

# CONTENTS

3.	EVALUATION OF OU 3-14 SITES .....	3-1
3.1	Sources of Tank Farm Soil Contaminants .....	3-2
3.1.1	Site CPP-31 .....	3-8
3.1.2	Site CPP-28 .....	3-21
3.1.3	Site CPP-79 .....	3-30
3.1.4	Site CPP-15 .....	3-40
3.1.5	Sites CPP-27 and CPP-33 .....	3-42
3.1.6	Site CPP-26 .....	3-50
3.1.7	Site CPP-32 .....	3-55
3.1.8	Site CPP-16 .....	3-57
3.1.9	Site CPP-20 .....	3-58
3.1.10	Site CPP-25 .....	3-60
3.1.11	Site CPP-58 .....	3-61
3.1.12	Site CPP-24 .....	3-64
3.1.13	Site CPP-30 .....	3-64
3.1.14	Site CPP-96 .....	3-65
3.1.15	Suspect Piping .....	3-68
3.1.16	Summary of Operable Unit 3-14 Site Contamination .....	3-68
3.2	Tank Farm Residual Contamination .....	3-69
3.2.1	Tank Heels .....	3-69
3.2.2	Sand Pad Contamination .....	3-75
3.2.3	Residual Radionuclide Inventory in Piping .....	3-77
3.3	OU 3-13 Risk Assessment Summary .....	3-79
3.3.1	Summary of the OU 3-13 Tank Farm Surface Soil Pathway .....	3-79
3.3.2	Summary of the OU 3-13 Groundwater Pathway Modeling and Risk Assessment .....	3-79
3.4	Contaminant Data Review Summary .....	3-85
3.4.1	OU 3-13 Risk Assessment Uncertainties .....	3-85
3.4.2	Tank Farm Soil Contaminants of Potential Concern .....	3-87
3.4.3	OU 3-14 BRA COPC Screening .....	3-90
3.5	Conceptual Site Model for Risk Assessment .....	3-92
3.5.1	Contaminant Sources and Pathways .....	3-92
3.5.2	Surface Soil Exposure Routes and Receptors .....	3-92
3.5.3	Groundwater Exposure Routes and Receptors .....	3-93

# FIGURES

Figure 3-1. Known tank farm soil contamination sites .....	3-3
Figure 3-2. CPP-31 release site boundary and locations of monitoring wells and soil probes in and around the release site .....	3-9
Figure 3-3. Plan view of the piping configuration at the CPP-31 release site. ....	3-10
Figure 3-4. Extent of lateral contamination at the CPP-31 release site (measurements in R/hr) .....	3-14

Figure 3-5. Fence diagram showing vertical and lateral extent of soil contamination (measurements in R/hr) at CPP-31.....	3-15
Figure 3-6. East-to-west, A-to-A', fence diagram through the CPP-31 zone of contamination (radiation readings are in R/hr; readings >5R/hr are shown in red). .....	3-16
Figure 3-7. West-to-east, B-to-B', fence diagram through the CPP-31 zone of contamination (radiation readings are in R/hr; readings >5R/hr are shown in red). .....	3-17
Figure 3-8. North-to-south, C-to-C', fence diagram through the body of contaminated soil at CPP- 31 (radiation readings are in R/hr; readings >5R/hr are shown in red).....	3-18
Figure 3-9. North-to-south, D-to-D', fence diagram through the body of contaminated soil at CPP-31 (radiation readings are in R/hr; readings >5R/hr are shown in red).....	3-19
Figure 3-11. CPP-28 trenching investigation location map. ....	3-22
Figure 3-12. Test pipes being driven into the ground during the contaminant release investigation in 1974 at CPP-28.....	3-24
Figure 3-13. Drill hole found in waste-transfer line 3" PWA-1005 at CPP-28. ....	3-26
Figure 3-14. CPP-13 fence diagram location map. ....	3-27
Figure 3-15. East-west fence diagram through the contaminated soil zone at CPP-28. ....	3-28
Figure 3-16. North-south fence diagram through the contaminated soil zone at CPP-28.....	3-29
Figure 3-17. CPP-79-Shallow piping configuration. ....	3-31
Figure 3-18. West-to-east fence diagram through A-61, CPP-79-1, and A-62 showing soil sample analytical results.....	3-34
Figure 3-19. Map of the tank farm showing locations of boreholes drilled around sites CPP-28 and -79. .3-36	
Figure 3-20. Cross section through CPP-79 release site showing planned excavation depths. ....	3-38
Figure 3-21. Site CPP-15 location map. ....	3-41
Figure 3-22. Schematic diagram showing piping layout in release area CPP-27/33. ....	3-44
Figure 3-23. Map of sites CPP-27 and -33 showing the boundaries of the sites and the locations of previous excavations. ....	3-46
Figure 3-24. Photo showing the amount of soil removed from the CPP-27/33 release area during 1983 excavation. ....	3-47
Figure 3-25. Map of site CPP-27 showing the locations of previously drilled boreholes. ....	3-48
Figure 3-26. Extent of 1983 excavation within the CPP-27/33 release sites. ....	3-49
Figure 3-27. Isometric view of piping associated with the CPP-26 steam release. ....	3-51
Figure 3-28. Location of the existing boreholes at site CPP-26. ....	3-53
Figure 3-29. Location of the excavated area within site CPP-26.....	3-54
Figure 3-30. CPP-32 east and west release sites. ....	3-56
Figure 3-31. Site CPP-16 location map. ....	3-57
Figure 3-32. Excavation in 1982 north of building CPP-604 showing the soil that was removed. ....	3-59
Figure 3-33. Closeup view of 1982 excavation north of building CPP-604 showing the soil that was removed.....	3-60
Figure 3-34. Site CPP-58 soil boring location map. ....	3-62
Figure 3-35. Tank farm map showing gamma survey results and well, probe, borehole, and cathodic-protection anode drilling locations.....	3-66
Figure 3-36. Tank farm map showing wells, cathodic-protection boreholes/anode estimated locations, and probe/soil-boring locations. ....	3-67
Figure 3-37. Decision logic for tank farm soil COPC identification. ....	3-88
Figure 3-38. CSM for OU 3-14.....	3-89
Figure 3-39. INTEC conceptual model features. ....	3-93

## TABLES

Table 3-1. Known release sites contained in CPP-96 (from WINCO 1993a; WINCO 1993b; DOE-1997a). .....	3-4
Table 3-2. Direct radiation measurements in 1975 from boreholes or observation wells installed at site CPP-31 after the release.....	3-12
Table 3-3. Summary of the subsurface radiation profile performed on selected probes at site CPP-31 on August 18, 1992.....	3-21
Table 3-4. 1974 test hole radiation readings for CPP-28 (R/hr). <sup>a, b, c</sup> .....	3-25
Table 3-5. Borehole sample result comparison table (results in pCi/g).....	3-35
Table 3-6. Estimated curies remaining at CPP-96 release sites.....	3-70
Table 3-7. Single tank heels inventory at the assumed time of facility closure in 2016..... (DOE-ID 2003b).....	3-73 3-73
Table 3-8. Inventory for the sand pads at the time of facility closure (2016).....	3-76
Table 3-9. Estimated radionuclide inventory for piping at facility closure in 2016.....	3-78
Table 3-10. Summary of OU 3-13 tank farm surface soil release sites, OU 3-13 COCs, and PRGs (DOE-ID 1998a).....	3-80
Table 3-11. Summary of the identified groundwater COPCs for OU 3-13 (DOE-ID 1999b).....	3-81
Table 3-12. Summary of the OU 3-13 maximum and peak simulated contaminant concentrations for the entire aquifer domain <sup>a</sup> (DOE-ID 1997a, 1997b).....	3-83
Table 3-13. OU 3-13 groundwater ingestion cancer risk and noncancer hazard quotients in the year 2095 and for the peak concentration if it occurs beyond the year 2095 (DOE-ID 1997a, 1997b, 1998a)....	3- 84
Table 3-14. Site-by-site preliminary summary of radionuclide analyses required to meet BRA data needs for OU 3-14 tank farm soil release sites. An asterisk indicates that the COPC has not been analyzed for at the site.....	3-90
Table 3-15. Site-by-site summary of inorganic analyses required to meet BRA data needs for OU 3-14 tank farm soil release sites. An asterisk indicates that the COPC has not been analyzed for at the site. .....	3-90



### 3. EVALUATION OF OU 3-14 SITES

This section summarizes the current understanding of each release site at the INTEC tank farm based on past characterization and process knowledge and, when possible, provides reasonable estimates of contamination remaining at each release site. For some sites, additional information is provided after extensive review of release site files and interviews with tank farm operation personnel. The sites with the largest known releases are presented first. Sites that have been recommended for no further action at least once in the investigation process are presented last. This section also describes residual contamination that may be left in the HLW tanks, piping, and tank vaults after decontamination activities are completed. The individual and combined soil and tank system contaminant inventory will be used to evaluate overall risk to human health and the environment. The contaminant inventory and the conceptual model provided in Subsection 4.1 provide the foundation for the OU 3-14 work plan rationale presented in Section 5.

Descriptions of the OU 3-14 sites and the sources of contamination at each site are based on past investigations and contaminants that were detected for any samples that were collected and analyzed. Analytical results from past investigations will be used for screening purposes, because not all COCs were analyzed for. These sites were either assigned to OU 3-14 in the OU 3-13 ROD (DOE-ID 1999a) or defined in the OU 3-14 scope of work (DOE-ID 1999b). Under OU 3-14, the tank farm soil sites were consolidated into CPP-96. Specifically, CPP-96 comprises sites CPP-15, -16, -20, -24, -25, -26, -27, -28, -30, -31, -32, -33, -58, -79, and all interstitial soils (Figure 3-1).

The OU 3-13 remedial investigation/baseline risk assessment (RI/BRA) (DOE-ID 1997a) determined which WAG 3 sites have contamination at levels likely to adversely affect human health and the environment. The OU 3-13 BRA evaluated the nature and extent of contamination. The site screening determined which sites to eliminate from further evaluation based on acceptable levels of residual contamination or previous no action/no further action determinations. Contaminant screening was performed on the sites that were carried over (see Table 7-1 in the OU 3-13 ROD [DOE-ID 1999a]). Contaminant fate and transport modeling was conducted, and risks associated with available and site-related contamination data for the WAG 3 release sites were estimated based on data and conceptual models available at the time. Sites with contamination above acceptable limits were carried over to the OU 3-14 investigation. In addition, three no action sites in the tank farm were included, and three no action sites outside the tank farm where the Agencies believed more data were needed were also included. These later three sites will be part of the OU 3-13 ESD and not OU 3-14.

The contaminants identified in the OU 3-13 RI/BRA for the tank farm soil were based on data compiled for known release sites. The inability to sample each site and the incomplete evaluation of the collected samples for the full range of potential contaminants (e.g., radionuclides, organics, and metals) left uncertainty in the source term and remedial options for these sites. This source term uncertainty—along with fate, transport, and extent of contamination uncertainties—was carried forward into the following:

- The site and contaminant screening process performed in the OU 3-13 RI/BRA, which generated a list of retained OU 3-13 contaminants of potential concern (COPCs) (DOE-ID 1997a, Table 5-51) for quantitative evaluation in the OU 3-13 RI/BRA
- The resulting OU 3-13 COCs for the tank farm soil surface pathway and the SRPA beneath INTEC.

### 3.1 Sources of Tank Farm Soil Contaminants

Contamination in tank farm soil resulted from past spills, leaks, and contaminated backfill. Spills have occurred during waste-handling and maintenance operations at the tank farm. Many of the leaks are from incompatible piping that corroded due primarily to contact with acidic waste. The time, duration, and volume of the releases are difficult to determine in some cases. Backfill with relatively low amounts of contamination was sometimes used during tank farm maintenance and contamination removal activities. Typical materials used to backfill tank farm excavations consisted of contaminated soil with contact radiation levels of 3 to 5 mR/hr.<sup>a</sup> This soil was placed in the bottom of excavated areas, and clean soil was placed on top for shielding purposes.

The known tank farm soil contamination sites are shown in Figure 3-1 and summarized in Table 3-1. The individual site descriptions are primarily a composite of the information contained in archived project record files, the OU 3-13 RI/BRA (DOE-ID 1997a), the OU 3-13 feasibility study (DOE-ID 1997b), the feasibility study supplement (DOE-ID 1998c), and the OU 3-13 ROD (DOE-ID 1999a). The generating process, release mechanism, and other details are discussed to provide a better understanding of the processes that produced the contamination in tank farm soil.

