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FAILURE OF 307 BASIN TRANSFER LINE AND RESULTANT GROUND CONTAMINATION

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CLASSIFICATION

FAILURE OF 307 BASIN TRANSFER LINE AND RESULTANT GROUND CONTAMINATION

INTRODUCTION

A leak of apparently long duration was discovered on December 9, 1969, in the transfer line from the 307 retention basins to the 340 contaminated waste system during the transfer of liquid from one of the 307 basins. This line was designed to carry only mildly-contaminated retention system waste. However, the uncovered line suggests that, over a period of time, the bottom half of the carbon steel transition section between the transfer line and the 340 contaminated waste system was corroded out. This permitted the highly contaminated waste to percolate into the soil beneath the missing pipe section.

Since neither the duration of leakage nor the exact origin or nature of the contaminants were known, this study was undertaken to: (1) estimate the amount of radioactivity released; (2) document its location with respect to the 340 Area and to the underlying groundwater; and (3) investigate its potential environmental impact.

Soil samples were collected to determine the approximate location and quantity of each of the radionuclides which had leaked to the soil. One-digit accuracy was deemed sufficient to decide what, if any, action would be required. This report documents the findings from the several exploratory holes drilled at and adjacent to the site of the corroded transfer line.

SUMMARY

Approximately 900 curies of relatively short-lived radionuclides, including 10 curies each of ^{90}Sr and ^{137}Cs inadvertently leaked to the soil as a result of the corrosion of an underground carbon steel pipe section. Greater than 90% of the contamination from this incident is confined within a cylindrical section of earth approximately 25 feet deep and 12 feet in diameter. Despite the fact that promethium and cerium were combined with complexing agents, both were substantially retained by the soil. Any groundwater contamination from this incident was minimal, because no 300 Area groundwater samples showed detectable concentrations of the nuclides found in the soil. Since the leak existed for some time (longer than a year), any further migration of the activity from its sorbed position in the soil should be negligible.

INCIDENT DESCRIPTION

On December 9, 1969, some difficulty was experienced during the transfer of liquid retention waste from a 307 basin to the 340 contaminated waste storage vault. The basin was suspected of containing beta-gamma emitters at a concentration of 8×10^{-5} μCi/ml which required disposal as contaminated waste. However, rechecking the sample indicated a concentration of only 2×10^{-5} μCi/ml, which did not require transfer to the 340 waste tanks. At full efficiency the 450 gpm pump should have transferred more than 40,000 gallons, but only 3,000 gallons were actually transferred. The next day the pump again labored as it had the previous day, then it quieted. Shortly thereafter, water appeared at the ground surface above the transfer line in the vicinity of its connection to the contaminated waste system main line. The pump was stopped and the damaged line was hand excavated. Upon examination, the damaged line appeared to have been corroded to the extent that the bottom section was missing entirely (Figure 1). When the damaged length of pipe was removed, the contaminated waste line was capped to prevent further release of material.

Because the bottom half of the transition piece of pipe was missing, it was assumed that the corrosion took place over a long period of time, and that the pipe could have leaked for some indefinite period. On March 20, 1968, about 70,000 gallons were transferred without apparent difficulty. Some difficulty was experienced on June 13, 1969, when about 40,000 gallons were transferred. These experiences may indicate that between those dates, the hole in the line became sufficiently large to allow inward movement of the surrounding soil to form a partial barrier.

Figure 2 is a schematic diagram showing typical waste lines in and around the 340 Retention and Neutralization Facility. The location from which the missing pipe section was found is marked with an X. An expanded view of the underground piping in the vicinity of the corroded line and the location of the exploratory holes dug after the leak was discovered are shown in Figure 3.

All underground contaminated waste (~30 μCi/ml) lines leading to the 340 waste storage vault are stainless steel. They originate in the laboratory buildings (308, 324, 325, 326, 327, 329), are joined in a common main between 340 and the 307 basins, and terminate in the underground waste storage tanks. In addition, a cast iron line from the 307 retention basins was joined to this common main by a carbon steel transition section near the waste storage vault. This cast

