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FINAL REPORT: SURFACE RADIATION SURVEY FOR
THE PHASE I REMEDIAL INVESTIGATION OF THE
300-FF-1 OPERABLE UNIT ON THE HANFORD SITE

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October 1990

Prepared for
the U.S. Department of Energy
under Contract DE-AC06-76RL0 1830

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PREFACE

This report summarizes Task 3a-1 of the Phase I Remedial Investigation for the 300-FF-1 Operable Unit on the Hanford Site, near Richland, Washington. The purpose of the Remedial Investigation is to determine the nature and extent of the risk presented by releases of hazardous substances from the operable unit. The purpose of Task 3a-1 was to locate any areas of contaminated soil outside of operable unit waste facility boundaries.

Westinghouse Hanford Company was responsible for coordinating Phase I efforts. The information presented in this report was collected by Pacific Northwest Laboratory, for Battelle, Pacific Northwest Division's Environmental Management Operations, at the request of Westinghouse Hanford Company. The Westinghouse Hanford Company technical coordinator for these activities was Larry C. Hulstrom. The Environmental Management Operations program manager was Donald A. Kane, and the Pacific Northwest Laboratory project manager was George V. Last.

SUMMARY

Surface radiation survey and sampling activities in the 300-FF-1 Operable Unit were conducted from September 1989 to December 1989 and April 1990 to June 1990. Surveys were conducted primarily using portable Geiger-Muller beta/gamma detectors. As a result, 77 locations were found where radiation occurred above a statistically calculated background estimate. The Ultra Sonic Ranging and Data System (USRADS) was also used to survey a limited area. Analysis of the USRADS data revealed several elevated measurements that were not detected at the same locations with the Geiger-Muller detector.

Contamination was primarily associated with soil; however, some contaminated metal and other materials were also found. Chemical analysis of samples from selected locations showed that the above-background radiation levels were caused primarily by the presence of uranium. Some of the soil samples also contained relatively high concentrations of copper, but there does not appear to be a linear relationship between the concentration of copper and uranium.

Additional surface radiation survey work is recommended to be performed using the USRADS equipment with the NaI detector. This work is needed to more completely characterize selected sites and provide information that will aid Task 3b-1 in siting borehole locations for soil sampling.

ACKNOWLEDGMENTS

The authors would like to acknowledge the following for their assistance in completing this task: Westinghouse Hanford Company (WHC), who funded this work, and L. C. Hulstrom, the WHC Technical Coordinator; D. A. Kane, Environmental Management Operations, for program management oversight; G. V. Last, Pacific Northwest Laboratory (PNL), for managerial and technical oversight; D. W. Glover, L. A. Doremus, and J. P. McDonald of PNL and the WHC Health Physics organization for field support; CHEMRAD Tennessee Corporation for technical support for the USRADS equipment; W. R. Gorst (PNL) for editorial support; the Sigma V text processing team for their support; D. J. Bates (PNL) for statistical interpretation of the USRADS data and for Figures 3.7, 3.8, and 3.9; J. S. Young for plotting the maps shown in Plates 1 and 2 and Figure 3.10; and D. C. Lanigan for Figures 1.1, 2.1, and 3.4.

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1.0 INTRODUCTION

This report discusses FY 1990 field activities and subsequent data analyses performed under Task 3a-1, Surface Radiation Survey, of the Phase I Remedial Investigation for the 300-FF-1 Operable Unit. The operable unit is located in the 300 Area of the U.S. Department of Energy's (DOE) Hanford Site in southeastern Washington. The Hanford Site is used for nuclear reactor operations, spent fuel reprocessing, and radioactive waste management. Westinghouse Hanford Company (WHC) is the Hanford Site operating contractor. Pacific Northwest Laboratory (PNL)^(a) performed the study for the Environmental Management Operations at the request of WHC.

The 300-FF-1 Operable Unit is a process liquid operable unit, which contains all of the major liquid waste disposal facilities associated with fuels fabrication in the 300 Area (DOE 1990). These waste disposal facilities include the North and South Process Ponds, Burial Grounds #4 and #5, and the 307 Trenches. A map of this operable unit showing the location of these waste disposal facilities and established radiation areas (prior to the completion of Task 3a-1) is shown in Figure 1.1. An infrared aerial photo of the operable unit is shown in Figure 1.2. A location map of the 300 Area and the Hanford Site is provided in Figure 1.3.

The Remedial Investigation/Feasibility Study Work Plan for the 300-FF-1 Operable Unit (DOE 1990) provided the direction for this work. Field activities for Task 3a began in September 1989, but were temporarily suspended on December 3, 1989, because of unfavorable weather conditions and a shift in funding priorities. Field activities resumed on April 24, 1990, and were concluded on July 2, 1990.

Work performed under this task included 1) radiation level determination near the 300 Area, 2) surface radiation surveys outside of established radiation areas, 3) geodetic surveys of locations above background, and 4) soil sampling and analysis.

These activities are discussed in detail in the following sections.

(a) PNL is operated for DOE by Battelle Memorial Institute.

FIGURE 1.1. Radiation Areas within the 300-FF-1 Operable Unit, Including Both Surface and Underground Contamination (prior to Task 3a-1)

FIGURE 1.2. Infrared Aerial Photo of the 300-FF-1 Operable Unit

FIGURE 1.3. Map of the Hanford Site with Detail of the 300 Area

2.0 DETERMINATION OF BACKGROUND RADIATION LEVELS

Prior to initiating the surface radiation survey, background radiation for the area was determined from measurements made at three "background plots." Three 50- by 75-ft plots, located in an area west of the operable unit boundary, were chosen as representative of background radiation for the operable unit. The location of these plots is shown in Figure 2.1. This area was chosen because it was upwind of, and probably not affected by, waste disposal operations. This area had been considered "clean" and has been used as a "borrow pit" for fill dirt needed to stabilize other surface radiation contamination areas. Therefore, it was concluded that it would yield an accurate representation of background for the operable unit. Within these plots, stakes were placed in a rectangular grid 25 ft apart, with 12 stakes per plot. The area around each stake was surveyed by WHC Health Physics Technicians (HPTs) using portable Geiger-Müller (GM) beta/gamma radiation detection meters (Eberline model BNW-1-1 meters with model P-11 probes).^(a) The results for the area around each stake were recorded in counts per minute (cpm). The results are shown in Appendix A. The area between each stake was also surveyed as the traverse was made to detect any anomalous readings; none were found.

The recorded background values (Appendix A) were statistically analyzed using the One-Sided Statistical Tolerance Limits Method (Lieberman 1958). A summary of the results is shown in Table 2.1. This method calculates an upper tolerance limit, which is an upper confidence limit on a proportion of the background population. Any values above the upper tolerance limit were assumed to be above background. The calculated upper tolerance limit was 108.

(a) Eberline Models BNW-1-1 and P-11 are tradenames of the Eberline Instrument Corporation, Santa Fe, New Mexico.

FIGURE 2.1. Background Radiation Plot Locations

TABLE 2.1. Statistical Estimates Obtained from the Background Plot Data Shown in Appendix A, Using the One-Sided Statistical Tolerance Limits Method (Lieberman 1958)

Average (cpm)(a)	67.78
Standard deviation	11.98
Confidence level	0.99
Proportion of population	0.99
Tolerance factor	3.33
Upper tolerance limit	108.0

(a) cpm = counts per minute.

3.0 SURFACE RADIATION SURVEYS

3.1 FIELD METHODS

The field survey team consisted of a PNL field team leader and two to four WHC HPTs. The surveys were conducted along traverses approximately 6 to 12 ft wide (depending on the number of HPTs). These traverses were marked with wooden stakes prior to surveying. A traverse is illustrated in Figure 3.1. As one traverse was completed, another traverse was marked. In this manner, the areas that had already been surveyed could be distinguished from the areas remaining to be surveyed.

The HPTs surveyed continuously across each traverse. The radiation detection meters were slung around the shoulders of the HPT with a strap, and the probe was fastened to a "walking stick," an attachment that allowed them

FIGURE 3.1. A View of a Typical Traverse (wooden stakes in foreground, survey team in background)

to move the probe in an arc across the land surface while walking in a normal, upright position (Figure 3.2). During surveying, the window of the probe was kept in contact (or nearly in contact) with the surface being surveyed (Figure 3.3). In several locations within the operable unit, the vegetation was so thick that the ground surface (soil) could not be surveyed; in these cases, the vegetation itself was surveyed. All survey activities were documented by the PNL field team leader in a PNL Laboratory Record Book. Documentation of field activities was consistent with WHC Environmental Investigation Procedure EII 1.5, "Field Logbooks" (WHC 1988). The HPTs also documented their activities in daily Radiation Survey Reports.

During surveying, the PNL field team leader periodically checked the area with a portable photoionization detector (an instrument that detects volatile organics). No readings above the detection level of the instrument were recorded within the operable unit.

FIGURE 3.2. Photograph of the Health Physics Technicians Performing a Survey

FIGURE 3.3. Close-up View of the Detection Instruments. Note the P-11 probe, which is fastened on the end of the "walking stick," the GM, which is held in the surveyors left hand, and the relative position of the P-11 probe to the ground surface.

3.1.1 Field Application of the Background Estimate

The statistical estimate for the upper tolerance limit for background was 108 cpm (see Table 2.1). Because the survey instruments have an analog readout that can be read only to the nearest 10 to 25 cpm (depending on the user), using 108 cpm as the absolute upper limit of background is not

realistic in the field. Additionally, the HPTs would not continuously read the dial of the instrument as they surveyed; instead, they would listen to the output from the external speaker on the instrument and periodically check the dial. An experienced user can accurately detect significant increases in cpm using this method, which is a standard approved practice on the Hanford Site.

Instead of 108 cpm, a more practical background estimate, taking into account the limits of the instruments and the subjectivity in each user's interpretation of the measurements, is approximately 100 cpm. Thus, this was the number that was actually used.

While surveying, HPTs would slow down or stop with indications of increased activity until they could determine whether or not radioactivity above ambient background was being observed. Selected above-background locations were also surveyed with an Eberline model E-140-B portable alpha meter (PAM). When measurements above the background value were found, the location was marked with wooden stakes and surveyor's tape or radiation area rope, and assigned a location number (e.g., R-1). The location number and the measured value were recorded on the stake. This temporary method of marking the boundaries of the areas was done until the locations could be permanently marked as "surface contamination areas" by personnel from WHC Inactive Facilities Surveillance and Maintenance.

