent) at all locations.

The variations itemized above appear highly significant although they tend to confirm similar observations made during previous periods. Again, these on-site variations in wind direction tend to influence the distribution and deposition pattern of radioactive gases on the vegetation in the environs of the Hanford Works; trace indications of detectable activity density of I-131 on vegetation at Wahluke Slope, Mesa, Ringold, Eltopia, Patterson, and McNary Dam were attributed to the varying wind directions noted at the perimeter. The pattern of activity density from I-131 elongated in the southeast direction from the 200 Areas was directly associated with the predominance of the northwest direction at the Meteorology Tower (Figures 7,8, &9.) The month to month variation in the distribution pattern of I-131 on vegetation was somewhat influenced by the month to month variation in wind direction observed at perimeter locations. These data are presented graphically in Figure 3 and in tabular form in Table II.

TABLE II
MONTH TO MONTH VARIATION IN WIND DIRECTION
HANFORD WORKS METEOROLOGY STATIONS
JANUARY, FEBRUARY, MARCH
1 9 5 1

units in percent of time observed

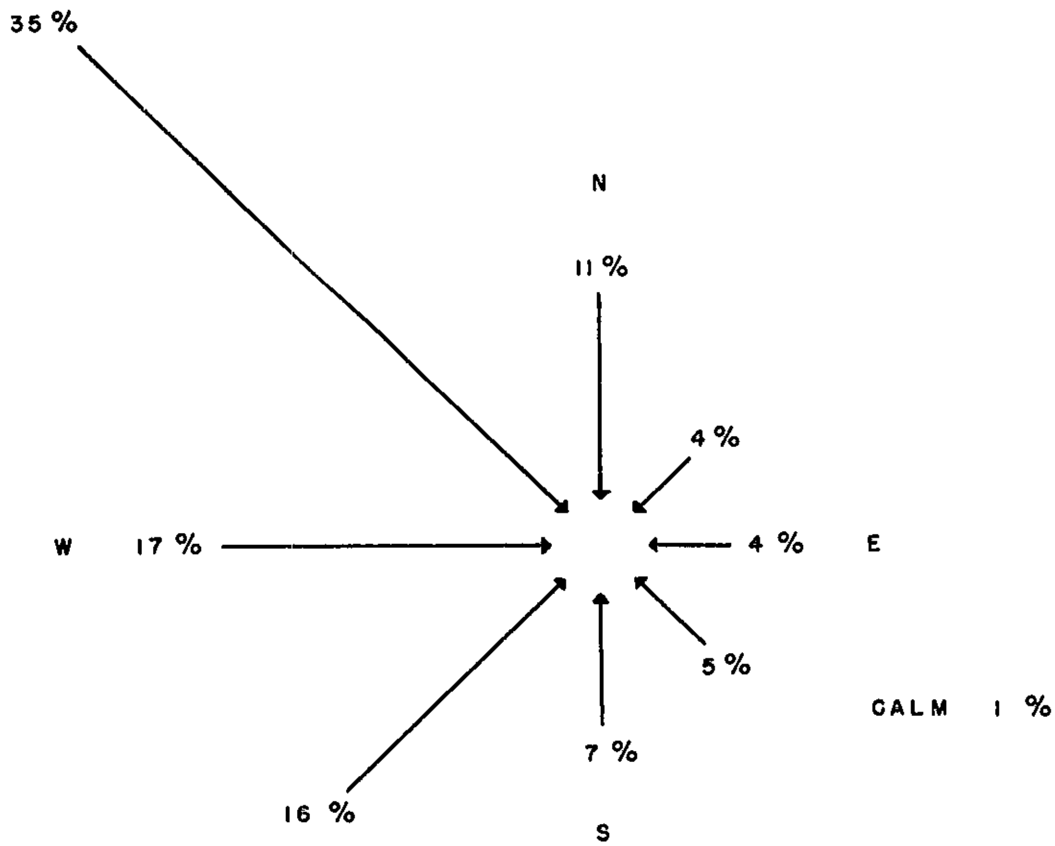
Location	Month	N	NE	E	SE	S	SW	W	NW	CALM
		WIND DIRECTION								
200 W	Jan.	10	4	6	5	9	16	19	29	2
	Feb.	12	5	2	4	4	15	13	44	1
	Mar.	10	4	4	5	7	18	18	33	1
100-B	Jan.	8	4	6	9	15	15	28	9	6
	Feb.	16	4	4	3	10	13	35	9	6
	Mar.	13	5	5	5	10	17	31	7	7
100-D	Jan.	8	3	9	1	14	9	17	2	37
	Feb.	8	3	4	1	11	7	13	5	48
	Mar.	19	5	9	2	16	10	23	3	13
100-F	Jan.	2	4	10	11	9	12	14	7	31
	Feb.	24	3	4	8	4	16	8	6	27
	Mar.	5	6	8	11	7	4	23	10	26

A detailed summary covering the meteorological conditions observed at the Hanford Works on the basis of a 24 hour day may be referred to in monthly meteorological summaries issued by the Synoptic Meteorology Group of the Control Functions Section of the Health Instrument Development Division.(1)

SECTION I

(Figures 1, 2, 3, and 4.)

SUMMARY WIND DIRECTIONS 200—W
DISSOLVING HOURS ONLY
JANUARY —— FEBRUARY —— MARCH
1951 FIGURE— I



SUMMARY AIR CONDITIONS —— 200 - W

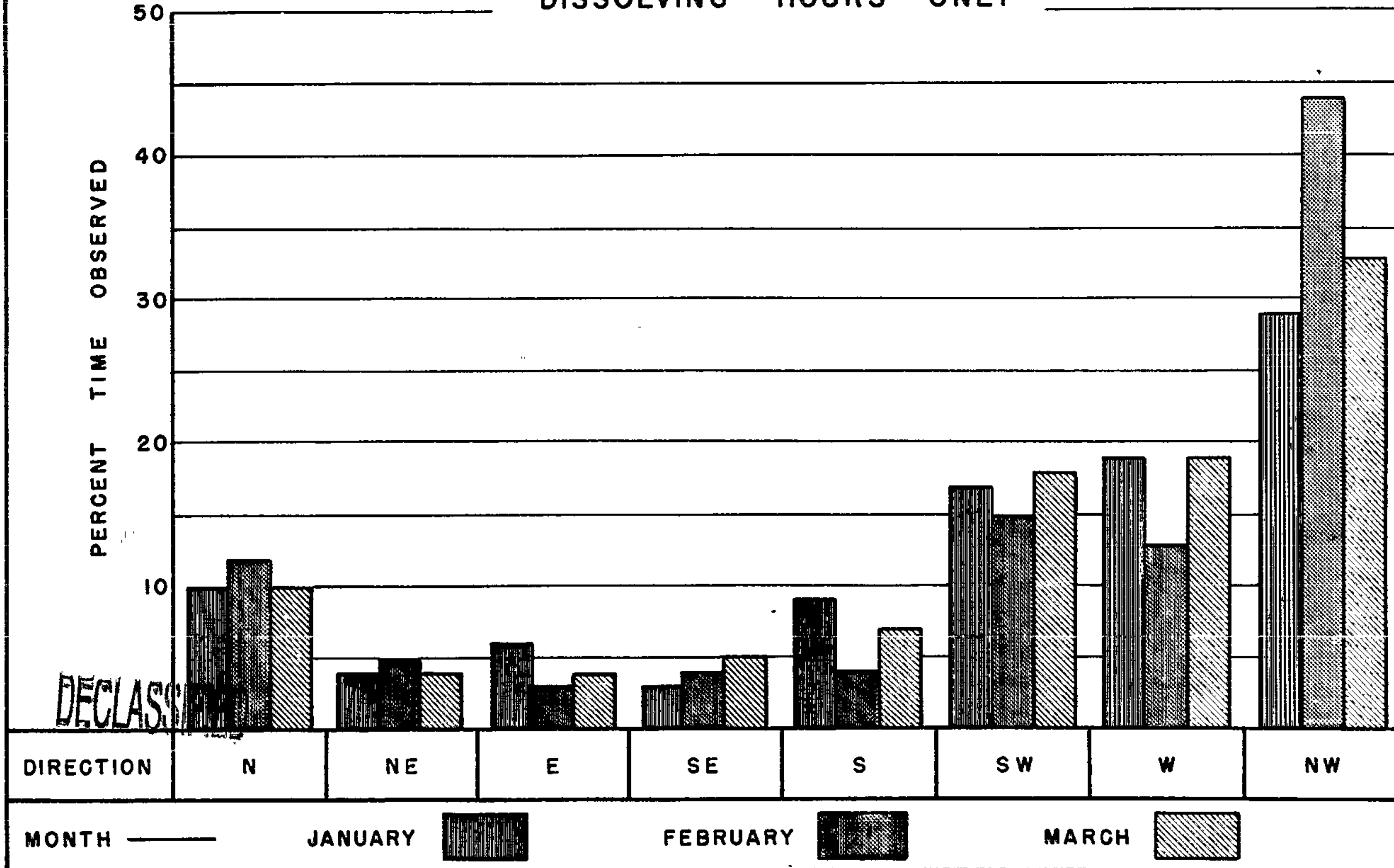
JANUARY —— FEBRUARY —— MARCH

1951

FIGURE — 2

WIND DIRECTIONS

DISSOLVING HOURS ONLY



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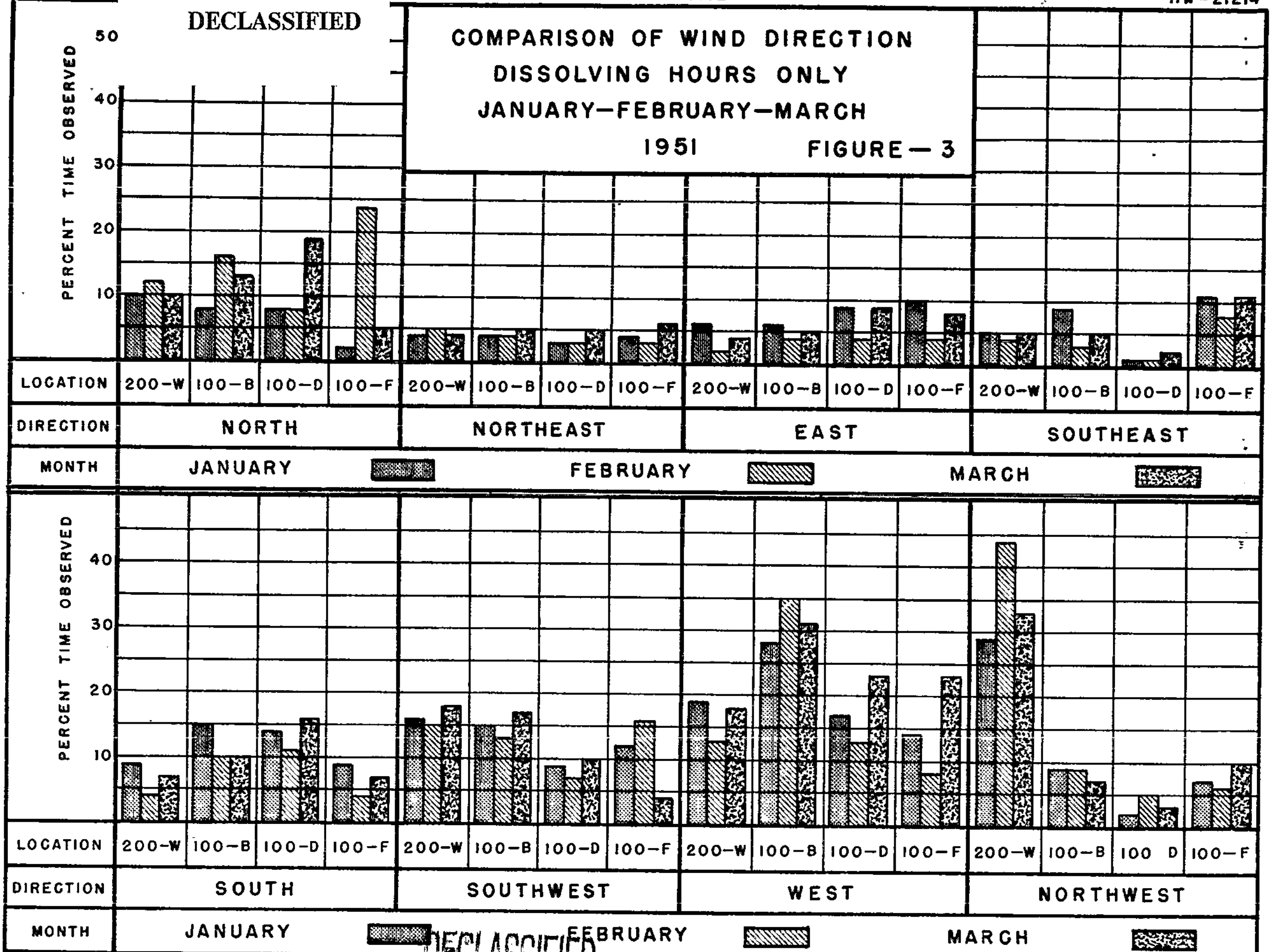
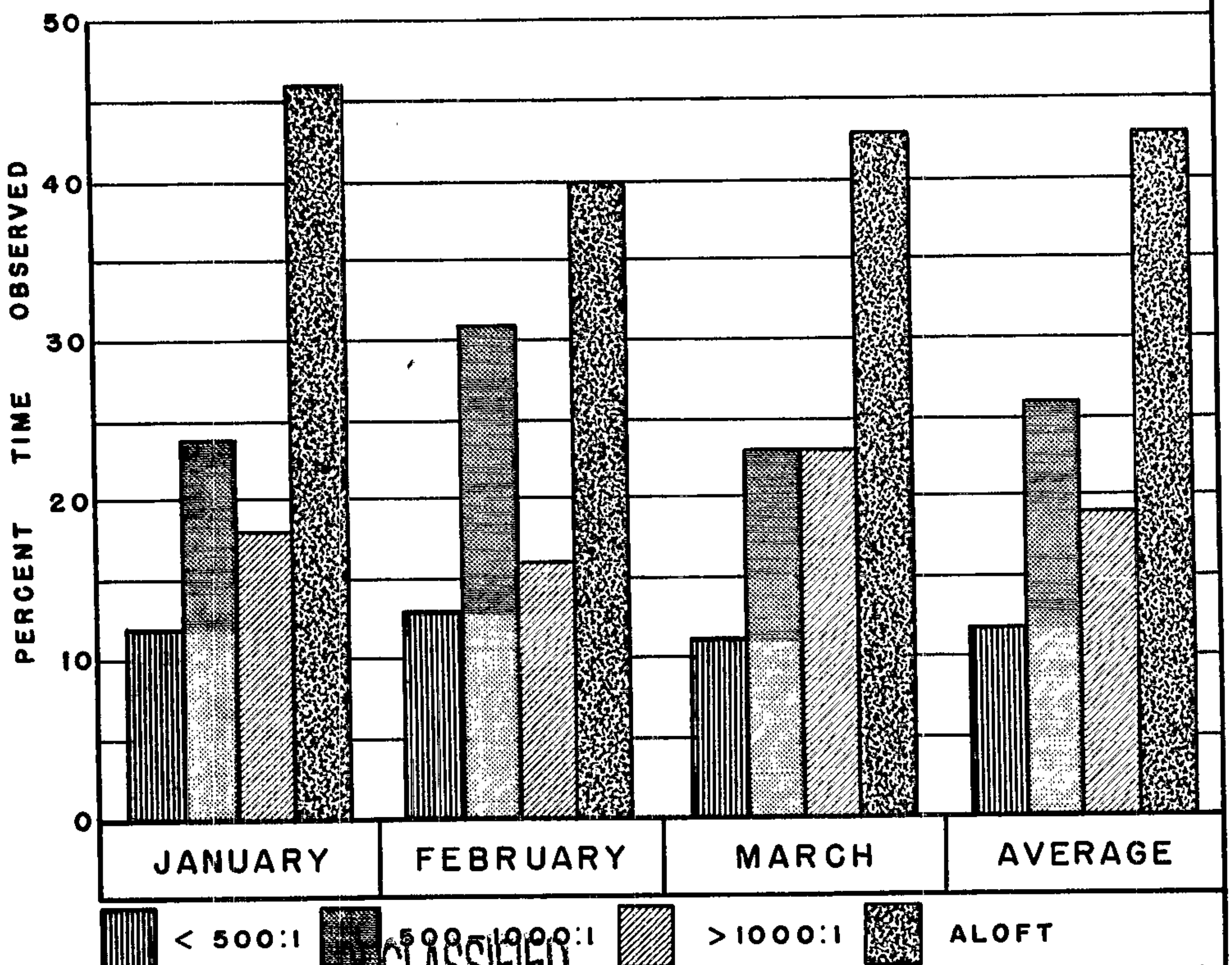

COMPARISON OF WIND DIRECTION
DISSOLVING HOURS ONLY
JANUARY—FEBRUARY—MARCH
1951
FIGURE — 3
PERCENT TIME OBSERVED
50
40
30
20
10
LOCATION
200-W
100-B
100-D
100-F
DIRECTION
NORTH
NORTHEAST
EAST
SOUTHEAST
MONTH
JANUARY
FEBRUARY
MARCH
SOUTH
SOUTHWEST
WEST
NORTHWEST

WIND DILUTION ANALYSIS
622 BLDG.—200-W AREA
DISSOLVING HOURS ONLY
JANUARY—FEBRUARY—MARCH
1951

FIGURE — 4



SECTION II

RADIOACTIVE CONTAMINATION ON VEGETATION

Radiochemical analysis for the activity density of beta emitters on vegetation were performed to determine the magnitude and extent of the deposition and distribution patterns of the radioactive effluent emitted from the two stacks in the separation areas at Hanford. These vegetation samples were analysed specifically for the activity density of 8 day I-131 and for the activity density of the non-volatile beta emitters. The latter emitters occur in lesser quantities and the analyses included the measurement of the natural activity density from the isotope of potassium (K-40) in vegetation.

The importance of a critical evaluation of the activity density of beta emitters in vegetation during this period was stressed as two significant variables influencing the quantities of I-131 emitted to the atmosphere were involved: 1. the reduction in the cooling time of irradiated metal which was initiated during early fall of 1950 was continued; 2. the installation of silver reactors in the off-gas lines of the four dissolvers was completed during this period. The latter item tended to diminish the number of curies of I-131 emitted to the atmosphere while the former one was responsible for an increase in the actual number of curies of I-131 involved in the dissolving operation. A summary of the number of curies of 8 day I-131 calculated to be involved in the dissolvers of the separation areas during January, February, and March, 1951 is presented in Table I.

TABLE I
CALCULATED I-131 INVOLVED IN DISSOLVERS
UNITS - CURIES OF I-131

Month	200 East Area	200 West Area	Total
January	1375	8561	9936
February	2540	2843	5283
March	9791	8235	18026
Total	13706	19639	33245

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A comparison of the data tabulated above with similar calculations representing previous quarterly periods showed that an increase approaching a factor of 3 in the amount of I-131 in the dissolver occurred during this quarter. The amount of I-131 involved in the dissolvers during July, August, and September, 1950, was 12,788 curies and during October, November, and December, 1950 was 12,770 curies. The increase in the amount of I-131 involved during this period was a direct result of the continuation of the dissolving of uranium which had been cooled for short periods when compared with cooling periods during the previous quarter; a small increase in the power level at some of the 100 Area piles also contributed to the additional amount of I-131; however, this cause was non-significant when compared to the effect of the shorter cooling period. Table II summarizes the cooling period data for the period January, February, March, 1951.

TABLE II
RANGE OF COOLING PERIOD FOR IRRADIATED URANIUM
units -- days between pile removal and dissolving

Month	200 East Area Minimum	200 East Area Maximum	200 West Area Minimum	200 West Area Maximum
January	76	87	50	78
February	58	92	65	78
March	52	71	53	109

The minimum periods indicated above were the lowest observed since the program involving the dissolving of shorter cooled metal was inaugurated early last fall. In general, the minimum periods prevailed in each of the separation areas during the month of March, whereas the maximum periods tended to occur more frequently during the month of February.

The installation of silver reactors in the dissolvers' off-gas lines for the purpose of removing I-131 were completed during this quarter. Although only one reactor was installed during the present period, the current 3 month interval represented the first chance to evaluate the effect of the installation of the four silver reactors. The installation dates of the reactors in each of the separations areas were: 200 West, December 12, 1950 and December 28, 1950 in the off-gas line of cells 3-5 R, and 4-5 L, respectively; and in the 200 East Area, January 29, 1951 and October 26, 1950 in cells 3-5 R and 4-5 L, respectively.

Estimations of the amount of I-131 admitted to the atmosphere over a 24 hour period were determined by monitoring the effluent leaving the stack at the 200 West Area. This program consisted of obtaining a representative sample from the 50' level of the stack and passing the 0.3 ft.^{3}/min. sample through a filter and caustic scrubber which were placed in series in the air stream. The flow rate was recorded for a 24 hour period after which time the samples were removed and analyzed for the activity density of I-131. A total of nineteen 24 hour collections were obtained during the quarterly period of January, February, March, 1951. The measured average quantity of I-131 emitted from the stack was 3.8 curies/day; the maximum measurement indicated 15.8 curies. The latter measurement was obtained during the dissolving of irradiated uranium which had been cooled 55 days. Previous measurements obtained in a similar manner before the installation of the silver reactors in the off-gas lines at 200 West indicated that an average of 10 to 11 curies/day were being emitted. The latter average was weighted considerably as the measurements previous to the installation of the reactors were representative of the dissolving of longer cooled metal, and on an over all basis, the amount of I-131 involved in the dissolvers was very small in comparison to that involved during the present period. (See Table II.) Percentage values based on theoretical calculations to determine the actual amount of I-131 involved during the dissolving process indicated that previous to the installation of the reactor about 15 percent of the available I-131 was admitted to the atmosphere; after the silver reactor was employed, the average dropped to about 1 percent indicating that the silver reactors at the 200 West Area were removing I-131 from the off gas line. It is apparent that the efficiency of the reactors is better than indicated by the ratio of the two previously mentioned figures for the amount of I-131 leaving the stack, as the present stack monitoring program includes I-131 from the Canyon exit air line as well as the dissolvers off-gas line. It has previously been estimated that about 10 percent of the total activity emitted to the atmosphere originated in the various cells and was emitted to the atmosphere via the Canyon exit air line; in view of current preliminary measurements, this value appears low by a factor of two to five. Measurements are currently under way to determine the amounts contributed by each of the two sources of I-131 in the air.

Over 2000 vegetation samples were collected and analyzed to determine the deposition pattern of 8 day iodine and non-volatile emitters in the environs of the Hanford Works. The bulk of these samples was obtained from locations within the Hanford Works perimeter and the adjoining communities of Pasco, Kennewick, and Benton City; however, nearly 500 samples were obtained from locations outside a radius of 40 miles of the separation areas stacks. Figure 5 is a location map which shows those locations which were sampled on a repetitive basis within the immediate environs of the Hanford Works. The methods employed in the radiochemical analysis of these samples for the activity density of the beta emitters have been discussed in detail in previous documents.(2) (3) Table III summarizes the results of these analyses for the period January, February, March, 1951; the averages which represented similar analysis during the previous quarterly period are included for comparison. (Please refer to Table III on the following page.)