FIGURE 1. Photograph of the Corroded Pipe Section

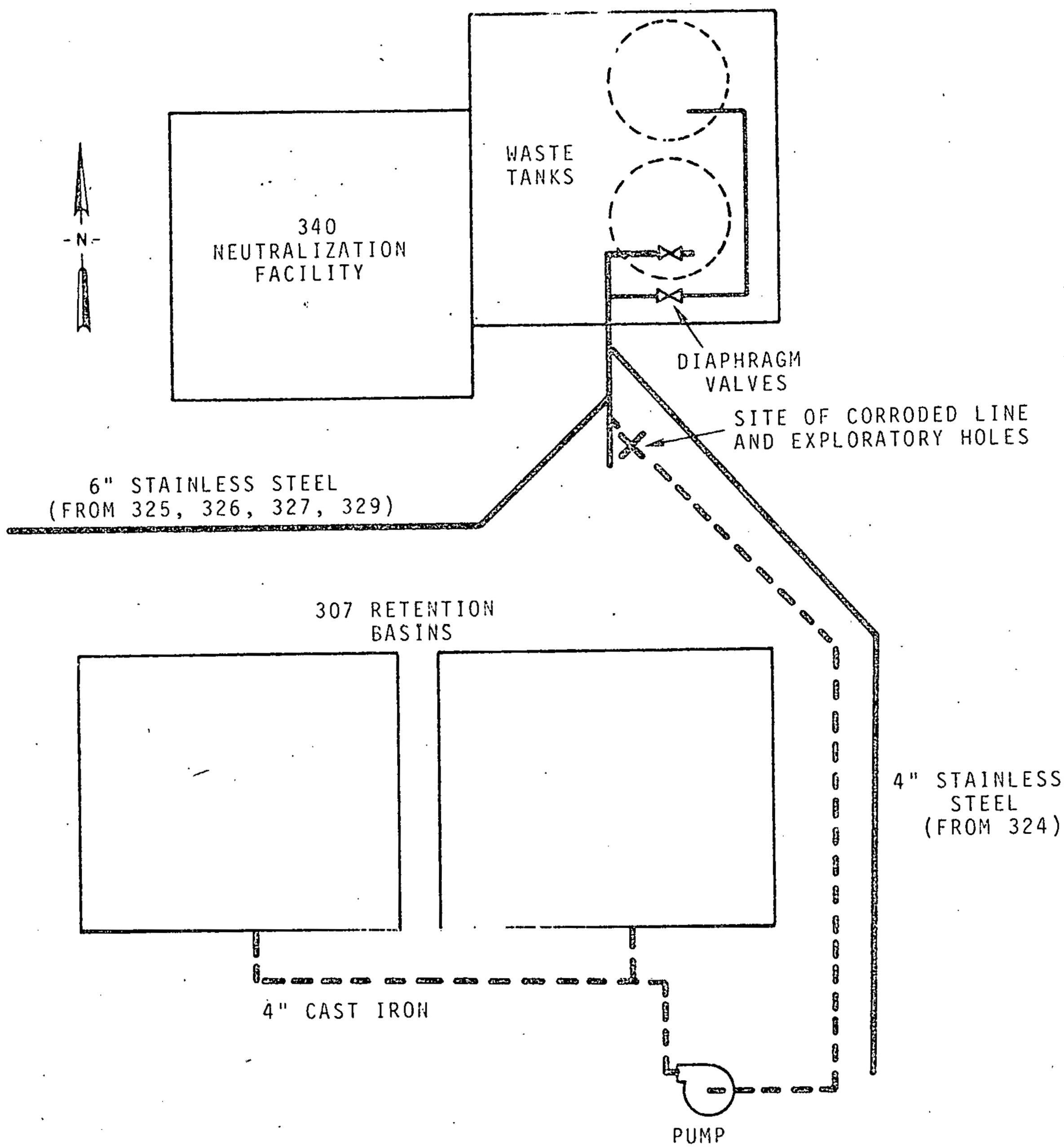

FIGURE 2. Schematic Diagram of Contaminated Waste and Retention Lines Near the 340 Building

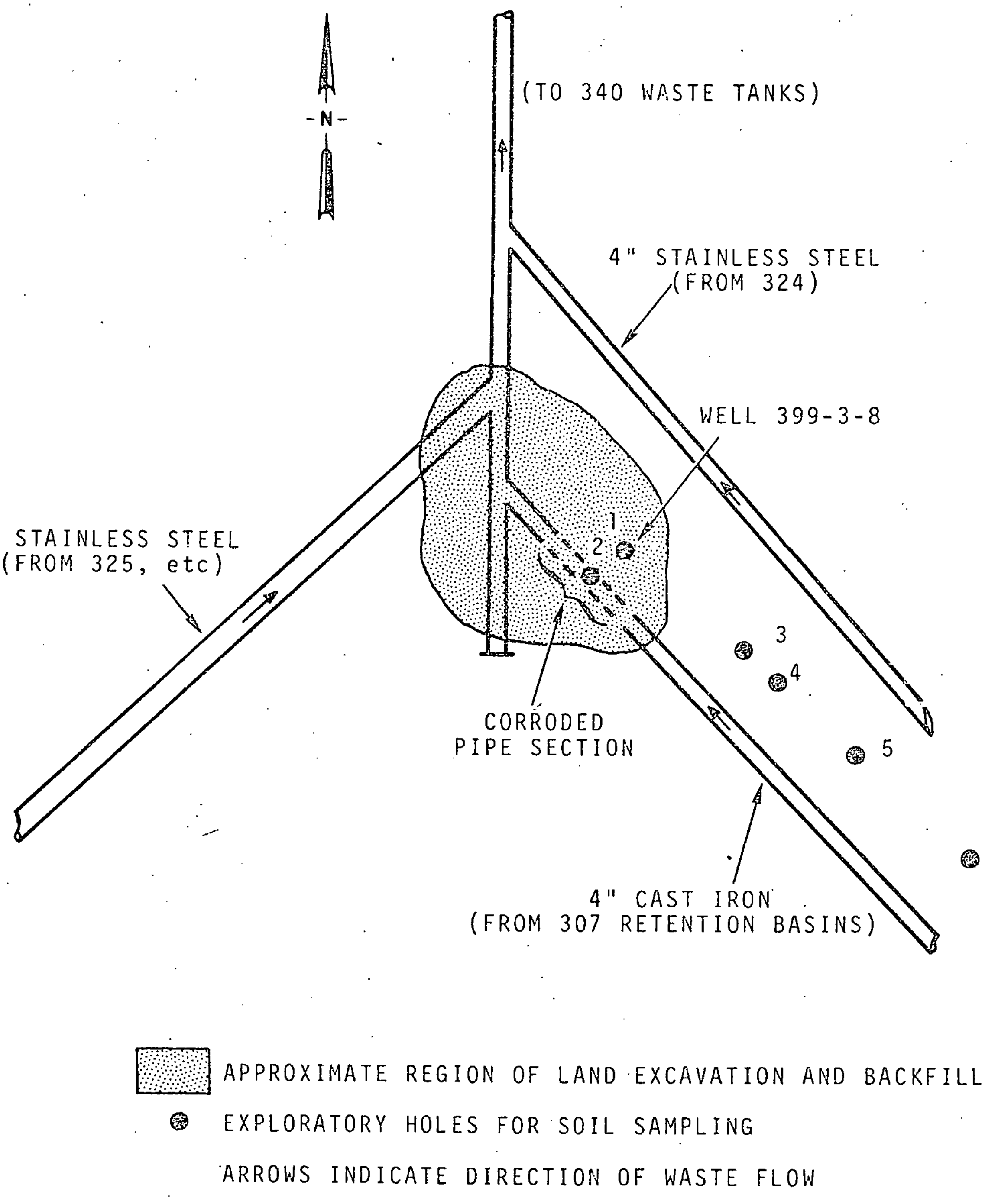

FIGURE 3. Expanded Diagram of Waste Lines Near the 340 Building

iron line was used to transfer non-dischargable (>$5x10^{-5}$ μCi/ml) retention waste to the contaminated waste system and hence, was normally empty. The stainless steel lines are gravity fed; however, there is a slight vacuum maintained on the waste storage tanks. Flow control for the two underground storage tanks is maintained by diaphragm valves mounted adjacent to the waste tanks (Figure 2).

The main waste line slopes upward slightly from the point where the retention basin transfer line joined it to the valves in the waste storage vault as shown (exaggerated) in Figure 4. The diaphragm valves have a four-inch weir against which the diaphragm seats. Because of the gentle slope and the weir, there was a potential for accumulation of liquid in the waste lines that could (and apparently did) extend into the transfer line. It was the carbon steel transition section joining the cast iron transfer line and the statinless steel main line that corroded.

A review of the quantity of radionuclides (Table 1) sent to 340 Building over the past several years indicates that only the most recent years are significant. While the exact source and nature of each nuclide are unknown, probable sources include the following programs: waste solidification (Ru), isotopic heat sources (Ce. Pm, rare earths), and radio-metallurgy (short-lived fission products). Additionally, much of the promethium and cerium sent to 340 were accompanied by complexing agents.