3.2 SURVEY RESULTS

Figure 3.4 shows the areas surveyed. The area due north of the sanitary trenches (the Clinch River equipment storage area) was radiologically surveyed by a separate WHC organization; no measurements above background were found. The area between the two sanitary trenches was not surveyed because the HPTs expressed health concerns about the raw sewage within the trenches and a review of aerial photos of the area taken between 1944 and 1989 showed no evidence of past practices in this area. The area around the Ash Pits and Filter Backwash Pond were not surveyed since historical information from the period of construction of these facilities had not identified any surface contamination.

FIGURE 3.4. Surface Radiation Survey Areas and Areas Above Background Radiation Within the 300-FF-1 Operable Unit

As a result of the survey, a total of 77 locations (identified as R-1 through R-77) were noted as exhibiting above-background radiation. These are shown diagrammatically in Figure 3.4, and in greater detail in Plates 1 and 2, and briefly discussed in the following sections (grouped according to proximity to waste facility). In the discussion, instrument readings are listed as cpm of beta/gamma radiation unless specifically noted as alpha radiation. Location descriptions, including areal extent, instrument readings in cpm, sample-collection indication, current status, and date identified, are presented in Appendix B. Geodetically surveyed coordinates for the areas above background are shown in Appendix C.

3.2.1 Burial Ground #4 (618-4)

Seven locations above background were found near Burial Ground #4, six near the entrance and one outside the north fence. Contamination was found both in soil (R-32) and in metal pieces (R-29 to R-31, R-33 to R-35). Possibly, these contaminated metal pieces were the aluminum end plugs or other material from uranium fuel cladding operations. At the locations where contamination was limited to metal pieces (no soil contamination), the pieces were picked up and placed in a "lard can" (a metal can used for storing low-level radioactive material) and placed within the fenced area of Burial Ground #4.

Location R-32 had the highest level of radiation at 50,000 cpm (within the top 3 in. of soil). Interim remedial actions are being planned to remove and/or isolate this contamination area. The next highest value near Burial Ground #4 was R-34 (1200 cpm).

The area within the burial ground was not radiologically surveyed as part of this task because this is done on an annual basis by WHC personnel as part of their Site Surveillance Program. Recent survey results (November 1989) are shown in Appendix D.

3.2.2 Burial Ground #5 (618-5)

One location above background (R-28) was found near Burial Ground #5 (see Figure 3.4). Location R-28 contained a piece of metal that measured 15,000 cpm. Laboratory analysis (discussed in Section 4.0) showed that it

contained significant levels of ^{238}U and ^{235}U . Near R-28, several uncontaminated items were observed on the ground surface that may indicate the presence of buried material. These included aerosol cans, paint cans, and old D-cell battery casings.

The area within Burial Ground #5 is radiologically surveyed tri-annually by WHC personnel as part of their Site Surveillance Program. A recent survey (April 1990) of this burial ground showed no contamination (Appendix D). During a survey of the burial ground in November 1988, a 4-ft² area containing ^{238}U "slugs" was found (located outside the posted fence) that measured 1400 cpm beta/gamma and 700 disintegrations per minute (dpm) (approximately 70 cpm) alpha (see Appendix D). Ground-penetrating radar also indicated that there may be material buried outside the fence. Therefore, a fence extension was added to include this area. This contaminated area was subsequently covered with approximately 2 ft of "clean" soil.

3.2.3 North Process Pond

Over 40 soil contamination locations were found within a 300-ft radius of the North Process Pond (see Figure 3.4). Contamination immediately adjacent to the pond chiefly occurred along the southwestern and southern perimeters. Most of the areas were only moderately above background (200 to 400 cpm). Exceptions to this include R-11 (200 to 1000 cpm), R-12 (200 to 900 cpm), R-38 (14,000 cpm), R-51 (800 to 1000 cpm), R-57 (800 cpm maximum, 10 cpm alpha), and a very small portion of R-77 (a mud dauber nest; 1500 to 3000 cpm, 70 cpm alpha). The mud dauber nest was located under some old plywood a few feet north of R-68.

Location R-77 includes the "scrapings disposal area." Dredged material from the pond was placed in the scrapings disposal area and then covered with coal fly ash. The apparent boundary of the scrapings disposal area was marked by two types of signs: One with the words "Radiation Zone" in the western one-third of the area and the other with the word "underground" placed above the tri-foil icon representing radioactivity in the eastern two-thirds of the area. These signs are placed approximately every 50 to 100 ft apart. The approximate location of the posted area is shown in Figure 1.2. The northern boundary of the posted area was approximately

30 ft south of the south perimeter road (see Plate 1 for the location of the south perimeter road). Locations R-59 to R-71 are found on or adjacent to the south perimeter road around the pond, and are within R-77 (see Plate 1). The entire area between the pond and the northern boundary of the signs was surveyed. The area defined by the signs was not surveyed entirely since it was suspected to be contaminated. Instead, the perimeter of this area was surveyed, and several longitudinal transects were made across the area to verify and define the boundary of the area in which contaminated material was suspected.

3.2.4 South Process Pond

Thirteen soil contamination locations were identified in the vicinity of the South Process Pond. Three of these are located close to the pond edge (R-74 to R-76) and the others (R-1 to R-10) are located east and northeast of the pond (outside the pond perimeter fence). Location R-1 exhibited the highest reading of this group at 10,000 cpm. The next highest reading of these was R-75, which averaged 200-400 cpm and had a maximum of 800-2000 cpm. Possible contamination sources include a pond overflow and dike failure. According to a letter from W. H. Durum to C. M. Patterson and H. M. Parker, the overflow occurred on August 8, 1945. The dike failure occurred at the north end of the pond on October 25, 1948 (Singlevich and Paas 1949). In both of the above events, pond liquids were discharged into the Columbia River.

Location R-1 was the only place where the soil contamination was removed. Locations R-2 through R-9 underwent preliminary investigations by WHC Inactive Facilities Surveillance and Maintenance personnel to determine whether the contamination at these locations could be easily removed. The contamination was found to extend greater than 6 in. beneath the ground surface. No further efforts were made to remove the contaminated soil. Contaminated soil from excavations made during this investigation were placed in lard cans and stored inside the fenced area of Burial Ground #5.

Extensive areas around the South Process Pond have been covered with coal fly ash. These areas include the zone between the east boundary of the pond and the river, and between the north boundary of the pond and the sanitary trenches. The coal fly ash can be seen as green-to-black areas on

the infrared aerial photo of the operable unit (Figure 1.3). Locations above background within these areas include R-75 and R-76.

An area southwest of the South Process Pond (due west of the ash pits) was not surveyed because of a significant increase in ambient background readings (Figure 3.4). The source of the elevated background is the 340 Complex, which consists of two aboveground buildings that house six 8000-gal aboveground tanks, and two belowground tanks (DOE 1990). At the fence between the South Process Pond and the 340 Complex, readings are 2000 cpm.

Uncontaminated objects in the vicinity of the pond include a steel tank and three 55-gal drums. The steel tank has a capacity of about 200 gal, with a 3-ft-long valve and 1-in.-diameter pipe attached to the tank. Its location is shown in Plate 1. The 55-gal drums are located along the west perimeter of the pond and appear to be empty.

3.2.5 Landfill Area

The contamination found at locations R-39 through R-46 appears to be associated with wastes buried in an undocumented landfill. Some of these wastes appear to have originated from a laboratory. Among the nonradiologically contaminated material visible on the surface were empty acid and mercury bottles, ceramics, and other glassware that appeared to be of laboratory type (e.g., pipettes and 500-ml amber glass bottles), metal, and a partially buried 55-gal drum. Materials that were radiologically contaminated include soil, tumbleweeds, pipes, ceramics, glass, and some small amounts of yellow material that resembled "yellow cake" (a complex uranium compound, the product of chemically refining natural uranium). Location R-40, which ranged from 350 cpm to 25,000 cpm, had the highest reading of these. The next highest was R-39 (7500 cpm).

Aerial photos of the operable unit taken from 1948 to the present show what appear to be trenches or excavations used at various times in an area along the river from approximately 100 ft south of the landfill area to location T-1 (see Figure 3.4). Figures 3.5 and 3.6, photos from 1956 and 1953, show what appear to be two separate trenches, one of which is in approximately the same location as the landfill area (Figure 3.6).

FIGURE 3.5. Photo of the Northern Part of the 300-FF-1 Operable Unit, May 1956. Note the active burial trench south of the burning cage and the disturbed area north of the North Process Pond.

3.2.6 Other Locations

Locations in this category include R-47 through R-50. Location R-47, in the center of a dirt road, is located approximately 80 ft north of the northern boundary of the 300-FF-1 Operable Unit. The location of this boundary (N117, 120 NAD'83 Lambert) has since been marked with stakes approximately 500 ft apart. Location R-47 measures 2500 cpm and is less than 6 in. in diameter. A potential source for this contamination is not known.

Location R-48, due south of the active process trench, is approximately 2.5 ft by 5 ft and measures 250 cpm. Potential sources for this contamination could include windblown material from Burial Grounds #2 and #3 (due

FIGURE 3.6. Photo of a Portion of the 300-FF-1 Operable Unit, June 1953. Note the active burial trench north of the burning cage (this appears to be a different trench than the one shown in Figure 3.2), the disturbed area north of the North Process Pond, and the mound near the river (to the right of the burning cage). The trench seen in the photo is in approximately the same location as the landfill area (see Section 3.2).

west of R-48) or mud droppings associated with swallow nesting activities. After the area near R-48 was surveyed for the current study, additional surface contamination areas were found between the Process Trenches and R-48 by a separate WHC organization. The contamination was caused by swallows collecting contaminated mud from the Process Trenches and then dropping it along their flight path to the 303M Building. This problem has been corrected by the installation of screens over the Process Trenches.

Locations R-49 and R-50 are near the northern fence of the active Process Trenches. Location R-49 consists of what appear to be goose droppings; the location measured 2000 cpm and is less than 2 in. in diameter. Location R-50 is a piece of metal (possibly lead) that measured 300 cpm and is less than 1 in. in diameter.

3.2.7 307 Trench Area

No locations above background were found on the surface of the soil overlying the 307 Trenches. This area was surveyed because the trenches were used in 1965 for the disposal of contaminated soil from the South Process Pond (DOE 1990). The contaminated soil was covered with coal fly ash and then capped with gravel.

3.2.8 Physical Characteristics of Contaminated Soil

Most of the locations shown in Figure 3.1 consisted of contaminated soil. In many of these locations, no visible evidence of contamination could be seen. In some locations, the contaminated soil exhibited an obvious physical change relative to the surrounding soil. Examples of this are shown in Table 3.1.

Contaminated soil samples previously collected from within the North and South Process Ponds (Dennison, Sherwood, and Young 1989) showed a characteristic green color; this was not seen at any of the locations in the current study. Additionally, in all cases the contamination appeared to be sufficiently attached to its associated medium that it was not "smearable."