Previously, three sites, CPP-28, CPP-31, and CPP-79, were determined to contain over 99% of the known radiological contamination (in curies) within the tank farm soils, ultimately driving the risk to groundwater (DOE-ID 1997a). However, review of available project files for each release site and interviews with tank farm personnel suggest that the release at CPP-28 was not as large as previously estimated and may not be associated with the deeper contamination found at CPP-79. Even so, based on the updated estimates presented in the following subsections, these three release locations still contain over 99% of the radiological activity.

An attempt was made to determine a source term for each of the known release sites based on process knowledge and past field investigation work for future use in an updated fate and transport model and the corresponding risk assessment. Knowing the particular waste type and the volume lost, a list of radionuclides and their radioactive concentrations can be generated. It was discovered late in the “data mining process” that engineering design files (EDFs) were written to document most of the releases in the tank farm, establishing what radionuclides would be present in the release and their activity levels. As a part of the baseline risk assessment for the tank farm soils, it will be necessary to locate and recover the EDFs to provide supporting source term data. For comparative reasons, estimates of the Cs-137 and Sr-90 curie content remaining at each site are provided in Table 3-1 and are based on process knowledge, past investigation data, and bounding subsurface structures. By knowing the Cs-137 activity and age of the release and corresponding waste stream, a list of associated radionuclides and their activity levels can be generated if an EDF does not exist.

Details about each of the known releases and their corresponding extents of contamination are discussed in the following subsections.

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a. R and mR are abbreviations for roentgen and milliroentgen, respectively, which are units for measuring radiation exposure. The measurement is defined for effects on air and applies to gamma measurements in the field.

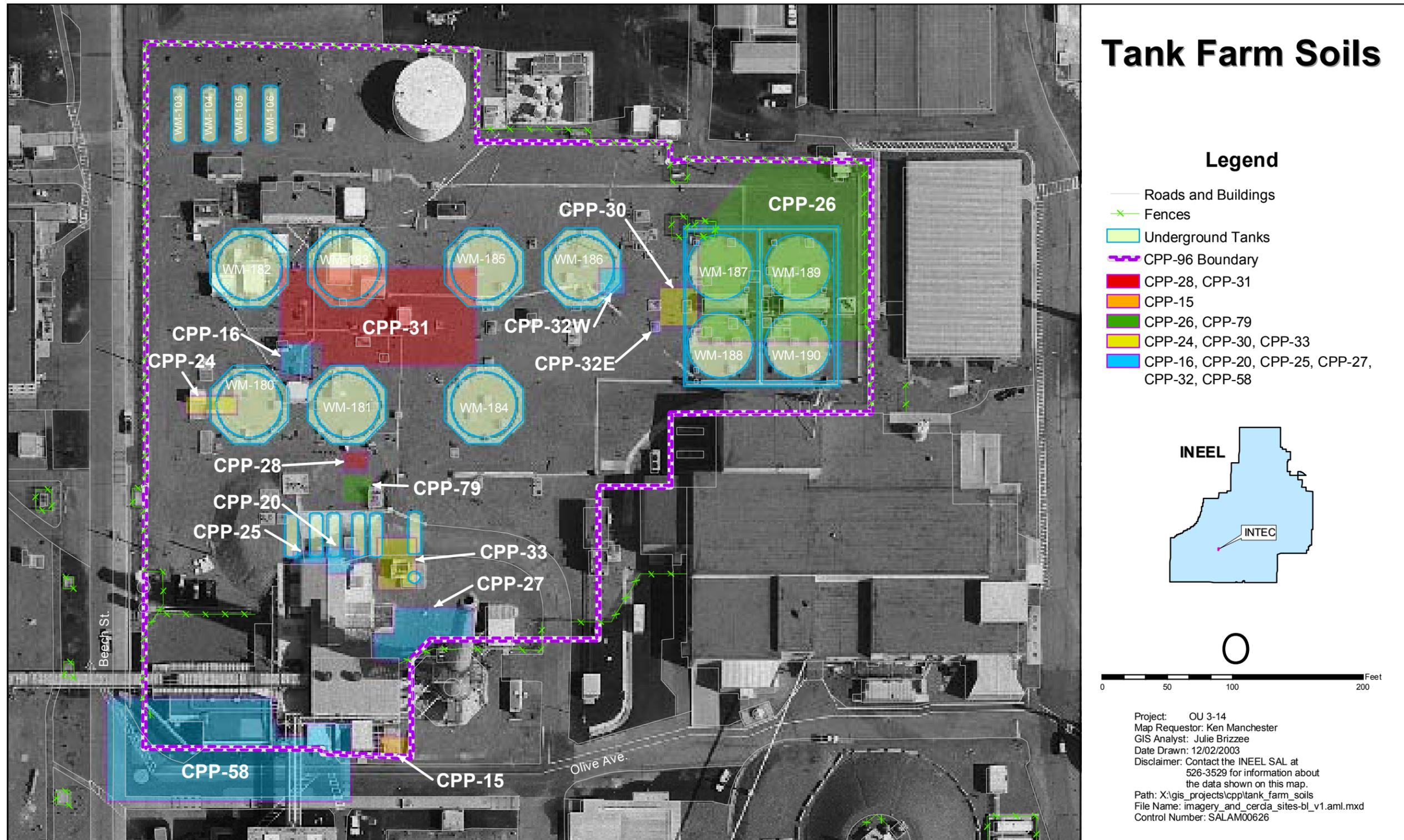


Figure 3-1. Known tank farm soil contamination sites.

Table 3-1. Known release sites contained in CPP-96 (from WINCO 1993a; WINCO 1993b; DOE-1997a).

Site	Estimated Curies Remaining	Estimated Extent of Remaining Contamination		Analyzed Contaminants	Status of Site Remediation/Characterization	Additional Comments	Past Investigation
		Area (ft <sup>2</sup> )	Depth (ft) bgs				
<u>CPP-15</u> Solvent burner east of CPP-605; release of an unknown volume of solvents	360 Ci	700	20	In 1995, six westside samples analyzed for volatile organic compounds (VOCs), antimony, selenium, thallium, zirconium, nitrate, silver, mercury, Am-241, Eu-154, Cs-134, Cs-137, Co-60, I-129, Np-237, Pu-238, Pu-239/240, Tc-99, Ru-103, Sr-90, U-234, U-235, U-238, and Ru-106. Most constituents not detected. Gross alpha/beta and Cs-137 analyses performed on samples above 10.5 ft. Deepest sample also analyzed for full suite of radioisotopes. Low concentrations of trichloroethene and methylene chloride were the only VOCs detected in the samples. The 1995 sampling was incomplete; only portions of the west side sampled and no sampling performed on east side. No sampling data are available for the eastern portion of CPP-15.	Contamination not completely removed in 1974 excavation. During 1983 demolition of solvent burner, an unknown amount of contaminated soil was removed with the solvent tank to a depth of 10 ft bgs. The 1983 soil contamination removal thought to be complete. In September 1995, Lockheed Martin Idaho Technologies Company construction personnel encountered contaminated soil in the western half of the site while excavating for an electrical duct bank and transformer pad. The highest activities were detected in a sample collected at 10.5 ft bgs.  Cs-137 contamination levels not consistent with the solvent waste stream.	Recommended as a no further action site in Track 2 report, based on reported removal of all soil contamination during removal of the solvent burner system.	OU 3-08 Track 2 and the OU 3-13 RI/FS (WINCO 1993b; DOE-ID 1997a, 1997b)
<u>CPP-16</u> WM-181 to PEW line valve leak; 3,000 gal of low-level contaminated wastewater released	1.1 Ci	450	~8	No soil analyses found.	Soil excavated during valve-box replacement. Excavation record incomplete and soil replaced with backfill. Backfill needs to be sampled according to Track 2.	Being re-investigated because of consolidation of tank farm sites into CPP-96. Backfill not a risk driver.	OU 3-07 Track 2 and the OU 3-13 RI/FS (WINCO 1993d; DOE-ID 1997a)
<u>CPP-20</u> CPP-604 radioactive waste unloading area; minor volumes of spilled liquid waste during transfers into waste tanks	Contamination removed < 1 Ci	NA	NA	No data available because this site was excavated without soil sampling being performed. Concentrations of inorganics and radionuclides are assumed to be similar to concentrations in soil previously excavated in the tank farm.	Contaminated soils found near valve box C-30 were removed. Spills reportedly cleaned up as they occurred; excavated to 40 ft during tank farm upgrades, replaced with backfill (1982–1984 and 1992–1994). Track 2 states backfill needs to be sampled. Although the precise area of contamination is unknown, a 1990–1991 radiological survey of the area had no detects above background.	No records describe types, amounts, or locations of spills. No records exist verifying effectiveness of cleanup; excavated soil would have removed any remaining contaminated surface soils.	OU 3-07 Track 2 and the OU 3-13 RI/FS (WINCO 1993b; DOE-ID 1997a, 1997b)
<u>CPP-24</u> Tank farm bucket spill; approximately 1 gal of radioactive waste solution spilled on ground surface	Contamination removed <1 Ci	NA	NA	No data available.	Reported site cleaned up using soil removal. Exact location of spill unknown.	Suspected contaminants based on process/spill knowledge. This is a no further action site.	OU 3-07 Track 2 and the OU 3-13 RI/FS (WINCO 1993b; DOE-ID 1997a, 1997b)
<u>CPP-25</u> Contaminated soil north of CPP-604	Contamination removed <1 Ci	NA	NA	This site was excavated without soil sampling being performed. Concentrations of inorganics and radionuclides are assumed to be similar to concentrations in soil previously excavated in the tank farm. No original soil data.	Entire area excavated and replaced with backfill twice (1981–1983 and 1992–1994); backfill material contaminant levels not well documented; no sampling records. Track 2 recommended sampling backfill. No records to verify the effectiveness of cleanup.		OU 3-07 Track 2 and the OU 3-13 RI/FS (WINCO 1993b; DOE-ID 1997a, 1997b)
<u>CPP-26</u> Radioactively contaminated steam release	45 Ci	12,850	5	Track 2 investigation drilled three boreholes (26 series). Borehole samples analyzed for VOCs, some metals, fluoride, nitrate/nitrite/pH, and radionuclides. Sr-90, Cs-137, and Eu-154 were primary radionuclide detects. Very low levels of Pu-238, Pu-239, and Am-241 detected.	Area disturbed extensively. The portion of the release site nearest the decontamination header was excavated during the construction of buildings CPP-654, CPP-699, and storage Bin Sets 4, 5, and 6. Contamination detected from boreholes indicates a possible additional source of contamination. It does not appear that radionuclide contamination has moved downward in the soil. Recent survey of surface shows no contamination.	Area within tank farm is covered with a liner and soil so that suspected contaminated area is 2.5 ft bgs. Lacking certainty that the borehole soil analysis reflects steam release.	OU 3-07 Track 2 and the OU 3-13 RI/FS (WINCO 1993d; DOE-ID 1997a, 1997b)

Table 3-1. (continued).