TABLE III
RADIOACTIVE CONTAMINATION ON VEGETATION
JANUARY, FEBRUARY, MARCH
1 9 5 1

Location	No. Samples	I-131 Activity Density x 10^6 μc/gram Maximum	I-131 Average	I-131 Previous Quarter Average	Non-Volatile Beta Emitters Activity Density x 10^6 μc/gram Maximum	Non-Volatile Beta Emitters Average	Non-Volatile Beta Emitters Previous Quarter Average
North of 200 Areas	203	210	17	44	220	25	<10
Near the 200 Areas	172	590	55	131	100	24	13
Route 3	12	5700	732	365	105	45	15
200 West Gate	113	21000	1508	1854	280	42	35
200 East Tower #16	112	900	138	386	150	35	26
Batch Plant	113	450	114	333	570	28	15
Meteorology Tower	13	740	184	401	30	15	14
South of 200 Areas	270	170	26	42	320	79	10
Richland	64	80	18	30	50	22	<10
Pasco	64	40	10	14	100	21	<10
Kennewick	92	250	15	18	90	20	<10
Benton City	39	70	19	14	85	22	<10
Richland "Y"	13	80	21	26	20	14	<10
Hanford	26	30	9	28	30	14	<10
200 East Area	32	215	60	345	150	45	20
200 West Area	60	1475	314	338	105	19	16
Redox Construction Area	83	3350	318	615	80	27	18
Wahluke Slope	152	40	9	14	100	17	<10
Goose Egg Hill	90	590	70	240	140	24	12
Rattlesnake Mountain	59	50	20	15	700	51	<10

A comparison of the data presented in Table III with the measurements representing the previous quarter indicated that a general decrease occurred in the over all activity density of I-131 in the environs. In general, this decrease appears as a factor of 2 to 4 at nearly all locations; however, several isolated spots indicated no apparent change. The latter condition tended to prevail at locations very close to the separations areas, particularly in the vicinity of the 200 West Area gatehouse and adjacent to Route 3. An estimation of the distribution pattern of deposited I-131 on vegetation during this period may be referred to in Figure 6.

Consistent with previous deposition patterns, the point of maximum deposition was indicated immediately outside the 200 West gatehouse; this area covered about 4 square miles. The average activity density of I-131 at this location was

1.5 x 10^{-3} μc/gram; maximum measurements included one result of 2.1 x 10^{-2} μc/gram. The majority of the higher measurements were on the order of 2 to 3 x 10^{-3} μc/gram. With the exception of a short period during the early part of January, when several random locations indicated higher activity deposition, the region around the 200 West gatehouse was the only location which indicated the activity density of I-131 to be in excess of 5.0 x 10^{-4} μc/gram throughout the quarter. In general, the activity density of I-131 was between 1.0 and 5.0 x 10^{-4} μc/gram in the area between the 2 separation areas and extending slightly to the southeast for about 2 miles below Route 4S. The average deposition in this region represented a decreasing trend throughout the period; during January (Figure 7) measurements approaching 5.0 x 10^{-4} μc/gram were detected 6 to 7 miles southeast of the separations areas, whereas during March (Figure 9) similar measurements indicated this order of magnitude was confined to a region which included parts of each separation area and the area between them.

The decrease of this activity density from I-131 also appeared significant when reviewing the results of samples collected on the Wahluke Slope. During January, the entire Wahluke Area showed detectable activity density which ranged from 5.0 x 10^{-6} μc/cc to 2.5 x 10^{-5} μc/cc. Except for a small area on the northeast part of the slope, the results of samples collected during the month of March indicated negligible activity density in the over all region.

Samples obtained from the residential communities which included Pasco, Richland, Kennewick, Benton City, and the populated area including the Richland "Y" and the Kennewick Highlands did not reflect the magnitude of decrease in activity density of I-131 which was noted at locations closer to the point of emission. Small decreases which approached a factor of 2 were deemed non-significant as they were accompanied by increases of similar magnitude at selected locations in the populated region. Although a review of monthly averages tends to indicate a continued decrease in the activity density of I-131 throughout the quarterly period, a rather significant increase in this activity was observed in samples which were collected between March 15 and March 25. The latter period represented one during which the irradiated uranium dissolved in the separation areas was cooled for less than 50 days. The total curies of I-131 emitted from the separation areas increased by a factor of 5 to 10. In respect to the quarterly period, the number of samples analyzed after March 15 were few and were representative of random locations; the meager data were not sufficient to determine whether a significant increase occurred during the latter part of the quarter. An outstanding maximum measurement obtained during this period represented a sample obtained from the Kennewick Highlands which indicated the activity density of I-131 to be 2.5×10^{-4} µc/gram.

The trend of the deposition pattern based on the averages obtained from the measurement of the activity density of I-131 on vegetation during this period is presented in iso-activity maps on Figures 7, 8, & 9 . Figure 6 is the over all average for the quarterly period.

The majority of samples collected were also analyzed for the activity density of the non-volatile beta emitters; these samples represented the activity density of longer half-lived fission product isotopes. In general, the analysis was performed on nearly all samples collected from the immediate environs and adjacent residential communities, and on about one-half of the samples collected from remote off-area locations. The results of analysis on samples collected during the month of January and early part of February were nearly identical to those obtained during the previous quarter; the average activity density of non-volatile emitters was less than 1.0×10^{-5} µc/gram at nearly all locations except those in the immediate vicinity of the 200 Areas. Samples collected after February 9 indicated a highly significant increase in the activity density of non-volatile emitters at all locations on and off the project. The average increase during February varied by a factor of from 3 to 10, whereas, the maximum increase approached a factor of 25. Maximum measurements were on the order of 2.0 to 5.0×10^{-4} µc/gram at locations which represented mean elevations on the project and were on the order of 7.0×10^{-4} µc/gram on top of Rattlesnake Mountain (3500'.) This increase in activity correlated favorably with increases noted in the concentration of airborne beta emitters on the 9th of February; the trend in each case was associated directly with the passing over the area of air masses which originated at the Las Vegas, Nevada bomb tests which were performed during the first few days of February, 1951.(4) The latter source was confirmed when reviewing the results from the radioautographs of air filters collected from many different stations for the presence of active particles. Table III summarizes the results obtained from the monitoring of the activity density of non-volatile beta emitters at representative locations during the quarterly period. The data representing the month of February was extracted from the quarterly averages and is presented in Table IV in an effort to show the difference noted between measurements obtained immediately before and immediately after the apparent deposition from the radioactive cloud.

TABLE IV
ACTIVITY DENSITY OF NON-VOLATILE EMITTERS ON VEGETATION
FEBRUARY 1951

Units of 10^{-6} uc/gram

Locations	Before February 9		After February 9	
	Maximum	Average	Maximum	Average
North of 200 Areas	23	<10	250	110
Near the 200 Areas	23	10	380	110
Route 3	14	11	250	250
200 West Gate	90	26	280	89
200 E Tower #16	140	32	140	71
Batch Plant	35	11	570	110
Meteorology Tower	24	15	<10	<10
South of 200 Areas	15	<10	240	86
Richland	13	<10	300	130
Pasco	22	<10	100	77
Kennewick	20	<10	130	30
Benton City	17	<10	250	110
Richland "Y"	18	14	57	57
Hanford	12	<10	130	67
Redox Construction Area	36	14	150	56
Rattlesnake Mountain	16	<10	700	190
Prosser to McNary to Kennewick	30	<10	170	56

A comparison of the average measurements summarized above with those representing the quarterly average as presented in Table III indicate that a general decrease in this activity occurred after the maximum measurements of February 9; this decrease continued for several weeks thereafter.

Off area vegetation sampling included repetitive surveys in the Pasco, Ringold, Eltopia region and Prosser, McNary Dam region. Spot surveys were made at many of the communities in the region bounded by Spokane and Walla Walla and Yakima and Sunnyside. In general, the activity density of I-131 averaged about 6 x 10^{-6} µc/gram in these areas. The higher measurements prevailed in the region between Prosser and McNary Dam where individual samples showed an activity density approaching 8.0 x 10^{-5} µc/gm; in contrast, the activity density of I-131 in the entire region bounded by Spokane and Walla Walla was less than the detectable limit of 3 x 10^{-6} µc/gram.

Measurement for the activity density of non-volatile emitters in samples collected from off area locations indicated the activity density to average between 1.0 and 2.0 x 10^{-5} µc/gram on an over all basis. Maximum measurements on the order of 1 to 1.5 x 10^{-4} µc/gram were found on many of the off area surveys during the latter part of the period and were directly associated with samples collected after February 9, 1951 when the radioactive cloud from the atom bomb tests passed over this region. Table V summarizes the results obtained from off area surveys which were maintained on a repetative basis.

TABLE V
RADIOACTIVE CONTAMINATION ON VEGETATION
OFF AREA SURVEYS
JANUARY FEBRUARY MARCH, 1951

		I-131 Activity Density x 10^6			Non-Volatile Beta Emitters Activity Density x 10^6		
		µc/gram		Previous Quarter	µc/gram		Previous Quarter
Location	No. Samples	Maximum	Average	Average	Maximum	Average	Average
Pasco to Ringold, Eltopia, Mesa Area	89	40	6	22	110	17	<10
Prosser to McNary to Kennewick	185	80	7	--	100	23	--
Spokane to Walla Walla	121	21	<3	--	140	24	--
Yakima, Sunnyside, Kiona Area	53	37	7	7	--	--	11

The general deposition of non-volatile emitters previously discussed in respect to the immediate Hanford Environs (Table IV) was also reflected at many off area locations; basically, the increase in activity noted during this period occurred during the early part of February; however, the normal frequency of vegetation sampling at remote locations did not provide ample data to evaluate this increase in respect to the date of occurrence. Surveys were completed in the Connell, Spokane, Walla Walla region during the last week of December, 1950 and the early part of March, 1951. The samples obtained in each of these surveys represented the various communities enroute and in nearly all cases, the averages were obtained from groups of 3 to 6 individual samples. The results obtained from each of these surveys in respect to activity density measurements of I-131 and non-volatile emitters are presented in Table VI. (See the following page.)

A review of the data tabulated in Table VI tends to magnify the significance of the increase in the activity density of non-volatile emitters when comparing the two periods. The increase in activity density varies from a factor of 2 to 9 and each increase represented a positive deposition in contrast with previous measurements which were below the detectable limit of analysis for non-volatile emitters.

The results of two off area surveys completed during January 1951 are presented in Figures 10 and 11. These data and graphs represent the maximum deposition of I-131 at off area locations during the quarterly period of January, February, and March, 1951.

TABLE VI
RADIOACTIVE CONTAMINATION ON VEGETATION
SPOKANE-WALLA WALLA REGION
DECEMBER, 1950 and MARCH, 1951

Location	I-131 Activity Density x 10^6 uc/gram				Non-Volatile Beta Emitters Activity Density x 10^6 uc/gram			
	December, 1950		March, 1951		December, 1950		March, 1951	
	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Average
Connell, Wash.	5	<3	4	<3	<10	<10	43	30
Lind, Wash.	8	<3	13	5	<10	<10	62	47
Ritzville, Wash.	3	<3	5	4	12	<10	140	50
Sprague, Wash.	<3	<3	21	7	<10	<10	24	20
Chaney, Wash.	6	<3	3	<3	11	<10	80	68
Spokane, Wash.	6	4	8	3	<10	<10	50	31
Rosalia, Wash.	<3	<3	3	<3	11	<10	100	72
Spangle, Wash.	--	-	<3	<3	--	--	90	49
Steptoe, Wash.	--	-	4	3	--	--	50	28
Colfax, Wash.	8	<3	<3	<3	13	<10	30	25
Pullman, Wash.	--	-	5	3	--	--	140	65
Colton, Wash.	--	-	<3	<3	--	--	10	10
Lewiston, Idaho	--	-	20	5	--	--	20	18
Pomeroy, Wash.	--	-	<3	<3	--	--	20	19
Chard, Wash.	--	-	<3	<3	--	--	20	19
Dayton, Wash.	11	<3	4	<3	<10	<10	90	51
Waitsburg, Wash.	6	5	4	<3	<10	<10	110	97
Dixie, Wash.	--	-	<3	<3	--	--	60	34
Walla Walla, Wash.	6	<3	5	<3	<10	<10	90	52
Lowden, Wash.	3	<3	<3	<3	<10	<10	10	10
Stanfield, Ore.	--	-	<3	<3	--	--	15	16
Pendleton, Ore.	--	-	--	-	--	--	20	24
Meecham, Ore.	--	-	<3	<3	--	--	20	23

SECTION II

(Please Refer to Figures 5, 6, 7, 8, 9, 10, and 11.)

25

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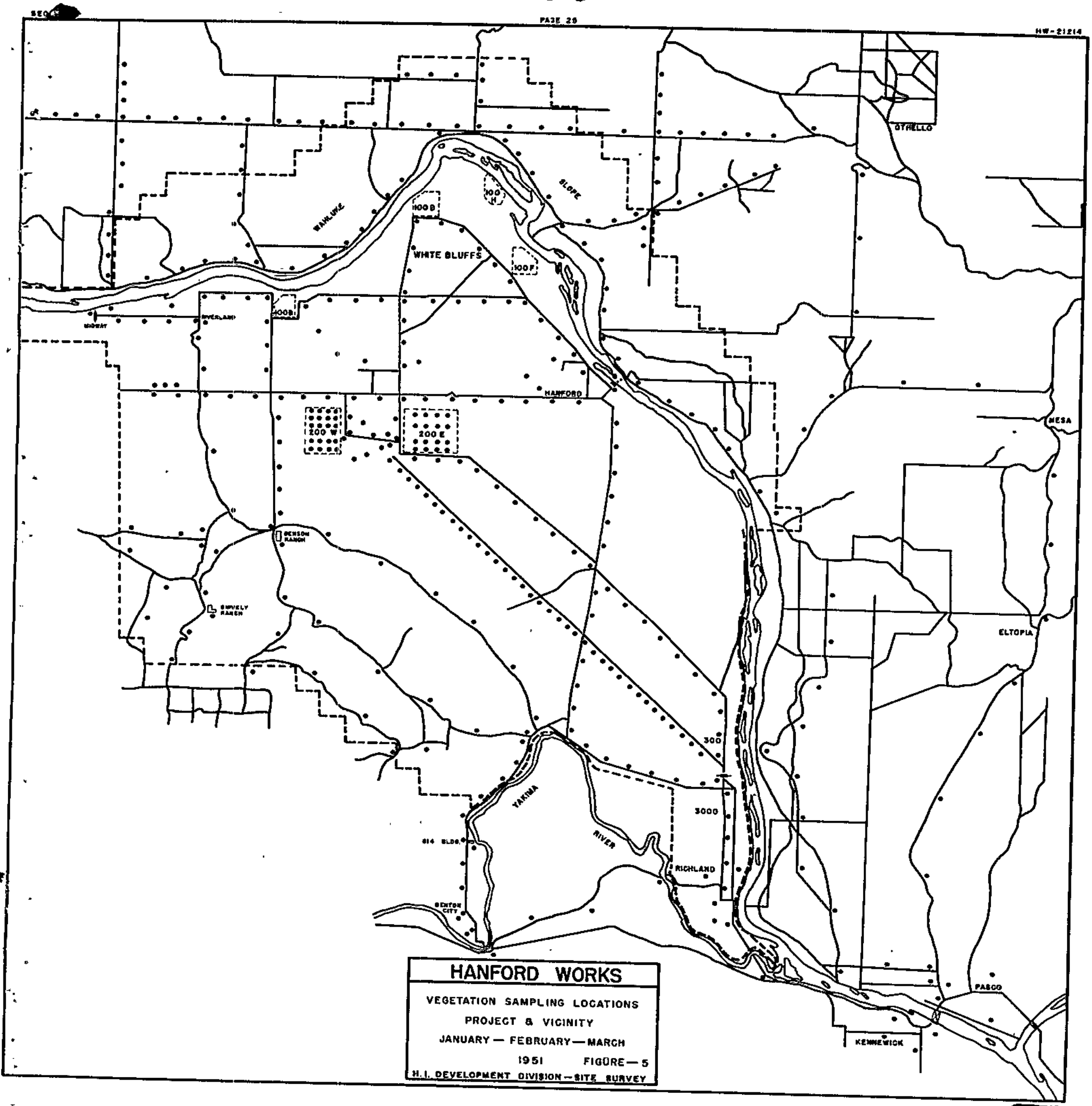

HANFORD WORKS

VEGETATION SAMPLING LOCATIONS
PROJECT & VICINITY
JANUARY — FEBRUARY — MARCH
1951 FIGURE — 5
H.I. DEVELOPMENT DIVISION — SITE SURVEY

DECLASSIFIED

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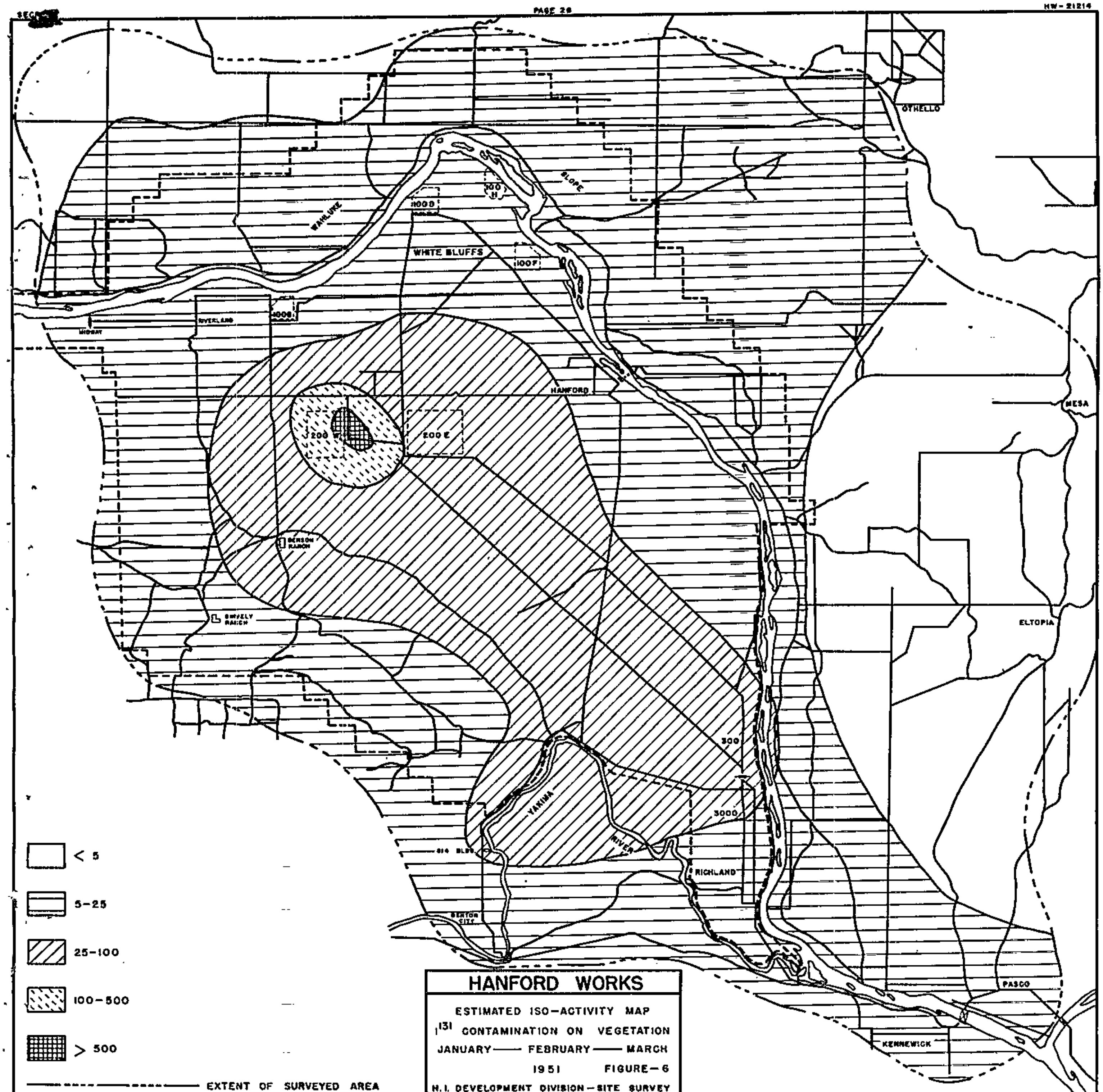