TABLE 3.1. Observed Physical Characteristics of Contaminated Soil

<u>Location</u>	<u>Physical Characteristic</u>
R-2 through R-8	Absence of vegetation, "bleached" appearance
R-38	Darker color than surrounding soil, absence of vegetation
R-48	"Rusty-red" color
R-53 to R-57, R-62, R-63 R-65, R-68, R-69	Light gray sandy mud (lighter than surrounding soil)

3.3 ULTRA SONIC RANGING AND DATA SYSTEM (USRADS)

The Ultra Sonic Ranging and Data System (USRADS)^(a) was used on a limited basis during this study. USRADS is a computerized data collection system that enables the user to correlate geographic location with data gathered at that location. A variety of measuring devices may be used with this system; for the present study, a 2- by 1-in. NaI (Tl) radiation detector was used.

The system consists of a detector, data pack, stationary receivers (SRs), a master receiver, and a portable computer. Two people are required to operate the system; a surveyor who carries the data pack and detector, and another person to operate the computer and master receiver.

During setup, the SRs (up to 15) are positioned in an array across the survey area. The ideal size area for a survey is 200 ft by 200 ft or less. Therefore, an area larger than 40,000 ft² would require a separate setup. The positions of the SRs are then plotted on a coordinate system relative to a "baseleg." The baseleg consists of two SRs at a known distance from each other. The position of the baseleg SRs must be geodetically surveyed (either before or after the USRADS survey) so that survey data can be referenced to a standard coordinate system (i.e., Lambert coordinates).

Once the survey begins, the position of the surveyor is determined by differences in arrival times of an ultrasonic pulse, which is sent from the data pack at 1-s intervals to the SRs. At the same time that the ultrasonic pulse is sent from the data pack, a radio frequency transmission is sent to the master receiver from the data pack that also includes a measurement by the detector. As soon as the ultrasonic signal from the data pack is received by the SRs, a radio frequency transmission is sent to the master receiver. The time period between the two radio frequency transmissions is used by the computer to calculate the distance between the surveyor and the SRs. The location of the surveyor can then be determined by triangulation, and the location and detector reading are recorded on disk by the computer

(a) USRADS is manufactured by CHEMRAD Tennessee Corporation, Oak Ridge, Tennessee.

for each 1-s interval. The operator can also view the location of the surveyor on a "track map" on the computer screen. This enables the operator to see any gaps in the data record and direct the surveyor to the location of the gaps.

3.3.1 USRADS Survey Results

The area that was surveyed using the USRADS equipment is shown in Figure 3.4 and Plate 1. Plate 1 also shows the above-background locations previously found using the GM/P-11 probes. The USRADS survey was done as part of a training session on the equipment under the supervision of a CHEMRAD Tennessee Corporation representative. In the approximately 25,000 ft² area that was surveyed, 7820 data points were collected. A color-coded track map showing the range of measurements is shown in Figure 3.7. The blank strip in the northwestern portion of this figure represents an area not surveyed because the slope of the land surface was too great to safely allow traverses.

It is not possible to apply the calculated background estimate (Section 2.0) to the USRADS data because the sensitivity of the two detectors differ. Both the GM/P-11 and NaI (Tl) detectors can detect beta and gamma radiation. However, the GM/P-11 detector is more sensitive to gross beta radiation and the NaI (Tl) detector is more sensitive to gamma radiation and can to some extent, detect radiation beneath the ground surface. Therefore, to judge whether contamination may be present in the USRADS results, the data were statistically analyzed in order to isolate areas with significantly elevated measurements.

3.3.2 Statistical Analysis of the USRADS Data

Summary statistics for the USRADS data are shown in Table 3.2. As shown in this table, the minimum, maximum, and mean values found were 2160 cpm, 7520 cpm, and 3510 cpm, respectively. The above number of samples did not include 12 obviously incorrect readings; these were removed from the data. These incorrect values were either large negative numbers or numbers much greater than 8000 cpm (2 million and 645 million). These erroneous data points were apparently caused by a malfunction in the data pack. The cause of this malfunction is under investigation.

enough to be shielded from the GM/P-11 detector. The above hypotheses could be tested by soil sampling and analysis of selected locations within the survey area; this could be performed under Task 3b (Soil Sampling and Analysis).

FIGURE 3.8. Histogram of the USRADS Data

KCOUNTS ● ● ● 2.0-3.0 ● ● ● 3.0-3.5 ● ● ● 3.5-4.0
 ● ● ● 4.0-5.0 ● ● ● 5.0-7.5

FIGURE 3.7. Color-Coded Track Map of the USRADS Survey Area. The colors represent measurement levels for the NaI (Tl) detector.

TABLE 3.2. USRADS Data Summary Statistics

Number of samples	7820
Minimum (cpm)	2160
Maximum (cpm)	7520
Mean (cpm)	3510
Median (cpm)	3480
Standard deviation	376
5th percentile	2960
95th percentile	4120

A histogram of the data is shown in Figure 3.8. This histogram gives the appearance of an approximately bell-shaped, normal distribution of measurements with a small number of larger measurements in the right tail (>95th percentile). Since a normal distribution represents expected natural and measurement variability, a deviation from the normal distribution might represent contamination, especially if the points are found in clusters and are not randomly dispersed throughout the survey area.

Figure 3.9 is a normal probability plot (based on a method in Holoway et al. 1981) of the USRADS data. If all the data were from a normal distribution then all of the plotted points would be expected to form a straight line pattern. Examination of this plot shows that a majority of the data (more than 98%) appear to be from an underlying normal distribution. However, there is a discernible shift in the plotted points at about 4.4 kcpm (thousand counts per minute) and another at about 5.1 kcpm. Therefore, measurements above 4400 cpm may be indicative of contamination. Figure 3.10 is a map that shows the locations of points with values above 4400 cpm overlain on a portion of Plate 1.

The points shown on Figure 3.10 generally have a north-south trend and do not correlate with the above-background locations found with the GM/P-11 detector. Hypotheses for the lack of correlation between the two detectors include: 1) the type of radiation found by the two detectors differed (i.e., the locations found by the GM/P-11 probe consisted primarily of beta radiation of insufficient energy to be detected by the NaI (Tl) detector, and the locations found by the NaI (Tl) detector consisted primarily of gamma radiation that was undetected by the GM/P-11 detector; 2) the locations found by the NaI (Tl) detector consisted of gamma radiation buried at a depth great

FIGURE 3.9. Normal Probability Plot of the USRADS Data. Note the changes in slope at 4.4 kcpm (4400 cpm) and 5.1 kcpm (5100 cpm).

FIGURE 3.10. Locations of Points Above 4400 cpm

4.0 SOIL SAMPLE COLLECTION AND ANALYSIS

Several of the locations shown in Figure 3.1 were sampled, these locations are indicated in Appendix B. Sediment samples were collected with a stainless steel spatula and placed into 500 ml clear-glass, wide-mouth bottles with Teflon-lined lids. These samples were analyzed by PNL for selected metals and gamma, and ^{90}Sr emitting radionuclides. Laboratory sample analysis methods are discussed in Appendix E.

The results from these analyses are presented in Table 4.1. The results indicated that the above-background radiation levels were due primarily to the presence of uranium. The sample from R-1 was the only sample that had an elevated concentration of ^{90}Sr . Three soil samples contained concentrations of copper exceeding 1000 ppm and four contained concentrations between 100 and 1000 ppm, but there does not appear to be a linear relationship between the concentration of copper and uranium.

Several pieces of non-radioactive, brown, fibrous, tile of the type generally used as siding material for houses and buildings during the 1940s and 1950s were observed on the ground surface in the northeast portion of the operable unit. A sample of this tile (T-1) was collected for analysis by the Hanford Environmental Health Foundation (HEHF); the sample location is shown in Figure 3.1. The analysis results indicated that the sample contained 10% to 20% chrysotile asbestos. The analysis report for this sample is presented in Appendix F.

TABLE 4.1. Analytical Results from Samples Collected During Surface Radiation Survey Activities

Constituent Sample I	Sample Type	U-238 (pci/g)	U-235 (pci/g)	Copper (ppm)	Selenium (ppm)	Lead (ppm)	Arsenic (ppm)	Uranium (ppm)	Sr-90 (pci/g)
300-FF-1 R1	SED	22.8	<3	180.6 ± 9.7	0.90 ± 0.43	19.5 ± 1.6	4.30 ± 0.74	680 ± 48	752 ± 73
300-FF-1 R2	SED	102.0	4.93	85.0 ± 5.0	<0.95	31.2 ± 2.5	7.2 ± 1.2	517 ± 36	0.23 ± 0.06
300-FF-1 R6	SED	153.0	6.54	123.6 ± 6.8	<0.93	37.9 ± 2.6	5.9 ± 1.1	706 ± 50	0.39 ± 0.07
300-FF-1 R8	SED	112.0	4.23	114.8 ± 6.4	<0.93	33.5 ± 2.4	5.7 ± 1.1	502 ± 35	0.27 ± 0.07
300-FF-1 R9	SED	101.0	6.34	1005 ± 51	<0.91	25.9 ± 2.1	5.2 ± 1.1	492 ± 35	0.27 ± 0.06
300-FF-1 R10	SED	165.0	13.10	5650 ± 280	<1.0	79.3 ± 4.6	2.8 ± 1.4	674 ± 47	0.39 ± 0.06
300-FF-1 R11	SED	197.0	7.99	110.0 ± 6.1	<0.04	16.4 ± 1.6	3.16 ± 0.81	466 ± 34	<0.06
300-FF-1 R12	SED	63.2	3.50	73.3 ± 4.3	<0.80	15.5 ± 1.6	1.63 ± 0.76	185 ± 13	0.14 ± 0.06
300-FF-1 R13	SED	21.5	<3	34.0 ± 2.4	<0.81	16.1 ± 1.6	2.20 ± 0.75	169 ± 12	<0.06
300-FF-1 R14	SED	77.2	4.12	43.0 ± 2.9	<0.82	24.3 ± 1.9	1.64 ± 0.84	226 ± 16	0.20 ± 0.06
300-FF-1 R15	SED	75.8	3.49	34.9 ± 2.5	<0.79	23.9 ± 1.8	1.80 ± 0.78	155 ± 11	0.14 ± 0.06
300-FF-1 R16	SED	119.0	6.10	28.9 ± 2.2	<0.83	21.4 ± 1.8	1.60 ± 0.79	153 ± 11	0.54 ± 0.09
300-FF-1 R17	SED	61.8	3.20	29.3 ± 2.3	<0.84	18.8 ± 1.7	2.97 ± 0.85	147 ± 10	<0.05
300-FF-1 R19	SED	61.4	<3	39.5 ± 2.8	<0.79	24.4 ± 1.9	3.04 ± 0.86	182 ± 13	0.12 ± 0.04
300-FF-1 R20B	SED	60.4	3.20	35.5 ± 2.8	<0.83	22.3 ± 1.8	2.28 ± 0.85	140 ± 10	<0.05
300-FF-1 R23	SED	289.0	18.20	4420 ± 220	<1.0	76.2 ± 4.4	<2.4	1115 ± 78	0.23 ± 0.06
300-FF-1 R26	SED	46.5	2.68	144.2 ± 7.9	<0.87	26.9 ± 2.1	4.19 ± 0.94	219 ± 16	0.14 ± 0.05
300-FF-1 R27	SED	45.1	2.52	60.9 ± 3.7	<0.84	21.0 ± 1.8	3.45 ± 0.86	171 ± 12	<0.07
300-FF-1 R28	METAL	18900.0	843.00	NA	NA	NA	NA	NA	NA
300-FF-1 R32	SED	4410.0	23.80	38.9 ± 2.8	<0.99	58.9 ± 3.5	2.3 ± 1.1	18500 ± 1300	NA
300-FF-1 R38	SED	90.9	5.33	77.7 ± 4.7	<0.91	78.5 ± 4.5	2.9 ± 1.2	1322 ± 93	NA