Site	Estimated Curies Remaining	Estimated Extent of Remaining Contamination		Analyzed Contaminants	Status of Site Remediation/Characterization	Additional Comments	Past Investigation
		Area (ft <sup>2</sup> )	Depth (ft) bgs				
<u>CPP-27/33</u> Contaminated soil east/northeast of CPP-604	Most of the contamination was removed; estimated 25 mCi remain	2,000	25	A 1974 radionuclide analyses performed; only Cs-137, Sr-90, and Pu-239/240 would be present today due to radioactive decay. No soil samples were collected during the 1987 investigation. Samples taken in 1990 were analyzed for VOCs, semivolatile organic compounds, pesticides, PCBs, herbicides, dioxins, furans, metals, cyanide, pH, and radonucleides. 1993 samples analyzed for VOCs, metals, fluoride, nitrate, nitrite, pH, and radionucleides. I-129, Tc-99, and Np-237 were excluded in soil analysis.	First soil samples collected during 1974 excavation when majority of contaminated soil was removed. The area was excavated again in 1983 and backfilled with soils having up to 25 mrem/hr contaminant levels. In 1987, 10 boreholes were drilled for radiation measurement characterization. Track 2 investigation drilled and sampled three boreholes (CPP-27 series) in 1992. An investigation in 1991 involved drilling and sampling borehole 33-1.	Borehole 27-1 was drilled in an area not previously excavated. Contamination encountered 6 ft higher than reported release for CPP-27/33, indicating a possible new source at borehole 27-1. Backfill should not be a risk driver. There is some uncertainty regarding the depth of beta-gamma contamination.	CPP-27: OU 3-08 Track 2 and the OU 3-13 RI/FS (WINCO 1993b; DOE-ID 1997a, 1997b)  CPP-33: OU 3-06 Track 2 and the OU 3-13 RI/FS (WINCO 1993c; DOE-ID 1997a, 1997b)
<u>CPP-28</u> Leak in first-cycle extraction liquid waste-transfer line; estimated 120 gal released through 1/8-in. hole in waste line	360 Ci	65	12	Six boreholes drilled to determine extent of contamination. Soil samples were collected from bottom of each hole for beta-gamma radiation measurements. Only one hole had detectable contamination. Metals, organics, and isotope analyses not performed. Eleven soil probeholes were installed after the waste-transfer line was excavated and a portion of the contaminated soils was removed. The probeholes were measured for radiation levels at discrete depths to determine the extent of contamination. Results of the radiation survey indicated that the contamination from the release was limited to a relatively small volume.	Partial soil excavation in 1974 removed approximately 3,000 Ci of activity, leaving approximately 3,000 Ci in the release area. Portions of the site also excavated to 15 ft bgs (5 R/hr) between 1993 and 1996. Characterized along with CPP-79; bounding calculations estimate the amount of contamination leaked to the soil. Volume released in question—estimated approximately 120 gal of high-level liquid waste.	Previous work related the contamination found at CPP-79-Deep to the contamination at CPP-28. However, no pathways between the two sites have been identified. The contamination at CPP-28 appeared to be well bounded based on the characterization work completed in 1974. Excavations during subsequent tank farm upgrades did not encounter highly contaminated pathways linking CPP-28 to CPP-79-Deep.	OU 3-07 Track 2 and the OU 3-13 RI/FS (WINCO 1993d; DOE-ID 1997a, 1997b)
<u>CPP-30</u> Contaminated soil near valve box B-9; result of maintenance personnel placing contaminated equipment and clothing on the ground	Contamination removed <1 Ci	NA	NA	Unknown if contaminant analysis was performed.	Soil excavated and placed in four 55-gal drums that were disposed of at the Radioactive Waste Management Complex. Surface surveys in 1991 and 1992 did not show radiation levels above background.	No records to verify the effectiveness of soil removal.	OU 3-07 Track 2 and the OU 3-13 RI/FS (WINCO 1993d; DOE-ID 1997a, 1997b)

Table 3-1. (continued).

Site	Estimated Curies Remaining	Estimated Extent of Remaining Contamination		Analyzed Contaminants	Status of Site Remediation/Characterization	Additional Comments	Past Investigation
		Area (ft <sup>2</sup> )	Depth (ft) bgs				
<p><u>CPP-31</u> 14,000 gal of second- and third-cycle extraction waste released to the soil south of WM-183</p>	23,850 Ci	10,550	25	<p>Thirty-three wells installed in 1975 to investigate site. Soil samples taken and analyzed for radionuclides. Direct radiation readings also taken. Additional observation wells (81 series) were installed in 1980s. The 1993–1994 investigation installed borehole A-60 to delineate the western edge of CPP-31. This borehole was sampled for radiological contaminants; results from A-60 not characteristic of CPP-31. Organics, metals, and RCRA constituents were not sampled during any of the investigations.</p>	<p>Carbon-steel line cut and capped at the valve; boreholes installed to delineate extent of contamination. No documented cleanup. Most of the contaminated soil is 10 to 25 ft bgs.</p>	<p>CPP-31 is one of the most significant sites with respect to the transport of plutonium and Sr-90 to the perched water zones and the SRPA. Soil samples collected for radiological analysis were collected from the soil that was brought to the surface by the auger flights. The soil samples collected were likely contaminated soil mixed with potentially uncontaminated soil. The results indicate the general type of contamination present.</p>	<p>OU 3-07 Track 2 and the OU 3-13 RI/FS (WINCO 1993d; DOE-ID 1997a, 1997b)</p>
<p><u>CPP-32E</u> Contaminated soil adjacent to valve box B-4; release of contaminated water vapor condensate from B-4</p>	<1	14	5	<p>Borehole drilled and soil samples collected at two depths. Analyzed for VOC, metals, and radionuclides. Initial radiation levels on the soil measured up to 2 R/hr.</p>	<p>Area has been covered with soil and the tank farm membrane. No documented cleanup.</p>	<p>Field radiation readings peaked between 1.4 and 2.9 ft bgs. Readings decreased from 2.9 to 5 ft</p>	<p>OU 3-07 Track 2 and the OU 3-13 RI/FS (WINCO 1993d; DOE-ID 1997a, 1997b)</p>
<p><u>CPP-32W</u> Contaminated soil northwest of valve box B-4; result of a leak of radioactive liquid from a aboveground transfer line used to pump water from tank sumps to the PEW evaporator</p>	<1	6	1	<p>Results from CPP-32E assumed to represent contaminants concentrations in CPP-32W. No soil samples were collected, because the location of release was approximate. Surface radiation readings up to 2 R/hr recorded during initial site investigation.</p>	<p>Unknown if any cleanup occurred.</p>	<p>Track 2 recommended this site not be investigated at the time. Suggested deferring investigation to comprehensive RI/FS.</p>	<p>OU 3-07 Track 2 and the OU 3-13 RI/FS (WINCO 1993d; DOE-ID 1997a, 1997b)</p>

Table 3-1. (continued).

Site	Estimated Curies Remaining	Estimated Extent of Remaining Contamination		Analyzed Contaminants	Status of Site Remediation/Characterization	Additional Comments	Past Investigation
		Area (ft <sup>2</sup> )	Depth (ft) bgs				
<p><u>CPP-58</u> PEW evaporator condensates pipeline releases (CPP-58E and -58W); approximately 20,000 gal of PEW condensates headed for service waste were released in 1976 at the CPP-58E site, and CPP-58W is associated with unknown volumes of PEW condensates leaked to the ground in 1954</p>	1.3 Ci	13,650	40	<p>During the Track 2 investigation, only the CPP-58E site was analyzed for contaminants. Thirteen samples were taken from two boreholes and analyzed for VOCs, metals, fluoride, pH, nitrate/nitrite, and radionuclides. Two boreholes sampled in area with nitric acid contamination found elevated concentrations of nitrates, mercury, Sr-90, and Cs-137. Characterization data exist only for the east portion of the site.</p> <p>During the 2001 TFIA field activities, two new areas of contamination were discovered. A moist brown material (nitric acid contamination) was discovered in the CPP-58E area in 2001, and a sample was analyzed (pH, 2.41; nitrates, 3.67 mg/mL; mercury, 0.639 mg/kg; and Cs-137, 6.98 pCi/g). The results were consistent with past PEW overhead releases identified for CPP-58E. A radiological area with radiological activity typically between 200 and 300 counts per minute (cpm), with a high of 500 cpm, was encountered west of CPP-58W at the corner of Olive Avenue and Beech Street. This resulted in combining CPP-58E and -58W and revising the boundary to extend farther south and west of CPP-58W.</p>	Contamination from 1954 (CPP-58W) is assumed to have been left in place and may be under building CPP-649. Nitric acid/nitrate contamination typical of PEW condensate was found adjacent to the original CPP-58 and included within site CPP-58. Additional investigation of the extent of contamination in this larger CPP-58 site was recommended for investigation in OU 3-14.	Low levels of contamination exist. Regarding 1954 release, there is no information on how often transfer line was used, how long the pipe leaked, the quantity of condensate released, or the length, width, or depth of contamination. Nitric acid and nitrate contamination discovered in 2001 resulted in a new area added to CPP-58. The source of this contamination is not evident.	OU 3-11 Track 2 (WINCO 1993a)
<p><u>CPP-79-Shallow</u> Approximately 2,500 gal of dilute calciner decontamination solutions was lost (through split-tile encasement after the waste backed up through valve box A-2)</p>	7.0 Ci	~450	30	Soil boring CPP-79-1 drilled near release site during Track 2 investigation. Soil samples were analyzed for nitrate/nitrite, VOCs, Target Analyte List metals, pH, and radionuclides.	Condensate contained low-level radioactivity, metals, and organic compounds. After 1976 release, condensate analyzed (I-129, H-3, gross beta, and uranium found). Portions of site excavated in 1994. Site well characterized and source well known.	CPP-79-1 was installed approximately 10 ft south of the two lines (3" PUA-1013 and 3"PUA-203) where the release was believed to have occurred.	OU 3-08 Track 2 and the OU 3-13 RI/FS (WINCO 1993b; DOE-ID 1997a, 1997b)
<p><u>CPP-79-Deep</u> First-cycle wastes likely from former valve box A3A</p>	Lower limit: 3,807	628	28 to 34	Gross alpha, gross beta, Cs-137, Sr-90, Eu-154, U-234, U-235, U-238, Pu-238, Pu-239, and Am-241.	Only one data point exists for this release site. Excavations conducted in this area of the tank farm during the 1992 through 1994 upgrade encountered contaminated soils with radiation readings of 5 R/hr.	Previously reported soil contamination readings were incorrect. The highest radiation readings recorded in field logbooks was 1.2 R/hr. The 400 R/hr value presented in the December 2000 OU-3-14 RI/FS work plan (DOE-ID 2000b) should have been 400 mR/hr. The source for this release has not been determined. The source may have been from a leaking valve in valve box A3A, in which waste moved downward through split-tile encasement and into the soil through flaws in the encasement.	OU 3-08 Track 2 and the OU 3-13 RI/FS (WINCO 1993b; DOE-ID 1997a, 1997b)
	Upper limit: 13,535	353	28 to 41				

NA – Not Applicable

### 3.1.1 Site CPP-31

Site CPP-31 resulted from a valve inadvertently left open or partially open during a liquid waste transfer in November 1972, allowing the waste to contact a normally isolated carbon-steel line. The waste contacting the line caused corrosion and failure of the line and allowed the release of waste solution into the soil. The release and its investigations are described chronologically below.

In September 1973, ten 2-in. monitoring wells (A-40 through A-49) were drilled and installed by the United States Geological Survey (USGS) at various locations in and around the tank farm. No contamination was encountered during drilling of these wells. In September 1975, 10 additional monitoring wells (A-50 through A-59) were drilled and installed to extend the monitoring network to the older part of the tank farm. On September 18, 1975, while drilling monitoring well A-53, located approximately 15 ft southwest of tank WM-183 and 10 ft south of the edge of the tank vault (Figure 3-2), contaminated soil was brought to the surface. Beta/gamma radiation levels in the auger drill cuttings reportedly ranged from 100 mR/hr at 15 ft bgs to 500 mR/hr at 22 ft bgs. A radiation profile was taken by lowering a radiation detector into the hollow-stem augers. Readings greater than 10 R/hr were measured at depths of 14, 18, 19, and 23 ft below grade. Well A-55, located southwest of WM-185, also encountered contaminated soil but at lower concentrations than A-53.

Fifteen additional exploratory holes (A-53-1 through A-53-15) were drilled to a depth of 25 ft by the USGS to define the limits of the contaminated area. Soil samples and a radiation measurement plot were collected from each hole. These holes were not cased and were backfilled as the bit was removed. Contaminated soil was encountered in nine of the 15 holes (A-53-1, -2, -3, -4, -5, -6, -10, -13, and -15). Sixteen additional soil probe pipes (A-53-16 through -31) were driven into the ground between early November and December 7, 1975, to help pinpoint the source of contamination and further characterize the lateral and vertical extent. Location A-53-18, just north of valve box A-6, was unique in that significant radiation was measured at 4, 9, and 10 ft bgs. This suggested that the leak might have originated from a point above the elevation of the main waste lines located in the concrete encasements.