HANFORD WORKS

ESTIMATED ISO-ACTIVITY MAP

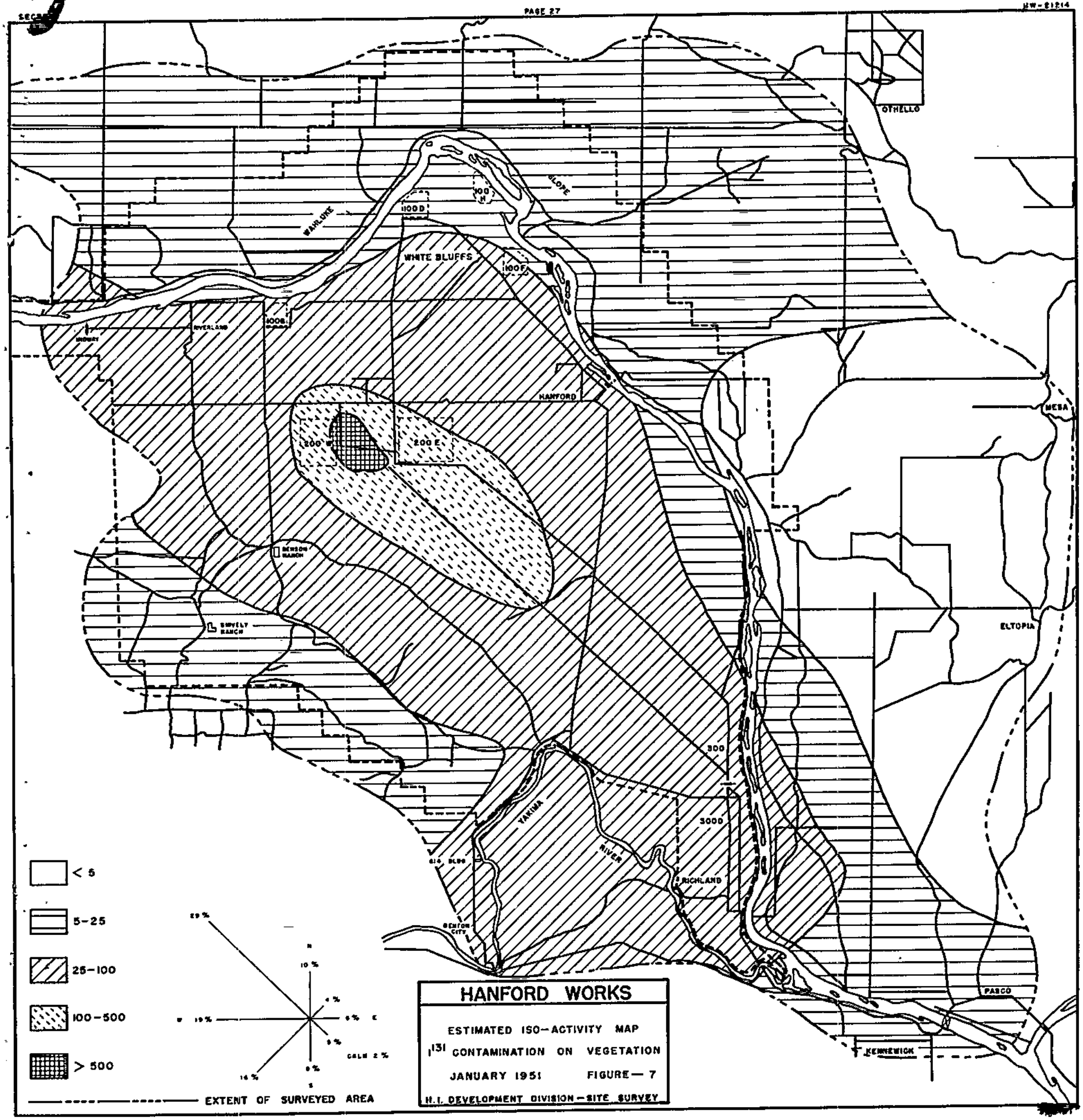
I^{131} CONTAMINATION ON VEGETATION

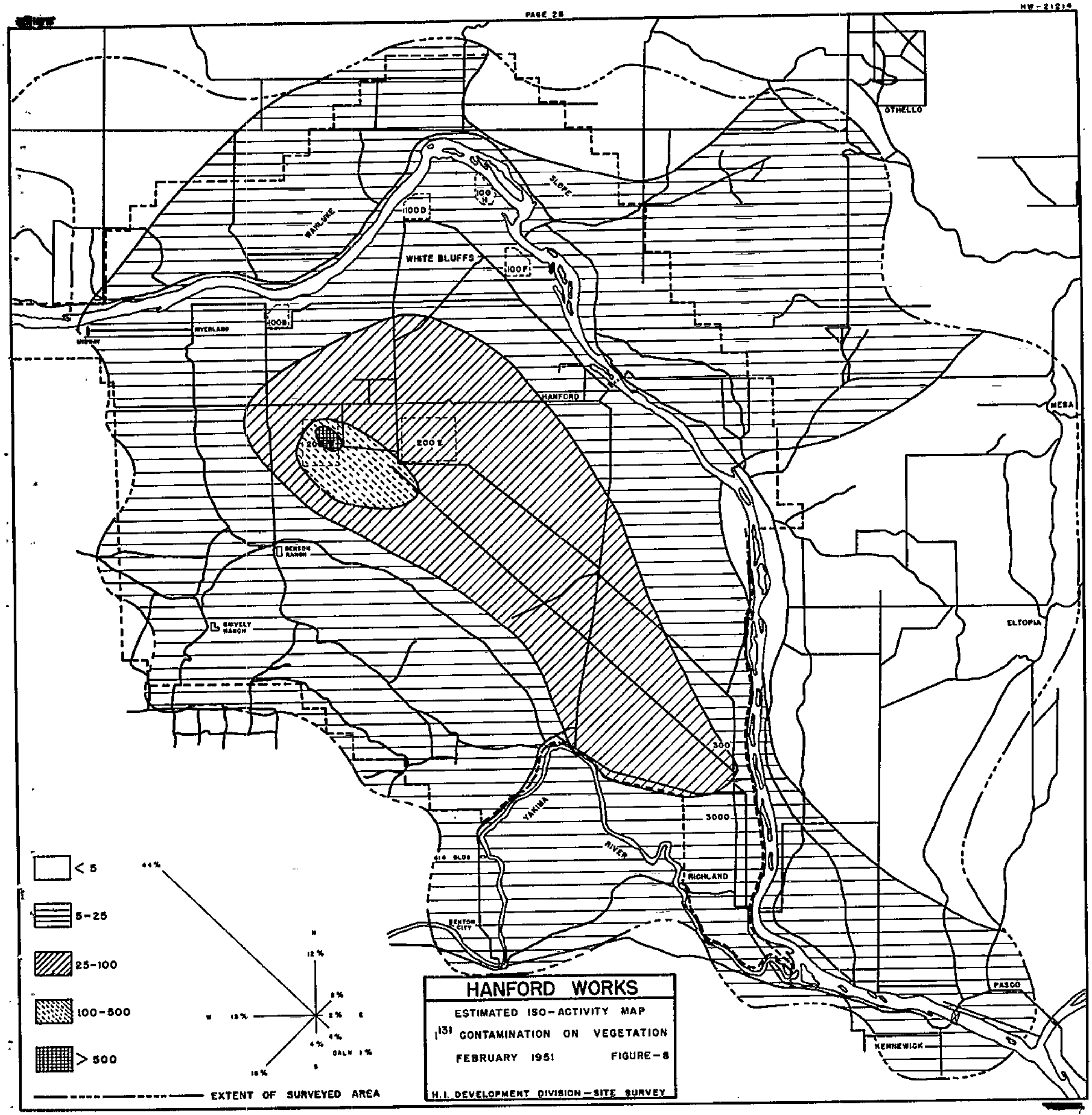
JANUARY —— FEBRUARY —— MARCH

1951 FIGURE-6

H.I. DEVELOPMENT DIVISION-SITE SURVEY

DECLASSIFIED


PAGE 27
HW-21214
OTHELLO
WAHLUKE
SLOPE
100 D
100 H
WHITE BLUFFS
100 F
100 B
RIVERLAND
HANFORD
200 W
200 E
BENSON RANCH
SNIVELY RANCH
MESA
ELTOPIA
300
3000
YAKIMA
RIVER
RICHLAND
BENTON CITY
PASCO
KENNEWICK
< 5
5–25
25–100
100–500
> 500
EXTENT OF SURVEYED AREA
HANFORD WORKS
ESTIMATED ISO–ACTIVITY MAP
I131 CONTAMINATION ON VEGETATION
JANUARY 1951
FIGURE— 7
H.I. DEVELOPMENT DIVISION—SITE SURVEY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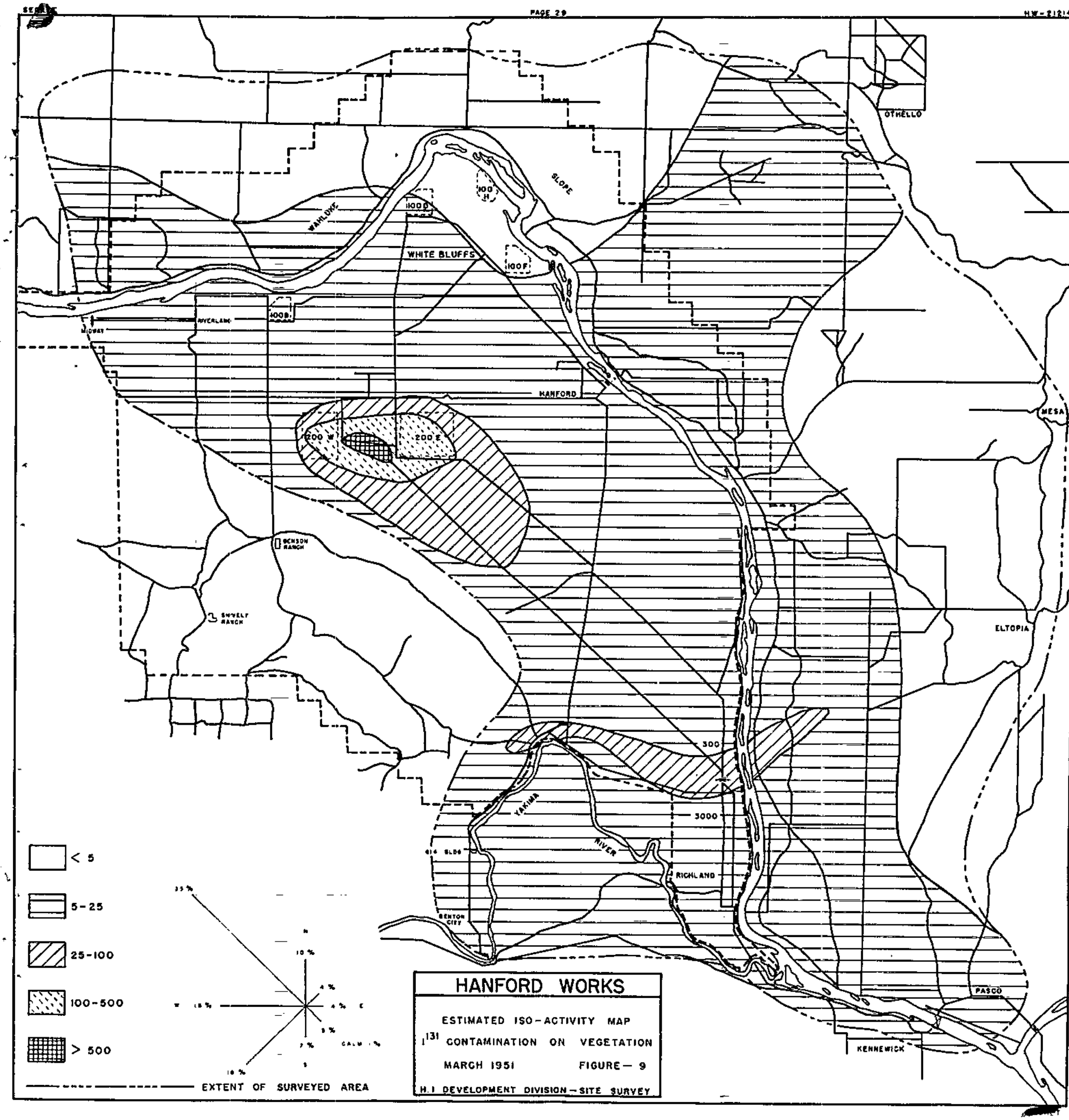
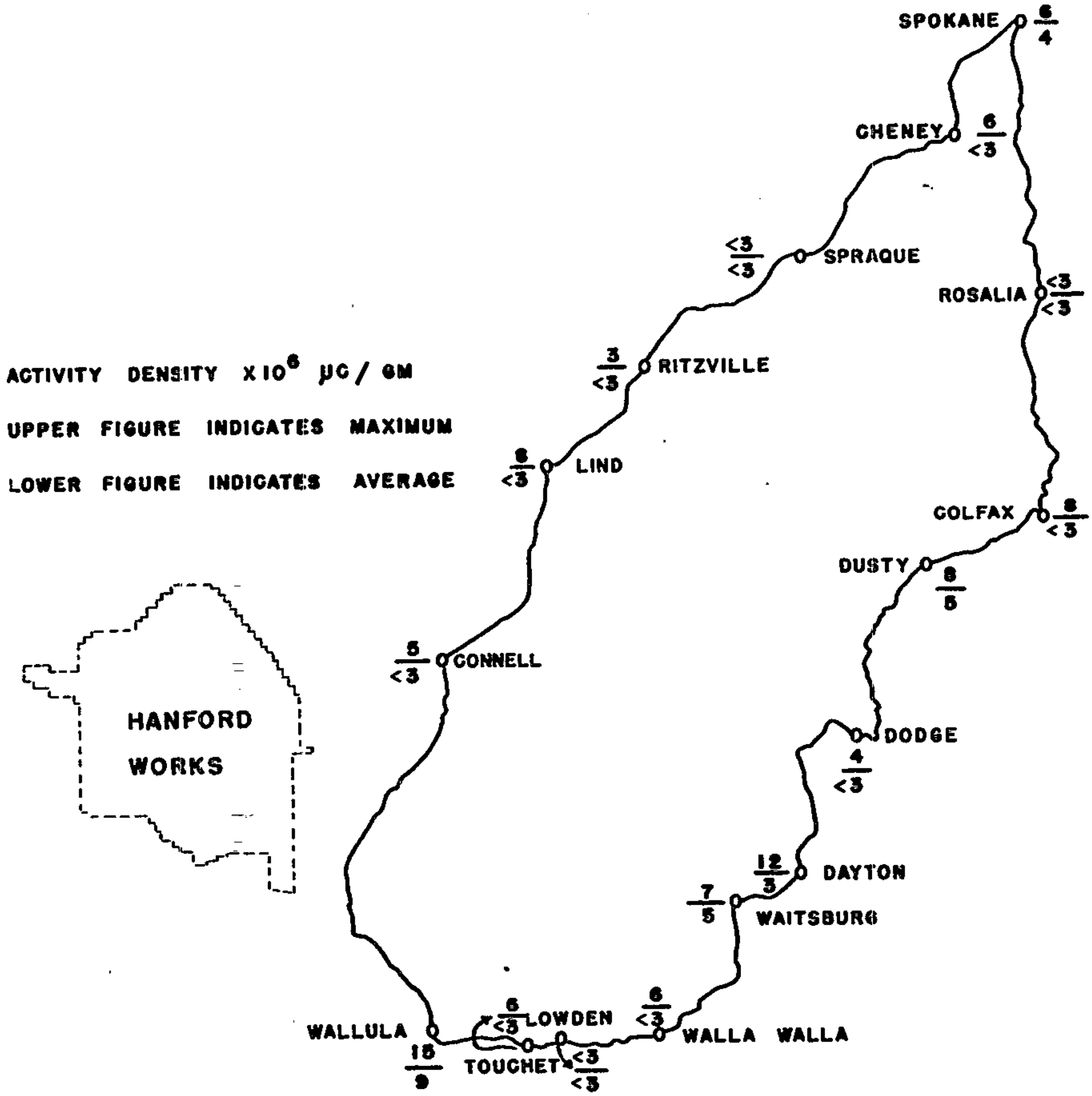
HW-21214
OTHELLO
SLOPE
WAHLUKE
100D
100 H
WHITE BLUFFS
100F
100B
RIVERLAND
HANFORD
200 E
200 W
BENSON RANCH
SNIVELY RANCH
MESA
ELTOPIA
300
3000
YAKIMA
RIVER
RICHLAND
BENTON CITY
PASCO
KENNEWICK
< 5
5-25
25-100
100-500
> 500
EXTENT OF SURVEYED AREA
HANFORD WORKS
ESTIMATED ISO-ACTIVITY MAP
I131 CONTAMINATION ON VEGETATION
FEBRUARY 1951
FIGURE-8
H.I. DEVELOPMENT DIVISION—SITE SURVEY


PAGE 29
HW-21214
OTHELLO
WAHLUKE
SLOPE
WHITE BLUFFS
100 D
100 H
100 F
100 B
RIVERLAND
MIDWAY
HANFORD
200 W
200 E
MESA
ELTOPIA
BENSON RANCH
SHIVELY RANCH
300
3000
YAKIMA
RIVER
RICHLAND
BENTON CITY
PASCO
KENNEWICK
< 5
5-25
25-100
100-500
> 500
EXTENT OF SURVEYED AREA
HANFORD WORKS
ESTIMATED ISO-ACTIVITY MAP
I131 CONTAMINATION ON VEGETATION
MARCH 1951 FIGURE— 9
H.I DEVELOPMENT DIVISION — SITE SURVEY

I-131 CONTAMATION ON VEGETATION
NEARBY COMMUNITIES
JANUARY 1951

FIGURE — 10



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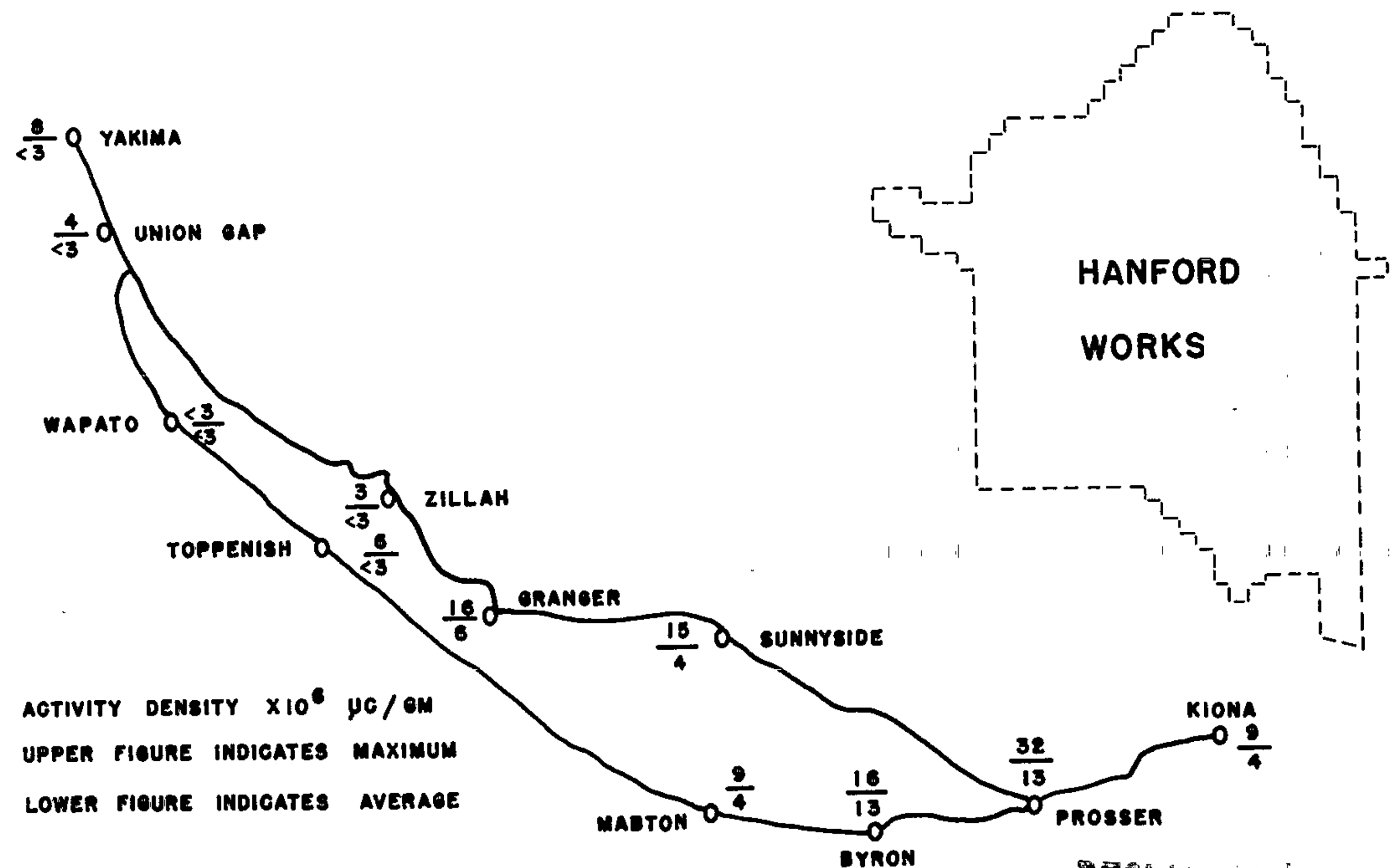
I-131 CONTAMATION ON VEGETATION
NEARBY COMMUNITIES
JANUARY 1951

FIGURE – 11



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SECTION III

RADIOACTIVE CONTAMINATION IN THE ATMOSPHERE

Radioactive contamination in the atmosphere of the Hanford Works area originates from the waste gases of the separation areas. The principal contaminants are eight-day I-131 and the beta emitters from the longer half-lived fission product isotopes; the I-131 is the predominating contaminant from a biological hazard point of view. In addition to the radioactive gases, the environs are also subject to contamination from radioactive particles which emanate from the separation areas stacks.

The measurement for the activity density of beta emitters in the atmosphere along with the measurement of dosage rates were accomplished by various methods. The more common devices employed were recording type fixed instrumentation, portable type ionization chambers, air filtering devices, and air scrubbing monitors. The location at which this equipment is installed and the type of equipment employed was largely dependent on the source and type of activity; the frequency at which various measurements were maintained was determined from evaluating the trend of the current data as compared with previous measurements. Fixed air monitoring stations at which the various types of equipment were employed were located around the perimeter of the Hanford Works operating areas and in the nearby residential communities including Richland, Benton City, and Pasco. Two or three stations were maintained at each of the operating areas whereas only one unit was used in the residential areas. The fixed equipment was supplemented with portable type instrumentation which was carried on at various locations between the operating areas. Several air filtering units were maintained at remote locations in the states of Montana, Oregon, Idaho, and Washington for the purpose of evaluating the background and natural activity in the atmosphere as well as evaluating the activity concentrations which may originate at locations other than the Hanford Works. Figure 12 is a map showing the location at which monitoring stations were maintained during this period.

Radiation dosage rates in the operating areas and residential communities were evaluated from the recorded readings from Victoreen integrons. Individual readings were obtained for each eight hour interval throughout the period; these data were accumulated for the over all period from each unit in a given region; the average dosage rate determined in this manner included the measurement of natural background in the region. The average dosage rates computed in this manner are summarized for the individual months and the quarterly period in Table I.

TABLE I
AVERAGE DOSAGE RATES AS MEASURED BY VICTOREEN INTEGRONS
JANUARY, FEBRUARY, MARCH
1 9 5 1

units of mrep per 24 hours

Location	Number of units	January	February	March	Quarterly Average
100-B Area	3	0.4	0.3	0.2	0.3
100-D Area	3	1.9	0.3	0.1	0.8
100-F Area	3	0.2	0.2	0.3	0.2
100-H Area	3	0.5	0.6	0.2	0.6
200 West Area	2	<0.1	0.1	0.6	0.3
200 East Area	3	0.1	0.1	0.1	0.1
Riverland	1	<0.1	0.1	0.2	0.1
300 Area	1	0.6	5.6	1.0	2.4
700 Area	1	0.6	0.2	0.6	0.5
Pasco	1	0.3	<0.1	0.7	0.4
Benton City	1	0.3	0.1	<0.1	0.2
3000 Area North	1	0.2	0.7	0.2	0.4
3000 Area South	1	0.5	0.5	0.5	0.5
Hanford	1	0.2	0.3	0.1	0.2

With the exception of three isolated readings, a review of the above data indicates very little change in the average dosage rate during the period January, February, and March. The monthly averages at 100-D during January, and 300 Area during February and March appear slightly higher than normally expected because several questionable readings which could be attributed to faulty instrumentation were included in these averages. In general, quarterly averages tabulated for each of the locations were essentially within the variation of natural background recorded by this type of instrumentation (0.3 to 0.5 mrep/24 hours.) In contrast to the slightly higher measurements observed during the early part of 1950, the above data indicate that the current dosage rates are about normal and in very close agreement with similar measurements recorded before the program encompassing the dissolving of shorter cooled metal was inaugurated. The recorded data from the Victoreen integrons were confirmed by exposing detachable "C" type ionization chambers inside the air monitoring stations at which the integron units were maintained. Two chambers were exposed at each location; the radiation level was evaluated by using the minimum reading from the two chambers. Erroneous readings which may have been attributed to excessive leakage or faulty chamber construction were deleted from the data. A summary of the radiation levels measured in this manner at the Hanford operating areas is presented in Table II.

TABLE II
"C" TYPE DETACHABLE IONIZATION CHAMBERS
JANUARY, FEBRUARY, MARCH
1 9 5 1

mrep per 24 hours

Location	January	February	March	Quarterly Average
Within 100-B Area	0.4	0.3	0.3	0.3
Within 100-D Area	0.5	0.4	0.4	0.4
Within 100-F Area	0.4	0.3	0.4	0.4
Within 200 West Area	0.3	0.6	0.3	0.4
Within 200 East Area	0.6	0.5	0.6	0.5

A comparison of the above data indicade that no significant change occurred within the months involved and further comparison with similar measurements obtained during previous quarterly periods indicates the current quarterly averages to be in very close agreement with the past. Minor fluctuations on the order of 0.1 to 0.2 mrep per 24 hours were within the expected range of background variation.

Air radiation levels at random field locations between the Hanford Works operating areas and the nearby residential communities were determined from the readings obtained by exposing small detachable ionization chambers (M and S type.) These chambers were exposed at portable monitoring stations; the chambers were positioned approximately 5' above ground level. Two chambers were used at each location; the minimum reading of both chambers was used to compute the dosage rate in a manner similar to that used for the "C" type chamber. These chambers were read at various intervals which varied with the location and the chamber capacity. Normal frequencies were on the order of two or three readings per week. A summary of the average air radiation levels as determined by detachable chambers at representative locations is presented in Table III, which is shown on the following page.

A review of the quarterly averages summarized in Table III indicates that the radiation levels during this period were comparable with those observed during the last 6 months of 1950. A general increase in radiation level occurred during the early fall of 1950 when the shorter cooled metal was dissolved in the separation areas at Hanford; this general increase tends to be confirmed when reviewing the quarterly averages; however, the significance of these trends appears to be minimized when comparing the average radiation levels for the individual months during this period. On a month to month basis, the average radiation level was considerably higher at many of the locations during the month of February; the data at several specific locations such as Route 3, Mile 1; Route 4S, Mile 6; and Route 11-A, Mile 1 became a significant factor in weighting the quarterly average. The higher readings observed during the month of February were observed during the period immediately following February 9, 1950 when an apparent deposition of radioactive particles occurred in this region due to the passing of a radioactive cloud which apparently originated at the special tests performed in Nevada during the early part of the month. The increase in the airborne radiation level caused by this cloud may be further evaluated by reviewing the data and discussion accompanying Tables IX and X of this section. After questionable averages were deleted from the over all appraisal and from the data presented in Table III, the resultant averages for many of the individual locations would reflect a decrease in air radiation levels which could be attributed to the over all effect of the use of silver reactors in the off gas lines of the dissolver cells at the Hanford Works separation areas.