TABLE 1. Summary of Radioactivity to Contaminated (Liquid) Waste System

A. Total Quantity, 1954-1969

	Beta-Gamma Activity (Curies)	Volume (10^6 gal)
1954	200	0.4
1955	400	0.6
1956	600	0.9
1957	800	1.2
1958	1,000	1.5
1959	1,100	2.0
1960	1,150	2.4
1961	2,200	3.0
1962	1,100	3.6
1963	1,800	4.5
1964	3,600	3.9

TABLE 1. (Continued)

A. Total Quantity, 1954-1969 (Continued)

	Beta-Gamma Activity (Curies)	Volume (10^6 gal)
1965	14,000	14.5
1966	14,000	3.8
1967	15,000	2.4
1968	43,000	1.6
1969	180,000	1.6

B. Specific Radionuclides to 340 Waste, 1968 and 1969

Nuclide	1968 (Curies)	1969 (Curies)*
Total Beta	43,000	180,000
Total Alpha	< 470	< 160
^{106}Ru-Rh	8,100	4,700
^{95}Zr-Nb	1,200	430
^{144}Ce-Pr	4,700	11,000
^{137}Cs	200	2,600
^{60}Co	30	24
^{147}Pm	31,000	170,000
^{90}Sr	1,500	3,600
^{134}Cs	50	60
^{103}Ru	210	70
Vol. (10^6 gallons)	1.6	1.6

* 11 Months (prior to discovery of leak)

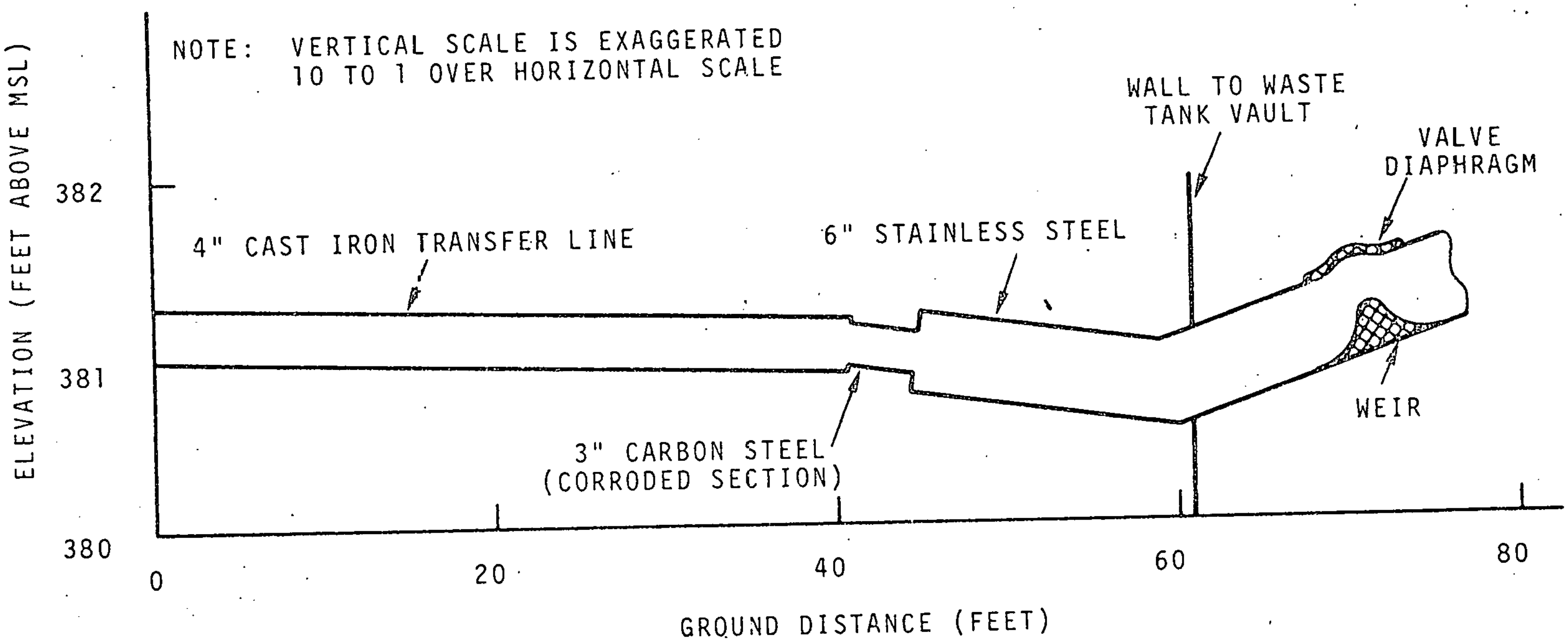

FIGURE 4. Elevation of 307 Basin Transfer Line

Soil Sampling and Analysis

After the appearance of water at the ground surface on December 10, 1969, the site was covered and roped off for several days while a course of action was planned. The preliminary hand excavation took place during the week of December 15 to 20. The soil above and in the immediate vicinity of the leak was grossly contaminated and was removed to the 200 Areas for burial. The site of the leak (corroded pipe section) was five feet below the ground surface. Using an extended post-hole auger, a 9-foot deep hole was hand dug directly beneath the point where the corroded pipe section was found. Soil samples therefrom were collected at several depths and were sent to the laboratory for isotopic analysis. As a check on potential radionuclide movement through the ground, a second 11-foot deep hole was dug 10 feet to the east without encountering any activity using a GM detector in the field. In the meantime, the site of the leak was covered with plastic until further decisions were made.

About the middle of January 1970 it was decided that additional holes should be dug and, in particular, that at least one should go to groundwater. The site was prepared for drilling by filling the excavation with uncontaminated earth.

From the original excavation most of the contamination appeared to be confined within a roughly cylindrical section of earth beneath the missing pipe section. Therefore, it was deemed sufficient to determine the extent of contaminated soil by drilling a well (399-3-8) to groundwater near the site of the missing line and several other holes 15 to 20 feet deep to define the lateral spread. Because for administrative decisions only one-digit accuracy was required, the exploratory holes (Figure 3) were drilled along a single radial line extending in a southeasterly direction (the probable direction of flow[1]) from 399-3-8. These holes were drilled at 5, 6 1/2, 10, and 15 feet from the original hole.