Late in November 1975, a potential leak mechanism was identified during the process of reviewing design criteria for the Liquid Waste Improvement Project. One of the tasks to be completed during the project was to disconnect and abandon a carbon-steel line (3"WRN1037) having no secondary containment, which connected to the stainless-steel pipe-within-a-pipe intermediate waste-transfer line (3"PWA1014). The transition from carbon steel to stainless steel occurred at a point located just southwest of valve box A-6 at a depth of approximately 5 ft bgs (Figure 3-3). A stainless-steel valve (WRV-147) located in the line about 6 ft north of the point of connection provided isolation between the two lines. The 3"WRN1037 carbon-steel line, originating in building CPP-628, was originally plumbed into the waste-handling system as a means of discarding cooling water circulating in a closed-loop system in the event that it became contaminated due to a tank cooling coil leak. The line, which was disconnected and blinded off in building CPP-628, was pressure tested against the closed valve. The line failed to hold pressure. It was presumed that the carbon-steel line came into contact with waste that was highly corrosive to carbon steel.

On December 11, 1975, the junction of 3"WRN1037 and 3"PWA1014 was uncovered, and on December 16, 1975, the stainless-steel line and encased portions of drain line were cut and capped. Pressure tests were applied to both the stainless-steel portion of the abandoned line to determine whether valve WRV-147 could have leaked in the closed position and the intermediate waste-transfer line 3"PWA1014. Both tests maintained pressure, demonstrating that those lines were not leaking. No further fieldwork was conducted, and the investigation concluded that valve WRV-147 was open or partially

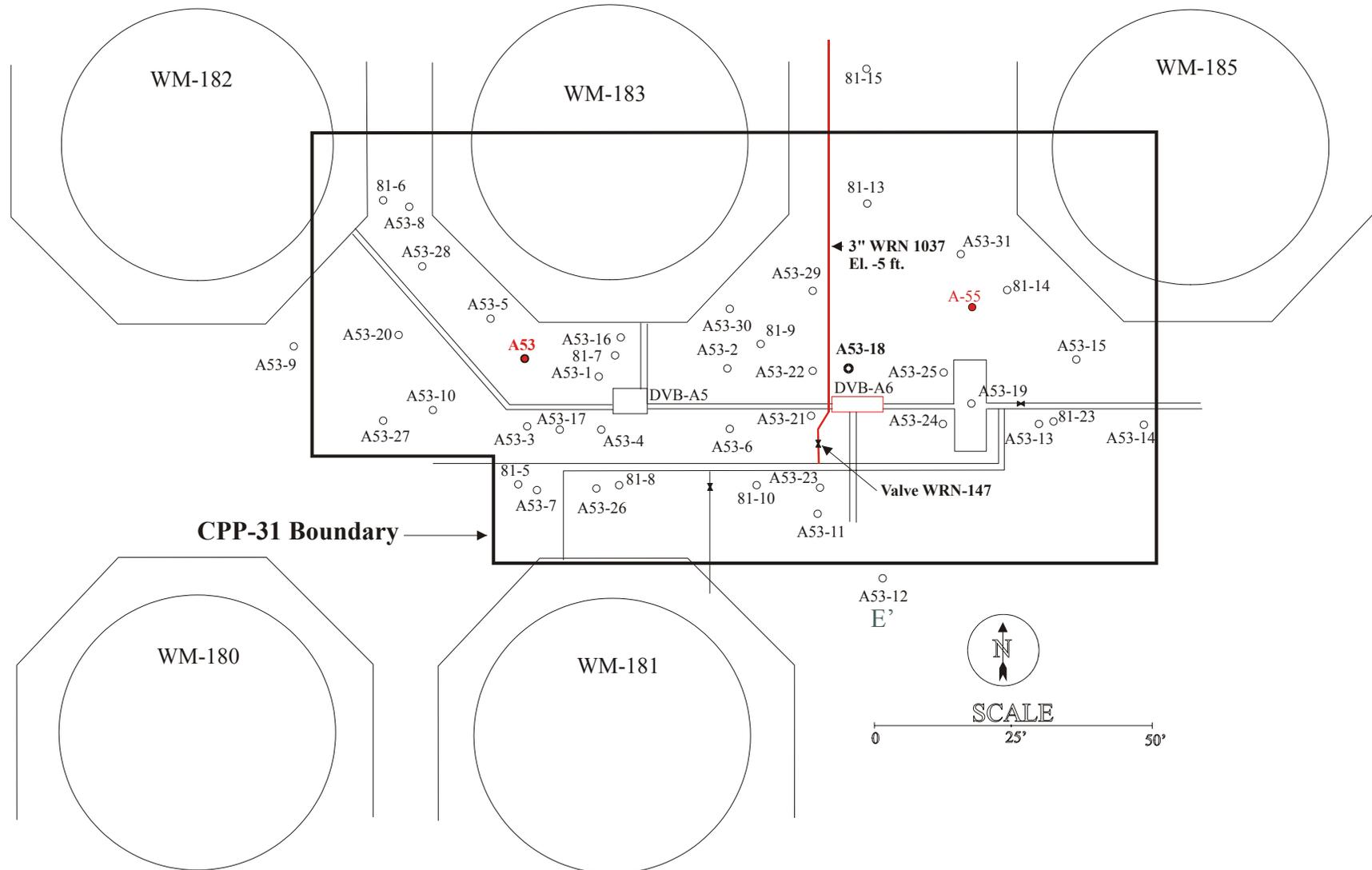


Figure 3-2. CPP-31 release site boundary and locations of monitoring wells and soil probes in and around the release site.

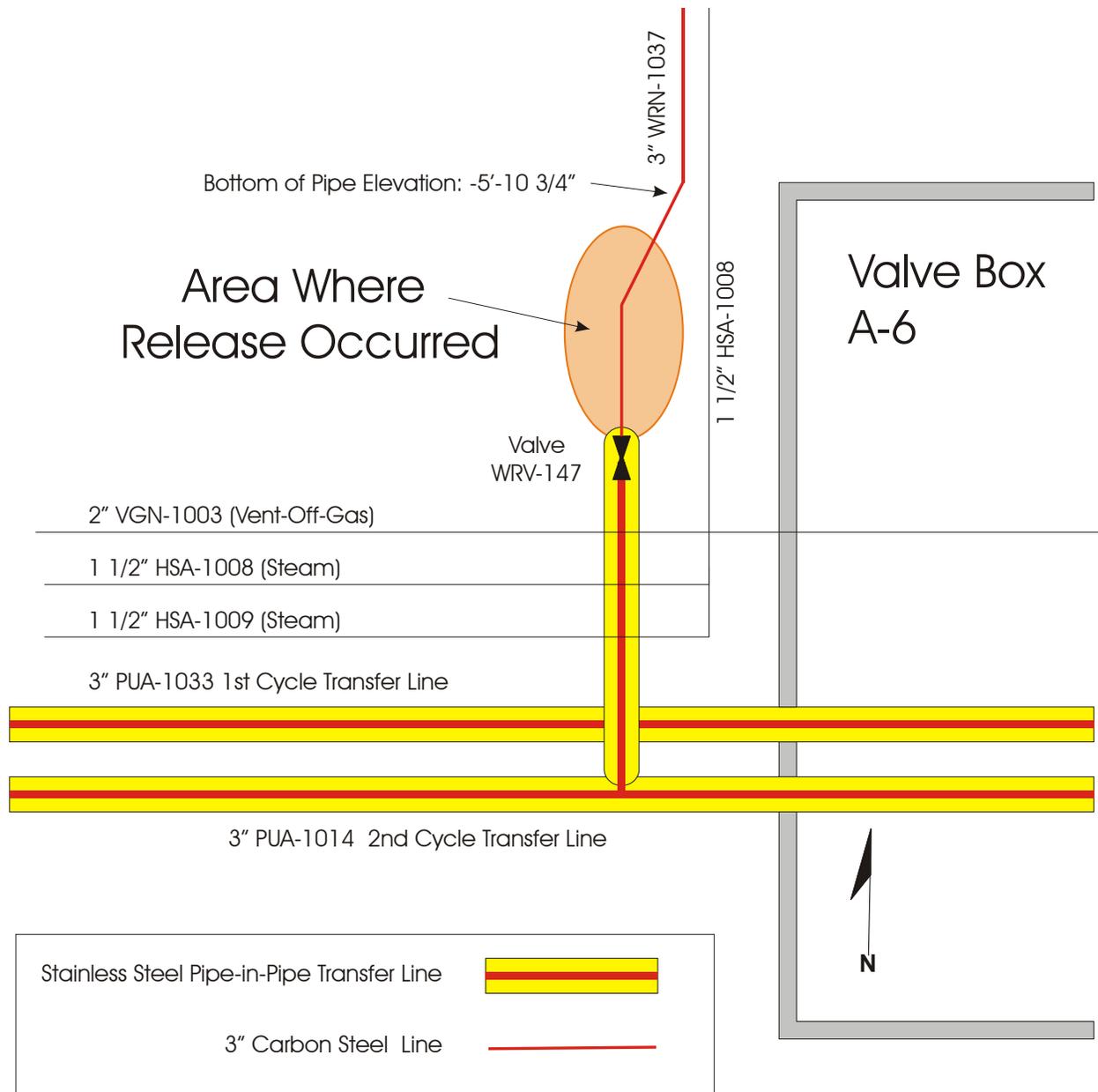


Figure 3-3. Plan view of the piping configuration at the CPP-31 release site.

open during one major liquid waste transfer in November 1972, when the contents of WM-181 (PEW bottoms and second- and third-cycle waste) were transferred to WM-180. The records show that about 271,000 gal of waste was transferred from WM-181, and approximately 265,000 gal were received in WM-180; this is 6,000 gal less than was sent. Taking jet dilution into account, the volume reaching WM-180 should have been about 8,000 gal greater than was transferred out of WM-181, resulting in approximately 14,000 gal backing through valve WRV-147 to the corroded carbon-steel line and into the soil.

**3.1.1.1 Extent of Soil Contamination at CPP-31.** Following the installation of boreholes and observation wells, direct readings were obtained from the subsurface by lowering a string of thermoluminescent dosimeter chips down the cased hole or drill rod, exposing the chips for 1 hr. The results of these measurements taken in 1975 are presented in Table 3-2. The vertical contaminant distribution in some of the boreholes was believed to be somewhat distorted due to the auger drill used. Activity near the top of the holes was considered to be primarily activity augered up from the main pocket of activity at a depth of 12 to 25 ft. Likewise, higher levels of activity at the bottom of the hole were considered to be the result of drill bit contamination and contaminated soil falling into the hole from the highly contaminated horizons above. The data presented were used to develop a map depicting the lateral extent of contaminated soil (Figure 3-4). Six fence diagrams (Figures 3-5 through 3-10) show the vertical contaminant distribution along various transects through the contaminated zone. The contaminant distribution appears to be associated with zones of preferential movement in the horizontal direction, mainly along waste-transfer lines 3”PWA-601/602 connecting valve boxes A-5 and A-6 to WM-182 and waste-transfer lines 3”PWA-609/610 buried approximately 11 to 12 ft bgs.

In the early 1980s, several additional monitoring wells, designated the “81 series,” were installed in the tank farm area near CPP-31 (Figure 3-2). As a part of the 1992 OU-3-07 Track 2 investigation (WINCO 1993a), radiation profile surveys were performed on 10 existing wells, including eight of the 81 series wells. Results of the 1992 surveys are presented in Table 3-3. A comparison of those results to previous subsurface radiation profile measurements is inconclusive as to whether migration has occurred since the time of release or if the radiation levels in the soil were increasing or decreasing over time.

Based on the number of monitoring wells installed and their associated radiation profiles, the lateral and vertical extent of the contaminated soil appears to be adequately bounded, with the exception of a small area east of valve box A-6 along the piping runs of 3”PWA-1005 and 3”PWA-1030. Monitoring well A53-25 encountered contaminated soil but did not penetrate the vertical extent of contamination at that location. However, based on reviews of data from other probes, it is likely that the contamination extends no deeper than 25 ft bgs, leaving approximately 15 ft of alluvial material between the bottom of the measured contamination and the top of the basalt.

**3.1.1.2 Volume of Contaminated Soil and Associated Activity at CPP-31.** The volume of soil with contact radiation levels exceeding 1 R/hr was estimated to be 800 yd<sup>3</sup>, and a calculated gross activity of 2 to 3 × 10<sup>4</sup> Ci was determined from the field data. However, a more accurate source term for the CPP-31 release can be determined using process knowledge and WM-181 tank sampling results from September 1972. The 1972 sample results of the liquid in WM-181, consisting of second- and third-cycle waste along with evaporator bottoms, indicated that in 1972, the Cs-137/Sr-90 curie content would be 1.7 Ci/gal. Multiplying the estimated 14,000-gal loss by the curie content per gallon results in a 23,800-Ci release.