Three new air monitoring locations were established in new construction areas and near military encampments. The average radiation level measured in the semi

TABLE III
RADIATION LEVEL OBSERVED WITH
"M" AND "S" TYPE DETACHABLE IONIZATION CHAMBERS
JANUARY FEBRUARY MARCH
1 9 5 1

units-mrep per 24 hours

Location	January	February	March	Quarterly Average	Group Average
100-Areas and Environs					
Route 1, Mile 8	0.69	0.50	0.45	0.55	
Route 2N, Mile 10	0.53	0.52	0.46	0.50	
Route 2N, Mile 5	0.38	0.49	0.39	0.42	
At White Bluffs	0.45	0.41	0.37	0.41	
Route 11-A, Mile 1	0.53	1.15	0.47	0.72	0.47
At Hanford 614	0.42	0.37	0.45	0.41	
Intersection-Rt. 1 and Rt. 4N	0.51	0.40	0.39	0.43	
At Hanford 101	0.43	0.41	0.37	0.40	
100-H Area	0.50	0.47	0.39	0.45	
P-11 Area	0.43	0.43	0.39	0.42	
Within 5 miles of 200 East Area					
Route 4S, Mile 6	0.52	1.56	0.89	0.99	
Batch Plant	0.57	0.58	0.53	0.56	
Route 11-A, Mile 6	0.59	0.58	0.58	0.58	
Route 3, Mile 1	1.22	2.13	0.59	1.31	
Meteorology 200'	1.42	1.61	0.56	1.20	1.05
Route 4S, Mile 2.5*	1.45	1.08	1.03	1.19	
Redox Area	1.37	1.34	1.17	1.29	
Route 4S, Mile 4.5	0.99	1.22	1.24	1.15	
Semi-Process Construction #1*	0.98	1.40	1.10	1.16	
Semi-Process Construction #2*	1.39	0.75	0.97	1.04	
Within 10 Miles of 200 East Area					
Route 4S, Mile 10	0.59	1.75	1.20	1.18	
Route 10, Mile 1	1.02	0.70	0.51	0.74	0.91
Route 10, Mile 3	0.88	0.81	1.18	0.96	
Route 2S, Mile 4	0.76	1.01	0.52	0.76	
Near 300 Area					
Route 4S, Mile 16	0.79	1.13	1.85	1.26	
Route 4S, Mile 22	1.68	0.38	0.62	0.89	
3000 Area North	0.39	0.80	0.42	0.54	0.79
3000 Area South	0.39	1.05	0.65	0.70	
300 Area	0.36	0.86	0.50	0.57	
Outlying					
Richland	0.57	0.96	0.63	0.72	0.75
Benton City	1.21	0.64	0.47	0.77	

* New locations established during this period.

works construction area inside the 200 East Areas was 1.1 mrep/24 hours; this dosage rate was comparable with that observed at several locations adjacent to the 200 East Area. The monitoring stations located at Route 4S, Mile 2.5 and Mile 4.5 were established to evaluate the dosage rate to which military personnel may be exposed; average radiation levels were on the order of 1.2 mrep/24 hours and although in reasonable agreement with measurements at nearby locations, these values were among the higher dosage rates noted outside of the operating areas.

The extent and magnitude of the activity density of filterable beta emitters in the atmosphere were evaluated by filtering representative amounts of air through small filters which employed CWS #6 filter paper as the filtering media. An air flow of 2.0 or 2.5 c.f.m. was maintained through a filter having a surfce area of 1.8 in.^{2}. In most cases, the filters were changed on a weekly basis and held for two to three days to allow for the decay of the daughter products of radon and thoron; thin mica-window counters were used to determine the activity on these filters. A summary of the results obtained from measurements performed in this manner during the period January, February, and March, 1951, is presented in Table IV, which is shown on the following page.

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TABLE IV
AVERAGE FILTERABLE BETA EMITTERS IN AIR
JANUARY, FEBRUARY, MARCH
1 9 5 1

Location	January	February	March	Quarterly Average	Maximum Weekly
	BETA EMITTERS - AVERAGE ACTIVITY DENSITY x 10^{14} µc/cc				
200 Areas & Vicinity					
200 East Southeast	41	81	12	42	224
200 East Tower #16	157	142	41	108	311
200 East Semi-Works	96	127	64	93	359
200 West Tower #4	149	112	733	388	3890
200 West Gate, WEC	160	163	134	151	334
200 West Redox Area	170	188	119	156	388
Gable Mountain	44	94	15	48	323
200 East Tower #15	47	151	35	74	320
100 Areas & Vicinity					
100-D	70	103	29	64	343
100-H	60	123	29	70	394
Hanford 101 Building	16	3	22	14	54
Hanford 614 Building	16	44	11	33	152
White Bluffs	47	77	13	43	260
300 Area					
300 Area 614 Building	29	52	15	31	168
Outlying					
Richland	7	29	9	14	83
North Richland	62	46	8	37	208
Pasco	8	68	19	30	218
Benton City	13	22	10	14	81
Riverland	26	32	9	21	84
Dual Units					
200 WEC #1	58	406	393	294	1144
200 WEC #2	212	94	14	90	402
200 ESE #1	70	91	24	59	257
200 ESE #2	35	47	18	32	105
2707EA #1	116	206	75	126	254
2707EA #2	78	229	30	106	485

A review of the data tabulated in Table IV indicates that the maximum activity density measured in the atmosphere prevailed in the vicinity of the 200 West Area. Air monitoring stations located near the 200 West Area gatehouse (WEC station) and at Tower #4 indicated the average activity density during the quarterly period to be 2.9×10^{-12} and 3.9×10^{-12} µc/cc, respectively. Individual weekly measurements approached 4.0×10^{-11} µc/cc at Tower #4 and 1.1×10^{-11} µc/cc near the gatehouse.

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Maximum measurements obtained at stations inside the 200 East Area and in the construction zones which included the Redox Area and the Semi-Works were lower by a factor of 10 when compared with the maximum measurements. A comparison of these atmospheric concentrations with those measured during the last quarter of 1950 indicates a rather general decrease in activity density of beta emitters by factors of 2 to 5 at most of the separations area locations. Although the average reflected a general decrease, several of the individual weekly measurements obtained during the current period were higher than those observed during the previous quarter. The latter fact was attributed to the greater amount of dissolving during daylight house which were accompanied by a considerable amount of "looping" which brought the air masses closer to the earth's surface in the immediate vicinity of the stacks.

Small decreases in the average activity density of filterable beta emitters in the atmosphere were also observed in the vicinity of the 100 Areas and related construction zones in the vicinity of White Bluffs. These decreases were of the magnitude of those noted in the vicinity of the separation areas; however, they were in reasonable agreement with the over all trend noted throughout the period. Maximum results in this region were observed in the vicinity of the 100-H Area where the average activity density was 7.0×10^{-13} μc/cc; the previous quarterly average at this same location was 8.6×10^{-13} μc/cc. Maximum weekly measurements were on the order of 6.0×10^{-12} μc/cc in the vicinity of Hanford.

Air monitoring in the nearby residential communities reflected decreases in the activity density of filterable beta emitters at all locations except Pasco where the current quarterly average of 3.0×10^{-13} μc/cc was on the same order of magnitude as the previous quarterly average of 1.9×10^{-13} μc/cc. The over all decrease in the remaining communities exceeded a factor of 10 at Benton City in the extreme cases and approached a factor of 2 in Richland and Riverland. The maximum concentration during any given week in a populated region was 2.2×10^{-12} μc/cc at Pasco.

The general decrease in the activity density of filterable beta emitters observed during this period was attributed to the completion of the installation of silver reactors in the off gas lines of the dissolvers. The over all effectiveness of the silver reactors may be somewhat obscured when comparing these data to that of the previous period because the amount of I-131 involved in the dissolvers increased significantly since the reactors were employed in the off gas lines. A more detailed discussion of the effect of the silver reactors may be referred to in Section II.

Direct measurement for the activity density of I-131 in the atmosphere was performed by scrubbing air samples through a caustic scrubber media of approximately 2 liters volume. This solution contained 1.6 grams of sodium carbonate and 4 grams of sodium hydroxide in addition to a small amount of sodium iodide which was used as a carrier. Caustic scrubbers of this type were placed in series behind the air filters which were connected to motoairs at selected locations throughout the environs. Table V summarizes the results obtained from measurement of the activity density of I-131 in the atmosphere by the method described above.

TABLE V
AVERAGE ACTIVITY DENSITY OF I-131 DETECTED IN SCRUBBERS
JANUARY, FEBRUARY, MARCH
1951

ACTIVITY DENSITY x 10^{14} µc/cc

Location	January	February	March	Quarterly Average	Maximum Weekly
200 Areas & Vicinity					
200 East Southeast	164	108	137	139	298
200 East Tower #16	515	270	242	339	1574
200 West Gatehouse	770	963	1193	994	2330
Gable Mountain	94	96	39	69	200
Outlying Locations					
100-H Area	249	27	9	84	842
300 Area	44	52	33	41	112
Richland	65	81	27	52	248
North Richland	33	11	9	21	83
Benton City	28	15	8	20	74

In general agreement with the measurements made for the activity density of filterable beta emitters in the atmosphere, the activity density of I-131 as determined by scrubbers showed a decrease at nearly all locations during this period. This decrease was on the order of a factor of 4 in the more contaminated regions near the separations area and was less than a factor of 2 at outlying locations around the project perimeter. Only 2 stations indicated an increase in the activity of I-131. At the 200 West Area gatehouse, the current average 1f 9.9×10^{-12} $\mu c/cc$ represented an increase over the previous quarterly average of 6.8×10^{-12} $\mu c/cc$; at the 100-H Area, the average of 8.4×10^{-13} $\mu c/cc$ represented about a $1\frac{1}{2}$ fold increase over the previous 4.9×10^{-13} $\mu c/cc$. Maximum measurements were observed at the 200 West Area gatehouse where a scrubber which was operated for a one week period indicated the average activity density to be 2.3×10^{-11} $\mu c/cc$; maximum measurements in the 200 East Area were on the order of 1.5×10^{-11} $\mu c/cc$ at a location in the southeast corner of the area. All maximum measurements were observed at locations directly down wind from the prevailing wind direction when reviewed with respect to the location of the separation area stacks.

In the residential areas adjacent to the project, the average activity density of I-131 did not exceed 8.1×10^{-13} $\mu c/cc$ during any month in the period; the maximum quarterly average was noted in Richland where the activity density was 5.2×10^{-13} $\mu c/cc$. The maximum weekly measurement was 2.5×10^{-12} $\mu c/cc$.

Special scrubber samples were obtained in several instances where visual observation indicated the stack gases to be looping close to the ground level in the 200 Areas. Most of these samples were obtained by taking the mobile equipment to the location and scrubbing air at the rate of 2.5 c.f.m. for a period of 15 to 30 minutes. The maximum concentration observed by taking samples in this manner was 1.4×10^{-10} $\mu c/cc$ in a 30 minute sample collected in the 200 West Area along the perimeter fence near the Meteorology Building. Most results were on the order of 10^{-11} $\mu c/cc$ with maximum measurements on the order of 1×10^{-10} $\mu c/cc$.

The total activity density of beta emitters in the atmosphere at representative locations in the environs of the Hanford Works for the period January, February, March, 1951 may be appraised from Figure 13, which is a graphic presentation showing the activity density from I-131 and from filterable emitters.

The number of particles in the atmosphere at representative air monitoring locations was determined by radioautographing small air filters obtained from locations summarized in Table IV. These small filters were exposed to type K X-ray film for a period of 168 hours. The radioautographs were usually started one week after the filter had been removed from the location and the subsequent activity of beta emitters determined with thin mica-window counters. The number of particles was estimated by visually counting the darkened spots on the developed film. A summary of the active particles on the filters estimated in the above manner is presented in Table VI. The tabulation includes all locations at which any particles were detected at any time throughout the period January, February, March, 1951.

A review of the data presented in Table VI, (presented on the following page) indicates that the number of particles in the atmosphere during January and March was comparable with that observed during the last quarter of 1950. During these two months the active particles in the atmosphere at locations removed from the separation areas were on the order of 1.0 to 5.0 particles/meter^3; in the immediate vicinity of the 200 Areas, the concentration was about 10 times higher with the maximum measurements on the order of 4.0×10^{-2} particles/meter^3. The latter results were noted during March when it was believed that residual particles from the higher concentrations observed in February were still present in the atmosphere.

The higher concentrations of particles in the atmosphere observed during the month of February were apparently the result of a general particle deposition in this region which was caused by the passing of a cloud of active particles which originated from the Nevada "A" bomb tests. The significance of this increase and the magnitude of the area in which it was observed may be appraised in greater detail after the data tabulated in Table VI is reviewed in conjunction with tabulations presented in Tables VII and VIII, which summarize the results of particle measurements as determined from units which were operated primarily to detect the number of active particles in the atmosphere.

TABLE VI
PARTICLE DEPOSITION - SMALL FILTERS
Units of 10^{-3} particles/meter^3
January, February, March
1 9 5 1

Location	Total Volume of air sampled m^3	January	February	March	First Quarter 1951 Average	Fourth Quarter 1950 Average
200 East Area						
H. I. Garden	7948	3.5	17.0	6.2	11.0	**
Tower #15	7337	4.4	0.9	7.3	3.8	**
ESE Decade Filter	7882	3.4	30.0	10.0	17.0	3.2
ESE Twin #1	4063	10.0	22.0	8.9	15.0	**
ESE Twin #2	5802	2.4	18.0	8.5	11.0	**
2707EA #1	5377	2.8	56.0	4.5	25.0	9.4
2707EA #2	3758	<1.2	36.0	1.0	19.0	5.5
Tower #16	6751	10.0	17.0	11.0	14.0	5.0
200 West Area						
200 WEC Decade	7523	4.6	27.0	4.9	14.0	6.9
EC #1	2951	21.0	65.0	39.0	42.0	35.0
EC #2	5350	16.0	43.0	1.4	21.0	47.0
200 West Tower #15 (Redox)	9926	2.7	25.0	4.9	13.0	1.7
200 West Tower #4	7974	6.0	21.0	4.7	13.0	3.3
200 Area Environs						
Gable Mountain	7394	1.7	0.4	3.5	1.8	1.3
Hanford 101 Building	5740	0.7	<1.1	7.9	3.1	0.1
100-HSE	7325	0.9	1.5	7.1	3.0	1.0
100-D	8674	1.1	<0.3	5.1	2.1	0.7
Hanford 614 Building	9744	2.1	23.0	2.5	10.0	0.3
White Bluffs	9150	1.7	<0.3	5.3	2.3	1.2
300 Area Decade	7165	1.3	43.0	2.2	16.0	1.2
Adjacent to Environs						
Benton City	7926	1.3	17.0	3.9	8.5	0.6
Pasco 614 Building	9150	2.4	<0.3	5.0	2.3	0.5
3000 Area North	6783	1.7	<0.4	5.3	2.2	0.3
Riverland 614 Building	8951	<0.4	24.0	5.7	11.0	0.4
700 Area 614 Building	7955	1.3	13.0	4.8	7.0	0.1

** These installations were made during the first quarter of 1951.

The number of active particles in the atmosphere at locations summarized in Tables VII and VIII was accomplished by passing air volumes of 2 or 10 c.f.m through CWS # 6 filter paper and subsequent radioautograph analysis. The surface areas of the filters used in conjunction with the smaller volume was 6.3 square inches and 23.5 square inches with the 10 c.f.m. These filters were changed at weekly intervals and were exposed to type K X-ray film or a period of 168 hours in a manner similar to that used for the small air filters. In general, filters obtained from locations in the immediate environs were radioautographed within one week of their removal and those obtained from the remote air monitoring stations in Idaho, Oregon, Washington, and Montana were exposed during the second week after their removal. The volume of sampled air was accurately summed by placing running time meters in series with the motor and using the total operating time along with the pre-calibrated flow rate. The actual estimation of the number of active particles on a radioautograph was determined by visually counting the number of darkened areas on the exposed film. A summary of results obtained in this manner for locations in the immediate environs of the separation areas is presented in Table VII; a similar tabulation for locations at the project perimeter and off area locations is presented in Table VIII.

A review of the data summarized in Tables VII and VII, which are shown on the following pages, confirms the observations noted when reviewing the measurements presented in Table VI. Two significant changes are indicated; 1.) the average concentration of particles in the atmosphere showed a significant increase when comparing the current quarterly averages with those of the previous quarter; 2.) this increase was significantly weighted by the results obtained during the month of February. A detailed review of the weekly measurements for the month of February indicated that the number of particles in the atmosphere previous to February 9 was comparable with measurements representing the month of January and the last quarter of 1950. Small deviations on the order of a factor of 2 to 3 were normal and were representative of the magnitude of change normally expected within any given quarterly period. The filters that were removed on February 9 and 10 showed the first indications of a significant increase in particle concentration in the atmosphere. The trend was first noted from filters which were removed at various elevations on the Meteorology Tower between ground level and 400 feet. These filters indicated that the particle concentration had increased by a factor of 100 and also showed that this deposition was rather uniform between ground

TABLE VII
SUMMARY OF ACTIVE PARTICLES IN THE ATMOSPHERE
JANUARY, FEBRUARY, MARCH
1 9 5 1

Units of 10^{-3} particles/meter^3 of air sampled

Location	Total Volume of air sampled m^3	January	February	March	First Quarter Average 1951	Fourth Quarter Average 1950
200 East Vicinity						
2704 Outside	8551	3.1	50.0	4.3	16.0	2.1
H. I. Garden	10378	16.0	40.0	13.0	23.0	4.0
BY-SE	8274	130.0	185.0	42.0	133.0	260.0
BY-NE	9617	22.0	45.0	20.0	30.0	7.1
"B" Gate	9680	10.0	54.0	11.0	26.0	10.0
222-B Outside	6740	37.0	110.0	19.0	54.0	28.0
2701 Outside	8178	9.0	41.0	22.0	24.0	5.4
2704 Inside	9622	11.0	50.0	17.0	26.0	8.6
221-B	9682	24.0	110.0	18.0	49.0	26.0
222-B Hall	9681	120.0	98.0	55.0	94.0	37.0
222-B Lab.	6968	770.0	410.0	740.0	650.0	420.0
2701 Inside	9449	9.8	64.0	17.0	31.0	5.4
200 West Vicinity						
2701 Outside	9013	12.0	33.0	21.0	21.0	6.1
2722	9565	11.0	48.0	24.0	28.0	12.0
"T" Gate	9396	25.0	52.0	22.0	34.0	6.7
222-T Outside	9032	43.0	65.0	28.0	47.0	47.0
231 Area	9405	34.0	53.0	44.0	44.0	6.7
South Guard Tower	9601	11.0	40.0	14.0	22.0	2.6
"U" Gate	--	--	--	--	--	3.2
West Guard Tower	9644	8.3	54.0	30.0	30.0	2.2
2701 Inside	9612	9.8	100.0	26.0	46.0	13.0
272 Building	9724	14.0	20.0	11.0	15.0	7.7
222-T Hall	9677	96.0	78.0	58.0	79.0	95.0
222-T Lab.	9675	360.0	320.0	450.0	370.0	410.0
Meteorology Tower						
3'	32572	2.2	50.0	12.0	28.0	1.5
50'	32572	77.0	59.0	7.5	33.0	1.5
100'	25866	3.4	35.0	10.0	21.0	1.9
150'	22610	5.3	54.0	9.6	30.0	16.0
200'	20883	32.0	49.0	12.0	37.0	10.0
250'	20883	42.0	49.0	7.9	23.0	11.0
300'	20883	5.7	60.0	8.2	34.0	6.1
350'	19353	3.6	70.0	8.8	37.0	5.1
400'	13030	36.0	66.0	10.0	45.0	5.3

TABLE VIII
SUMMARY OF PARTICLE DEPOSITION
JANUARY, FEBRUARY, MARCH
1 9 5 1

Units of 10^{-3} particles/meter^3

Location	Total Volume of air sampled m^3	January	February	March	First Quarter 1951 Average	Fourth Quarter 1950 Average
Area Locations						
100-B Area	35190	1.1	20.0	4.4	9.2	0.5
100-D Area	36002	1.1	19.0	8.1	9.7	1.5
White Bluffs	39848	1.0	17.0	9.2	9.1	0.3
100-F Area	37077	0.8	40.0	6.0	14.0	0.6
300 Area	39933	4.1	25.0	5.9	12.0	1.6
Foster's Ranch	39950	0.9	23.0	6.0	10.0	0.5
Off Area Locations						
Richland, Wash.	38998	1.6	60.6	9.3	24.1	0.1
Benton City, Wash.	38131	1.8	3.3	4.7	3.3	0.2
Pasco, Wash.	40797	2.0	17.0	7.2	7.8	0.2
Boise, Idaho	9693	<0.3	18.0	21.0	13.0	0.2
Klamath Falls, Ore.	9873	<0.3	0.4	16.0	5.0	<0.2
Stampede Pass, Wash.	9172	<0.2	<0.2	7.8	0.6	<0.1
Great Falls, Mont.	9352	<0.4	0.7	35.0	14.0	<0.1
Walla Walla, Wash.	13676	<0.3	38.0	15.0	20.0	<0.2
Meacham, Ore.	9717	<0.3	<0.4	49.0	17.0	<0.2
Lewiston, Idaho	9837	<0.3	63.0	8.9	24.0	<0.1
Spokane, Wash.	44013	<0.6	43.0	7.6	16.0	<0.1

level and 400 feet. The average concentration of particles in the atmosphere at this location was on the order of 0.3 to 0.4 particles/meter^3. This increase was further confirmed after reviewing the radioautographs of filters which were removed during the week ending February 16. These data indicated that the number of particles in the environs averaged between 0.1 and 0.4 particles/meter^3 at nearly all locations for the one week period. Similar measurements obtained from remote locations in the surrounding states of Oregon, Idaho, and Montana also indicated a significant increase on the same order of magnitude. The increase in particles noted during this period was apparently caused by the "follow up" from a radioactive cloud which originated at the site of the "A" bomb tests in Nevada. Although the higher concentrations were specifically noted during the period mentioned above, several indications of residual particles in the atmosphere were also noted during the week or two following the above mentioned period. Slightly

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higher than normal concentrations were observed throughout the period ending March 2, 1951. A detailed summary of the week by week results which includes the period during which the significant increase in particles was observed is presented for the representative monitoring locations in Tables IX and X. Table IX represents locations in the immediate environs of the 200 Areas and Table X includes off-site stations and those around the project perimeter. These Tables are presented on the following pages.

With the exception of those measurements which represented the month of February the active particle measurements representing this period were well within the normal range expected. Small fluctuations on the order of a factor of 2 or 3 when comparing individual months or individual weeks were believed nonsignificant when compared with the low concentrations found at outside locations. As in the past, the maximum number of active particles were measured at each of the 222 laboratories; in the 200 East Area in room 7 of the 222-B Laboratory, the quarterly average was 0.7 particles/meter^3, whereas the same location in 200 West Area showed an average of 0.4 particles/meter^3. Monitoring units located in the hallway of each of the laboratories indicated the average particle concentration to be 0.08 and 0.09 particles/meter^3 in the 200 West and 200 East Areas, respectively.

Particle monitoring units at the project perimeter and in the residential areas of Richland, Benton City, and Pasco indicated that the average concentration resulting from the Hanford operation was on the order of 10^{-3} particles/meter^3. As in the past, the number of particles in the atmosphere at distant locations in the neighboring states before February 9, 1951 was negligible.

A more detailed appraisal of the activity deposited from the cloud of radioactive particles was obtained by reviewing the data recorded on the scaler-chronolog combination. A review of the data from representative locations indicated that the cloud was detected at the various stations between 0600 and 1700 on February 9 and remained in the general vicinity until late afternoon on February 10.

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TABLE IX

SUMMARY OF ACTIVE PARTICLES IN THE ATMOSPHERE

Units of 10^{-3} particle/meter^3

1 9 5 1

Location	Filters Removed During Week Ending Period 2/2	2/9	2/16	2/23	3/2
200 East Vicinity					
2704 Outside	<1.4	*	177.3	2.9	7.1
H. I. Garden	2.8	5.7	176.1	11.4	17.3
BY-SE	140.0	180.0	226.6	71.3	59.9
BY-NE	<1.4	7.1	184.1	62.8	5.9
B Gate	2.9	1.4	225.4	12.8	14.3
222-B Outside	200.0	39.0	242.7	28.0	5.2
2701 Outside	2.9	<1.7	162.9	22.7	21.5
2704 Inside	5.7	8.5	212.5	28.5	17.1
221-B	100.0	17.0	345.1	32.8	2.9
222-B Hall	205.0	49.0	148.7	54.2	49.6
222-B Lab	260.0	*	410.8	827.4	589.2
2701 Inside	1.2	5.6	283.3	24.3	20.6
200 West Vicinity					
2701 Outside	30.0	1.4	113.3	32.4	20.6
2722 Building	5.7	5.7	216.8	29.6	11.8
"T" Gate	3.2	3.8	214.0	9.9	14.3
222-T Outside	30.0	9.9	219.7	29.7	11.3
231 Area	4.2	1.4	228.2	11.3	7.4
South Guard Tower	2.8	<1.4	182.6	12.7	13.2
West Guard Tower	<1.4	<1.4	256.8	8.5	2.9
2701 Inside	30.0	7.1	442.2	28.2	19.1
272 Building	10.0	20.0	57.1	7.6	4.4
222-T Hall	45.0	30.0	192.6	57.7	32.8
22 -T Lab.	300.0	270.0	403.7	467.4	264.9
Meteorology Tower					
3'	---	1.1	280.0	---	11.7
50'	---	1.4	330.0	---	7.5
100'	---	1.3	200.0	---	10.1
150'	---	2.0	300.0	---	9.6
200'	---	3.3	270.0	---	12.3
250'	---	2.2	370.0	---	7.9
300'	0--	3.3	340.0	---	8.2
350'	---	2.7	390.0	---	8.8
400'	---	1.3	370.0	---	10.1

Table XI summarizes the activity density measurements for beta emitters as determined during the period, in which the cloud was detected at representative stations.