SED = Sediment Sample
NA = Not Analyzed

5.0 RECOMMENDATIONS FOR FUTURE WORK FOR TASK 3a-1

Additional surface radiation survey work is recommended. This will more completely characterize selected sites and provide information that will aid Task 3b-1 in siting borehole locations for soil sampling. This work would utilize the USRADS equipment and an NaI (Tl) and GM/P-11 detectors and would include the following locations:

- the landfill area (Figure 3.4) and areas adjacent to it that show evidence of disturbance based on field observations or from examination of aerial photos
- selected areas between the North and South Process Ponds and the river, especially near locations where measurements above back-ground were found with the GM/P-11 probe
- the Scrapings Disposal Area
- the surface of the North and South Process Ponds.

Comparison of the data previously collected by the two types of detectors (GM/P-11 and NaI) show the limitations of using only data from the GM/P-11 detector (Section 3.2). Resurveying the above sites with the NaI detector will provide a more complete view of the lateral extent of contamination. Also, because this probe can, to some extent, detect contamination from beneath the ground surface, it will provide some information on the extent of near-surface contamination.

Finally, it is recommended that proposed locations of boreholes for background soil characterization be surveyed using the USRADS equipment and the NaI detector to ensure that the location was not affected by facility operations.

6.0 REFERENCES

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APPENDIX A

MEASUREMENTS RECORDED AT BACKGROUND PLOTS 1, 2, AND 3

APPENDIX A

MEASUREMENTS RECORDED AT BACKGROUND PLOTS 1, 2, AND 3

<u>Background Plot #1</u>	
<u>Stake No.</u>	<u>Measurement (cpm)</u>
A-1	70
A-2	70
A-3	70
A-4	80
B-1	80
B-2	70
B-3	80
B-4	70
C-1	50
C-2	50
C-3	60
C-4	60

<u>Background Plot #2</u>	
<u>Stake No.</u>	<u>Measurement (cpm)</u>
D-1	70
D-2	70
D-3	70
D-4	60
E-1	80
E-2	70
E-3	50
E-4	80
F-1	60
F-2	80
F-3	50
F-4	70

<u>Background Plot #3</u>	
<u>Stake No.</u>	<u>Measurement (cpm)</u>
G-1	80
G-2	60
G-3	60
G-4	70
H-1	100
H-2	50
H-3	50
H-4	70
I-1	80
I-2	70
I-3	50
I-4	80

APPENDIX B

DESCRIPTION OF AREAS ABOVE BACKGROUND FOUND DURING
THE SURFACE RADIATION SURVEY OF THE 300-FF-1
OPERABLE UNIT, SEPTEMBER 1989 TO JUNE 1990

TABLE B.1. Description of Areas Above Background Found During the Surface Radiation Survey of the 300-FF-1 Operable Unit, September 1989 to June 1990

Location	Approximate Areal Extent	GM/P-11 Instrument Reading (cpm)	PAM Instrument Reading (cpm)	Sampled?	Date Identified	Description/Status
R-1	6 in. diameter	10,000	-	yes	9/27/89	Contaminated soil/Removed
R-2	4 ft diameter	250-300	-	yes	9/27/89	Contaminated soil/Locations R-2 through R-8 are included in one surface contamination radiation area.
R-3	4 ft diameter	250-300	-	no	9/27/89	
R-4	6 in. diameter	250-300	-	no	9/27/89	
R-5	6 in. diameter	250-300	-	no	9/27/89	
R-6	6 ft x 10 ft	250-300	-	yes	9/28/89	
R-7	6 in. x 1 ft	250-300	-	no	9/28/89	Contaminated soil/Marked as a surface contamination radiation area.
R-8	6 in. x 1 ft	250-300	-	yes	9/28/89	
R-9	6 ft x 9 ft	500-1500	-	yes	9/29/89	
R-10	1 ft diameter	600-700	-	yes	9/29/89	
R-11	2 ft diameter	200-1000	-	yes	10/13/89	
R-12	2 ft x 8 ft	200-900	-	yes	10/13/89	
R-13	3 ft diameter	250-400	-	yes	10/16/89	

TABLE B.1. (contd)

Location	Approximate Areal Extent	GM/P-11 Instrument Reading (cpm)	PAM Instrument Reading (cpm)	Sampled?	Date Identified	Description/Status
R-14	6 in. diameter	500	-	yes	10/17/89	Contaminated soil/Locations R-14 through R-16 have been included in one surface con- tamination radiation area.
R-15	4 ft diameter	500	-	yes	10/17/89	
R-16	6 in. diameter	500	-	yes	10/17/89	
R-17	6 in. diameter	750	-	yes	10/17/89	Contaminated soil/Locations R-17 through R-27 have been included in one surface con- tamination radiation area.
R-18	6 in. diameter	500	-	no	10/17/89	
R-19	2 ft diameter	400	-	yes	10/18/89	
R-20A,B	4 ft x 20 ft	250	-	yes	10/18/89	
R-21	2 ft diameter	250	-	no	10/18/89	
R-22	50 ft diameter	150	-	no	10/18/89	
R-23	5 ft x 20 ft	350	-	yes	10/18/89	
R-24	Within 80 ft x 200 ft area	250	-	no	10/18/89	Contaminated soil/Locations R-17 through R-27 have been included in one surface contamination radiation area.
R-25	Within 80 ft x 200 ft area	250	-	no	10/18/89	
R-26	Within 80 ft x 200 ft area	250	-	yes	10/18/89	
R-27	Within 80 ft x 200 ft area	250	-	yes	10/18/89	

TABLE B.1. (contd)

Location	Approximate Areal Extent	GM/P-11 Instrument Reading (cpm)	PAM Instrument Reading (cpm)	Sampled?	Date Identified	Description/Status
R-28	0.5 in. x 1 in.	15,000	-	yes	10/31/89	Contaminated metal/Removed and sent to lab for analysis.
R-29	2 in.	300	< det. (a)	no	11/1/89	Contaminated metal/Removed and placed in a "lard can" within Burial Ground #4 fenced area.
R-30	3 in.	700	< det.	no	11/1/89	
R-31	2 in.	300	< det.	no	11/1/89	
R-32	5 ft diameter	50,000	50	yes	11/1/89	Contaminated soil/Marked as a surface contamination radiation area.
R-33	2 in.	300	< det.	no	11/1/89	Contaminated metal/Removed and placed in a "lard can" within Burial Ground #4 fenced area.
R-34	<1 ft	1200	< det.	no	11/2/89	
R-35	<1 ft	200	< det.	no	11/2/89	
R-36	3 ft x 3 ft	200-600	< det.	no	11/6/89	Contaminated soil/Marked as a surface contamination radiation area.
R-37	3 ft x 3 ft	200-600	-	no	11/6/89	
R-38	5 in.	14,000	< det.	yes	11/8/89	
R-39	4 ft x 11 ft	7500	-	no	11/15/89	

TABLE B.1. (contd)

Location	Approximate Areal Extent	GM/P-11 Instrument Reading (cpm)	PAM Instrument Reading (cpm)	Sampled?	Date Identified	Description/Status
R-40	11 ft x 74 ft	350-25,000	< det.	no	11/15/89	Contaminated soil and glass/ Marked as a surface contami- nation radiation area.
R-41	18 ft x 14 ft	850-1000	< det.	no	11/16/89	Contaminated soil and pipes/ Marked as a surface contami- nation radiation area. Also contains nonradioactive, empty mercury bottle, metal, and ceramics.
R-42	6 ft x 9 ft	800	-	no	11/16/89	Contaminated soil and tumble- weed/Marked as a surface con- tamination radiation area.
R-43	6 in. diameter	200	-	no	11/17/89	Contaminated soil/Marked as a surface contamination radiation area. Also con- tains nonradioactive, broken glass and ceramics.
R-44	6 in. diameter	150	-	no	11/17/89	Contaminated disks of metallic or ceramic composition, rusty- red color/Marked as a surface contamination radiation area.
R-45	12 ft x 16 ft	150-350	-	no	11/20/89	Small mound with debris on top - contaminated soil and ceramics/Marked as a surface contamination radiation area.