Table 3-2. Direct radiation measurements in 1975 from boreholes or observation wells installed at site CPP-31 after the release.

Depth (ft)	Borehole or Observation Well (all measurements in R/hr)															
	A53	A53-1	A53-2	A53-3	A53-4	A53-5	A53-6	A53-7	A53-8	A53-9	A53-10	A53-11	A53-12	A53-13	A53-14	A53-15
1	1.0	1.0	0.3	0.5	0.2	0.015	0.4	0.02	0.01	0.01	1.0	0.01	0.01	0.3	0.007	0.55
2	—	—	—	0.6	0.2	0.01	0.35	0.01	0.01	—	1.5	—	—	—	—	0.61
3	—	—	—	0.65	0.35	0.04	0.4	0.01	—	—	1.5	—	—	—	—	0.45
4	—	—	—	0.6	0.4	0.07	0.4	0.01	—	—	1.5	—	—	—	—	0.5
5	1.5	2.0	0.25	0.6	0.5	0.2	0.45	0.05	0.01	0.01	1.5	0.085	0.02	0.5	0.003	0.5
6	—	—	—	—	1.0	0.5	0.5	0.02	—	—	1.5	—	—	—	—	0.6
7	—	—	—	0.65	1.3	1.6	0.55	0.02	—	—	1.5	—	—	—	—	0.35
8	—	2.0	—	0.6	1.0	2.5	0.55	0.01	—	—	1.5	—	—	—	—	0.3
9	—	3.0	—	0.6	1.8	4.0	0.55	0.01	—	—	1.5	—	—	—	—	0.2
10	2.0	2.5	0.45	0.5	1.1	3.5	0.7	0.01	0.005	0.01	1.5	0.01	0.015	0.55	0.005	0.2
11	—	3.0	0.5	0.6	2.0	4.0	0.8	0.01	—	—	—	—	—	—	—	0.2
12	—	3.0	1.5	0.6	2.5	5.0	0.9	0.01	—	—	2.0	—	—	—	—	0.2
13	2.0	>10.0	>10.0	2.0	4.0	5.0	>10.0	0.01	—	—	2.0	—	—	—	—	0.15
14	>10.0	8.0	1.5	7.0	3.5	7.0	>10.0	0.005	—	—	>10.0	—	—	0.9	0.01	0.2
15	3.0	1.5	0.1	0.6	2.0	4.5	0.35	0.006	0.005	0.0032	>10.0	0.005	0.01	3.0	0.005	0.3
16	3.0	2.0	—	0.45	3.0	5.5	0.1	0.004	—	—	4.0	—	—	0.5	0.006	5.0
17	10.0	>10.0	—	0.85	8.5	9.0	0.1	0.003	—	—	2.0	—	—	0.5	—	4.0
18	>10.0	>10.0	—	9.0	>10.0	>10.0	0.1	0.002	—	—	10.0	—	—	—	—	0.2
19	>10.0	5.0	—	1.4	3.0	>10.0	0.05	0.003	—	—	0.6	—	—	—	—	0.1
20	2.5	0.2	0.01	1.1	2.5	8.5	0.05	0.008	0.003	0.006	0.35	0.006	0.006	0.035	0.003	0.05
21	2.5	—	—	—	0.7	10.0	0.05	0.004	—	—	0.20	—	—	—	—	0.01
22	5.0	—	—	—	—	6.0	0.02	0.004	—	—	0.10	—	—	—	—	0.01
23	>10.0	—	—	0.15	—	1.0	0.025	0.005	—	—	0.10	—	—	—	—	0.01
24	6.0	—	—	—	—	0.15	0.03	0.01	—	—	0.1	—	—	0.015	—	0.01
25	0.3	0.2	0.08	0.25	2.0	1.0	0.04									

Table 3-2. (continued).

Depth (ft)	Borehole or Observation Well (all measurements in R/hr) (continued)															
	A53-16	A53-17	A53-18	A53-19	A53-20	A53-21	A53-22	A53-23	A53-24	A53-25	A53-26	A53-27	A53-28	A53-29	A53-30	A53-31
1	<0.001	<0.001	<0.001	<0.001	<0.001	—	—	Bkg	0.02	Bkg	0.02	0.015	Bkg	Bkg	—	Bkg
2	<0.001	<0.001	<0.001	<0.001	<0.001	1.0	0.05	Bkg	4.06	0.04	0.02	Bkg	Bkg	Bkg	—	Bkg
3	<0.001	<0.001	0.02	<0.001	<0.001	9.8	0.06	Bkg	Bkg	0.03	0.03	0.02	Bkg	0.035	Bkg	Bkg
4	<0.001	<0.001	1.3	<0.001	<0.001	23.7	1.79	Bkg	3.9	0.18	Bkg	Bkg	Bkg	2.03	Bkg	Bkg
5	<0.001	<0.001	0.1	<0.001	<0.001	41.8	6.29	Bkg	Bkg	0.03	Bkg	Bkg	Bkg	Bkg	Bkg	Bkg
6	<0.001	<0.001	0.1	<0.001	<0.001	50.2	3.13	Bkg	0.02	0.04	0.02	0.04	Bkg	0.03	0.01	Bkg
7	<0.001	<0.001	0.1	<0.001	<0.001	49.2	0.38	Bkg	0.02	0.02	0.03	Bkg	Bkg	Bkg	0.06	Bkg
8	<0.001	<0.001	0.2	<0.001	<0.001	46.1	0.13	Bkg	0.01	0.04	0.03	Bkg	Bkg	0.2	0.01	Bkg
9	<0.001	<0.001	3.4	0.002	<0.001	49.2	0.18	Bkg	0.06	0.04	Pipe Broken In Coupling	Bkg	Bkg	7.5	Bkg	Bkg
10	<0.001	0.002	2.8	0.005	<0.001	40.0	—	Bkg	0.02	0.19		Bkg	Bkg	1.6	Bkg	Bkg
11	<0.001	0.006	0.34	0.1	<0.001	24.8	—	Bkg	0.03	0.47		Bkg	Bkg	0.2	0.08	Bkg
12	0.03	0.04	0.27	0.15	0.004	27.8	—	Bkg	0.26	2.0		Bkg	Bkg	4.0	0.60	Bkg
13	1.1	1.78	3.1	1.9	0.22	27.3	—	Bkg	4.9	2.6		Bkg	Bkg	1.5	0.10	Bkg
14	11.6	8.2	8.8	16.0	7.3	26.9	—	Bkg	14.9	33.9		6.6	Bkg	—	0.04	Bkg
15	15.1	15.2	1.76	28.0	9.08	22.6	—	Bkg	16.2	40.1		—	Bkg	—	—	Bkg
16	2.4	23.5	5.4	23.0	6.8	10.3	—	Bkg	20.2	43.2		—	0.07	—	—	Bkg
17	1.9	6.8	0.25	13.0	16.4	12.3	—	Bkg	3.8	34.5		—	0.8	—	—	Bkg
18	8.6	19.9	0.04	3.4	1.57	1.16	—	Bkg	1.6	36.6		—	5.8	—	—	Bkg
19	12.6	2.1	0.03	2.3	0.16	0.61	—	Bkg	1.6	—		—	—	—	—	Bkg
20	0.6	3.3	0.04	4.0	0.7	—	—	Bkg	—	—	—	—	—	—	Bkg	

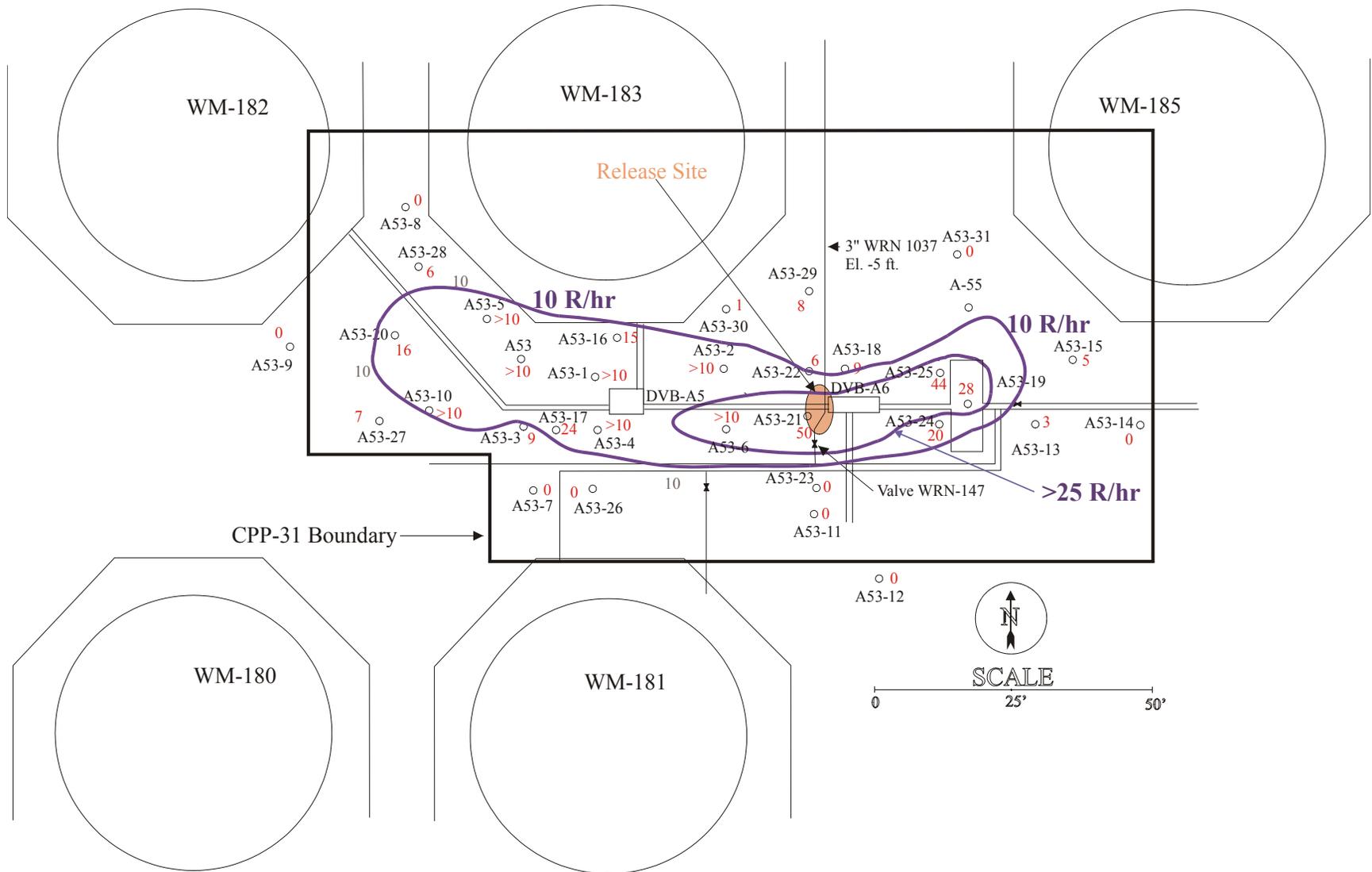


Figure 3-4. Extent of lateral contamination at the CPP-31 release site (measurements in R/hr).