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TABLE X
SUMMARY OF PARTICLE DEPOSITION

Units of 10^{-3} particles/meter^3

Location	Filters Removed During Week Ending Periods				
Area Locations	2/2	2/9	2/16	2/23	3/2
100-B Area	0.3	30.0	70.4	4.9	3.4
100-D Area	0.4	0.7	68.3	9.3	8.9
White Bluffs	0.4	0.4	86.3	2.5	1.0
100-F Area	---	0.8	130.5	5.6	5.3
300 Area	1.8	50.0	81.5	----	7.9
Foster Ranch	0.4	0.4	14.5	7.7	3.5
Off Area Locations					
Benton City, Washington	0.4	0.4	16.5	6.3	6.0
Pasco, Wash.	0.3	0.4	82.3	11.7	3.2
Boise, Idaho	1.4	1.4	89.2	26.5	14.2
Klamath Falls, Ore.	1.4	1.3	----	----	15.0
Stampede Pass, Washington	1.0	---	7.9	----	7.9
Great Falls, Montana	1.8	8.8	169.9	9.7	----
Walla Walla, Washington	1.2	1.0	227.3	19.1	14.6
Meacham, Oregon	1.4	1.4	216.7	8.5	----
Lewiston, Idaho	---	---	242.7	12.2	9.3
Spokane, Washington	---	0.2	195.9	9.6	8.8

TABLE XI
ACTIVITY DENSITY OF BETA EMITTERS IN THE ATMOSPHERE
FEBRUARY 9, 1951

Activity Density x 10^{12} μc/cc

Location	Average	Maximum Hour	Time encountered on Feb. 9th
Benton City	1.2	3.9	0900
Richland	0.9	2.8	1700
Riverland	1.1	8.8	1300
200 ESE #1	3.5	25.8	1200
200 ESE #2	8.2	26.4	0600
2707EA #1	10.2	31.1	0900
2707EA #2	7.8	30.4	1200
200 West Tower #4	5.6	46.2	0800
200 West Redox Area	6.0	23.3	0800
200 West #2	4.2	26.8	1400

In addition to those measurements discussed above in respect to the bomb tests in Nevada, the Site Survey Group cooperated in an over all AEC program to determine the extent and magnitude of particle deposition in the West and Pacific Northwest. Units were installed in New Mexico, Colorado, Utah, Idaho, and Washington for this specific purpose for a one month period which included the latter part of January and early part of February. The data obtained from the operation of these units is currently being prepared and till be published in a separate document in the near future.[4]

SECTION III

(Please refer to Figures 12 and 13.)

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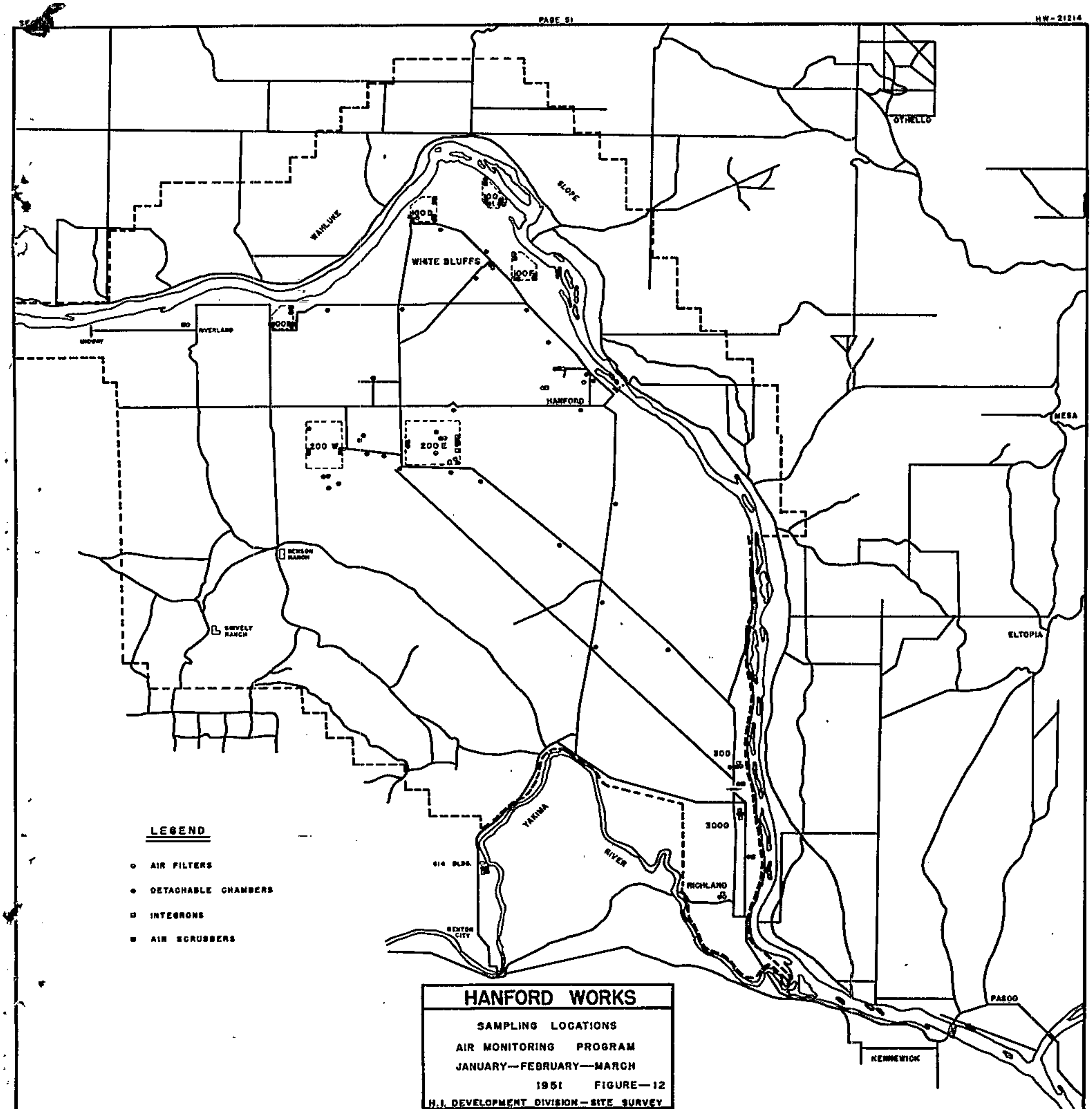

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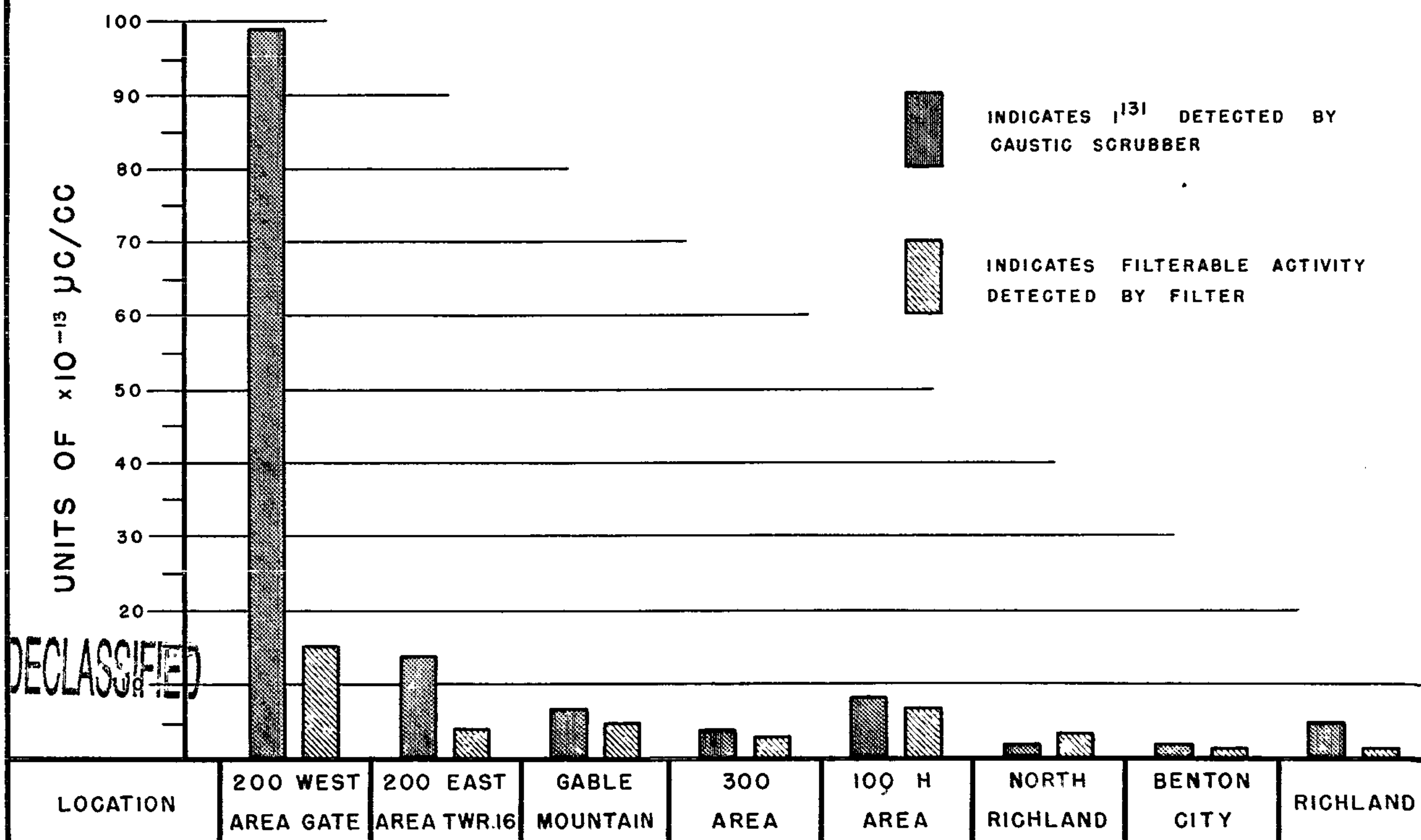
AVERAGE ACTIVITY DENSITY OF BETA EMITTERS DETECTED IN ATMOSPHERE

JANUARY — FEBRUARY — MARCH

1951

FIGURE — 13



SECTION IV

RADIOACTIVE CONTAMINATION IN THE HANFORD WASTES

Measurements for the activity density of the alpha and beta emitters in Hanford wastes were made by obtaining and analyzing by radiochemical methods direct samples of the liquid and solid waste materials; radiation levels at the various open waste zones were determined by employing portable instruments such as VGM's and CP meters. The subsequent discussion of the results obtained from this monitoring program for the period January, February, and March of 1951 is presented separately for the 100, 200, and 300 Areas.

100 AREAS:

Two hundred and eighty-five samples were collected at the outlet side of the 107 basins of the four pile areas. These samples were analyzed for the activity density of the alpha and beta emitters according to procedures discussed in a previous document.[4] A summary of the results obtained from samples collected during periods of normal pile operation is presented in Table I. These results represented samples where activity density determinations were performed on the same day that the sample was obtained; the application of exorbitant decay corrections were minimized by omitting analyses made more than 24 hours after sampling time.

TABLE I
RADIOACTIVE CONTAMINATION IN THE 107 BASINS
DURING PERIODS OF NORMAL PILE OPERATION
JANUARY, FEBRUARY, MARCH
1 9 5 1

Location	No. Samples	Alpha Emitters Average Activity Density dis/min/liter	Beta Emitters Activity Density x 10^4 µc/cc Maximum	Beta Emitters Activity Density x 10^4 µc/cc Average
100-B Area	51	<8	22.1	7.7
100-D Area	58	<8	18.2	6.0
100-DR Area	59	<8	25.5	9.7
100-F Area	60	<8	80.0	11.0
100-H Area	57	<8	16.4	8.9

The average activity density of beta emitters in the effluent water increased at each of the areas during the current period. The order of magnitude of this increase varied from 1.0 x 10^{-4} µc/cc to 2.0 x 10^{-4} µc/cc at the different basins. Although these differences were essentially within the normal range of fluctuation experienced in this type of monitoring, the current magnitude of activity approached significance when compared with the activity measurements obtained during July, August, and September, 1950. In many cases, the current average represented a two-fold increase above the measurements obtained last summer.

The increasing activity density of beta emitters in the pile effluent water appears to be directly associated with the increase in power level at the pile areas. During the last 9 months, the power levels have been steadily increased and the current data indicate that the piles are now operating at the highest power levels since the start-up of the Hanford Works. The maximum activity density measured in the effluent water was 8.0 x 10^{-3} µc/cc in a sample obtained from the 107-F basin on March 14, 1951. This measurement represented one of the highest values obtained for effluent water during the history of the Hanford Works.

Radiochemical analyses for the activity density of alpha emitters in the effluent water indicated averages less than 8 dis/min/liter at all areas. Several individual samples which indicated this activity to be greater than 8 dis/min/liter were further analyzed for the activity density of alpha emitters from uranium and/or plutonium. The results obtained from the latter measurements indicated this activity to be less than 6 dis/min/liter in all cases. In general, resamples of the basin water were obtained within a day after a sample would indicate detectable alpha activity; the results from the resamples did not confirm the presence of the activity measured in the initial samples.

Monthly spot samples were obtained from each of the basins for the specific measurements of the activity density of polonium. The activity density was less than 6 dis/min/liter in each sample analyzed.

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During late December and early January, a rather unusual condition was observed near the 100-F Area when a large number of small springs were found to be emanating from the bank into the river. Direct sampling and subsequent analyses for the activity density of gross beta emitters indicated a range of activity of 1.1×10^{-6} μc/cc to a maximum of 3.8×10^{-6} μc/cc. The average activity density of beta emitters in these springs (1.8×10^{-6} μc/cc) was nearly identical to that observed in the Columbia River water at the 100-F Area during the month of January (2.2×10^{-6} μc/cc.) There were several indications that this water may originate from a leak in the 107-F basin. Temperature measurements indicated that the temperature of the water at the point where the springs emptied into the river showed reasonable agreement with that of the effluent water leaving the 107 basin (108° F;) while the temperature of the Columbia River was on the order of 45° F. The springs were observed to flow continuously up till January 6, on which date the 100-F Area entered an extended shut down. The flow from many of the springs stopped on this date and tended to decrease materially in the few remaining springs which showed any flow what-so-ever. Plans to reinvestigate the source of activity in these small springs were not completed as the springs were not found to resume flow immediately after the area started up during the latter part of January. A small rise in the river flow immediately following the start-up period prohibited the obtaining of additional samples as the spring outlets were covered by river water.

One hundred and forty samples were obtained from the sump tank in the waste discharge line from the Biology Farm operated by the Health Instrument Divisions in the 100-F Area. This waste material is discharged into the Columbia River. The samples obtained represented the period previous to the flushing operation and immediately after the completion of the flushing. The latter samples should represent the peak concentrations admitted to the river as a flushing operation constitutes the washing down of all accumulated radioactive waste in the farm building. The results obtained from the analyses of these samples for the activity density of I-131 during the period January, February, and March, 1951 is presented in Table II. DECLASSIFIED

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TABLE II
ANIMAL FARM WASTE SAMPLES
JANUARY, FEBRUARY, MARCH
1 9 5 1

	No. Samples	Beta Emitters - I-131 Activity Density x 10^{-6} μc/cc Maximum	Average
Before Flushing	72	510	21
After Flushing	68	1120	85

A review of this data summarized above indicates that the measurements obtained during the current period were among the highest recorded since the sampling was inaugurated during early 1950. The higher results represent a continuation of an upward trend which has been in progress throughout the operation of the Biology Farm. The magnitude of the increase in activity density of I-131 for the before and after flushing periods is by a factor of 4 when compared with similar measurements obtained six months ago. During the period July, August, and September, 1950, the average activity density measured after the flushing operation was 2.2×10^{-5} μc/cc; similar measurements obtained during October, November, and December indicated an average of 6.2×10^{-5} μc/cc, whereas the current average is 8.5×10^{-5} μc/cc. Maximum individual measurements have increased accordingly; one sample which indicated the activity density to be 1.1×10^{-3} μc/cc represented a two fold increase over the maximum result noted during the previous quarter which was 5.5×10^{-4} μc/cc. In comparison with the measurements obtained during the past 9 months, all current individual results and period averages represent significant increases.

Estimations of the total quantity of I-131 discharged by the operation of the Biology Farm into the Columbia River on a daily basis were attempted by metering the total volume flow and using the average activity density measurements which were based on the before and after flushing samples. Based on a total waste volume of 13.8×10^{6} liters and an over all average activity density of 5.2×10^{-5} μc/cc, it is estimated that 0.72 curies were admitted to the river during this quarterly period. Approximately 7 to 8 milli-curies were admitted to the river on a daily basis. Similar measurements during previous quarters indicated that 6 milli-curies were discharged daily during October, November, and December of 1950, and 3 milli-curies were discharged daily during July, August, and September, 1950.

Semi-weekly samples were obtained directly from the Columbia River at Hanford; these were analyzed for the activity density of I-131 in the Columbia River. The results indicated that the average activity density during this period was 1.4×10^{-7} µc/cc including a maximum measurement of 5.3×10^{-7} µc/cc. The magnitude of this activity at the Hanford location was in reasonable agreement with theoretical calculations based on estimated dilution factors. Assuming uniform distribution with no channelling effects, the calculated average activity density of I-131 in the river at Hanford was estimated as 3.1×10^{-7} µc/cc. A comparison of the measurements at Hanford with those obtained during the past several months reflect the same general order of increase in activity density as noted from the direct sampling at the Biology Farm.

200 AREA WASTES:

A summary of the results obtained from the radiochemical analysis of over 400 samples of water and mud obtained from the open waste areas in the 200 Areas is presented in Table III, which is shown on the following page.

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TABLE III
RADIOACTIVE CONTAMINATION IN THE 200 AREA WASTE SYSTEMS
JANUARY, FEBRUARY, MARCH
1 9 5 1

LIQUID SAMPLES

Location	No. Samples	Alpha Emitters Activity Density dis/min/liter Maximum	Average	Beta Emitters Activity Density x 10^7 µc/cc Maximum	Average
T Swamp	34	140	6	89	5
U Swamp	24	13	6	3	<1
Laundry Ditch	24	130	27	6	2
231 Ditch	24	38	13	21	2
200 E "B" Ditch	34	17	<6	26	8
200 E "B" Swamp	20	22	<6	43	9
234-35 Ditch	12	9	<6	1	<1
200 E Retention Pond	47	7	<6	41	14
200 W Retention Pond	11	240	42	--	--
		SOLID SAMPLES dis/min/gram		Activity Density x 10^5 µc/gram	
T Swamp	21	120	16	18	4
Laundry Ditch	12	50	14	67	11
200 E "B" Ditch	31	16	<6	280	90
200 E "B" Swamp	18	10	<6	110	55
234-35 Ditch	12	110	24	2	1

A review of the data tabulated above indicated no significant trends from past data. With the exception of several isolated samples, the general levels of radioactive contamination in the waste areas was slightly lower than it was during the latter part of 1950. The decrease does not appear significant as considerable fluctuation occurs between successive weekly samples. The samples which indicated the activity density of alpha emitters to be above the detectable limit of 6 dis/min/liter were also analyzed for the activity density of uranium. These measurements indicated values below 50 µg U/liter. Several samples obtained from the Laundry Ditch and adjacent shore line mud indicated the activity density to be on the order of 40 µg U/liter in the liquid and 20 µg U/gram of mud. Isolated samples obtained directly from the T and U swamps in the 200 West area indicated the activity density of uranium to be between 10 and 20 µg/liter. Spot measurements for the activity density of plutonium in several of the open waste zones indicated this

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activity to be less than 6 dis/min/liter.

Portable instrument surveys were performed on a weekly basis on the terrain in the 200 East and West Areas and on a semi-monthly basis around the edges of the various open waste areas. In general, the radiation levels averaged less than 100 c/m above background in all cases. Maximum measurements of open terrain were on the order of 300 c/m above background; counting rates of this order of magnitude were observed in the 200 West Area in an area between the T Plant stack and the 200 West Area gatehouse. Readings above the background of the instrument tended to prevail in this general region more often than at any other location in the separations area. Portable instrument surveys around the edges of the West ditches and swamps in the 200 West Area indicated readings between 100 and 500 c/m above background; maximum measurements were on the order of 1600 c/m along the edge of the laundry ditch. As in the past, the higher radiation levels were observed in the 200 East Area in the vicinity of the "B" ditch and swamp; average readings in this region ranged from 500 to 2000 c/m with maximum measurements on the order of 6000 c/m.

300 AREA WASTES:

Table IV summarizes the results obtained from the radiochemical analysis of direct samples obtained from waste and mud sources at the 300 Area ponds.

With the exception of the results summarized for the 300 Area waste line, the maximum and average activity measurements summarized in Table IV were within the normal range of fluctuation observed in the past. Considerable variation occurred between successive samples; however, the over all average activity density measurements closely paralleled those of the previous quarter.

Samples were obtained from the 300 Area waste line by two methods; during the early part of the period the integrated water sampler was used and during the latter part of the quarter, direct spot samples were obtained from the line. The integrated water sampler tended to be affected by the amount of solid material passing down the waste line and was discontinued after it appeared that the samples obtained in this manner were not actually representative of the average activity passing

TABLE IV

RADIOACTIVE CONTAMINATION IN 300 AREA WASTES

JANUARY, FEBRUARY, MARCH

1 9 5 1

Location	No. Samples	Beta Emitters Activity Density x 10^7 uc/cc Maximum	Beta Emitters Average	Alpha Emitters Activity Density dis/min/liter Maximum	Alpha Emitters Average	Fluorophotometer ug U/liter Maximum	Fluorophotometer Average
Old Pond Inlet (Liquid)	13	24	5	5700	2300	3400	1900
New Pond Inlet (Liquid)	13	9	2	4200	1200	900	500
300 Area Waste Line	60	160	9	49000	2200	39000	1900
		Activity Density x 10^3 uc/gram		Activity Density dis/min/gram		ug U/gram	
Old Pond Inlet (Solid)	12	4.8	0.9	13000	4100	5100	840
New Pond Inlet	8	11.6	2.1	5000	2500	660	400

through the line. A total of 60 samples obtained from the line showed that the activity density of alpha emitters would vary from negligible activity to 50,000 dis/min/liter. Uranium measurements on the same samples showed negative results in several cases and in extreme cases approached 40,000 µg U/liter. The wide variation in magnitude of activity was attributed to the various times at which samples were obtained and also to the particular operation that was in progress at the time of the sampling. Each of the samples were analyzed for the activity density of alpha emitters from plutonium; maximum measurements indicated this activity to be 350 dis/min/liter; however, the over all average was 25 dis/min/liter. The bulk of the plutonium measurements indicated that the activity density was less than 10 dis/min/liter, and therefore the significance of the average value was weighted considerably by the one or two higher values obtained during the period.