TABLE B.1. (contd)

Location	Approximate Areal Extent	GM/P-11 Instrument Reading (cpm)	PAM Instrument Reading (cpm)	Sampled?	Date Identified	Description/Status
R-46	6 in. diameter	150-350	-	no	11/20/89	Contaminated soil and metal/ Marked as a surface contami- nation radiation area.
R-47	<6 in. diameter	2500	-	no	11/28/89	Contaminated soil
R-48	2.5 ft x 5 ft	250	-	no	4/24/90	Contaminated soil/Marked as surface contamination radiation area.
R-49	<2 in. diameter	2000	-	no	5/8/90	Contaminated animal feces/ Marked as surface contami- nation radiation area.
R-50	<1 in. diameter	300	-	no	5/8/90	Contaminated metal/Marked as surface contamination radiation area.
R-51	1 ft diameter	800-1000	< det.	no	6/1/90	Contaminated soil/Marked as surface contamination radiation areas.
R-52	2 ft diameter	250	-	no	6/8/90	
R-53	1 ft diameter	200-250	< det.	no	6/12/90	
R-54	5 ft x 10 ft	400	10	no	6/12/90	
R-55	<1 ft diameter	400	< det.	no	6/12/90	
R-56	<1 ft diameter	300	< det.	no	6/12/90	
R-57	22 ft x 72 ft	800 maximum	10	no	6/12/90	
R-58	4 ft x 4 ft	250	< det.	no	6/12/90	

TABLE B.1. (contd)

Location	Approximate Areal Extent	GM/P-11		PAM Instrument Reading (cpm)	Sampled?	Date Identified	Description/Status
		Instrument Reading (cpm)	Instrument Reading (cpm)				
R-59	80 ft x 60 ft	450 maximum		< det.	no	6/12/90	Contaminated soil/Locations R-59 to R-71 have been included in one large sur- face contamination radiation area that is labeled R-77.
R-60	8 ft x 3 ft	300		< det.	no	6/13/90	
R-61	<6 in. diameter	200		< det.	no	6/13/90	
R-62	3 ft x 5 ft	200		< det.	no	6/13/90	
R-63	<6 in. diameter	200		< det.	no	6/13/90	
R-64	<6 in. diameter	200		< det.	no	6/13/90	
R-65	<6 in. diameter	200		< det.	no	6/13/90	
R-66	<6 in. diameter	500		< det.	no	6/13/90	
R-67	<6 in. diameter	400		< det.	no	6/13/90	
R-68	7 ft x 32 ft	200-400 500 maximum		< det.	no	6/13/90	
R-69	3 ft x 5 ft	300 maximum		< det.	no	6/13/90	
R-70	2 ft x 3 ft	300		< det.	no	6/13/90	
R-71	10 ft x 10 ft	650 maximum		10	no	6/14/90	

TABLE B.1. (contd)

Location	Approximate Areal Extent	GM/P-11 Instrument Reading (cpm)	PAM Instrument Reading (cpm)	Sampled?	Date Identified	Description/Status
R-72	2 ft diameter	400	< det.	no	6/18/90	Contaminated soil/Locations R-71 and R-72 are included in surface contamination radiation area.
R-73	2 ft diameter	400	< det.	no	6/18/90	
R-74	40 ft x 138 ft	300 maximum	< det.	no	6/19/90	Contaminated soil/Marked as surface contamination radiation areas.
R-75	30 ft x 300 ft	200-400 avg. 800-2000 maximum	< det.	no	6/25/90	
R-76	62 ft x 10 ft	100-200	< det.	no	6/25/90	Contaminated soil/Large sur- face contamination radiation area that includes locations R-59 to R-71 (see above).
R-77	650 ft x 200 ft	100-200 avg. 1500-3000 maximum	< det. 70 maximum	no	6/18/90	

(a) det. = detection limit.

APPENDIX C

GEODETTIC SURVEY RESULTS FOR SURFACE RADIATION SURVEY LOCATIONS ABOVE BACKGROUND

APPENDIX C

GEODETIC SURVEY RESULTS FOR SURFACE RADIATION SURVEY LOCATIONS ABOVE BACKGROUND

NOTE: The metal fragments at locations R-28 through R-31 and R-33 through R-35 were not surveyed because they had been removed by the time the geodetic survey was performed.

KAISER ENGINEERS HANFORD		SURVEY DATA REPORT		Request No. — 9 0 1 — 0 1 5	
Project/W.O. No. 880979		Title 300-FF-1 OPERABLE UNIT		File No. 3 A N E — 1 0 2 6	
KEH Job No. 880979		Prepared By N.P. Fastabend		Date 01/30/90	
				Reviser <i>[Signature]</i> 114	
DESCRIPTION OF WORK		ACCEPTABILITY (Within Plan Tolerance)		DISTRIBUTION	
Horizontal location of new surface radiation		Yes ☐		Survey File ☐ 00	
zones which have been fenced and flagged.		No ☐		Field Project File ☐ 0	
		NA ☒		M. Chambers ☐ 1	
		TBD by			
		Requestor ☐			
SURVEY RESULTS AND COMMENTS					
RADIATION AREA NO.	COORDINATES		DESCRIPTION		
	NAD '83 (Meters)	OLD RICHLAND (U.S. Feet)			
R1	N: 116,131.53 E: 594,446.16	N: 55,102.4 E: 16,316.5	STAKE MARKED "R1"		
R2-8	N: 116,146.92 E: 594,443.13	N: 55,153.0 E: 16,307.3	S.W. COR. FENCE		
R9	N: 116,215.10 E: 594,429.47	N: 55,377.3 E: 16,265.7	"		
R10	N: 116,229.51 E: 594,451.53	N: 55,423.5 E: 16,338.8	"		
R11	N: 116,659.48 E: 594,330.01	N: 56,840.0 E: 15,960.8	"		
R12	N: 116,683.47 E: 594,324.47	N: 56,919.0 E: 15,943.8	"		

KEH-150,115-24

KAISER ENGINEERS HANFORD		FIELD SKETCH	
Attachment To Or Description: 300-FF-1 OPERABLE UNIT-Hor. location new surface rad. zones			Sheet 2 of 4
RADIATION AREA NO.	COORDINATES		DESCRIPTION
	NAD '83 (Meters)	OLD RICHLAND (U.S. Feet)	
R13	N: 116,746.67 E: 594,256.57	N: 57,129.6 E: 15,724.0	S.W. COR. FENCE
R14-16	N: 116,725.46 E: 594,210.90	N: 57,062.2 E: 15,573.2	"
R17-27	N: 116,704.99 E: 594,194.93	N: 56,995.8 E: 15,519.8	ANGLE POINT "A" OF FENCED AREA
R17-27	N: 116,700.49 E: 594,196.85	N: 56,981.0 E: 15,525.9	" "B" "
R17-27	N: 116,674.67 E: 594,188.86	N: 56,896.7 E: 15,498.4	" "C" "
R17-27	N: 116,667.56 E: 594,182.89	N: 56,873.6 E: 15,478.5	" "D" "
R17-27	N: 116,661.56 E: 594,176.27	N: 56,854.3 E: 15,456.5	" "E" "
R17-27	N: 116,655.95 E: 594,173.24	N: 56,835.7 E: 15,462.7	" "F" "

KEH-159.2 4-82

KAISER ENGINEERS HANFORD		FIELD SKETCH	
Attachment To Or Description: 300-FF-1 OPERABLE UNIT - Hor. location new surface rad. zones			Sheet <u>3</u> of <u>4</u>
RADIATION AREA NO.	COORDINATES		DESCRIPTION
	HAD '83 (Meters)	OLD RICHLAND (U.S. Feet)	
R17-27	N: 116,642.78 E: 594,151.00	N: 56,793.9 E: 15,372.7	ANGLE POINT "G" OF FENCED AREA
R17-27	N: 116,666.33 E: 594,139.88	N: 56,871.7 E: 15,337.3	" "H" "
R17-27	N: 116,682.74 E: 594,159.98	N: 56,924.5 E: 15,404.1	" "I" "
R32	N: 116,933.83 E: 593,849.60	N: 57,763.2 E: 14,397.8	S.W. COR. FENCE
R36	N: 116,496.55 E: 594,402.53	N: 56,302.0 E: 16,190.9	"
R37	N: 116,538.96 E: 594,382.66	N: 56,442.1 E: 16,127.7	"
R38	N: 116,643.16 E: 594,358.98	N: 56,785.1 E: 16,055.1	"
R39	N: 116,836.12 E: 594,300.97	N: 57,421.0 E: 15,374.0	"

10-4-1997 J.D.P.

KAISER ENGINEERS
HANFORD

FIELD SKETCH

300-FF-1 OPERABLE UNIT - Here. location new surface rad. cones

Sheet 1 of 1

RADIATION AREA NO.	COORDINATES		DESCRIPTION
	NAD '83 (Meters)	OLD RICHLAND (U.S. Feet)	
R40	N: 116,842.50 E: 594,304.29	N: 57,441.7 E: 15,885.2	S.W. COR. FENCE
R41-43	N: 116,861.62 E: 594,331.42	N: 57,503.2 E: 15,975.1	"
R44	N: 116,860.32 E: 594,310.32	N: 57,499.9 E: 15,905.8	"
R45	N: 116,883.29 E: 594,276.09	N: 57,576.9 E: 15,794.6	"
R46	N: 116,856.25 E: 594,301.68	N: 57,487.0 E: 15,877.3	"
R47	N: 117,145.29 E: 594,269.34	N: 58,436.8 E: 15,785.1	STAKE MARKED "R47"

51 592 432

KAISER ENGINEERS HANFORD		SURVEY DATA REPORT		Project No. — 3123 — 2000	
Project No. No. S-30079		File 300-FF-1 OPERABLE UNIT		File No. 3123 N E — 2000	
Project No. No. S-30079		Project No. No. N.E. FACTABEND		Date 9/14/90	
DESCRIPTION OF WORK		ACCEPTABILITY Within Plan Tolerance		DISTRIBUTION	
Obtain both Lambert (NAD'83) and old Richland (300 Area) coordinates of additional "hot spots."		Yes ☐		Survey File ☐	
		No ☐		Field Project File ☐	
		NA ☒		M. Chamness ☐	
		TBD by Requestor ☐			
SURVEY RESULTS AND COMMENTS					
RADIATION AREA NO.	COORDINATES		DESCRIPTION		
	LAMBERT NAD'83 (METERS)	OLD RICHLAND (U.S. FEET)			
USRAD #1	N 116,589.3 E 594,360.5	N 56,608.3 E 16,057.5	STICK (SO MARKED)		
USRAD #2	N 116,592.2 E 594,385.3	N 56,616.8 E 16,140.6	"		
R-48	N 116,329.8 E 594,078.3	N 55,770.5 E 15,119.2	S.W. COR.		
R-49	N 116,932.8 E 594,072.9	N 57,749.2 E 15,130.5	STICK (SO MARKED)		
R-50	N 116,941.4 E 594,052.3	N 57,778.3 E 15,064.3	"		
R-51	N 116,647.5 E 594,175.3	N 56,808.2 E 15,452.7	S.W. COR.		

KEH 1021-112

KAISER ENGINEERS
HANFORD

FIELD SKETCH

Attachment to SF Description

SHEET

21

300-FE-1 OPERABLE UNIT/SURVEY LOCATION OF "HOT SPOTS"

RADIATION AREA NO.	COORDINATES		DESCRIPTION
	LAMBERT NAD'83 (METERS)	OLD RICHLAND (U.S. FEET)	
R-52	N 116,548.2 E 594,386.3	N 56,472.4 E 16,140.2	S.W. COR. (STICK MARKED R-51)
R-53	N 116,547.1 E 594,139.3	N 56,480.4 E 15,329.8	S.W. COR.
R-54	N 116,526.9 E 594,136.9	N 56,414.2 E 15,320.9	"
R-55	N 116,507.7 E 594,139.1	N 56,351.3 E 15,327.1	"
R-56 & R-57	N 116,503.8 E 594,132.6	N 56,338.8 E 15,305.8	N.W. COR.
"	N 116,503.9 E 594,138.5	N 56,338.9 E 15,325.1	N.E. COR.
"	N 116,476.7 E 594,138.8	N 56,249.7 E 15,324.6	S.E. COR
"	N 116,476.5 E 594,133.0	N 56,249.1 E 15,305.7	S.W. COR.
R-58	N 116,463.1 E 594,136.2	N 56,205.1 E 15,315.4	S.W. COR.