The Hatch Drilling Company of Pasco, Washington, performed the drilling operations between March 12 and 23, 1970. All drilling was performed using a dry barrel to prevent the redistribution of contaminants in the soil by wet drilling methods. Soil (mud, rocks, sand, clay, etc.) samples were collected at two-foot intervals in each hole beginning at six feet below grade. A typical soil profile as a function

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(1) *W. A. Haney. Dilution of 300 Area Uranium Wastes Entering the Columbia River, HW-52401. September 1957.*

of depth is shown in Figure 5 using the data from the drilling log (Appendix B). A one-liter sample of the groundwater from well 399-3-8 was collected before the well was developed.

Based upon the results of portable instrument surveys, hand-dug soil samples, and preliminary multichannel analyzer data, only selected soil samples (300-500 grams each, wet weight) were submitted to the laboratory[2] for radiochemical analysis. Rocks were removed in the laboratory before the samples were divided into two parts, one for direct gamma analysis and the other for radiochemical separation.

Gamma analysis for fission products was done directly on paired 15-gram (wet weight) portions of soil using a Ge(Li) gamma spectrometer. Observed count rates for specific nuclides were converted to disintegration rates from which curie quantities could readily be computed.

Duplicate 10-15 gram portions of soil were leached three times for a minimum of one hour using 30 ml of concentrated nitric acid. The three leach solutions were combined and diluted with distilled water to a standard volume (250 ml). Americium-241 was measured by plating a 10 µl aliquot of the leach solution on a stainless steel planchet, drying and counting on a gas flow proportional alpha counter. The ^{241}Am was identified using a surface barrier alpha spectrometer. Promethium-147 and strontium-90 were separated by cation exchange techniques and were measured using a gas flow beta counter.

Groundwater from well 399-3-8 was analyzed using a standard volume of 10 ml.

RESULTS

Analytical results from the soil sampling indicate ^{147}Pm was the principal radionuclide found in the soil. This agrees well with the fact that ^{147}Pm was the most abundant nuclide in 340 waste in the last two years (Table I). Additionally, the concentration variation with distance from the corroded line indicated that, despite the complexing agents, ^{147}Pm was retained by the soil. This soil retention also was confirmed, at least to a limited extent, by the fact that samples from existing 300 Area test wells (Figure 6) and well 399-3-8 did not show detectable ^{147}Pm.

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(2) *Radiochemistry and Standards Section, Chemistry Research Department, Battelle-Northwest.*