SECTION IV

SECTION V

RADIOACTIVE CONTAMINATION IN THE COLUMBIA AND YAKIMA RIVERS

Over five hundred samples of Columbia River water were analyzed to determine the magnitude and extent of the activity density of alpha and beta emitters in this river between 100-B Area and McNary Dam. The radioactive contamination in the Columbia River originated from the discharge of the radioactive effluent of the 107 basins in each of the five pile areas at Hanford Works. This water is discharged directly into the river after a short holdup period of about three to four hours at each area. Samples were obtained at least once per week from all locations indicated on Figure 14 except Bonneville Dam and The Dalles; samples from the latter two locations were obtained on a monthly basis. One selected location on the south bank of the river at the Hanford Ferry was used as a control station and daily samples were obtained throughout the period. In addition to the control sampling, several special studies were performed to determine the distribution pattern of the radioactive effluent with respect to the depth, width, and flow rate of the river.

The determination of the activity density of alpha and beta emitters in the river was performed by analyzing 500 ml. samples according to methods and procedures which have been outlined in detail in previous documents of this series.(5) In addition, for measurement of the activity density of gross beta emitters, selected samples were specifically analyzed for the activity density of uranium by the fluorophotometer method and for plutonium by the lanthanum fluoride method. The latter measurements were performed on spot samples and were also completed in all cases where the activity density of the total alpha emitters was greater than 6 dis/min/liter.

In general, the average levels of radioactive contamination in the Columbia River did not differ significantly from the results obtained during the previous quarter; the activity density of alpha emitters averaged less than the detectable limit of 6 dis/min/liter at all locations, the average activity density of gross beta emitters did not exceed 3.7 x 10^{-6} µc/cc at any location. The negligible change in magnitude was directly associated with small variation in the flow rate of the Columbia River during this period. The minimum flow rate as measured by the Power Division at the Lee Boulevard location in Richland was 736,000 gallons per second during the three month period. The maximum flow was 1,043,000 gallons per second measured during the middle of February, whereas the mean flow of 604,000 gallons/second prevailed toward the latter part of the quarterly period. Past data indicated that the flow rate of the river tends to be at a minimum during each of the periods under discussion and as a general rule shows very little trend or change over the six month period. Figure 15 is a graph showing the trend of the flow rate of the Columbia River during the past six months.

A summary of the results obtained from the radiochemical analysis for the activity density of gross beta emitters in the Columbia River during the period January, February, March, 1951, is presented in Table I.

A review of the data summarized in Table I, which is presented on the following page, indicates that the activity density from beta emitters remained essentially the same on a month to month basis throughout the period. The minor fluctuations noted were directly associated with changing operating conditions in the 100 Areas and in no case did these changes exceed the variation normally expected from this type of monitoring. The activity density of beta emitters which may occur naturally in the Columbia River were evaluated by obtaining samples at Wills Ranch which is up stream from the Hanford pile operations; these measurements indicated the activity to average less than 5 x 10^{-8} µc/cc during each month within the quarterly period. First indications of activity were observed at the 100-B Area where samples obtained near the 181 building which is slightly above the effluent line showed an average of 9 x 10^{-8} µc/cc during this quarter. During January and March, this location showed the activity density of beta emitters to be 1.2 x 10^{-7} µc/cc, whereas similar measurements during February indicated the activity to be below the detectable limit of 5 x 10^{-8} µc/cc; the latter fact was attributed to the

TABLE I

AVERAGE ACTIVITY DENSITY OF GROSS BETA EMITTERS IN THE COLUMBIA RIVER

JANUARY, FEBRUARY, MARCH

1 9 5 1

Location	January Average	February Average	March Average	Quarter Average	Last Quarter Average	Maximum Measurement This Quarter
	Activity Density x 10^8 μc/cc					
Wills Ranch	<5	<5	<5	<5	<5	7
100-B Area 181 Building	12	<5	11	9	8	20
Allard Pumping Station	126	13	76	77	35	342
100-D Area 181 Building	96	55	43	65	63	171
100-H Area 181 Building	105	151	124	127	111	260
Below 100-H	198	344	261	267	239	605
100-F Area 181 Building	195	327	228	233	262	385
Below 100-F Area	239	597	261	367	333	820
Foster Ranch	84	108	102	98	116	152
Hanford South Bank	250	451	454	388	374	767
Hanford Middle	301	288	265	283	300	482
Hanford North Bank	141	193	159	164	110	281
300 Area	192	171	183	183	158	232
Richland	120	189	173	164	131	238
Hifhlands Pumping Station	67	212	88	123	23	536
Pasco Bridge (Kenn. Side)	61	81	101	82	70	128
Pasco Bridge (Pasco Side)	83	99	89	90	83	154
Sacajawea Park	---	---	63	63	---	105
McNary Dam	---	48	50	49	---	77
Patterson	---	32	31	32	---	56
Snake River Mouth	---	<5	<5	<5	---	7
Yakima River Mouth	<5	<5	<5	<5	<5	10

slightly higher flow rate of the Columbia River during February which apparently eliminated the back water effect previously noted at this location during periods of low flow. Samples obtained at represtntative locations between the 100-B Area and the Hanford Ferry showed the activity density to increase as the sampling progressed down stream with an order of magnitude which was representative of the effluent emitted from each of the pile areas located along this part of the river near the Hanford Ferry and immediately below the 100-F Area. The average activity density of 3.9×10^{-6} μc/cc found at the Hanford south bank represented the location of the maximum average activity for the period; one sample obtained immediately below the 100-F Area which indicated 8.2×10^{-6} μc/cc represented the maximum individual measurement. The predominance of the bulk of the activity along the south shore (Benton County side) of the Columbia River in the vicinity of the Hanford Ferry was further confirmed when reviewing the results obtained from the analysis of samples which were taken on the surface of the river at locations along the south bank, north bank, and middle of the river. As indicated in the past, the activity density along the north bank of the river was less than half of that observed along the south bank; current measurements indicate the average along the north bank to be 1.6×10^{-6} μc/cc as compared with 3.9×10^{-6} μc/cc along the south bank.

As the sampling progressed down stream, decreases in magnitude of activity density which were either significant or approaching significance were observed at successive monitoring locations. At Richland along the Benton County shore, the average activity density was 1.6×10^{-6} μc/cc and was representative of a decrease by a factor of over three when compared with maximum average measurements at the Hanford Ferry. The decrease noted over the 24 miles of river between Hanford and Richland was attributed to the decay of the shorter half-lived isotopes along with a more uniform distribution of the activity across the entire surface and depth of the river. Sampling locations below Richland and beyond the project perimeter indicated a continuation of the decrease in activity density which was mentioned previously; additional factors which contributed to the over all decrease were the entrance of significant volumes of non-contaminated water from the Yakima and Snake Rivers. Sampling at each side of the Pasco-Kennewick Bridge indicated a rather uniform distribution of the activity density of beta emitters; the averages were 8.2×10^{-7} μc/cc and 9.0×10^{-7} μc/cc on the Kennewick and Pasco sides, respecrively. A comparison of the individual monthly averages obtained from the samples which represented these two locations indicated that the difference in magnitude did not exceed 2.2×10^{-7} μc/cc during any period. This small difference along with the predominance of the higher measurements along the Pasco side were in direct agreement with similar measurements obtained during the latter part of 1950.

Previous to 1951, a program involving river sampling at remote down stream locations was conducted on a more or less spot sampling basis. The frequency of sampling did not appear adequate when compared with the large variation in flow rate of the Columbia River and when compared with the changing operating conditions of the 100 Areas at Hanford. Selected locations at Sacajawea Park immediately below Pasco, at the site where McNary Dam is being constructed, and at the Patterson Ferry were incorporated into the weekly sampling program. Results obtained during February and March indicate that the activity density from gross beta emitters at these down stream locations was subject to very little variation on a month to month basis. At McNary Dam, the average activity density during the quarter was 4.9 x 10^{-7} μc/cc and 3.2 x 10^{-7} μc/cc at the Patterson Ferry. Individual monthly averages were nearly identical to these values.

A program which included the measurement of the activity density of beta emitters which occur naturally in river water was inaugurated at the mouth of the Snake River during February. The results to date indicate this activity to average less than 5 x 10^{-8} μc/cc; the order of this activity is comparable with that measured at the mouth of the Yakima and in the Columbia River up stream from the Hanford Works.

The effect of the entrance of the waters of the Yakima River on the dispersion pattern of the activity density of beta emitters in the Columbia River was studied during the latter part of January and during February. In one case, the depth dispersion pattern was estimated by obtaining a series of samples at various depths from a cross section location near the Richland Dock; a similar study was completed at a location immediately below the mouth of the Yakima River which is approximately two miles down stream from the former location. Samples were obtained at various depths between the surface and bottom of the river and at a horizontal frequency which allowed about 10 separate studies at each cross section location. Roughly, the depth studies were performed at 200' intervals across the river. The two surveys were completed on January 23 and 25; the activity in the river on these days represented the operation from four of the 100 Areas.

Forty-one samples were obtained from the survey opposite the Richland Dock. The average activity density of gross beta emitters at this location was 2.2×10^{-6} μc/cc; maximum measurements were on the order of 7.0×10^{-6} μc/cc. The latter measurement was unusually high when compared with the bulk of the data; the majority of individual analyses indicated that the activity density varied from 1.0 to 2.5×10^{-6} μc/cc throughout this portion of the stream. An estimated iso-activity map (Figure 16) based on the individual measurements indicates that the activity density was rather uniformly dispersed throughout the entire cross-section at this location. Measurements which indicated the activity density to be greater than 2.5×10^{-6} μc/cc were found in samples obtained from small isolated areas that prevail near the Franklin County shore of the river. The survey below the mouth of the Yakima River was completed two days after the initial survey. The average activity density from gross beta emitters at this location was 1.1×10^{-6} μc/cc; maximum measurements were on the order of 1.5×10^{-6} μc/cc with one rather high result showing 1.8×10^{-6} μc/cc. An estimated iso-activity map showing the distribution of the activity density at this location is presented in Figure 16. A comparison of this portrayal with that presented for the cross section above the Yakima River indicates that the bulk of the activity has been effectively pushed towards the Franklin County shore. Negligible activity was observed on the Benton County shore where the water of the Yakima enters the Columbia. The result of this survey indicates that the entrance of the Yakima River reduced the over all average activity in the river by about a factor of 2; however, the magnitude of activity on the far shore of the river remained essentially the same as that above the entrance of the Yakima River. A small portion of the river was inaccessible to survey due to the turbulence of the river at the point where the Yakima River enters the Columbia; the trend of the results which represented samples obtained near this location would indicate that the activity density in this region would be below or very close to the sensitivity limit of the analysis (5.0×10^{-8} μc/cc.) A comparison of the river depth, width, and activity distribution pattern as determined by the above two surveys may be reviewed graphically by referring to Figure 16, which presents the results obtained from each of the above surveys.

On February 15, the dispersion pattern on the surface of the Columbia River was studied in an area between Richland and the Pasco-Kennewick Bridge. This study was confined to the radiochemical analysis of surface samples which were obtained at one mile intervals throughout the course of the river; approximately 5 samples were obtained from the surface at each cross section location. The effect of the entrance of the waters of the Yakima River appeared very pronounced in this survey as the result indicated a material reduction in the magnitude of the activity on the Benton County side of the river for a distance in excess of 7 miles down stream. Beyond 7 miles, the effect of the Yakima River did not appear to be significant. Figure 17 shows a lay out of a portion of the river which was surveyed and includes the individual measurement along with the location from which the samples were obtained. The magnitude of activity indicated from the results of this survey tended to essentially confirm the order of magnitude measured on the cross section depth studies which were completed during January of 1951. The results of eabh of the two surveys tend to be somewhat in contrast with similar surveys performed in the past; the current survey indicated that the magnitude of activity on the Franklin County side of the river remained essentially the same below the Yakima River as it was above the mouth, whereas, previous surveys tended to show that the activity was effectively pushed toward the Franklin County shore and usually indicated an over all increase of minor significance occurring at this location.

Although the activity density measurements of the survey which comprised the study of the effect of the Yakima River on the activity density pattern were on the order of 10^{-6} µc/cc, the somewhat higher results observed during the January study were due to the lower flow of the Columbia River during this period. The river flow at the time of the cross section depth study during January was 740,000 gallons/second, whereas the flow rate at the time of the surface study during

February was 990,000 gallons/second.

Radiochemical analysis to determine the activity density of alpha emitters from uranium and/or plutonium in Columbia River water indicated the average to be less than 6 dis/min/liter at each of 23 locations which were sampled on a weekly basis. In four isolated cases, individual samples indicated the activity density of alpha emitters to be on the order of 10 to 35 dis/min/liter; these measurements represented random locations and the values were not confirmed by subsequent sampling. These particular results were attributed to cross-contamination in the laboratory or to an interchange of samples while in transit.

Nearly 400 samples of mud were obtained from along the shore of the rivers near the Hanford Works. The bulk of these samples were obtained along the Columbia River between the 100-B Area and the Pasco-Kennewick Bridge; background samples were obtained from that portion of the Columbia River above the project perimeter in the vicinity of Wills Ranch and from two locations along the Yakima River. Several new locations were added during February when the mud sampling program was extended to remote down-stream locations along the Columbia River; a weekly sampling program was inaugurated at Sacajawea Park, Patterson, and at McNary Dam. Background studies in the lower Columbia River region were evaluated from samples obtained at the mouth of the Snake River.

Two samples were obtained each time a location was monitored; one sample represented the mud along the edge of the river and the second sample was obtained from below the surface of the water at a distance removed approximately 5 to 7 feet from the shoreline. The activity density of beta emitters was measured by mounting one gram of dry mud on a 1" stainless steel plate and counting this material directly using mica-window tubes in which the window thickness averaged about 3 mg/cm^2. The activity density of alpha emitters was evaluated by ether extracting the previously analyzed sample and counting with a standard alpha counter. Specific measurement for the activity density of uranium was conducted on a frequency of at least one sample per month from each of the routine sampling locations. The latter evaluations were determined by the fluorophotometer method.

A summary of the results obtained from the analysis of the activity density of gross beta emitters in mud samples during January, February, and March, 1951 is presented in Table II.

TABLE II
RADIOACTIVE CONTAMINATION IN COLUMBIA RIVER MUD SAMPLES
JANUARY, FEBRUARY, MARCH
1 9 5 1

Location	January Average	February Average	March Average	Quarter Average	Last Quarter Average	Maximum This Quarter
	BETA EMITTERS - ACTIVITY DENSITY x 10^5 μc/gram					
Wills Ranch, shore	1.6	1.4	1.4	1.5	1.3	2.8
5' out	1.5	1.4	1.0	1.3	1.8	1.9
Allard Pumping Sta. shore	1.4	2.2	1.3	1.5	1.6	3.2
5' out	1.3	8.6	1.3	1.2	1.5	1.8
100-H Area shore	2.7	2.7	1.6	2.3	1.6	5.2
5' out	1.4	1.8	1.3	1.5	1.6	2.0
Below 100-F Area shore	1.8	6.6	1.6	2.8	2.9	14.4
5' out	1.9	2.5	2.5	2.3	2.0	3.3
Richland Dock Shore	1.4	1.8	1.6	1.6	1.8	3.2
5' out	1.6	1.6	1.6	1.6	2.1	2.5
300 Area shore	2.0	1.6	5.7	3.6	1.7	23.3
5' out	1.7	3.7	2.3	2.3	2.5	5.8
Pasco Bridge (Pasco side)	1.3	1.5	1.3	1.4	1.5	3.5
5' out	1.3	1.4	1.5	1.4	1.8	2.0
Pasco Bridge (Kenn. side)	1.3	1.9	1.7	1.6	1.6	3.1
5' out	2.3	1.4	1.4	1.7	1.6	3.9
Hanford Ferry shore	1.2	2.2	3.1	2.2	2.3	5.0
5' out	1.3	1.6	2.2	1.7	2.1	4.4
Highland Pumping Sta. shore	2.3	1.8	2.3	2.2	2.0	4.2
5' out	1.5	1.5	1.5	1.5	2.3	1.9
Byers Landing	3.0	2.2	1.2	2.1	---	2.9
Sacajawea Park 5' out	---	0.9	1.4	1.2	---	2.2
Patterson, 5' out	---	1.1	1.1	1.1	---	1.7
McNary Dam, 5' out	---	1.5	1.2	1.3	---	1.8
Snake River Mouth 5' out	---	1.3	1.4	1.3	---	1.6

A comparison of the results summarized above with similar measurements obtained during previous periods indicates that the activity density of beta emitters in mud samples is currently on the same order of magnitude as that observed in the past. In general, the magnitude of activity in mud obtained from the shore of the river did not differ significantly from that measured in samples which were obtained below the surface of the river. Also, the magnitude of activity measured in mud obtained from locations at which the Columbia River is known to be contaminated, did not appear to be materially different than the magnitude of the measurement which represented background locations. A comparison of the results on a month to month basis indicated no significant trends.

A small isolated scum deposit was observed in the vicinity of the Hanford Ferry on December 27, 1950. This foam-like deposit appeared oily and showed evidence of possibly being formed by coal dust or soot at some location up stream. Three samples of this material were obtained; one sample, which was extremely representative of the oily type material, showed an activity density of beta emitters on the order of 1.7×10^{-3} μc/gm. The remaining two samples, which were more representative of the foam like substance indicated activity density of 2.1×10^{-3} and 7.3×10^{-4} μc/gram, respectively. Although these results appeared to be abnormally high when compared with the activity density measurements in other solid media such as soil and mud, this order of magnitude was somewhat in agreement with previous measurements performed on samples of floating material taken from the surface of the Columbia River during the summer of 1950. In contrast to previous observations of scum on the Columbia River, the current condition was definitely confined to a small region in the Hanford Area, whereas all findings during the summer of 1950 represented conditions that were found at many locations along the shore of the Columbia River in the environs of the Hanford Works.

Three mud samples were obtained from the base of Bonneville Dam and analyzed for the activity density of the beta emitters and alpha emitters from uranium and/or plutonium. The activity density of beta emitters in mud samples was on the same order of magnitude as that noted at background locations along the shore of the Columbia River in the vicinity of Hanford Works; individual measurements showed 1.4, 1.6, and 1.2×10^{-6} μc/gram. The activity density of alpha emitters in the same samples was less than 2 dis/min/gram. One sample of algae obtained during January indicated the activity density of beta emitters to be 3.0×10^{-6} μc/gram. The activity measurements performed on the samples of various media obtained from

Bonneville Dam were all on the order of magnitude of background measurements obtained in the vicinity of Hanford; several samples of Columbia River water were analyzed and the activity density of the beta emitters was less than 5.0×10^{-8} μc/cc in every case.

Samples were obtained at weekly intervals from the raw water supplies of the operating areas of the Hanford Works. The raw water is originally pumped from the Columbia River at one of the 100 Areas and after purification and chlorination is transported to the remaining areas for ultimate drinking purposes. A summary of the results obtained from the radiochemical analysis for the activity density of the beta emitters in the raw water during the period January, February, and March, 1951, is presented in Table III.

TABLE III
RADIOACTIVE CONTAMINATION IN RAW WATER - RIVER EXPORT LINE
JANUARY, FEBRUARY, MARCH
1 9 5 1

Location	BETA EMITTERS - ACTIVITY DENSITY x 10^8 μc/cc				Last	Maximum
	January Average	February Average	March Average	Quarter Average	Quarter Average	This Quarter
183 Building 100-B Area	< 5	< 5	< 5	< 5	< 5	< 5
183 Building 100-D Area	19	17	8	14	12	29
183 Building 100-H Area	23	27	17	22	33	45
183 Building 100-F Area	70	33	57	57	47	97
183 Building 100-DR Area	--	--	< 5	6	--	6
283 Building 200 East Area	6	14	< 5	8	6	30
283 Building 200 West Area	6	17	< 5	9	7	38

* Sampling was inaugurated at this location during March, 1951

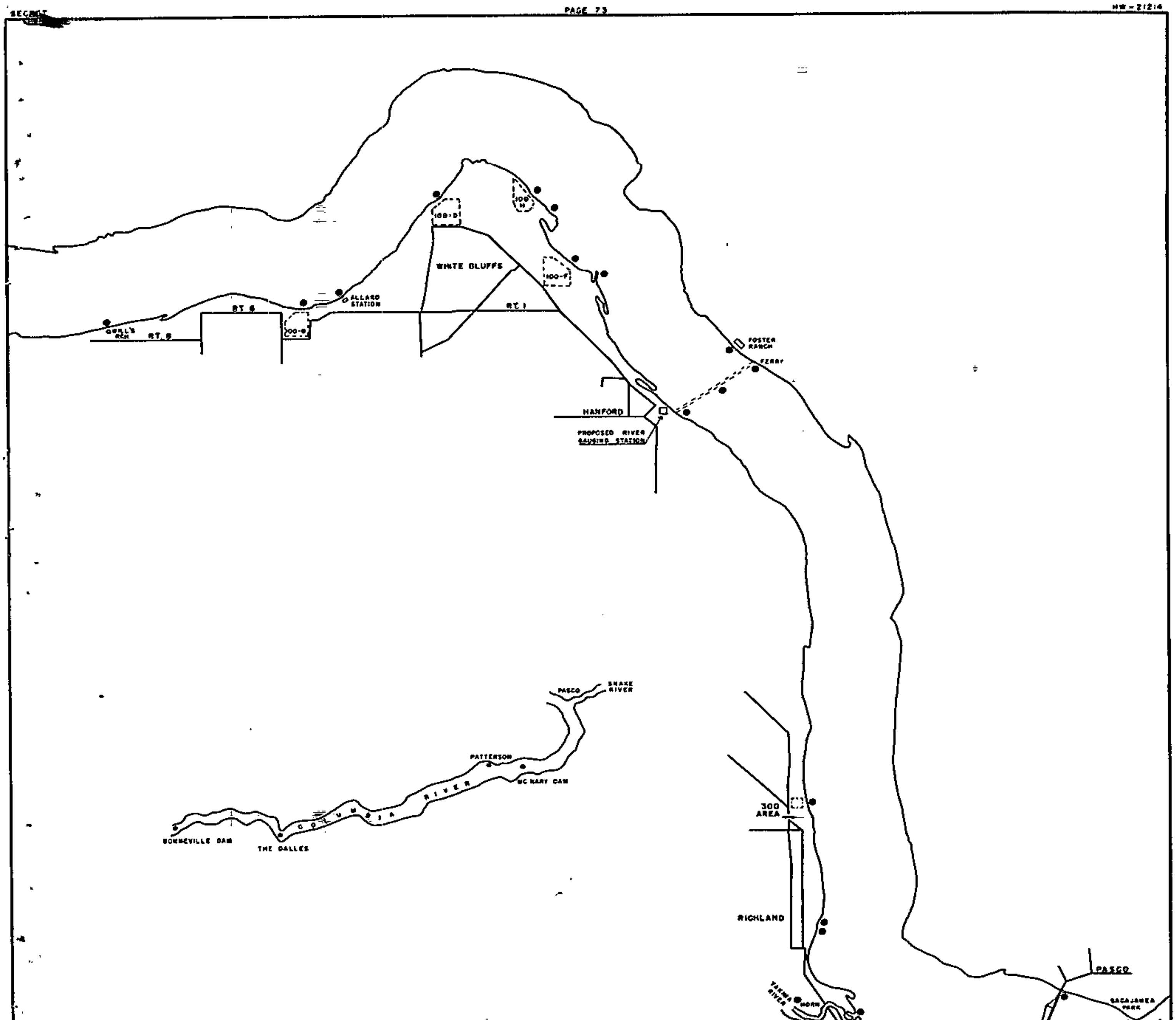
A review of the results summarized above indicate that the activity density of beta emitters in raw water did not deviate from the order of magnitude expected when compared with past data. In general, the measurements summarized above were nearly identical to those noted during the previous period and were in agreement with the magnitude of results expected during a period in which the river flow of the Columbia River remained essentially the same. As in the past, the higher measurements were obtained at the 100-F Area which represents the most down stream location from which the raw water originated.

The sampling of the raw water supplies in the 200 Areas was supplemented with a direct sampling program in which samples were obtained from the retention basins in each of the separation areas. The activity density of beta emitters in the water of the retention pond at the 283 building was barely above the detection limit of the analysis. Average measurements during the quarterly period were 8.0×10^{-8} µc/cc and 9.4×10^{-8} µc/cc at the 200 East and 200 West Areas, respectively. The maximum measurements during this period was 3.8×10^{-7} µc/cc in a sample obtained from the 200 West Area. The activity measurements which represented the retention basin were not indicative of any trend or change when compared with previous analysis. Spot measurements for the activity density of alpha emitters in the raw water supplies and retention basins of the 200 Areas indicated that this averaged less than 6 dis/min/liter throughout the period.