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HANFORD

FIELD SKETCH

Attachment To 37 Description

300-FF-1 OPERABLE UNIT/SURVEY LOCATION OF "HOT SPOTS"

Sheet 3

RADIATION AREA NO.	COORDINATES		DESCRIPTION
	LAMBERT NAD'83 (METERS)	OLD RICHLAND (U.S. FEET)	
R-59 Thru R-71 & R-77	N 116,443.0 E 594,133.4	N 56,139.1 E 15,305.5	ANGLE PT. BOUNDARY
R-59 Thru R-71 & R-77	N 116,414.2 E 594,134.1	N 56,044.6 E 15,306.4	ANGLE PT. BOUNDARY
"	N 116,413.4 E 594,139.1	N 56,042.0 E 15,322.7	"
"	N 116,387.1 E 594,138.5	N 55,955.6 E 15,319.4	"
"	N 116,378.3 E 594,145.7	N 55,926.3 E 15,342.7	"
"	N 116,374.8 E 594,152.5	N 55,914.6 E 15,364.8	"
"	N 116,377.4 E 594,175.1	N 55,922.2 E 15,438.9	"
"	N 116,375.7 E 594,197.8	N 55,915.4 E 15,513.5	"
"	N 116,380.0 E 594,221.4	N 55,929.4 E 15,591.2	"

KAISER ENGINEERS
HANFORD

FIELD SKETCH

Attachment To Or Description

Sheet

4

7

300-FF-1 OPERABLE UNIT/SURVEY LOCATION OF "HOT SPOTS"

RADIATION AREA NO.	COORDINATES		DESCRIPTION
	LAMBERT NAD'83 (METERS)	OLD RICHLAND (U.S. FEET)	
"	N 116,404.3 E 594,297.1	N 56,004.5 E 15,840.4	"
R-59 Thru R-71 & R-77	N 116,414.4 E 594,307.9	N 56,037.2 E 15,876.6	ANGLE PT. BOUNDARY
"	N 116,451.3 E 594,319.9	N 56,157.5 E 15,917.5	"
"	N 116,429.9 E 594,332.3	N 56,086.6 E 15,957.2	"
"	N 116,430.4 E 594,341.4	N 56,087.9 E 15,987.1	"
"	N 116,477.8 E 594,349.3	N 56,242.9 E 16,015.2	"
"	N 116,491.4 E 594,359.5	N 56,287.3 E 16,049.4	"
"	N 116,501.3 E 594,354.4	N 56,319.8 E 16,033.3	"
R-72 & R-73	N 116,345.3 E 594,144.1	N 55,818.1 E 15,335.7	S.W. COR.

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HALLFORD

FIELD SKETCH

Attachment 13. Description 300-FE-1 OPERABLE UNIT/SURVEY LOCATION OF "HOT SPOTS"			Sheet 5 of 7
RADIATION AREA NO.	COORDINATES		DESCRIPTION
	LAMBERT NAD'83 (METERS)	OLD RICHLAND (U.S. FEET)	
R-74	N 115,995.4 E 594,281.0	N 54,663.5 E 15,768.0	ANGLE PT. BOUNDARY
"	N 116,002.8 E 594,280.4	N 54,688.1 E 15,766.5	"
"	N 116,006.5 E 594,267.4	N 54,700.6 E 15,723.9	"
"	N 116,000.1 E 594,240.5	N 54,681.0 E 15,635.5	"
"	N 115,994.0 E 594,240.2	N 54,661.0 E 15,634.3	"
R-76	N 116,209.4 E 594,299.9	N 55,364.7 E 15,840.3	"
"	N 116,212.1 E 594,322.9	N 55,372.5 E 15,915.8	"
"	N 116,208.7 E 594,324.7	N 55,361.2 E 15,921.7	"
"	N 116,204.3 E 594,319.1	N 55,347.2 E 15,903.1	"

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HANFORD

FIELD SKETCH

Attachment To Or Description

300-FF-1 OPERABLE UNIT/SURVEY LOCATION OF "HOT SPOTS"

Sheet 6 of 7

RADIATION AREA NO.	COORDINATES		DESCRIPTION
	LAMBERT NAD'83 (METERS)	OLD RICHLAND (U.S. FEET)	
R-75	N 116,213.7 E 594,269.7	N 55,380.4 E 15,741.5	ANGLE PT. BOUNDARY
"	N 116,219.5 E 594,264.8	N 55,399.8 E 15,725.8	"
"	N 116,213.1 E 594,249.2	N 55,379.3 E 15,674.1	"
"	N 116,204.1 E 594,232.8	N 55,350.8 E 15,620.1	"
"	N 116,208.1 E 594,230.3	N 55,363.9 E 15,612.1	"
"	N 116,207.9 E 594,219.4	N 55,363.8 E 15,576.3	"
"	N 116,198.1 E 594,200.3	N 55,332.6 E 15,513.1	"
"	N 116,192.8 E 594,200.3	N 55,315.2 E 15,512.9	"
"	N 116,179.9 E 594,183.6	N 55,273.8 E 15,457.2	"

KAISER ENGINEERS
HANFORD

FIELD SKETCH

Attachment to Description

Sheet 7 of 7

300-FF-1 OPERABLE UNIT/SURVEY LOCATION OF "HOT SPOTS"

RADIATION AREA NO.	COORDINATES		DESCRIPTION
	LAMBERT NAD'83 (METERS)	OLD RICHLAND (U.S. FEET)	
R-75	N 116,173.1 E 594,186.1	N 55,251.1 E 15,465.4	ANGLE PT. BOUNDARY
"	N 116,183.7 E 594,205.8	N 55,284.9 E 15,530.3	"
"	N 116,181.9 E 594,217.2	N 55,278.5 E 15,567.7	"

KAISER ENGINEERS HANFORD		SURVEY DATA REPORT		Accession No. 9 0 3 1 2 1 1 4	
Project W.O. No. B-30979		Title 300-FF-1 OPERABLE UNIT		File No. 3 A N E 1 0 2 6	
KEH Job No. B-30979		Prepared by N.P. FASTABEND		Date 3/24/90	
				Reviewer <i>Michael Polster</i> 1 1	
DESCRIPTION OF WORK		ACCEPTABILITY (Within Plan Tolerance)		DISTRIBUTION	
Set series of stakes every 500 FT. or so along		Yes ☐		Survey File ☐ OR	
a line with Lambert NAD'83 Northing of N 117,120		No ☐		Field Project File ☐ 0	
from the edge of North-South gravel road East		NA ☒		M.A. Chamness ☐ 1	
to the river.		TBD by			
		Requestor ☐			
SURVEY RESULTS AND COMMENTS					
<p>N 117,120 (NAD'83 Lambert)</p> <p>Set Lath every $\pm$ 500 FT. marked North boundary 300-FF-1</p> <p>Burial Ground #4</p> <p>Columbia River</p>					

KEH-159.1 (6-84)

APPENDIX D

WHC RADIATION SURVEY REPORTS FOR BURIAL GROUNDS #4 AND #5

APPENDIX D

WHC RADIATION SURVEY REPORTS FOR BURIAL GROUNDS #4 AND #5

ENVIRONMENTAL PROTECTION DATA SHEET FOR RADIOACTIVE WASTE DISPOSAL SITES

SITE 618-4 Burial Ground

FREQUENCY OF SURVEY: M BM Q SA (A) CIRCLE ONE

Date: 11/22/89 Radiation Protection Tech: D. Causey

Survey Card = 89-4815

MAXIMUM DOSE RATE: CP 6510 Micro R meter _____ CHECK ONE OR BOTH

Window Open 2.5 @ Contact Window Open _____ @ 1 Meter

Window Closed 2D @ Contact Window Closed _____ @ 1 Meter

SURFACE CONTAMINATION: Use procedure described in the Environmental Surveillance and Control Manual as a guide for survey. Readings will be in cpm (counts-per-minute) EXCEPT when using a portable alpha monitor for alpha surveys, then readings will be in dpm (disintegrations-per-minute). State instrument used. Attach map of site surveyed to data sheet if contamination is detected, showing location, nature and levels of contamination.

PLEASE CHECK: GM _____ PAM _____

Contamination Found: (check as needed) Surface _____ Subsurface _____ None ✓

Type of contaminated vegetation found: N/A

Total number of LIVE plants found contaminated: N/A

Percent of site contaminated with vegetation: N/A

Animal Activity (i.e. Burrows, feces) found: rabbit feces

PHYSICAL CONDITION:

Cave in or depressions present: YES should be lots of depressions NO _____

Concrete ID Posts: YES ✓ NO _____

Steel Posts: YES _____ NO _____

Chain: YES Chain Link fence NO _____

Type of Zone: Surface ✓ Underground _____ Other (Specify) _____

General Appearance (HOUSEKEEPING): Good 10 9 (3) 7 6 5 4 3 2 1 Poor

Legend: Background 100 cpm Scale: 1" = 75'

○ CONCRETE POST

General Contamination 50 cpm

ENVIRONMENTAL PROTECTION DATA SHEET FOR
RADIOACTIVE WASTE DISPOSAL SITES

SITE 618-5 buried ground

FREQUENCY OF SURVEY: M BM Q SA (A) CIRCLE ONE

Date: 11/26/89 Radiation Protection Tech: DH Causey

Survey Card = 89-4811

MAXIMUM DOSE RATE: ca 6410 Micro R meter _____ CHECK ONE OR BOTH

Window Open 2.5 @ Contact Window Open _____ @ 1 Meter

Window Closed 10 @ Contact Window Closed _____ @ 1 Meter

SURFACE CONTAMINATION: Use procedure described in the Environmental Surveillance and Control Manual as a guide for survey. Readings will be in cpm (counts-per-minute) EXCEPT when using a portable alpha monitor for alpha surveys, then readings will be in cpm (disintegrations-per-minute). State instrument used. Attach map of site surveyed to data sheet if contamination is detected, showing location, nature and levels of contamination.