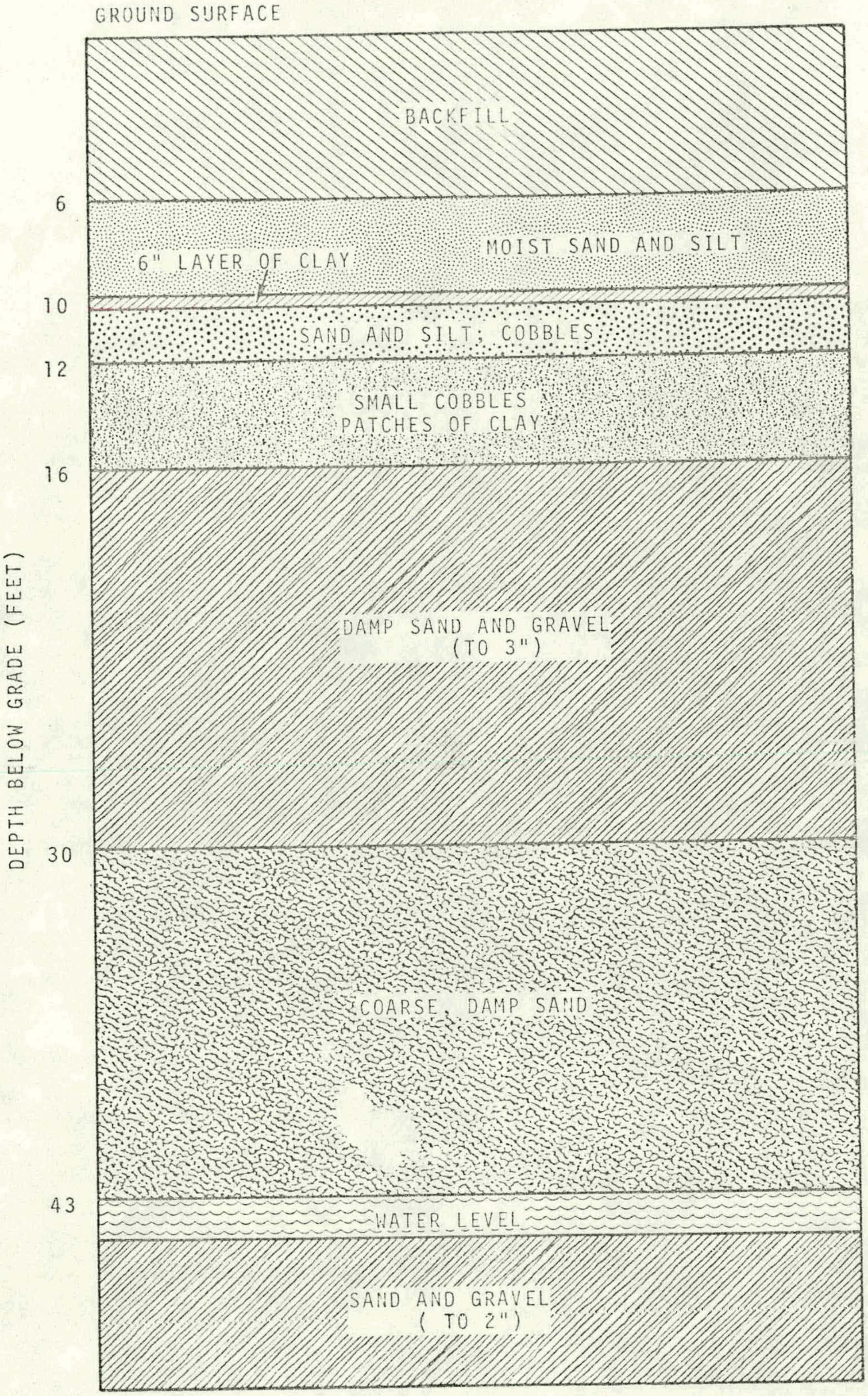

FIGURE 5. Soil Profile Near 340 Building

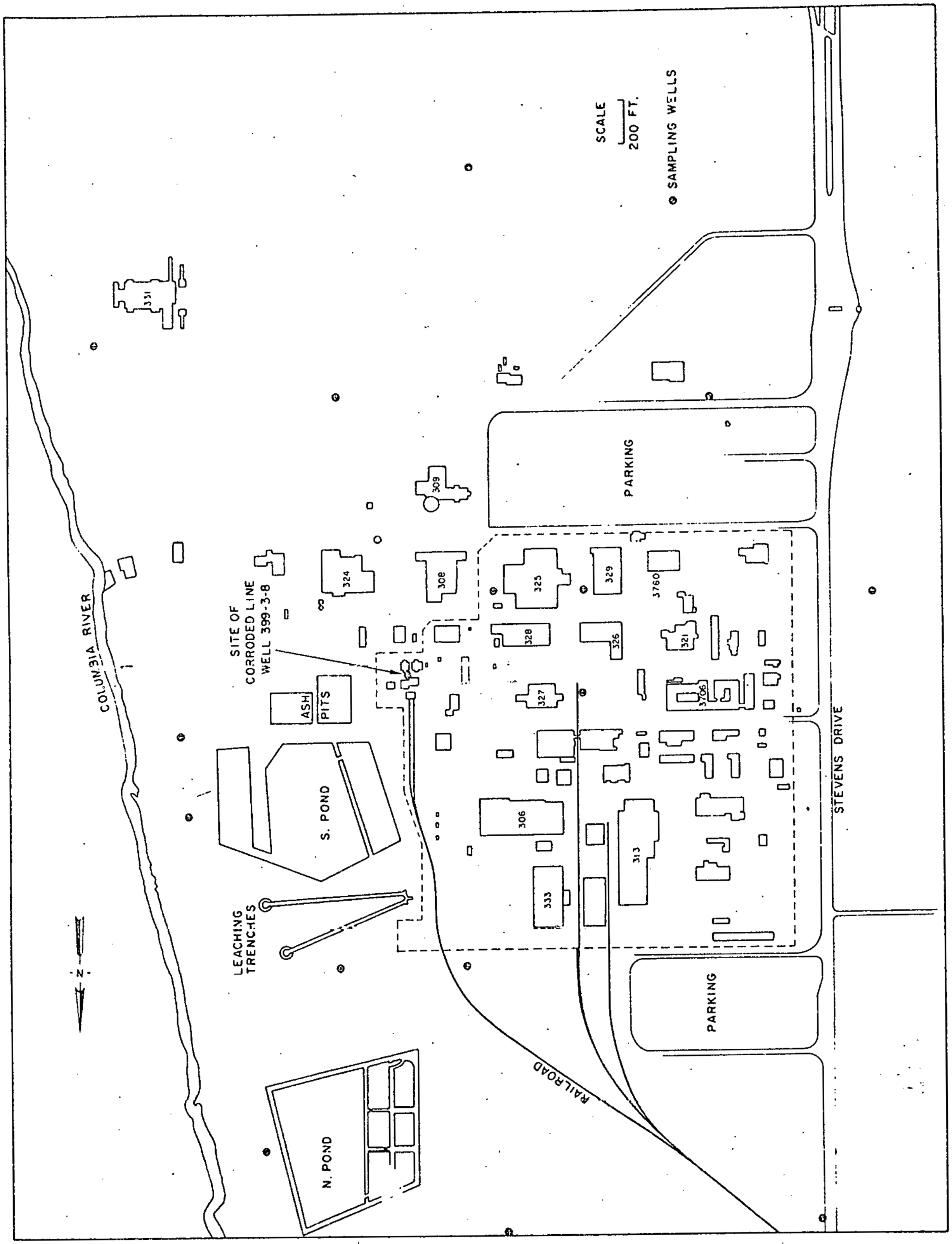

FIGURE 6. Map of 300 Area Showing Groundwater Sampling Wells

Analytical data for the soil and groundwater samples are given in Appendix A. A plot of the observed concentration for several nuclides as a function of vertical depth in the soil (from the primary test hole, 399-3-8) is given in Figure 7. The peak concentration for each nuclide occurred 10 to 20 feet below grade, except for ^{137}Cs, which occurred at six feet. The ^{147}Pm peak concentration was observed at the 18-foot level, almost an order of magnitude greater than at the 12- or 14-foot levels. The ^{90}Sr concentration remained essentially constant down to the 30-foot level, indicating a relatively long percolation time into the soil. Each nuclide exhibited a similar decrease in concentration with depth (after the peak concentration was reached)--approximately an order of magnitude for each five feet. The ^{137}Cs gradient was much steeper, about three feet for each order of magnitude decrease.

The quantity of each radionuclide in the soil was calculated by determining the volume (and mass) of soil affected. This volume was assumed to be symmetrical about the central axis (well 399-3-8), and to be a series of vertically stacked cylinders. The cylinder height was chosen to encompass those depths at which concentrations were observed within the same order of magnitude. The cylinder radius was chosen to be somewhat less than the radius indicated by the exploratory hole in which the specific nuclide was not detected. In addition, the volume thus defined was assumed to be uniformly contaminated. Thus, the total activity therein was the product of the arithmetic average concentration from all samples within the volume and the mass represented by that magnitude decrease in soil concentration until the depth at which the respective radionuclide detection limits were reached. The total activity was determined for each nuclide and is shown in Table 2 along with the associated volume of contaminated soil.

The volume of contaminated soil was assumed to consist only of earth, sand, and clay with an average bulk density of 2 g/cm^3. Therefore, the computed soil masses (and radionuclide inventories) represent upper limits because no correction was made for the relatively large void spaces taken up by rocks and cobbles. In addition, although the lateral extent of contamination probably was greatest in the southeasterly direction, it was assumed that any contamination encountered in the exploratory holes drilled along the southeasterly radius was representative of contamination at the same depth for all points equidistant from the central axis.