The sampling program at the inlet of the North Richland pond which represents water which is ultimately used for drinking purposes and originates in the Yakima River was discontinued during the early part of the period when the cold weather prevailed. The sampling program was resumed during the latter part of March and all results indicated that the activity density of beta emitters in this water remained below the sensitivity limit of the analysis (5×10^{-8} µc/cc.)

SECTION V

(Please refer to Figures 14, 15, 16, and 17.)



HANFORD WORKS

RIVER SAMPLING LOCATIONS

JANUARY—FEBRUARY—MARCH

1951 FIGURE—14

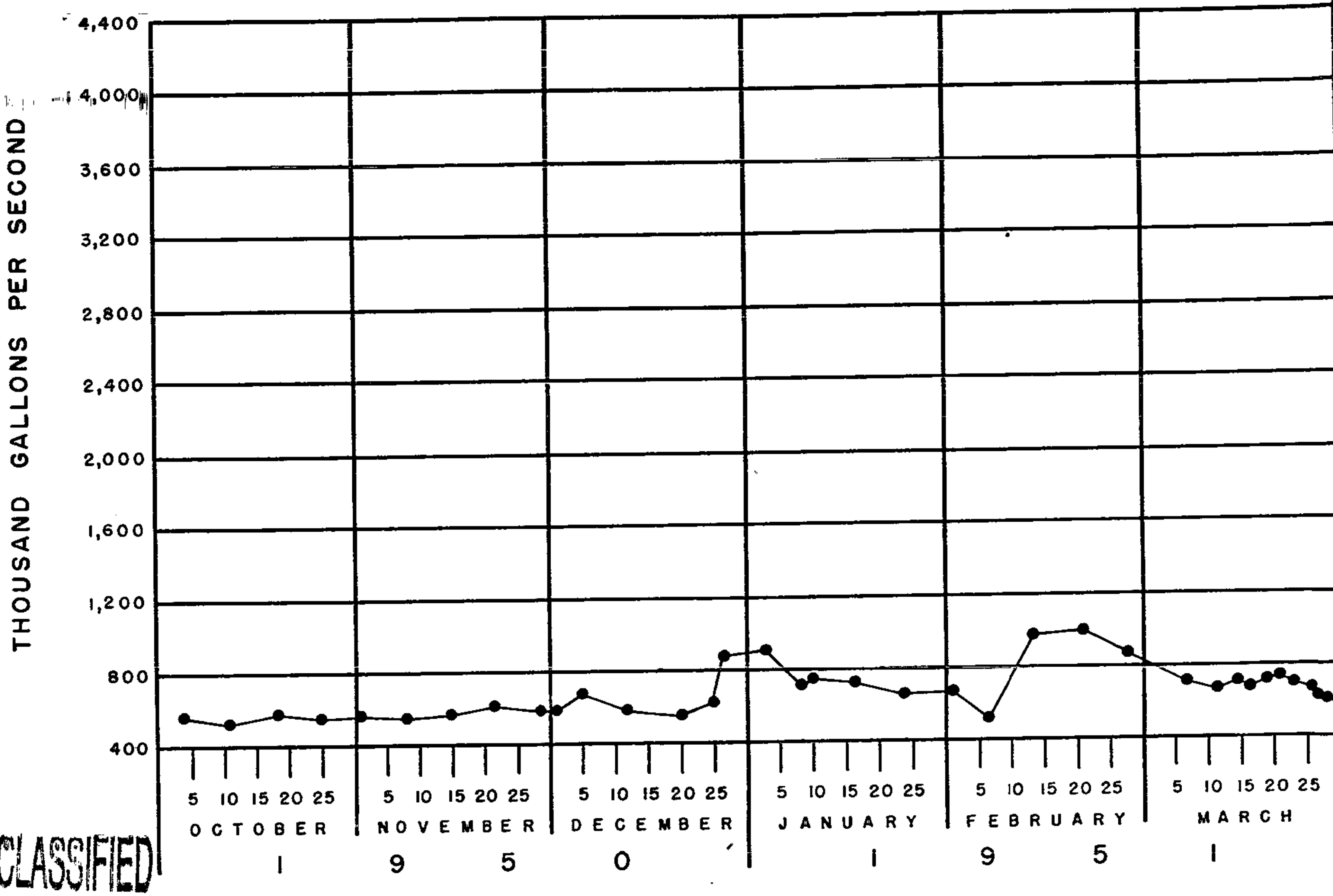
H.I. DEVELOPMENT DIVISION—SITE SURVEY

COLUMBIA RIVER FLOW

JANUARY—FEBRUARY—MARCH

1951

FIGURE — 15

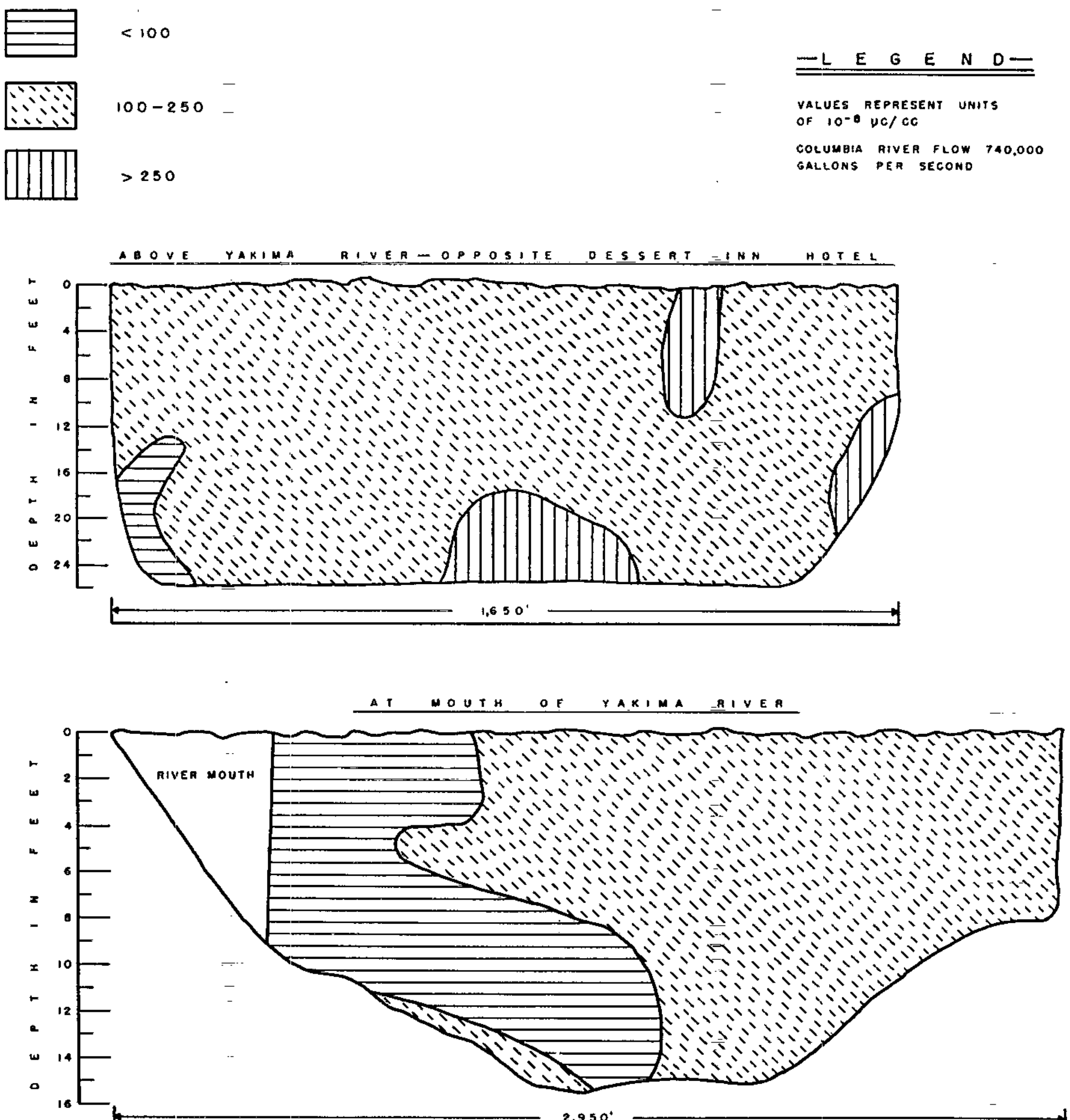


ACTIVITY DENSITY FROM GROSS BETA EMITTERS

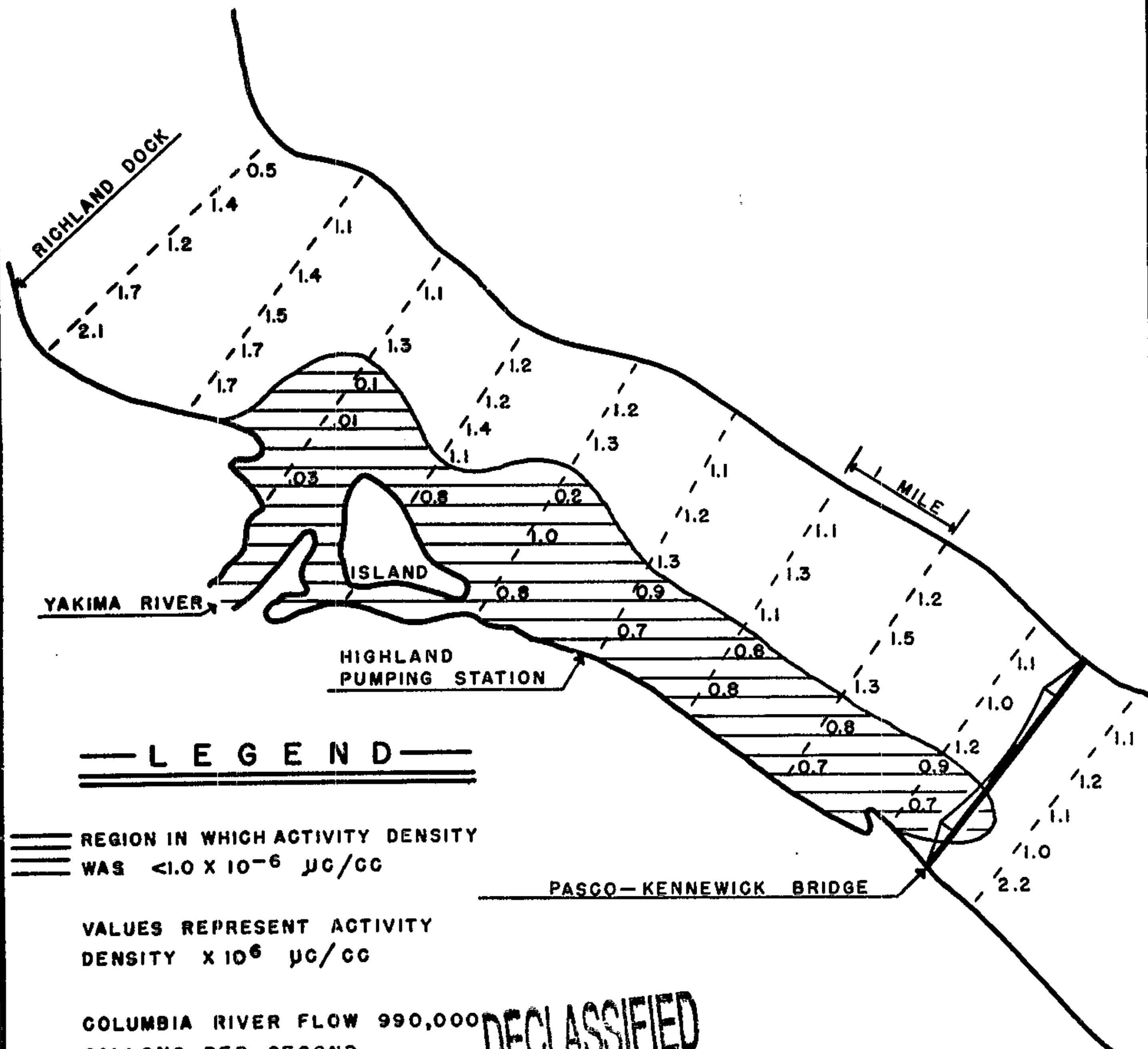
COLUMBIA RIVER

JANUARY —— 1951

FIGURE — 16



ACTIVITY DENSITY FROM GROSS BETA EMITTERS
COLUMBIA RIVER AT MOUTH OF YAKIMA RIVER
FEBRUARY 15 —— 1951 FIGURE—17



—LEGEND—

REGION IN WHICH ACTIVITY DENSITY WAS $<1.0 \times 10^{-6}$ µc/cc

VALUES REPRESENT ACTIVITY DENSITY $\times 10^{6}$ µc/cc

COLUMBIA RIVER FLOW 990,000 GALLONS PER SECOND

SECTION VI

RADIOACTIVE CONTAMINATION IN RAIN

The amount of rainfall measured at the Meteorology Tower near the 200 West Area during the period January, February, March, 1951, was 1.81 inches. This amount of precipitation was considered normal for the period involved as it was identical to the all time Hanford average as tabulated for a period of 36 years. The current period was somewhat in contrast to that of a year ago when nearly twice as much rainfall was measured at Hanford.

Samples of rainfall were collected from 27 representative locations where 500 ml. collecting vessels were placed. The activity density of beta emitters in rain was evaluated by standard techniques and the results were regarded as qualitative estimations of the aerosol activity during periods of precipitation. The number of samples collected at individual locations varied from 6 to 21; the latter figure was the number of samples collected at the Meteorology station where each individual rainfall was segregated as an individual sample. In all, a total of 227 rain samples were analyzed during this period.

Table I summarizes the rainfall data for the period January, February, and March, 1951 as measured at the Meteorology Station near the 200 West Area. Similar data for 1949 and 1950 are included for comparison.

TABLE I
PRECIPITATION MEASURED AT HANFORD WORKS
JANUARY, FEBRUARY, MARCH, 1951
units-inches

Year	January	February	March	Quarterly Total
1949	0.13	0.68	1.12	1.93
1950	1.80	1.06	0.87	3.73
1951	0.84	0.51	0.46	1.81

In general, the average activity density of beta emitters in rainfall was less than 1.0×10^{-6} μc/cc at locations along the outside of the project perimeter; in contrast, the average activity density measured in samples collected inside the separation areas ranged from 3.0×10^{-6} μc/cc to 8.0×10^{-5} μc/cc. The higher results tended to prevail inside the 200 West Area at monitoring locations which were approximately 5000' and 8000' southeast of the stack. The maximum measurement of 4.4×10^{-4} μc/cc was observed in a sample collected 4900' southeast of the 200 West Area stack. The region in which the maximum measurements prevailed was nearly identical to the locations at which the maximum deposition of I-131 was noted during the period. (Figure 6, Section II,)

Sixty-nine rain samples were collected in the immediate environs of the 100 Areas. The activity density of beta emitters in these samples was negligible and averaged less than 1.0×10^{-6} μc/cc, at each of 7 locations. The monitoring locations in this group included the construction zones of White Bluffs, and Hanford 101 Building.

Forty samples were collected from locations adjacent to the project including Benton City, Pasco, and Richland. The activity density of beta emitters measured in samples obtained from populated regions averaged less than 1×10^{-6} μc/cc with maximum measurements on the order of 4.0×10^{-6} μc/cc observed at North Richland and Richland. Monitoring of rainfall was continued in most of the construction zones on the site. Maximum measurements obtained from samples collected in construction zones were noted at the Redox Area and at the Batch Plant which is located between the separation areas. Individual samples from each of these locations indicated the activity density to be 1.3×10^{-5} μc/cc and 6.0×10^{-6} μc/cc; however, the average at each of these locations during the quarterly period was 3.0×10^{-6} μc/cc.

Table II summarizes the results obtained from the measurement of the activity density of beta emitters in rainfall at the various locations. Figure 18 is a location map showing the places where rain collectors were established.

TABLE II
ACTIVITY DENSITY FROM GROSS BETA EMITTERS IN RAIN
JANUARY, FEBRUARY, MARCH, 1951

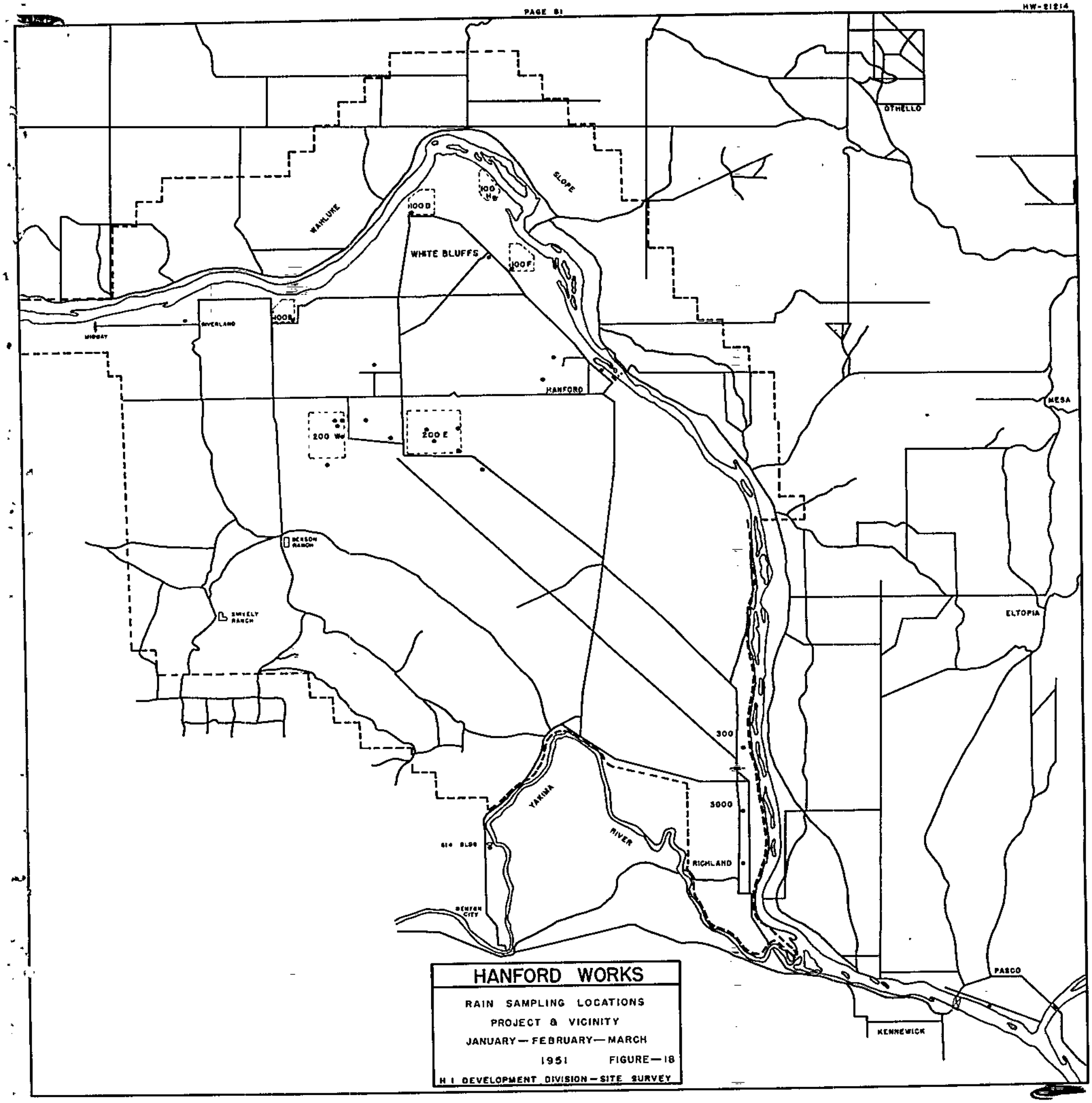
Location	Number Samples	Activity Density x 10^6 μc/cc Maximum	Average
In 200 East Area			
250' East of Stack	7	30	7
2000' East of Stack	7	4	2
750' SE of Stack	7	28	8
3500' SE of Stack	7	11	4
Summary	28	30	5
In 200 West Area			
1000' E of Stack	6	21	11
7000' E of Stack	6	44	19
8000' SE of Stack	6	57	19
4900' SE of Stack	6	439	80
Redox Area	6	13	3
Summary	30	439	26
100 Area Environs			
100-BSE	9	1	<1
100-DSW	10	<1	<1
100-FSW	12	<1	<1
Hanford 614 Bldg.	10	<1	<1
Hanford 101 Bldg.	9	<1	<1
White Bluffs	10	1	<1
100-HSE	9	<1	<1
Summary	69	1	<1
Perimeter Locations			
Richland	8	<1	<1
Pasco H & R	6	<1	<1
Benton City	9	2	<1
Riverland	9	4	<1
3000 Area North	8	4	1
Summary	40	4	<1
Intermediate Locations			
Route 4S, Mile 6	8	12	4
300 Area 614	9	<1	<1
200 North 614	8	139*	2
Gable Mountain	9	13	4
Batch Plant	5	6	3
622 Building	21	58	4
Summary	60	139*	3

* Unusually high result for location; not confirmed by recount or decay and may be due to laboratory contamination.

A program was initiated during this period for evaluating the activity density of alpha emitters in large volume collections of rainfall. The roofs of several representative buildings at which the water-shed ranged from 600 to 1600 square feet have been eaved and large vessels have been installed for the collection of the water shed. Preliminary measurements have indicated that volume collections on the order of 50 to 75 gallons are available in this manner. To date, four large volume samples have been analyzed for the activity density of the alpha emitter of uranium and/or plutonium; the results to date are not conclusive; several refinements and modifications in the method of analyses for large volume rain samples are currently under way to give reliable data with extremely low sensitivities.

SECTION VI

(Please refer to Figure 18.)


OTHELLO
WAHLUKE
SLOPE
100 D
100 H
100 F
100 B
WHITE BLUFFS
RIVERLAND
HANFORD
MESA
200 W
200 E
ELTOPIA
YAKIMA
RIVER
300
3000
RICHLAND
PASCO
KENNEWICK
HANFORD WORKS
RAIN SAMPLING LOCATIONS
PROJECT & VICINITY
JANUARY — FEBRUARY — MARCH
1951 FIGURE — 18
H I DEVELOPMENT DIVISION — SITE SURVEY

SECTION VII

RADIOACTIVE CONTAMINATION IN DRINKING WATER AND TEST WELLS

Samples of drinking water supplies were obtained from representative locations on and adjacent to the Hanford Works. These samples were analyzed for the activity density of gross beta emitters and for the activity density of alpha emitters from uranium and/or plutonium. The two main sources of activity which could enter drinking water supplies as a result of the operation of Hanford Works were the radioactive effluent discharged from the pile areas into the Columbia River and the open and cribbed waste areas which are located within the operating areas. In addition, the radiochemical analysis of samples of drinking water were performed to evaluate the magnitude of naturally occurring uranium, radium, and radon.

During the period January, February, March, 1951, over 700 samples from various drinking water supplies were analyzed. Six hundred and twenty of these samples were 500 ml. samples and the remainder were 12 liters in volume. The large volume samples were analyzed primarily to determine the activity density of alpha emitters of uranium and/or plutonium; the smaller volume samples were used primarily to evaluate the activity density of the beta emitters.

The frequency of sampling the various drinking water supplies varied from daily to monthly. The frequency for a given location was based on the current trend of the activity density measurement, the location of the well, and the probability of contamination. A small decrease in the total number of well samples analyzed during this period was necessitated by limited laboratory facilities for a short interval during the quarter.

The activity density measurements summarized in this section were accomplished according to procedures identical to those used in the past; these procedures were described in detail in previous publications.(5)

The results obtained from the radiochemical analysis of drinking water supplies for the activity density of alpha emitters indicated that the locations which continually showed activity above the sensitivity limit of an individual analysis (greater than 6 dis/min/liter) were confined to wells located in the general region of Benton City and Richland. The activity density of the alpha emitters measured in samples for these two regions was consistent with observations made during the past. In nearly every case, the alpha emitter in these samples was found to be that of uranium, which apparently occurs naturally in this area. In several isolated cases where the activity density of alpha emitters was not accounted for as uranium, the small deviations were attributed to normal variations encountered in laboratory procedures and sampling techniques.