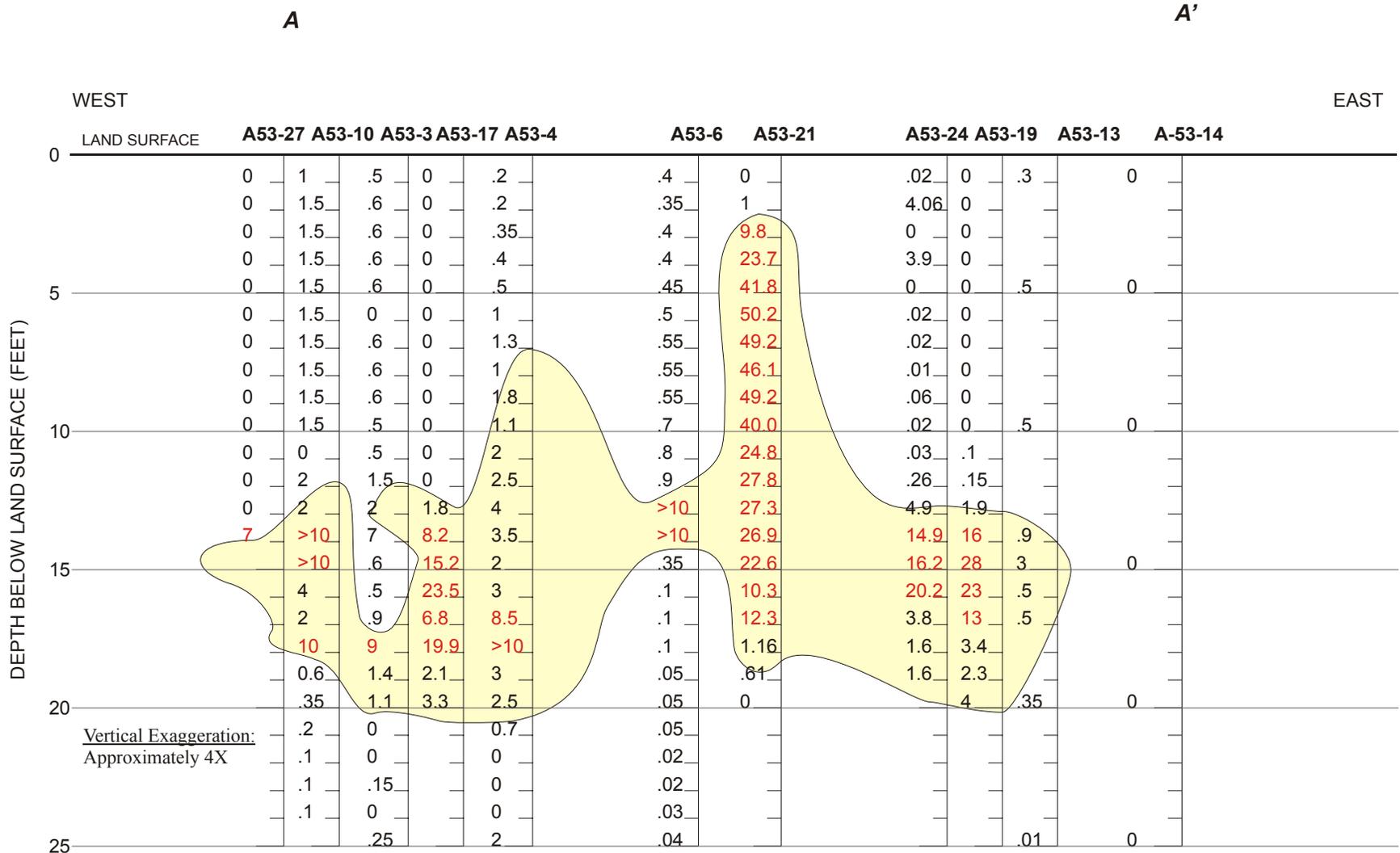


Figure 3-6. East-to-west, A-to-A', fence diagram through the CPP-31 zone of contamination (radiation readings are in R/hr; readings >5R/hr are shown in red).

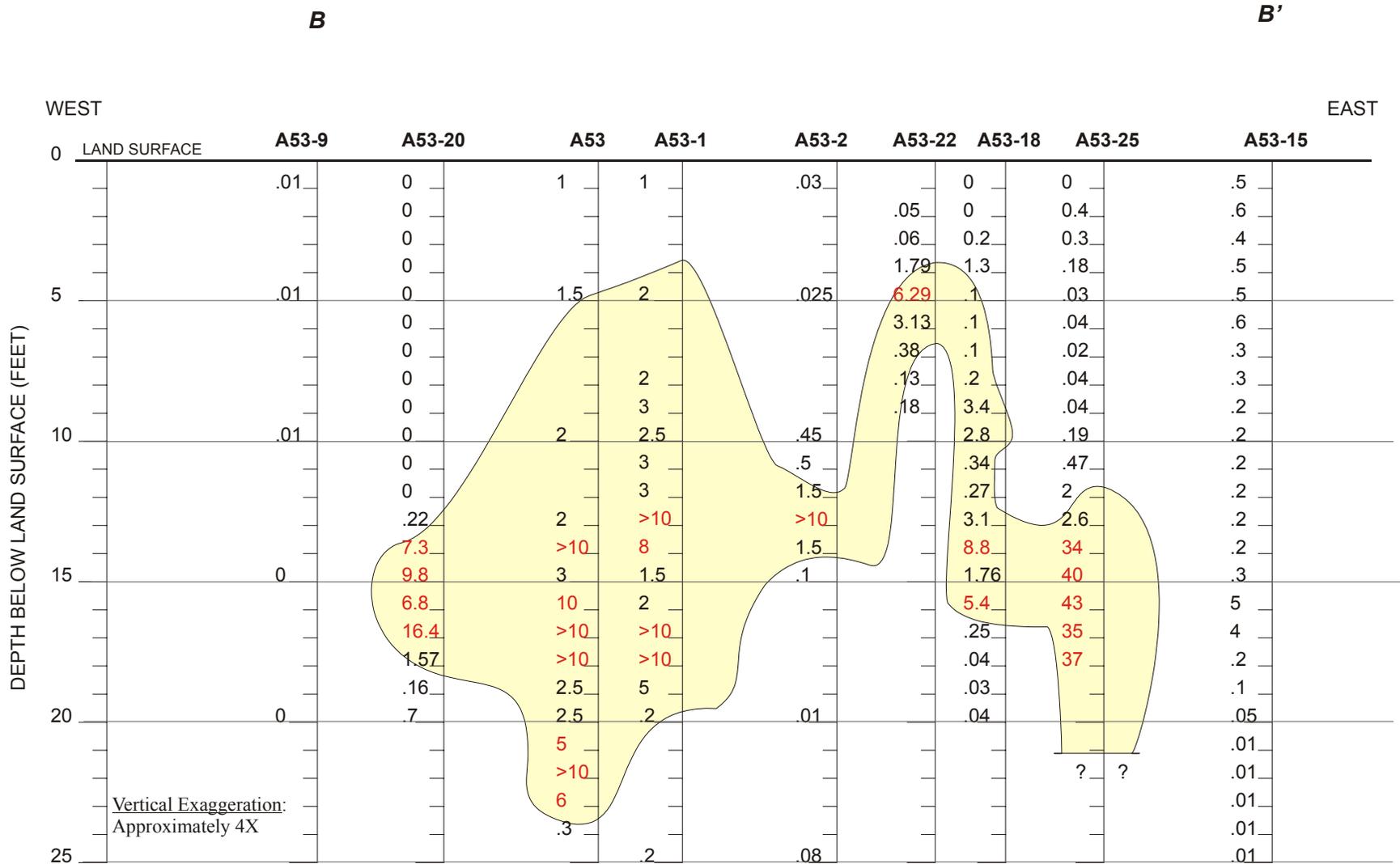


Figure 3-7. West-to-east, B-to-B', fence diagram through the CPP-31 zone of contamination (radiation readings are in R/hr; readings >5R/hr are shown in red).

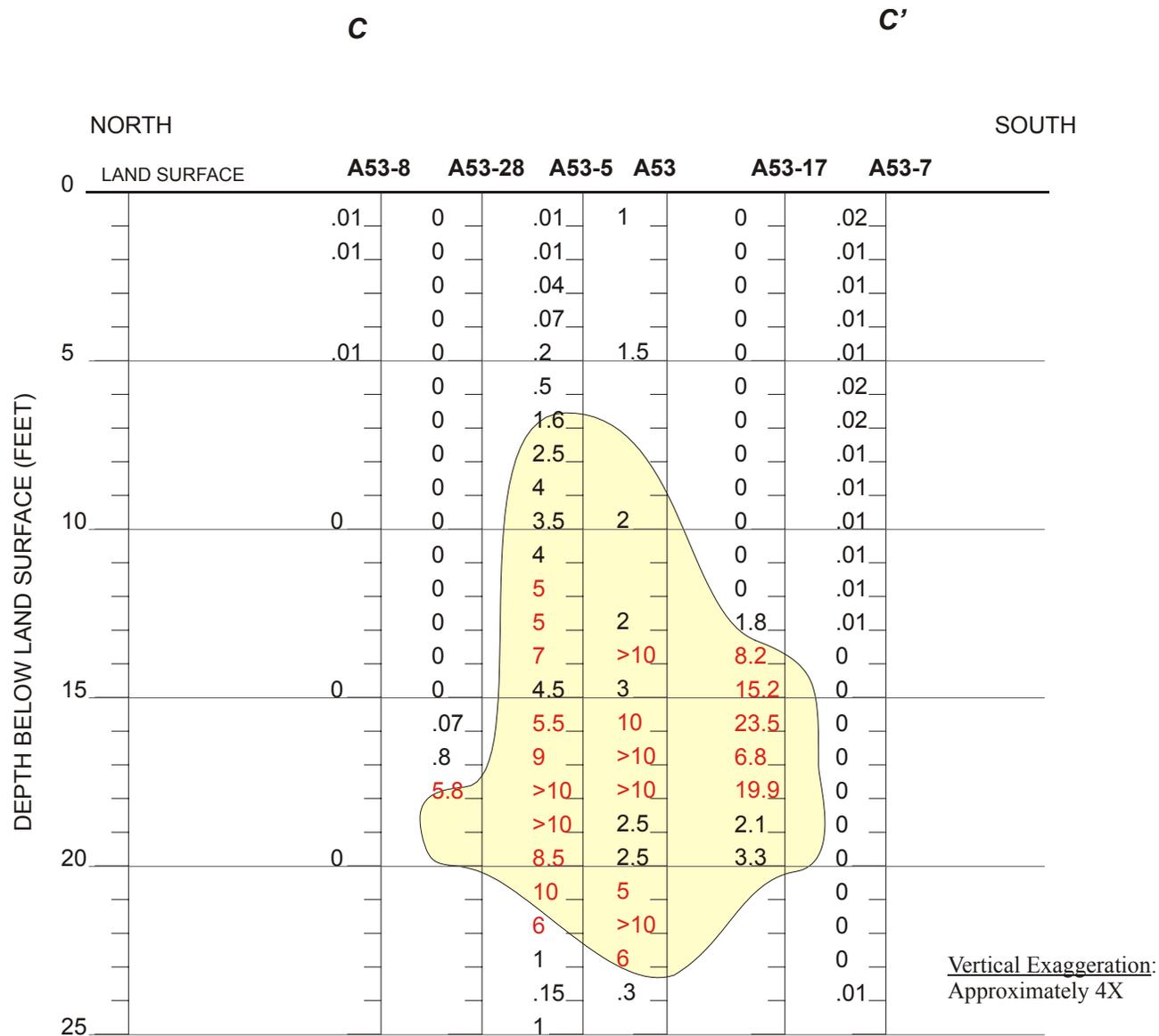


Figure 3-8. North-to-south, C-to-C', fence diagram through the body of contaminated soil at CPP- 31 (radiation readings are in R/hr; readings >5R/hr are shown in red).