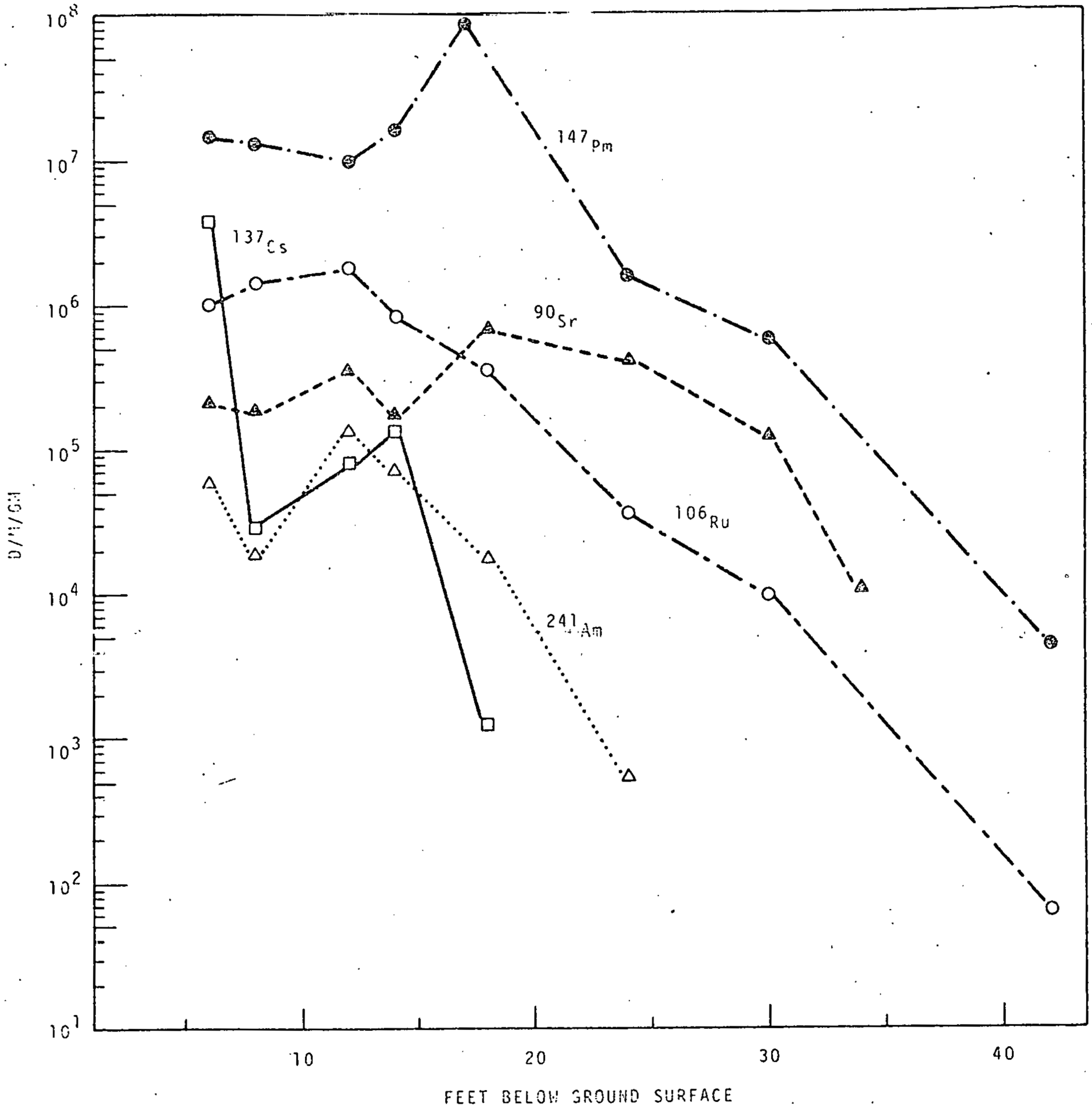

FIGURE 7. Concentration of ^{90}Sr, ^{106}Ru, ^{137}Cs, ^{147}Pm, and ^{241}Am as a Function of Vertical Depth in the Soil

TABLE 2. Inventory of Radionuclides and Volume of Contaminated Soil Beneath the Corroded 307 Basin Transfer Line

Nuclide	Total Activity, Curies (as of 6/1/70)	Contaminated Soil Volume (cubic yards)
^{147}Pm	800	70
^{106}Ru	20	40
^{144}Ce	20	70
^{90}Sr	10	70
^{137}Cs	10	40
^{241}Am	0.7	20
^{134}Cs	0.4	30
^{95}Zr	0.2	40
^{103}Ru	0.04	40
^{141}Ce	0.03	70
^{95}Nb	0.02	10

CONCLUSIONS

Corrosion of the carbon steel transition section in the 307 basin transfer line probably occurred over a relatively long period of time. Because the contaminated waste line has very little slope, the four-inch weir in the diaphragm valve caused an accumulation of liquid in the corroded transition section which permitted the highly contaminated waste to percolate into the soil. Since the last potential release of ^{241}Am was during the curium operations performed in December 1967 and January 1968, the presence of ^{241}Am in the soil indicates that the leak probably existed for more than two years. However, it was only during the last two years that substantial quantities of waste were present in the contaminated lines.

Analytical data from soil samples showed that ^{147}Pm, the most abundant nuclide sent to 340 in the last two years, was the principal radionuclides. Despite the fact that promethium and cerium were combined with complexing agents, both were substantially retained by the soil. Only ^{90}Sr and the relatively short-lived ($T_{1/2}$ < 3 yr) nuclides penetrated the soil to depths greater than about 20 feet. The long-lived nuclides, ^{137}Cs and ^{241}Am, were retained in the first 10 to 15 feet of soil beneath the corroded pipe section. No detectable activity was found in any of the samples from the holes 10 to 15 feet away from the corroded line. In addition, only ^{147}Pm, ^{141}Ce, and ^{137}Cs were detected in the hole 6.5 feet from the leak. Primarily because of the low concentrations, ^{95}Nb, ^{103}Ru, and ^{134}Cs were only detected in samples from the hand-dug hole directly beneath the corroded line and well 399-3-8.

Since most of the contaminants in the soil were eluted by the aqueous waste, any further radionuclide movement in the soil should be negligible unless a future incident releases additional large volumes of liquid. If any radionuclides did migrate to the water table, their influence should have been observed by now; however, routine groundwater surveillance in the 300 Area has failed to show any changes in groundwater concentrations which might have resulted from this leak. Thus, if the radionuclides do migrate from a future leaching event, the gross beta concentrations in groundwater would not be expected to exceed 1000 pCi/l,[3] the maximum concentration observed in 300 Area groundwater during the past two years. Haney[4] has shown that a minimum dilution of 500 occurs when 300 Area liquid wastes enter the Columbia River via the regional groundwater. Therefore, the maximum anticipated concentration of beta emitters in the Columbia River near the 300 Area would be 2 pCi/l, well below the 100 pCi/l Concentration Guide for ^{90}Sr (the most restrictive concentration for the nuclides observed) recommended in AEC Manual Chapter 0525 for members of the general public. Routine sampling and analysis of 300 Area groundwater will be continued, however, to monitor for possible radionuclide movement through the soil.

(3) D. H. Denham. *Radiological Status of the Groundwater Beneath the Hanford Project, July-December 1969*, BNWL-1392. May 1970.