PLEASE CHECK: GM _____ PAM _____

Contamination Found: (check as needed) Surface _____ Subsurface _____ None ✓

Type of contaminated vegetation found: N/A

Total number of LIVE plants found contaminated: N/A

Percent of site contaminated with vegetation: N/A

Animal Activity (i.e. Burrows, feces) found: rabbit feces

PHYSICAL CONDITION:

Cave in or depressions present: YES ✓ NO _____

Concrete ID Posts: YES ✓ NO _____

Steel Posts: YES _____ NO _____

Chain: YES ✓ NO _____

Type of Core: Surface ✓ Underground _____ Other (Specify) _____

Initial procedure (HOUSEKEEPING) GOOD TO _____

618-5

Legend:

○ CONCRETE POST

Scale: 1" = 50'

ENVIRONMENTAL PROTECTION DATA SHEET FOR
RADIOACTIVE WASTE DISPOSAL SITES

SITE Celx-S burial ground

FREQUENCY OF SURVEY: M BM Q SA (A) CIRCLE ONE

Date: 11/28/88

Radiation Protection Tech: DAPausey

Survey Card # 12315

MAXIMUM DOSE RATE: CP _____ Micro R meter _____ CHECK ONE OR BOTH

Window Open _____ @ Contact Window Open _____ @ 1 Meter

Window Closed _____ @ Contact Window Closed _____ @ 1 Meter

SURFACE CONTAMINATION: Use procedure described in the Environmental Surveillance and Control Manual as a guide for survey. Readings will be in cpm (counts-per-minute) EXCEPT when using a portable alpha monitor for alpha surveys, then readings will be in dpm (disintegrations-per-minute). State instrument used. Attach map of site surveyed to data sheet if contamination is detected, showing location, nature and levels of contamination.

PLEASE CHECK: GM 1239/1180

PAM _____

Contamination Found: (Check one or both) Surface ✓ Subsurface _____

Type of contaminated vegetation found: N/A

Total number of LIVE plants found contaminated: N/A

Percent of site contaminated with vegetation: N/A

Animal Activity (i.e. Burrows, feces) found: rabbit feces

PHYSICAL CONDITION:

Cave in or depressions present: YES _____ NO ✓

Concrete ID Posts: YES ✓ NO _____

Steel Posts: YES ✓ NO _____

Chain: YES ✓ NO _____

Type of Zone: Surface ✓ Underground ✓ Other (Specify) _____

General Appearance (HOUSEKEEPING): Good 10 9 8 (7) 6 5 4 3 2 1 Poor

EXTENDED FENCELINE

618-5

Legend:
O CONCRETE POST

Scale: 1" = 50'

BACKGROUND 50-100 c/m

DON'T SAY IT --- Write It!

DATE July 26, 1989

TO A. R. Johnson T1-30

FROM W. F. Heine R1-15

cc: W. L. Osborne R2-77
WFH File/LB

3-1184

SUBJECT: INSPECTION REPORT EP-88-17

Environmental Restoration is requesting that you close out Inspection Report EP-88-17, which was issued against the 618-5 Burial Ground. The area that was found contaminated has been covered with clean dirt.

Attached you will find a copy of the RPT's survey done on June 23, 1989. This survey card states that there is no surface contamination present at this time.

Please send any documentation regarding the closure of this Inspection Report to W. L. Osborne at R2-77.

pgf

+

"TO MAKE LIFE LAST, PUT SAFETY FIRST"

+

ENVIRONMENTAL PROTECTION DATA SHEET FOR
RADIOACTIVE WASTE DISPOSAL SITES

SITE 618-5 B.G.

FREQUENCY OF SURVEY: M BM Q SA A CIRCLE ONE

Date: 6-23-89 Radiation Protection Tech: Primer

Survey Card = 45067

MAXIMUM DOSE RATE: CP Micro R meter CHECK ONE OR BOTH

Window Open N/A @ Contact Window Open N/A @ 1 Meter

Window Closed @ Contact Window Closed @ 1 Meter

SURFACE CONTAMINATION: Use procedure described in the Environmental Surveillance and Control Manual as a guide for survey. Readings will be in cpm (counts-per-minute) EXCEPT when using a portable alpha monitor for alpha surveys, then readings will be in dpm (disintegrations-per-minute). State instrument used. Attach map of site surveyed to data sheet if contamination is detected, showing location, nature and levels of contamination.

PLEASE CHECK: GM ✓ PAM

Contamination Found: (check as needed) Surface Subsurface None ✓

Type of contaminated vegetation found: NONE

Total number of LIVE plants found contaminated: NONE

Percent of site contaminated with vegetation: NONE

Animal Activity (i.e. Burrows, feces) found: NONE

PHYSICAL CONDITION:

Cave in or depressions present: YES NO ✓

Concrete ID Posts: YES ✓ NO

Steel Posts: YES ✓ NO

Chain: YES ✓ NO

Type of Zone: Surface ✓ Underground Other (Specify)

General Appearance (HOUSEKEEPING): Good 10 9 8 7 6 5 4 3 2 1 Poor

RADIATION SURVEY REPORT		Date <u>6-23-89</u>		Time From <u>0730</u> To <u>1530</u>		Survey Number <u>45067</u>		FC <u>N/</u>	
Bldg <u>NA</u>		Area <u>600</u>		Room <u>NA</u>		Location <u>618-S B.G.</u>			
RWP No <u>NA</u>		Check if appropriate When checked, do not place unrelated information on this record		☐ Personnel Contamination		☐ High Radiation Level Work			
		☐ CAM Radiation Alarm		☐ "Special Survey"		☐ Property Release			
		☐ Radiation Contamination Incident		☐ Establi. Dose Rates		☐ RAM Shipment			
Description of Job <u>SURVEY OF 618-S BURIAL GROUND,</u> <u>AFTER STABILIZATION ATTEMPTS, WITH</u> <u>MISC. #4208</u>									
Description of Work Performed, Radiation Controls, and Measurements		Meter Deflection W/O V/C		Dist C/F		DOSE RATE beta (non pen) mrad/hr gamma (pen) mrad/hr neutron mrem/hr		CONTAMINATION LEVELS Direct (dpm) beta alpha Smear 100 cm ² beta alpha (dpm) mrad/m	
1 SURVEY OF 618-S B.G. POST STABILIZATION WITH MISC. #4208		NA NA NA NA		NA NA NA NA		NA NA NA NA		NA NA NA NA	
NOTE: NEW TUMBLEWEED GROWTH IS VERY PREMINENT									
Check for personnel dose rate: ☐ Continued on supplemental report form		☐ CP		☒ G.M. Pancake		☐ PAM		☐ Respiratory Protection Worn	
Surveyed (s) <u>1829 g/g</u>		<u>4708</u>		☐ Supplied air		☐ Filter		☐ Other	
				☒ None					
Phase of Work <u>NA</u>		Based on Measurement(s) <u>NA</u>		Average Dose Rate <u>NA</u>		Limit Applying WBP <u>NA</u> E WBP <u>NA</u> E WBP <u>NA</u> E		Signed <u>Pr Mac ker 67577</u> PR No	
Exposure <u>NONE</u>		Work Location Code <u>NA</u>		Did you attend a pre-job meeting for this work? ☒ Yes ☐ No ☐ Yes		Date			

8D-0000-010 (12 B7)

8D-0000-010 (12 B7)

ENVIRONMENTAL PROTECTION DATA SHEET FOR
RADIOACTIVE WASTE DISPOSAL SITES

SITE 618-5 B.G.

FREQUENCY OF SURVEY: M BM Q SA (A) CIRCLE ONE

Date: 6-23-89 Radiation Protection Tech: P. Marler

Survey Card = 45067

MAXIMUM DOSE RATE: CP Micro R meter CHECK ONE OR BOTH

Window Open N/A @ Contact Window Open N/A @ 1 Meter

Window Closed @ Contact Window Closed @ 1 Meter

SURFACE CONTAMINATION: Use procedure described in the Environmental Surveillance and Control Manual as a guide for survey. Readings will be in cpm (counts-per-minute) EXCEPT when using a portable alpha monitor for alpha surveys, then readings will be in dpm (disintegrations-per-minute). State instrument used. Attach map of site surveyed to data and, if contamination is detected, showing location, nature and levels of contamination.

PLEASE CHECK: GM PAM

Contamination Found: (check as needed) Surface Subsurface None

Type of contaminated vegetation found: NONE

Total number of LIVE plants found contaminated: NONE

Percent of site contaminated with vegetation: NONE

Animal Activity (i.e. Burrows, feces) found: NONE

PHYSICAL CONDITION:

Cave in or depressions present: YES NO

Concrete ID Posts: YES NO

Steel Posts: YES NO

Chain: YES NO

Type of Zone: Surface Underground Other (Specify)

General Appearance (HOUSEKEEPING): Good 10 9 8 7 6 5 4 3 2 1 Poor

ENVIRONMENTAL PROTECTION DATA SHEET FOR
RADIOACTIVE WASTE DISPOSAL SITES

SITE 618-S

FREQUENCY OF SURVEY: M BM O (SA) A CIRCLE ONE

Date: 4/1/90 Radiation Protection Tech: L. Conatelli

Survey Card = 904816

MAXIMUM DOSE RATE: CP NA Micro R meter NA CHECK ONE OR BOTH

Window Open NA @ Contact Window Open NA @ 1 Meter

Window Closed NA @ Contact Window Closed NA @ 1 Meter

SURFACE CONTAMINATION: Use procedure described in the Environmental Surveillance and Control Manual as a guide for survey. Readings will be in cpm (counts-per-minute) EXCEPT when using a portable alpha monitor for alpha surveys, in readings will be in cpi (disintegrations-per-minute). State instrument used. Attach map of site surveyed to data sheet if contamination is detected, showing location, nature and levels of contamination.

PLEASE CHECK: GM 1090 PAM 6

Contamination Found: (check as needed) Surface Subsurface None ✓

Type of contaminated vegetation found: none

Total number of LIVE plants found contaminated: none

Percent of site contaminated with vegetation: 90%

Animal Activity (i.e. Burrows, feces) found: ant. Lills

PHYSICAL CONDITION

Cave in or depressions present: YES NO ✓

Concrete ID Posts: YES ✓ NO

Steel Posts: YES ✓ NO

Paint: YES ✓ NO

Type of Erosion: Surface Undergrowth ✓ Other (Specify)

Overall Appearance (HOUSEKEEPING) Good 10 9 8 7 6 5 4 3 2 1 Poor

618-5

Legend:
O CONCRETE POST

Scale: 1" = 50'

APPENDIX E

LABORATORY METHODS FOR SOIL SAMPLE ANALYSIS

APPENDIX E

LABORATORY METHODS FOR SOIL SAMPLE ANALYSIS

SAMPLE PREPARATION

Upon receipt of the sediment sample in the laboratory, the sample was homogenized by mixing. An aliquot was removed, weighed, dried at 105°C for 24 h, and then weighed again. The amount of moisture lost was then calculated and recorded in a Laboratory Record Book.