D

D'

NORTH

SOUTH

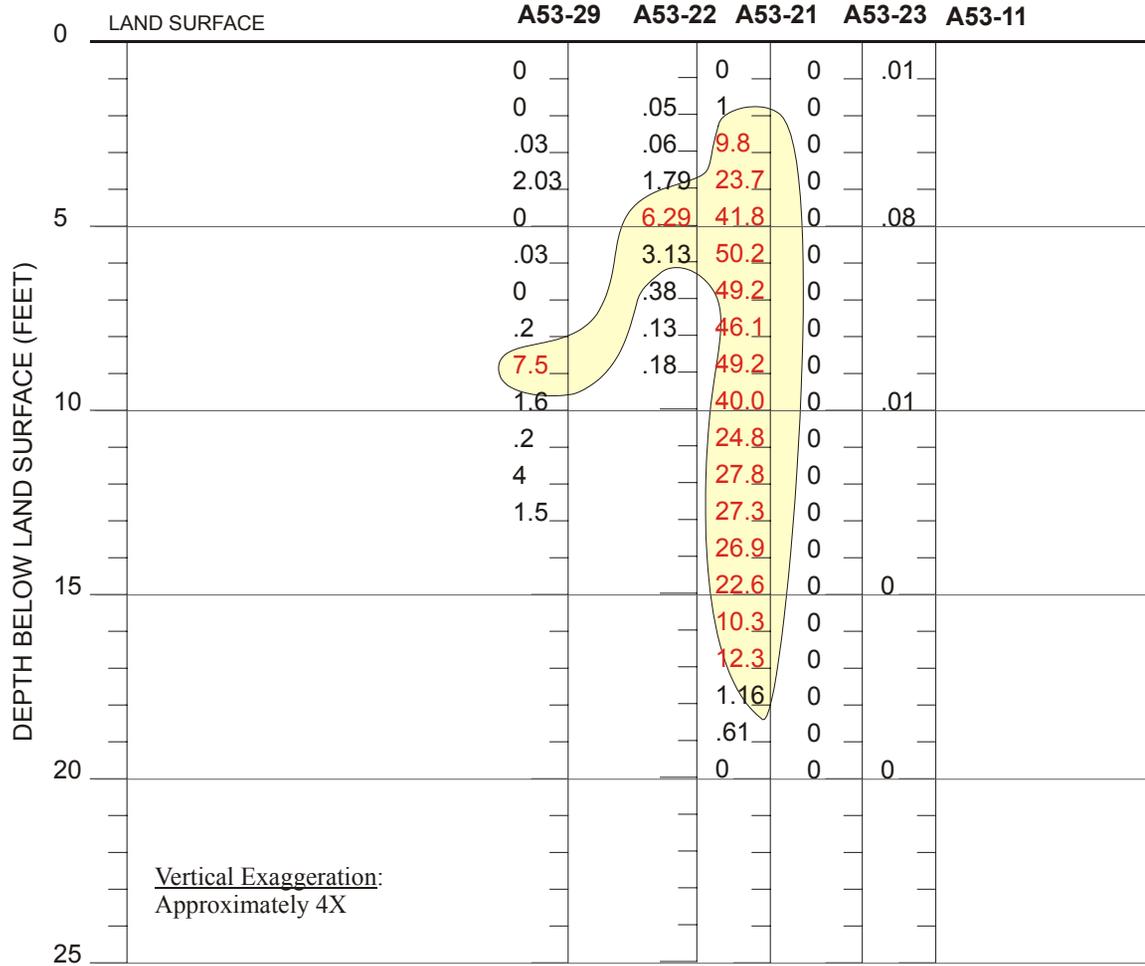


Figure 3-9. North-to-south, D-to-D', fence diagram through the body of contaminated soil at CPP-31 (radiation readings are in R/hr; readings >5R/hr are shown in red).

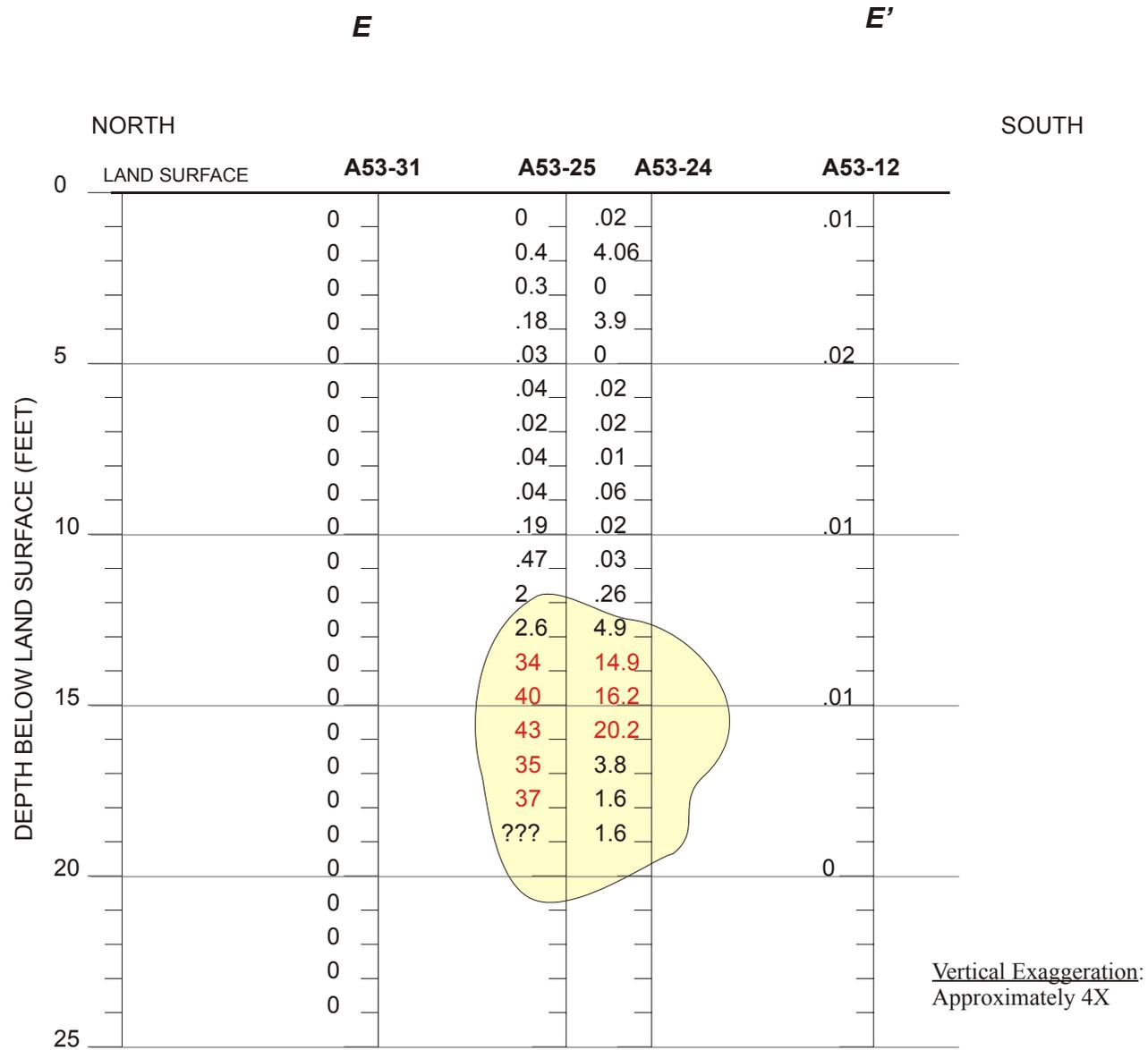


Figure 3-10. North-to-south, E-to-E', fence diagram through the body of contaminated soil at CPP-31 (radiation readings are in R/hr; readings >5R/hr are shown in red).

Table 3-3. Summary of the subsurface radiation profile performed on selected probes at site CPP-31 on August 18, 1992.

Depth (ft)	Exposure Rate in R/hr									
	A53-11	A53-19	81-3	81-6	81-7	81-8	81-9	81-10	81-13	81-14
2	0.1	0.1	0	0.1	0.1	0.1	0.1	0	0.1	0
4	0.1	0.1	0	0.1	0.1	0.1	0.1	0	0.1	0.1
6	0.1	0.1	0	0.1	0.1	0.1	0.1	0	0	0.1
8	0.1	0.1	0	0.1	0.1	0.1	0.1	0	0.2	0
10	0.2	0.1	0	0.1	0.1	0	0.1	0	7.4	0.1
12	0.1	0.1	0	0.1	0.1	0.1	1.2	0	0.2	0.1
14	0.1	0.2	0	0.1	0.1	0.1	0.2	0	0.1	0.1
16	0.1	13.1	0	0.1	0.3	0.1	1.1	0	0.1	0.1
18	0.1	22.3	0.5	0.1	0.6	0	0.1	0	0.1	9.3
20	0.1	9.0	0.1	0.1	0.1	0.1	0.1	0	0.1	0.1
22	0.1		Note: >0.2 @ 19 ft	0.1	8.4	0.1	0.1	0		0.1
24	0.1			0.1	8.8	0.1	0	0		0.1
26				0.1	Note: >2.0 @ 23 ft	0.1	0.1	0		0
28				0.1			0.1	0		0
30				0.2						
				Note: >1.5 @ 29 ft						

### 3.1.2 Site CPP-28

The contamination at site CPP-28 resulted from an inadvertent penetration of a waste-transfer line during construction, resulting in release of first-cycle waste over a period of about 18 years. The release and its investigation are described chronologically below.

On October 1, 1974, during the course of drilling operations in connection with an upgrade construction project for the INTEC cathodic protection system, contaminated soil was encountered at a location point identified as anode 1-42 (Figure 3-11). The hole being drilled for an anode encountered contaminated soil with contact radiation levels of 1 R/hr at 6 ft bgs; this hole is located 10 ft south of the concrete vault that houses liquid waste storage tank WM-181 and approximately 5 ft north of waste-transfer line 3”PWA-1005 used to transfer first-cycle raffinates. The borehole was advanced on October 2, 1974, to a depth of 10 ft, and soil samples were collected for analysis. Results of the sample analysis indicated Cs-137, Ru-106, Ce-144, and Sr-90 were the primary isotopes.

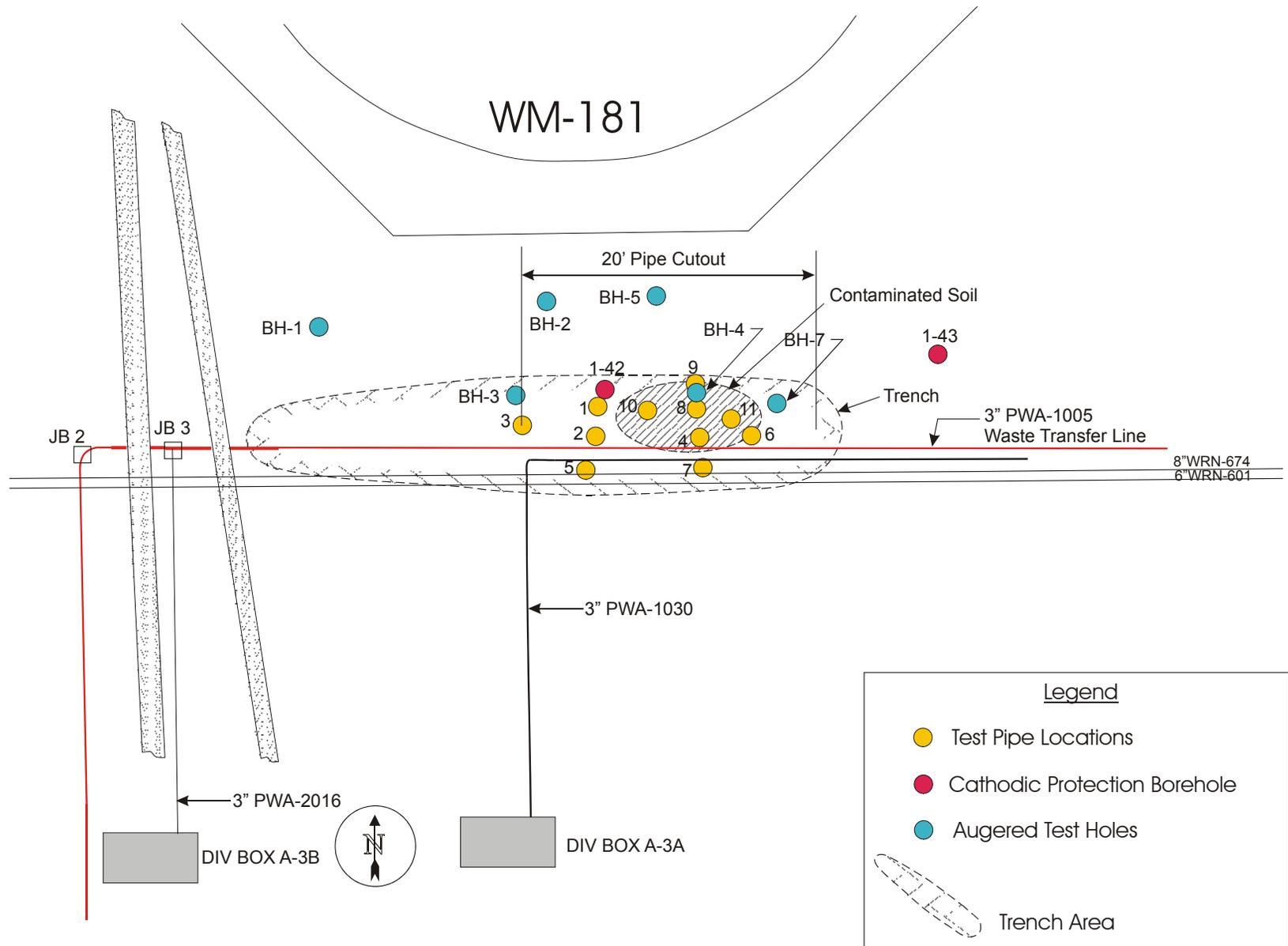


Figure 3-11. CPP-28 trenching investigation location map.