The maximum activity density of alpha emitters was again found in the Benton City region; individual samples from the Benton City Store and Benton City Water Company wells showed 40 and 38 dis/min/liter, respectively. The average activity density of alpha emitters in these same locations was 22 and 24 dis/min/liter, respectively. Measurements for uranium by the fluorophotometer method indicated an average of 14 µg U/liter at the Benton City Store and 16 µg U/liter at the Benton City Water Company supply. The maximum measured value was 41 µg U/liter at the Benton City Water Company well.

With the exception of one or two individual samples, the activity density of the alpha emitters measured in the wells of the Richland system was considerably lower than that found in the Benton City region. Six of the Richland wells showed positive alpha activity in which the activity density ranged from 7 to 14 dis/min/liter; the latter value represented Richland well #4 which also showed the maximum individual measurement of 39 dis/min/liter. All of the Richland wells showed trace amounts of uranium during the period; the average uranium content was on the order of 5 µg U/liter with maximum measurements on the order of 14 µg U/liter. The values summarized above for Richland and Benton City were nearly identical to those found during previous periods.

During February, a sampling program which included the drinking water supplies at Sacajawea Park and Patterson was initiated. The results of the radiochemical analysis for the activity density of alpha emitters at these locations indicated an average on the order of 13 to 16 dis/min/liter. The maximum measurement was 25 dis/min/liter measured in a sample obtained from Sacajawea Park.

Table I summarizes the locations at which the 500 ml. samples indicated the activity density of alpha emitters to be above the detectable limit of 6 dis/min/liter throughout the period January, February, March, 1951.

TABLE I
ACTIVITY DENSITY IN DRINKING WATER
JANUARY FEBRUARY MARCH
1 9 5 1

500 ml. samples

Location	Ether Extraction No. Samples	Ether Extraction dis/min/liter Maximum	Ether Extraction dis/min/liter Average	Fluorophotometer No. Samples	Fluorophotometer µg U/liter Maximum	Fluorophotometer µg U/liter Average
Richland Well #2	8	12	7	8	9	5
Richland Well #4	39	39	14	40	10	6
Richland Well #12	9	15	8	9	6	3
Richland Well #13	15	19	10	15	7	5
Richland Well #14	11	16	7	13	14	6
Richland Well #18	4	15	9	5	6	3
3000 Area Well "C"	9	15	6	10	3	2
Benton City Store	13	40	22	13	23	14
Benton City Water Co.	13	38	24	14	41	16
Cobb's Corner	13	16	6	14	7	3
Sacajawea Park*	8	25	13	--	--	--
Patterson*	8	22	16	--	--	--
251 Bldg. Sanitary	13	31	7	12	3	2
Byer's Landing*	2	7	6	--	--	--

* Sampling at these locations was inaugurated during the month of February.

Figure 19 is a graphic portrayal showing the average activity density of alpha emitters in the wells of the Richland system and includes a map showing the location of these wells in the city of Richland. In addition to those locations summarized above, several individual samples from random wells indicated trace activity density of alpha emitters. In the majority of cases the presence of this activity was not confirmed by resamples. A complete tabulation of the activity density measurements for those locations which indicated trace amounts of alpha activity at any time during the period January, February, and March, 1951, is presented in Tables II and III. Table II summarizes the results from the analysis of 12 liter samples and Table III summarizes the results obtained from the analysis of 500 ml. samples.

TABLE II
SUMMARY OF ALPHA EMITTERS MEASURED IN DRINKING WATER
12 LITER SAMPLES
Activity Density-units-dis/min/liter
JANUARY, FEBRUARY, MARCH
1 9 5 1

Location	Number Samples	Maximum	Average
Foster Ranch	6	2	<2
Richland Well #2	4	6	4
Richland Well #4	3	11	5
Richland Well #5	1	4	4
Richland Well #12	1	7	7
Richland Well #13	4	24	12
Richland Well #14	2	9	9
Tract House J-685	2	3	3
Hanford Well #1	4	4	3
Hanford Well #4	3	12	6
Hanford Well #7, San.	6	3	<2
3000 Area Well "A"	4	3	<2
3000 Area Well "B"	3	4	2
3000 Area Well "C"	3	4	3
3000 Area Well "E"	3	6	3
3000 Area Durand #5	5	7	5
Columbia Field Well "A"	3	2	<2
Columbia Field Well "B"	3	3	3
1100 Area Well #8	2	5	4
Benton City Store	5	28	14
Benton City Water Co.	6	22	14
Cobb's Corner	5	6	4
Enterprise	6	2	<2
Kennewick Standard Station	5	2	<2
Midway	6	3	<2
Wills Ranch	5	4	<2
P-11 Well	7	4	2
Pistol Range	5	5	3
White Bluffs	7	2	<2
251 Building San.	5	6	3

Figure 20 illustrates the locations from which the samples tabulated in Tables II and III were obtained.

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TABLE III

SUMMARY OF ALPHA AND BETA EMITTERS MEASURED IN WATER SUPPLIES

500 ml. samples
JANUARY, FEBRUARY, MARCH
1 9 5 1

Location	Number Samples	Alpha Emitters Activity Density dis/min/liter		Beta Emitters Activity Density x 10^8 μc/cc	
		Maximum	Average	Maximum	Average
Foster's Ranch	13	5	<2	2	<1
Headgate Well	12	7	<2	1	<1
Richland Well #2	8	12	7	2	<1
Richland Well #4	39	39	14	1	<1
Richland Well #5	11	8	4	3	<1
Richland Well #12	9	15	8	2	<1
Richland Well #13	15	19	10	2	<1
Richland Well #14	11	16	7	6	<1
Richland Well #18	4	15	9	1	<1
Tract House J-685	8	9	4	2	<1
Hanford Well #1	11	18	5	<1	<1
Hanford Well #4	12	5	3	4	<1
Hanford Well #7, San.	17	6	3	5	<1
3000 Area Well "A"	11	8	3	7	1
3000 Area Well "B"	4	7	2	<1	<1
3000 Area Well "C"	9	15	6	4	<1
3000 Area Well "E"	8	8	5	1	<1
3000 Area Durand #5	12	9	5	2	<1
Columbia Field Well "A"	12	12	4	4	<1
Columbia Field Well "B"	12	8	3	1	<1
1100 Area Well #8	9	12	5	1	<1
Benton City Store Well	12	40	22	4	<1
Benton City Water Co.	13	38	24	<1	<1
Cobb's Corner	13	16	6	1	<1
Enterprise Well	13	8	2	4	<1
Kennewick Standard Station	13	9	3	12	5
Riverland	13	4	<2	6	<1
Midway	13	7	<2	1	<1
Lower Knob	11	8	3	1	<1
Wills Ranch	11	6	<2	<1	<1
P-11 Well	10	7	3	2	<1
Pistol Range	12	9	5	3	<1
White Bluffs Ice House	12	8	3	20	6
Pasco Filter Plant San.	12	--	--	24	15
Pasco Filter Plant First Backwash	11	--	--	128	27
Redox Administration Building	10	7	2	9	3
251 Building Sanitary	13	31	7	1	<1
Byers Landing	2	7	6	2	<1
300 Area Sanitary	22	12	4	1	<1
200 East Sanitary	12	5	<2	6	<1
224-B East Sanitary	1	2	2	<1	<1
200 West Sanitary	12	6	<2	6	3
100-B Sanitary	13	3	<2	<1	<1
100-D Sanitary	12	6	<2	8	2

DECLASSIFIED

[redacted]

TABLE III (con't.)

SUMMARY OF ALPHA AND BETA EMITTERS MEASURED IN WATER SUPPLIES

500 ml. samples

JANUARY, FEBRUARY, MARCH

1 9 5 1

Location	Number Samples	Alpha Emitters Activity Density dis/min/liter		Beta Emitters Activity Density x 10^8 µc/cc	
		Maximum	Average	Maximum	Average
100-DR Sanitary	4	2	<2	8	3
100-F Sanitary	13	15	3	13	8
100-H Sanitary	13	17	3	9	3
Sacajawea Park	8	25	13	<1	<1
McNary Dam	8	21	3	9	5
Patterson	8	22	16	<1	<1
Plymouth	8	11	4	<1	<1
Prosser	8	7	<2	3	1

Fluorophotometer analyses to determine the presence of uranium were performed on samples from the locations summarized in Tables II and III at a frequency of at least one analysis per month. In general, the activity density of uranium was less than 2 µg U/liter in all samples; however, several samples indicated results on the order of 2 to 6 µg U/liter. The latter order of magnitude appeared at random locations and was not confirmed in more than one sample for a given location during this period.

Control sampling at one of the Richland Wells was maintained throughout the period to determine the daily trend of activity in this well. The analysis of 39 samples obtained from Richland Well #4 showed an average activity density of 14 dis/min/liter including a maximum of 39 dis/min/liter. These values represented a small increase when compared to the previous quarter; the average at that time was 10 dis/min/liter including a maximum of 23 dis/min/liter. This was the second consecutive quarter during which the activity density of alpha emitters showed an increase at this control location. During the period July, August, and September of 1950, the average activity density of alpha emitters was 6 dis/min/liter. The average activity density of uranium during the current period was 6 µg U/liter as compared with previous measurements which were on the order of 3 to 4 µg U/liter.

As in the past, radiochemical analysis for the activity density of beta emitters in drinking water supplies showed that the average activity density did not exceed 5.0×10^{-8} μc/cc at any location except those which utilize the Columbia River water as their source of supply. Drinking water supplies which indicated positive averages during this quarterly period were Kennewick, White Bluffs, Pasco, McNary Dam, and 100-F Area Sanitary Water. The maximum average was observed in the Pasco sanitary water which averaged 1.5×10^{-7} μc/cc including a maximum measurement of 2.4×10^{-7} μc/cc. In general, the magnitude of the activity density of beta emitters in the drinking water supplies mentioned above barely exceeded the sensitivity limit of an individual analysis (5×10^{-8} μc/cc.) Table III summarizes the results of the beta measurements at all locations for the period January, February, March, 1951. In comparison to past data, these results were not indicative of any change or trend in the magnitude or extent of this activity.

Weekly sampling at the Pasco Filtration Plant included the radiochemical analysis of the activity density of beta emitters in the various media through which the Columbia River water passes previous to consumption in the city of Pasco. Samples of sand obtained directly from the surface of the filter beds showed an average activity density of 2.4×10^{-5} μc/gram. The maximum measurement was 8.0×10^{-5} μc/gram; however, this value was considerably higher than the next highest value which was 4.7×10^{-5} μc/gram. Very little trend was noticed when comparing the monthly averages for this analysis during this quarter; values of 3.0, 1.2, and 2.9×10^{-5} μc/gram represented the averages for the months of January, February, and March, 1951. Samples were collected from the material which was flushed from the filter beds at the time of the first backwash; these samples consisted of the first backwash water along with the fine silt-like material which the filter basins retain from the filtration processes. The samples of this material were filtered in the laboratory previous to radiochemical analysis. The results of this analysis indicated that the major portion of the activity was retained in the solid material and that the activity indicated in the liquid portion of the sample was comparable

[redacted]

in magnitude to that normally found in the Pasco sanitary water. Ten samples of the filtered material showed an average of 3.6 x 10^{-3} µc/gram including a maximum measurement of 1.6 x 10^{-2} µc/gram. The latter measurement which was approximately 3 times greater than any previous value for this material was indicated in a sample obtained on February 14; except for this one high result, the monthly averages of 2.5, 5.4, and 2.4 x 10^{-3} µc/gram during January, February and March were not indicative of any significant trend. The filtrate, or liquid portion of the backwash, showed an average activity density of 2.7 x 10^{-7} µc/cc including a maximum measurement of 1.3 x 10^{-6} µc/cc. These values were within a factor of 2 when compared with the activity density measured in the sanitary water as it leaves the filter plant; 12 samples of the latter type indicated an average activity of 1.5 x 10^{-7} µc/cc.

Measurements to determine the activity density of naturally occurring alpha emitters were performed on spot samples obtained from the drinking water supplies in Sunnyside, Yakima, Wapato, and Toppenish. The average activity density of alpha emitters from uranium and/or plutonium was less than 6 dis/min/liter at these locations.

Nearly 300 samples were obtained from test wells on and immediately adjacent to the Hanford Works. One hundred and forty-eight of these samples were 500 ml. in volume and were analyzed for the activity density of alpha and beta emitters. The remaining samples were of 12 liter volume and were analyzed specifically for the activity density of alpha emitters of uranium and/or plutonium.

The four 200 Area wells continued to show the presence of alpha emitters on the same order of magnitude as observed during previous periods. In general, the average activity density of alpha emitters in these wells was on the order of 100 dis/min/liter; well #2 indicated the highest average activity density with a value of 116 dis/min/liter. The maximum measurement was 260 dis/min/liter as sampled from well #4. The activity density of principal alpha emitters in the 300 Area well system was identified as uranium. Wells #2 and #4 which indicated the maximum activity density of alpha emitters showed an average of 67 and 59 µg U/liter. Maximum uranium measurements were on the order of 100 µg U/liter.

During this period, sampling was inaugurated at the 300 North Area Well, which is located adjacent to a waste disposal area into which waste from the 321 building is placed. A total of 10 samples was obtained from this location and analyzed for the activity density of alpha emitters and the alpha emitters from uranium. The results showed considerable variation within samples; however, it was indicative that this well may possibly be the most contaminated well on the site. Maximum uranium measurements were in excess of 1400 µg U/liter and averaged 633 µg U/liter.

Table IV summarizes the results obtained from the measurements of the activity density of alpha and beta emitters in all test wells which indicated activity in any individual sample.

TABLE IV
SUMMARY OF ALPHA AND BETA EMITTERS MEASURED IN DRINKING WATER SUPPLIES
TEST WELLS
500 ml. SAMPLES
JANUARY, FEBRUARY, MARCH
1 9 5 1

Location		Alpha Emitters Activity Density dis/min/liter		Beta Emitters Activity Density x 10^8 µc/cc	
	Samples	Maximum	Average	Maximum	Average
300 Area Well #1	11	123	82	2	<1
300 Area Well #2	25	187	116	4	<1
300 Area Well #3	24	135	48	8	1
300 Area Well #4	12	260	105	3	<1
300 North Area	10	731	313	4	<1
B-Y Well	13	10	6	1	<1
Snively Ranch	2	2	<2	6	3
Rattlesnake Spring	2	6	3	<1	<1
200 North Well #5	7	15	5	2	<1
McGee Well	13	7	<2	5	1
Ford Well	13	10	<2	<1	<1
Meeker Well	13	12	3	2	<1

In addition to the sampling of established drinking water supplies and test wells, as summarized previously, random samples were obtained from many of the construction area drinking supplies and from various irrigation ditches which may possibly provide water for subsequent drinking purposes. The activity density

 [redacted]

from alpha and beta emitters in these supplies were consistently below the detectable limits of 6 dis/min/liter and 1×10^{-8} μc/cc, respectively.

SECTION VII

(Please Refer To Figure 19.)

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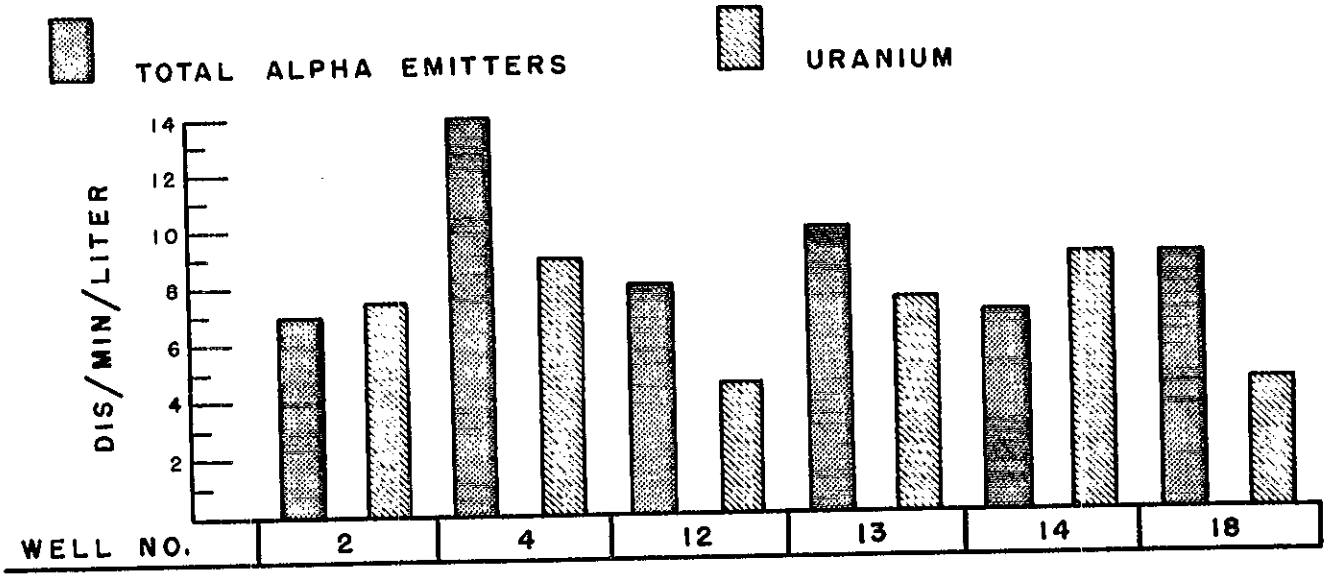
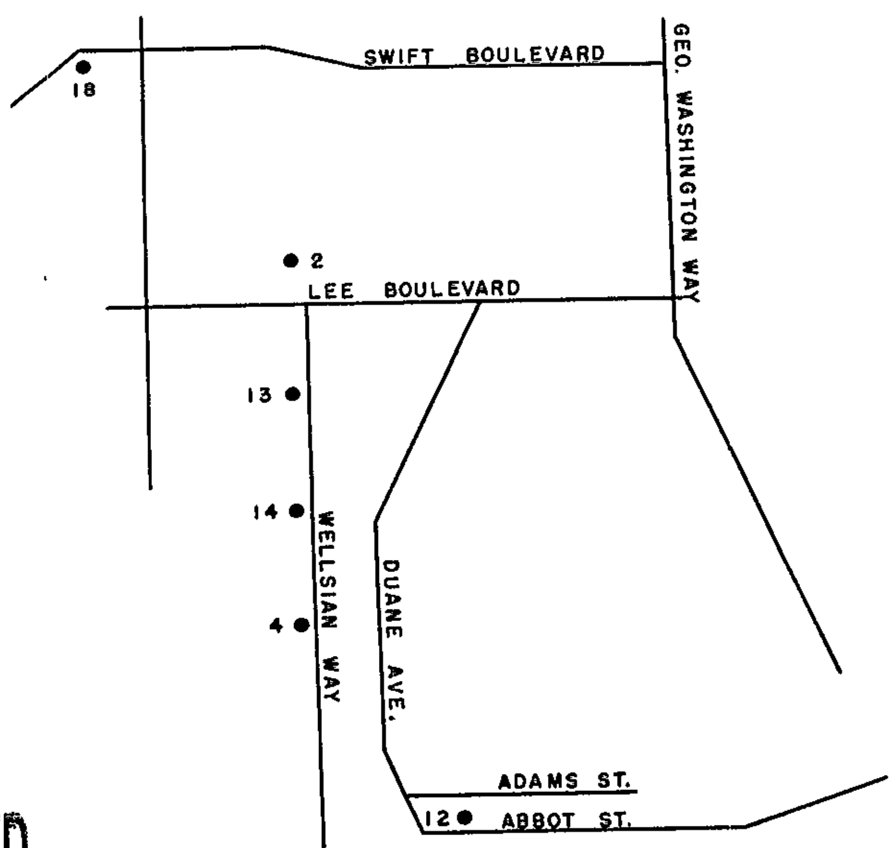
HEALTH INSTRUMENT DIVISIONS
DEVELOPMENT DIVISION

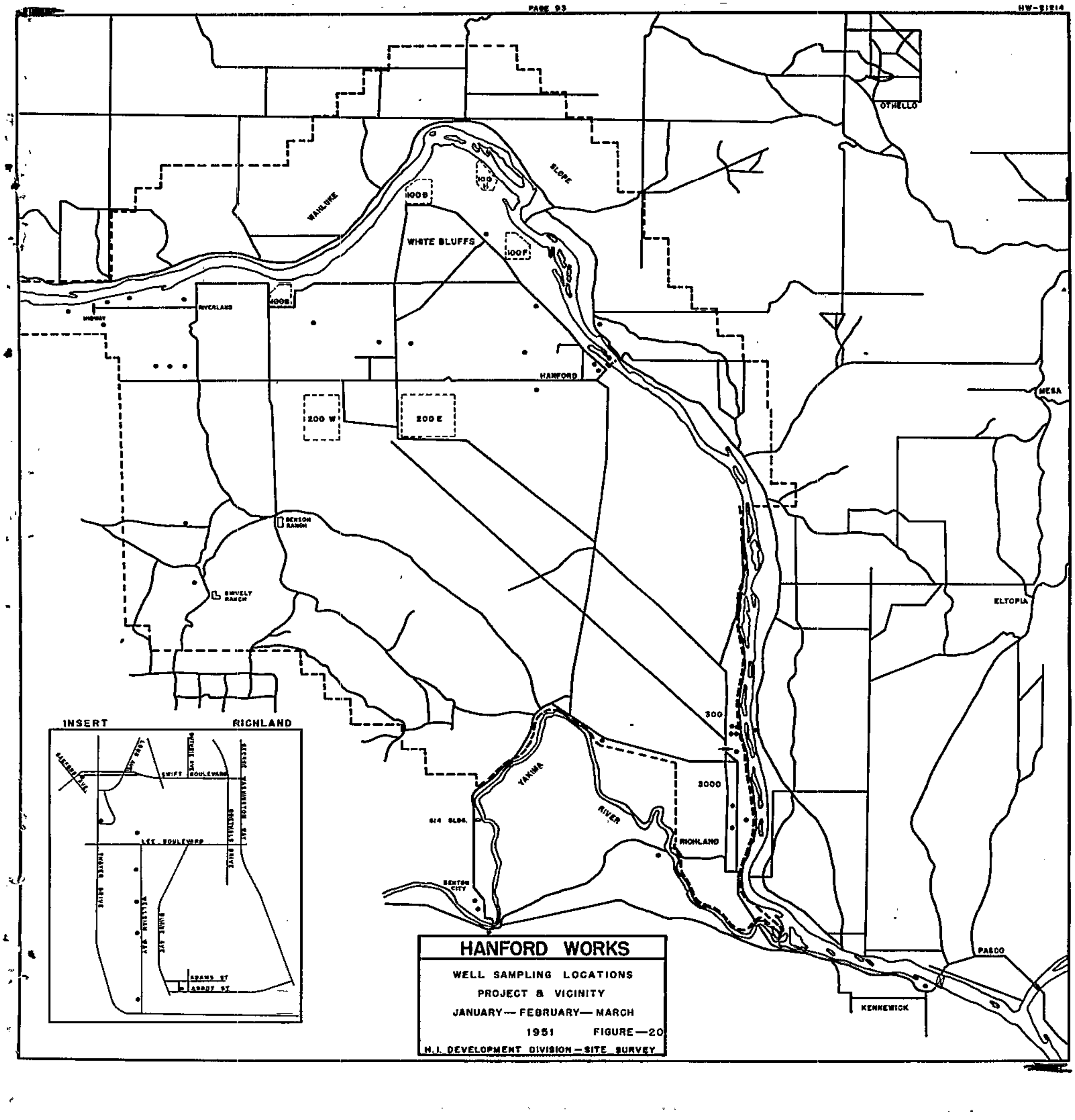
AVERAGE ACTIVITY DENSITY FROM ALPHA EMITTERS
RICHLAND WELLS
JANUARY — FEBRUARY — MARCH 1951

FIGURE — 19



LOCATION OF WELLS





HANFORD WORKS

WELL SAMPLING LOCATIONS

PROJECT & VICINITY

JANUARY — FEBRUARY — MARCH

1951 FIGURE — 20

H. I. DEVELOPMENT DIVISION — SITE SURVEY

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