GAMMA-EMITTING RADIONUCLIDE ANALYSES

The dried sediment was pressed into a 15-g pellet. If needed, a mixture of cellulose and dunite was added. The cellulose was added as a binding material for the pellet making process. The dunite was used as a diluent for the sediment to prevent saturation of the detector. This would be necessary if high activity was observed using a Geiger-Muller detector during the sample preparation process. The pellets were counted on a 2.25-in.-diameter (41 cc active volume) intrinsic-germanium detector with a resolution of 1.91 keV (full width at half maximum) at 1332 keV. Data were acquired using a Nuclear Data 6700 multichannel analyzer system.^(a) Sample counting time ranged from 30 to 480 min depending on the activity of the sample. Concentrations of selected radionuclides were determined by comparing detector response to USGS pitchblende standards. Results were reported in pCi/g (see Table 4.1).

X-RAY FLUORESCENCE ANALYSES

Soil sample analyses for metals were conducted in accordance with the PNL procedure for energy dispersive x-ray fluorescence spectrometry. A 500-mg pellet was prepared from the dried sample. Energy-dispersive x-ray fluorescence utilizes emissions that are induced in the inner electron shells. These electron transitions from the higher to lower shells yield the

(a) Nuclear Data 6700 is a tradename of Nuclear Data Systems, Schaumburg, Illinois.

characteristic x-ray emissions. The sample is excited through a two-step process. Electron bombardment of a tungsten target in the x-ray tube produces primary polychromatic bremsstrahlung radiation, which in turn is used to fluoresce one of several secondary targets. The secondary radiation consists of essentially mono-energetic x-rays characteristic of the target. This secondary radiation is in turn directed at the sample to produce x-ray fluorescence. Targets producing several different mono-energetic incident x-rays are needed because the maximum probability for photoelectric absorption occurs when the incident photon energy is just above the binding energy of the electron to be ejected. Therefore, the use of different secondary source targets can be converted into analytical efficiency for a given element or suite of elements by exciting with a photon energy as close to, but higher than, the binding energy as practically possible. In practice this results in a compromise analytical scheme consisting of a limited number of secondary source irradiations. For the samples analyzed, zirconium, titanium, silver, and gadolinium secondary fluorscopes were used.

The absorption of the characteristic x-rays or photon by a solid-state lithium-drifted silicon detector creates charge pulses that are proportional to the deposited energy. The preamplifier converts the total charge to a voltage signal that retains the amplitude of the energy deposit. This voltage is processed by a pile-up rejector, a main amplifier, and transformed according to energy (amplitude) by the analog-to-digital converter and stored according to the number of events by the multichannel analyzer.

Data analysis is performed on the stored intensity verses energy digital distribution of the detected x-rays. Before the data can be analyzed, corrections for sample self-absorption and enhancement effects, or matrix effects, must be made. Matrix effects are corrected by fundamental parameter calculations. The method of peak analysis used is described in Nielson (1973) and Nielson and Sanders (1982). Uncertainty calculation methods are presented in Nielson (1978). Results were reported in ppm (see Table 4.1).

STRONTIUM 90 ANALYSIS

Before the sample can be counted, the ^{90}Sr must first be concentrated in a precipitate. This is achieved by performing several iterations of adding nitric or oxalate acid, adjusting the pH by the addition of a base (NaOH , NaCO_3 , or NH_4OH), centrifuging, discarding the precipitate or the supernate (depending on the step), and then repeating.

When the final precipitate is obtained, it is counted on a 2-in.-diameter end-window, gas-flow proportional beta counter. On this counter, four primary detectors are surrounded by several proportional cosmic shield detectors that are about 1 m long and 5 cm in diameter. These shield detectors reduce the registration of counts from cosmic ray and other background sources. The detectors operate with a p-10 counting gas (90% argon, 10% methane). Results were reported in pCi/g (see Table 4.1).

REFERENCES

- Nielson, K. K. 1978. "Applications of Direct Peak Analysis to Energy-Dispersive X-Ray Fluorescence Spectra." X-Ray Spectra 7:15-22.
- Nielson, K. K., and R. W. Sanders. 1982. The SAP3 Computer Program for Quantitative Multielement Analysis by Energy-Dispersive X-Ray Fluorescence. PNL-4173, Pacific Northwest Laboratory, Richland, Washington.

APPENDIX F

ANALYSIS REPORT FOR SAMPLE T-1

HANFORD ENVIRONMENTAL
HEALTH FOUNDATION

December 4, 1989

CO 14811

Pacific Northwest Laboratory
MSIN K6-96

Attn: S. S. Teel

BULK SAMPLE ANALYSIS FOR FIBER CONTENT - M55028

The bulk sample received November 28, 1989, has been analyzed for fiber content using polarized light microscopy and dispersion staining in accordance with 40 CFR Chapter I (1-1-87 Ed.), Part 763, Subpart F, Appendix A. The sample contained asbestos. The results are attached.

Reported fiber percentages for samples and sample layers are based on the samples as received by the laboratory. The laboratory cannot verify that these values are representative of the original material sampled.

HEHF is accredited by the National Institute of Standards and Technology (NIST), National Voluntary Laboratory Accreditation Program (NVLAP), to analyze bulk samples for asbestos content. This accreditation does not constitute approval or endorsement of analytical results by NIST nor does it apply to other analyses performed by this laboratory.

If there are questions concerning this report, please contact the approved signatory listed below.

M. A. Baechler
Analyst
Environmental Health Sciences

M. K. Hamilton, CIH
Laboratory Director
Environmental Health Sciences
(Approved Signatory)

jt

HANFORD ENVIRONMENTAL
HEALTH FOUNDATION

CO 14811
December 3, 1989

BULK SAMPLE ANALYSIS FOR FIBER CONTENT - M55028

<u>Sample I.D.</u>	<u>Description</u>	<u>Fiber Content</u>
300-FF-1, T-1	Brown fibrous tile	10-20% chrysotile asbestos

Accredited by the National Institute of Standards and Technology, National Voluntary
Laboratory Accreditation Program, for bulk asbestos analysis using PLM.

300-FF-1 BOUNDARY

15000

594000

TANK

STAGE

DO

R74

L112

L116

L120

L122

L124

L126

L128

L130

L132

L134

L136

L138

L140

L142

L144

L146

L148

L150

L152

L154

L156

L158

L160

L162

L164

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L168

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L272

L274

L276

L278

L280

L282

L284

L286

L288

L290

L292

L294

L296

L298

L300

00081 3

N 116000

E 594800

N 54000

N 115600

300-FF-1 BOUNDARY

COLUMBIA RIVER

Plate 2

Topographic map of the southern portion of the operable unit showing locations above back-ground found as a result of Task 3a-1.

LEGEND

FIRE HYDRANT

TRAILS, OLD IRRIGATION LINES, ETC..

POWER POLES

LIGHT POLES

BUILDINGS

CONCRETE SLABES, VAULTS, ETC.

FENCE LINES

POSTS & WELLS

SIGNS

MANHOLÉS, PURGE WELL WATER TANKS, ETC.

- SIGNS
MANHOLES, PURGE WELL WATER TANKS, ETC.
BUSHES
R/R TRACKS
GRAVEL ROAD
PAVED ROAD
R/R CROSSING LIGHT
RADIO TOWER
MICROWAVE CONES
RADIATION CONTAMINATION
SURVEY LOCATIONS (RXX)

00525 N

00511 N 115200

SHEET INDEX

DATE		U.S. DEPARTMENT OF ENERGY RICHLAND OPERATIONS OFFICE	
BY		KAISER ENGINEERS HANFORD COMPANY	
APPROVAL		300 AREA TOPOGRAPHIC MAPPING	
PROJECT ENG		PROJECT TITLE 300-F-1 thru 5 OPERABLE UNITS	
QA		PROJ N/A	JOB N/A
APPROVED		SCALE 1:2000	INDEX N/A
BY		DRAWING NUMBER H-3-49599	
SAFETY		SHEET 4 OF 8	
APPROVED		REV 0	
BY			
CHECKED			
BY			
DRAWN			
BY			
DESIGNED			
BY			

DRAWING LIST	TITLE
REFERENCES	
MICROFILMED	
APPROVAL	BY-DATE
KEM APPROVAL	BY-DATE
REV BY DATE	DESCRIPTION
REVISIONS	REV
COMMENT REVIEW	

S H E E T
300-FF-1 BOUNDARY

E 594400

TO SHEET

N 58500

E 18000

E 594800

N 116800

Plate 1

Topographic map of the northern portion of the operable unit showing locations above back-ground found as a result of Task 3a-1, and the USRADS survey area.

LEGEND

HO- FIRE HYDRANT

~ TRAILS, OLD IRRIGATION LINES, ETC...

○- POWER POLES

☼ LIGHT POLES

■ BUILDINGS

□ CONCRETE SLABES, VAULTS, ETC.

*** FENCE LINES

○ POSTS & WELLS

● SIGNS

○ MANHOLES, PURGE WELL WATER TANKS, ETC.

DISC

COLUMBIA
RIVER

MANHOLES, PUMP WELL, WATER TANKS, ETC.

BUSHES

R/R TRACKS

GRAVEL ROAD

PAVED ROAD

R/R CROSSING LIGHT

RADIO TOWER

MICROWAVE CONES

IRRADIATION CONTAMINATION SURVEY LOCATIONS (RXX)

USRA'S SURVEY AREA

N 116400

N 55500

SHEET INDEX

0 10 20 30 40 50 60 70 80 90 100 200 METERS

DATE	BY	APPROVAL
	PROJ ENGR	
	QA	N/A
	APPROVED BY	N/A
	SAFETY	N/A
	APPROVED BY	
	CHECKED BY	
	DRAWN BY	CASCADE MAPPING
	DESIGNED BY	N/A

U.S. DEPARTMENT OF ENERGY RICHLAND OPERATIONS OFFICE	
KAISER ENGINEERS HANFORD COMPANY	
300 AREA TOPOGRAPHIC MAPPING	
PROJECT TITLE 300-FF-1 thru 5 OPERABLE UNITS	
PROJ N/A	JOB N/A
SCALE 1:2000	INDEX N/A
DRAWING NUMBER	SHEET 6
H-3-49599	REV 0

MICROFILMED	
BY-DATE	REV BY DATE
APPROVAL	KEH APPROVAL
REVISIONS	
DESCRIPTION	
COMMENT REVIEW	
TITLE	
REFERENCES	

END

DATE FILMED

12 / 11 / 90