(4) W. A. Haney. *Dilution of 300 Area Uranium Wastes Entering the Columbia River*, HW-52401. September 1957.

APPENDIX A

The following tabulation summarizes all of the radioanalytical data compiled from the water and soil samples collected during exploratory excavation (both hand dug post holes and well drilling) of the site between the 340 waste tank vault and the 307 retention basins. The observed groundwater concentrations from Well 399-3-8 are reported for March 25, 1970, the date of sample analysis. All soil concentrations are reported decay corrected to June 1, 1970.

RADIONUCLIDE CONCENTRATIONS IN GROUNDWATER FROM WELL 399-3-8

Nuclide	Concentration (d/m/ml)
^{90}Sr	< 40
^{95}Zr	< 20
^{95}Nb	NDA[a]
^{103}Ru	< 10
^{106}Ru	< 30
^{134}Cs	< 10
^{137}Cs	NDA
^{141}Ce	NDA
^{144}Ce	< 30
^{147}Pm	< 200
^{241}Am	< 20

RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES FROM BENEATH THE CORRODED 307 BASIN TRANSFER LINE

Sr-90 Concentration

(d/m/gm)

Feet Below Surface	Hole No.[b] (1)	Hole No. (2)	Hole No. (3)	Hole No. (4)	Hole No. (5)	Hole No. (6)
5 1/2	(c)	1.7×10^4				
6	2×10^5	2.0×10^5				
7		3.1×10^5				
8	1.8×10^5		2×10^4			
9		2.0×10^5				
12	3.2×10^5		3.5×10^5	$<1.2\times10^4$		
14	1.6×10^5					
15			1.3×10^5			
16				$<1.2\times10^4$	$<1.2\times10^4$	
18	6.4×10^5			$<1.2\times10^4$		
20					$<1.2\times10^4$	
24	3.9×10^5			$<1.2\times10^4$	$<1.2\times10^4$	
30	1.1×10^5					
34	$< 1\times10^4$					
40	$< 1\times10^4$					

Zr-95 Concentration
(d/m/ml)

Feet Below Surface	Hole No. (1)	Hole No. (2)	Hole No. (3)	Hole No. (4)	Hole No. (5)	Hole No. (6)
5 1/2		1.2×10^3				
6	9.1×10^2	3.4×10^4				
7		1.4×10^4				
8	3.1×10^3		NDA[a]			
9		1.4×10^3				
12	7.1×10^3		NDA	NDA		
14	6.8×10^3					NDA
15			6.1×10^3			
16				NDA	NDA	
18	1.8×10^4			NDA		
20					NDA	
24	6.6×10^2			NDA	NDA	
30	$< 3 \times 10^2$					
42	< 5					
48	NDA					

Nb-95 Concentration
(d/m/ml)

Feet Below Surface	Hole No. (1)	Hole No. (2)	Hole No. (3)	Hole No. (4)	Hole No. (5)	Hole No. (6)
5 1/2		$< 5 \times 10^2$				
6	4.8×10^3	1.7×10^4				
7		4.7×10^3				
8	$< 2 \times 10^2$		NDA			
9		6.8×10^2				
12	5.2×10^2		NDA	NDA		
14	1.5×10^3					NDA
15			NDA			
16				NDA	NDA	
18	NDA					
20					NDA	
24	NDA			NDA	NDA	
30	NDA					
42	NDA					
48	NDA					

Ru-103 Concentration
(d/m/gm)

Feet Below Surface	Hole No. (1)	Hole No. (2)	Hole No. (3)	Hole No. (4)	Hole No. (5)	Hole No. (6)
5 1/2		6.0×10^2				
6	1.5×10^4					
8	$< 3 \times 10^2$		NDA			
9		2.4×10^3				
12	$< 5 \times 10^2$		NDA	NDA		
14	$< 6 \times 10^2$					NDA
15			NDA			
16				NDA	NDA	
18	2.9×10^3			NDA		
20					NDA	
24	$< 3 \times 10^2$			NDA	NDA	
30	$< 1 \times 10^2$					
42	NDA					
48	< 3					

Ru-106 Concentration

(d/m/gm)

Feet Below Surface	Hole No. (1)	Hole No. (2)	Hole No. (3)	Hole No. (4)	Hole No. (5)	Hole No. (6)
5 1/2		1.1×10^5				
6	1.0×10^6	1.5×10^6				
7		1.5×10^6				
8	1.4×10^6		$< 9 \times 10^1$			
9		2.1×10^6				
12	1.8×10^6		1.8×10^4	NDA		
14	8.3×10^5					NDA
15			NDA			
16				NDA	NDA	
18	3.5×10^5			NDA		
20					NDA	
24	3.5×10^4			NDA	NDA	
30	9.7×10^3					
42	$< 6 \times 10^1$					
48	1×10^2					

Cs-134 Concentration

(d/m/gm)

Feet Below Surface	Hole No. (1)	Hole No. (2)	Hole No. (3)	Hole No. (4)	Hole No. (5)	Hole No. (6)
5 1/2		1.4×10^4				
6	8×10^4	5.1×10^5				
7		3.2×10^5				
8	$< 6 \times 10^2$		NDA			
9		2.0×10^4				
12	4.7×10^3		NDA	NDA		
14	6.9×10^3					NDA
15			NDA			
16				NDA	NDA	
18	$< 1.1 \times 10^3$			NDA		
20					NDA	
24	NDA			NDA	NDA	
30	NDA					
42	< 4					
48	NDA					

Cs-137 Concentration
(d/m/gm)

Feet Below Surface	Hole No. (1)	Hole No. (2)	Hole No. (3)	Hole No. (4)	Hole No. (5)	Hole No. (6)
5 1/2		3.8×10^5				
6	3.6×10^6	1.6×10^7				
7		1.2×10^7				
8	2.7×10^4		$< 1.7 \times 10^1$			
9		1.2×10^6				
12	7.3×10^4		NDA	NDA		
14	1.2×10^5					NDA
15			NDA			
16				2.5×10^3	NDA	
18	$< 1.1 \times 10^3$			9.1×10^2		
20					NDA	
24	NDA			NDA	NDA	
30	$< 1.8 \times 10^1$					
42	< 2					
48	$< 1.6 \times 10^1$					

Ce-141 Concentration
(d/m/gm)

Feet Below Surface	Hole No. (1)	Hole No. (2)	Hole No. (3)	Hole No. (4)	Hole No. (5)	Hole No. (6)
5 1/2		1.1×10^2				
6	5.4×10^3					
8	6.2×10^2		< 8			
9						
12	6.2×10^2		2.0×10^3	NDA		
14	1.0×10^3					NDA
15			5.1×10^2			
16				NDA	NDA	
18	1.0×10^3			NDA		
20					NDA	
24	3.0×10^2			NDA	NDA	
30	2.4×10^1					
42	< 5					
48	NDA					

Ce-144 Concentration

(d/m/gm)

Feet Below Surface	Hole No. (1)	Hole No. (2)	Hole No. (3)	Hole No. (4)	Hole No. (5)	Hole No. (6)
5 1/2		6.7×10^5				
6	1.6×10^6	3.0×10^6				
7		4.1×10^6				
8	6.4×10^5		$< 3.8 \times 10^1$			
9		1.9×10^6				
12	5.1×10^5		9.5×10^5	NDA		
14	4.7×10^5					NDA
15			2.7×10^5			
16				6.7×10^3	NDA	
18	1.8×10^6			2.7×10^3		
20					NDA	
24	5.2×10^4			NDA	NDA	
30	2.6×10^4					
42	NDA					
48	$< 7 \times 10^1$					

Pm-147 Concentration

(d/m/gm)

5 1/2		4.5×10^5			
6	1.3×10^7	4.0×10^6			
7		7.0×10^6			
8	1.2×10^7		$< 8 \times 10^3$		
9		5.3×10^6			
12	9.9×10^6		3.4×10^7	$< 9 \times 10^3$	
14	1.5×10^7				
15			8.4×10^6		
16				1.7×10^5	$< 9 \times 10^3$
18	8.5×10^7			4×10^4	
20					$< 9 \times 10^3$
24	1.4×10^6			$< 9 \times 10^3$	$< 9 \times 10^3$
30	5.8×10^5				
42	4.1×10^3				
48	$< 3 \times 10^3$				

Am-241 Concentration

(d/m/gm)

Feet Below Surface	Hole No. (1)	Hole No. (2)	Hole No. (3)	Hole No. (4)	Hole No. (5)	Hole No. (6)
5 1/2		2.9×10^3				
6	5.5×10^4	6.4×10^4				
7		1.0×10^5				
8	1.8×10^4		$< 5 \times 10^2$			
9		6.3×10^4				
12	1.2×10^5		1.1×10^4	$< 5 \times 10^2$		
14	6.9×10^4					
15			2×10^3			
16				$< 5 \times 10^2$	$< 5 \times 10^2$	
18	1.6×10^4			$< 5 \times 10^2$		
20					$< 7 \times 10^2$	
24	$< 5 \times 10^2$			$< 5 \times 10^2$	$< 5 \times 10^2$	
30	$< 4 \times 10^2$					

(a) No detectable activity

(b) Hole numbers are relative to #1, the site of Well 399-3-8; #2, the location of the corroded line; #3 five feet SE of 1; #4, six and one-half feet SE of 1; #5, ten feet SE of 1; and #6, fifteen feet SE of 1. (Hole #1 was drilled, cased and perforated from 28 to 48 feet. Soil samples were collected to the 48-foot depth and a water sample was collected at about 45 feet. Hole #2 was dug to 11 feet; #3 and #6 to 15 feet; and #4 and #5 to 24 feet.)

(c) A blank in the table indicates no analyses of soil were made at that depth.

Drilling Log

Well Number: 399-3-8 Project Number: JAJ-BL-0813

Depth (Ft.)	Type of Soil	Date	Time	Remarks
6	Sand, silt, cobbles	3/12/70	1050	Sampled
8	Sand & silt, moist	3/12/70	1125	Sampled
10	Sand & silt, moist	3/12/70	1300	Sampled
12	Sand & silt, moist	3/12/70	1315	Sampled, small cobbles & grey clay
14	Cobbles, grey clay	3/12/70		Sampled, sand & silt
16	Cobbles	3/12/70	1510	Sampled, dry material
18	Grey sand & silt, cobbles	3/13/70	0910	Sampled, dry material
20	Grey sand & silt, gravel to 3"	3/13/70	0925	Sampled, material damp
22	Grey sand & silt, gravel to 2"	3/13/70	0940	Sampled, material damp
24	Grey sand & silt	3/13/70		Sampled, material damp
26	Grey sand & silt	3/13/70		Sampled, material damp
28	Grey sand & silt	3/13/70		Sampled, material damp
30		3/13/70		Sampled, material damp

Depth (Ft.)	Type of Soil	Date	Time	Remarks
32		3/13/70		Sampled, material damp
34		3/13/70		Sampled, material damp
36		3/13/70		Sampled, material damp
38		3/13/70		Sampled, material damp
40		3/13/70		Sampled, material damp
42		3/13/70		Sampled, material damp
43		3/13/70		Water
48	Sand & gravel to 2"	3/13/70		Sampled, will perforate in AM from 28' to 48', 4 cuts per foot per round. Took water sample. Developed before perforating. Water level 43'. 52' 5" Casing in hole.
		3/17/70		Perforated 28' to 48'. Moved to 5 foot test hole.

Well Number: Test Boring 5' from 399-3-8

6	Sand & gravel to 4"	3/17/70		Sampled
8	Sand & silt, damp	3/17/70		Sampled
10	Sand & silt, damp	3/17/70		Sampled, 6" thick layer of clay at 10'
12	Sand & silt damp, large rocks	3/17/70		Sampled

Depth (Ft.)	Type of Soil	Date	Time	Remarks
13	Sand & silt damp	3/17/70		Sampled
14	Sand, cobbles	3/17/70		Sampled
15	Sand, large cobbles and clay	3/17/70		Sampled

Well Number: Test Borings 10' & 15' from 399-3-8

		3/18/70		Moved to 10' test hole Drilled hole to 16' Sampled at 4',6',8',10',11',12',13',14',15',16' Moved to 15' test hole Drilled hole to 15' Sampled at 3',5',6',8',10',12',14',15'
		3/19/70		Moved back to 10' test hole Drilled to 24' sampled 16',18',20',22',24' Moved to 6 1/2' test hole

Well Number: Test Boring 6 1/2' from 399-3-8

		3/20/70		Drilled to 15', hit obstruction, changed to hard tools Sampled 3',6',9',12',14'
16	Cobbles and gravel	3/23/70		Sampled
18	Cobbles and gravel	3/23/70		Sampled
20	Cobbles and gravel	3/23/70		Sampled
22	Cobbles and gravel	3/23/70		Sampled
24	Cobbles and gravel	3/23/70		Sampled