To help determine the nature and extent of contaminated soil, six soil borings were drilled on October 10, 1974. Soil samples were collected from the bottom of each hole, ranging in depth from 6.5 to 10 ft bgs. The boreholes are designated as BH-1 through -5 and BH-7. Contamination was encountered in only one of the six holes drilled (Figure 3-11). Hole #4 encountered contaminated soil readings of up to 35 R/hr beta-gamma at contact. No isotopic analyses were performed on any of the soil samples. Based on these results, it was believed that some type of waste release had occurred.

On October 17, 1974, a review team was appointed by Allied Chemical, Idaho Chemical Programs Operations Office Management, to evaluate the consequence, determine the release mechanism, and define the extent of the contaminated soil body. In order to accomplish its primary mission, the review team initiated immediate trenching operations to permit inspection of the 3" PWA-1005 waste-transfer line in the area of soil contamination, inspection of diversion valve boxes A-3A and A-3B, and plan for the installation of additional soil borings to determine the extent of soil contamination.

Trenching operations were started on October 22, 1974, beginning at the intersection of an underground electrical duct near junction box No. 3, approximately 25 ft west of anode 1-42, and working eastward directly above line 3" PWA-1005 (Figure 3-11). A lap joint in the encasement was uncovered and inspected approximately 10 ft west of anode 1-42. This inspection revealed a 1.5-in. separation at the lap joint and a longitudinal joint separation of several feet where the tapping screws had corroded. The inside of the encasement in the region of joint separation was partially filled with soil. At that point in the investigation, several holes were hand-augered to depths of 3 ft below the encasement with no indication of soil contamination.

Contaminated soil was first encountered during the trenching operations approximately 3 ft west of anode 1-42. It was believed that this soil was brought up during the augering of the exploratory test holes. Trenching continued eastward approximately 10 ft past the zone of contamination. A second encasement lap joint was encountered approximately due south of anode 1-42. Inspection of the joint revealed a greater degree of deterioration than with the first joint uncovered. A section of the upper carbon-steel cover approximately 1 ft long appeared to be severely corroded (presumably from contact with an acidic waste solution) and had some inward collapse.

During excavation activities, clean soil was stockpiled while contaminated soil was loaded into special containers for disposal at the Radioactive Waste Management Complex. Soil with radiation readings up to 75 R/hr gross beta-gamma was encountered at depths less than 2 ft beneath the encasement. Efforts to excavate to depths below the encasement in the central zone of contaminated soil were abandoned because of handling and exposure problems. A total of 56 yd<sup>3</sup> of contaminated soil containing an estimated 3,000 Ci of gross radionuclides were removed from the release site (Allied Chemical 1974). Samples taken from the contaminated soil had the following distribution of radionuclides (by activity): 0.2% Mn-54, 0.5% Co-60, 3.2% Ru/Rh-106, 1.4% Cs-134, 12.2% Cs-137, 21.4% Ce-144, 1.3% Eu-154, 0.8% Eu-155, and 59% Sr/Y-90.

After trenching operations were completed, monitoring test pipes were driven into the ground using a cable crane rig outfitted with a 750-lb drive shoe (Figure 3-12). Test pipes were driven in 11 locations adjacent to the pipeline encasement and in the area of soil contamination to depths up to 20 ft, as shown in Figure 3-11. After each test pipe was driven, a radiation-detection probe was lowered into the test pipe, and radiation readings were measured at specific depth intervals. Recorded radiation readings collected from the test pipes are presented in Table 3-4.



Figure 3-12. Test pipes being driven into the ground during the contaminant release investigation in 1974 at CPP-28.

Table 3-4. 1974 test hole radiation readings for CPP-28 (R/hr).<sup>a, b, c</sup>

Depth	Test Hole #1	Test Hole #2	Test Hole #3	Test Hole #4	Test Hole #5	Test Hole #6	Test Hole #7	Test Hole #8	Test Hole #9	Test Hole #10	Test Hole #11
0.0	—	—	—	—	0.030	—	—	—	—	—	—
1.0	0.035	—	—	—	0.030	0.025	0.020	0.040	0.010	0.040	0.040
2.0	0.035	0.050	0.025	0.060	0.050	0.030	0.015	0.050	0.040	0.040	0.040
3.0	0.035	0.050	0.025	0.070	0.060	0.035	0.006	0.070	0.040	0.040	0.050
4.0	0.035	0.050	0.025	0.100	0.060	0.070	0.002	0.080	0.040	0.050	0.060
5.0	0.030	0.050	0.025	0.150	0.070	0.200	0.003	0.100	0.040	0.060	0.050
6.0	0.007	0.200	0.018	0.200	0.060	0.250	0.010	0.350	0.012	0.090	0.150
6.5	—	—	—	<b>1.50</b>	—	—	—	<b>2.00</b>	—	—	—
7.0	<b>0.007</b>	<b>1.500</b>	<b>0.003</b>	<b>5.50</b>	0.100	0.150	0.010	<b>7.00</b>	0.008	0.350	<b>5.00</b>
7.5	—	—	—	<b>35.00</b>	—	—	—	<b>12.00</b>	—	—	—
8.0	0.007	0.300	0.002	<b>20.00</b>	<b>2.00</b>	0.040	0.010	<b>90.00</b>	0.008	<b>11.00</b>	<b>11.00</b>
8.5	—	—	—	<b>3.00</b>	—	—	—	<b>65.00</b>	—	<b>50.00</b>	—
9.0	0.050	0.060	0.001	0.800	0.050	0.020	0.050	<b>10.00</b>	0.006	<b>4.00</b>	0.250
9.5	—	—	—	—	—	—	—	<b>1.00</b>	—	—	—
10.0	0.040	0.005	0.0006	0.100	0.020	0.004	0.250	0.012	—	0.050	0.010
11.0	0.020	0.005	0.0005	0.010	0.050	0.001	0.050	0.004	<0.005	0.007	0.002
12.0	0.010	0.0015	<0.0005	0.006	0.050	<0.001	0.012	0.002	—	0.001	<0.001
13.0	0.010	0.001		0.003	0.060			0.001	<0.001	<0.001	
14.0		<0.0005		0.002	0.002			<0.001			
15.0				0.001	0.001						

a. — indicates radiation level was not measured.  
b. Values in bold red indicate radiation levels equal to, or greater than, 1.0 R/hr.  
c. Shading indicates the elevation of the waste-transfer line 3" PWA-0=1005.

On December 3, 1974, work began to cut, remove, and inspect the 20-ft section of the waste-transfer line to determine the cause of the contamination. After removal of the pipe section, a cursory inspection revealed a 1/8-in.-diameter drill hole in the side of the 3-in. stainless-steel pipe (Figure 3-13). After closer inspection, the hole in the pipe was determined to be 10 ft, 7 in. from the east pipe cut and oriented 90° from the top of the pipe on the south side as originally installed. This location corresponded closely with the location of the corroded area of the upper section of carbon-steel encasement observed in the field. The hole penetrated completely through the pipe wall, and small indents 40 to 50 mils deep existed along the pipe on 1-ft centers eastward from the hole. No holes or indents were found on the opposite (north) side of the pipe. The hole and indents were consistent with the stitch screw spacing used to hold the top cover of the encasement to the bottom trough. A metallurgical inspection indicated that the pipe suffered very little corrosion damage during its 18 years of intermittent service and that the failure was strictly due to a hole that had existed when it was inadvertently drilled into the waste line during construction from 1955 to 1956.



Figure 3-13. Drill hole found in waste-transfer line 3”PWA-1005 at CPP-28.

The position of the hole was such that no leakage could occur unless the waste-transfer line was at least one-half full of solution. This condition occurred only when pertinent block valves (valve box A6, etc.) in the waste transfer system downstream from the hole were closed during liquid waste transfer through the pipeline. The 3-in. line was not a pressurized line and instead used gravity drainage to transfer waste to the storage tanks. Normally, with diversion block valves in their proper open settings, solution transfer flow rates were insufficient to fill the 3-in. pipeline to the 50% full level. By design, any waste leaking through the hole should have been contained within the split-steel secondary containment and directed into downstream collection sumps. However, inspection indicated the encasement was badly deteriorated and partially filled with soil. The damming effect of the soil in the encasement caused sufficient liquid backup and flow outward through the joints of the encasement and into the surrounding soil.

From the data provided by the 11 test pipes, it was estimated that the zone of soil contamination was approximately 9 ft in diameter by 2 to 3 ft in average depth below the pipe encasement at a depth of 7 ft bgs (Figures 3-14 through 3-16). Calculations made during the investigation estimated that approximately 128 ft<sup>3</sup> of contaminated soil existed at the site and the amount of contamination remaining was around 3,000 Ci. The calculations were based on the following assumptions:

- Radiochemical analysis of a typical first-cycle raffinate of the type typically transferred through the 3”PWA-1005 line indicated the concentration of total radionuclides was 46 to 50 Ci/gal (Allied Chemical 1974).

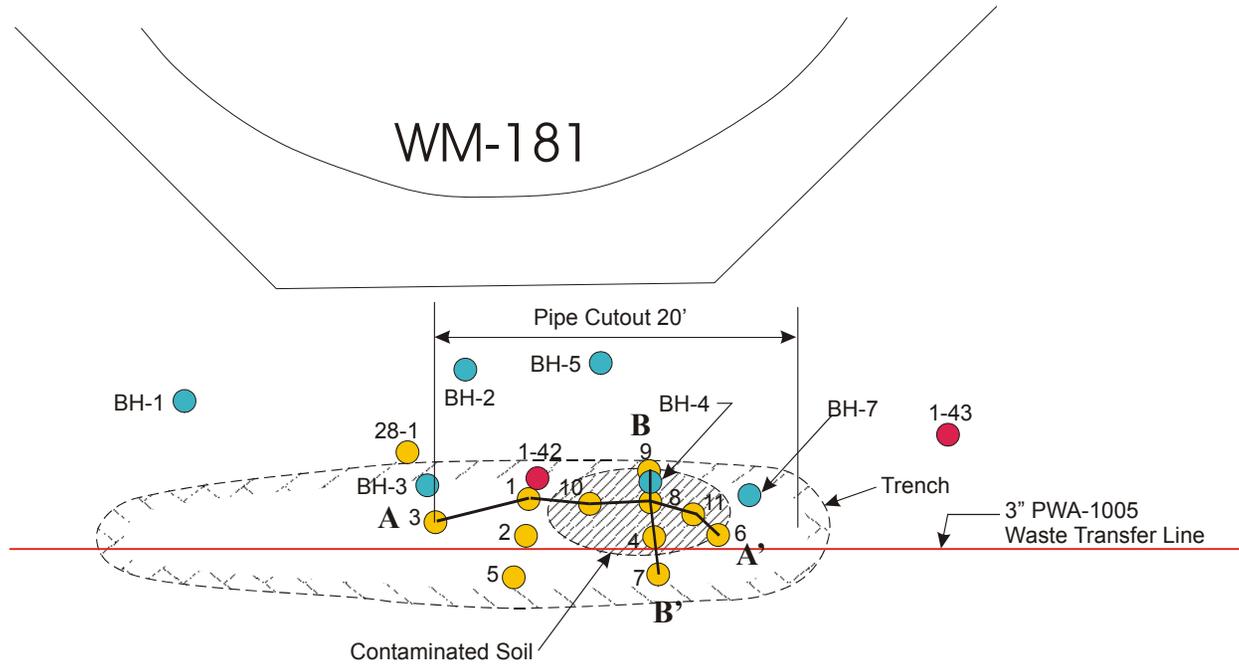


Figure 3-14. CPP-13 fence diagram location map.

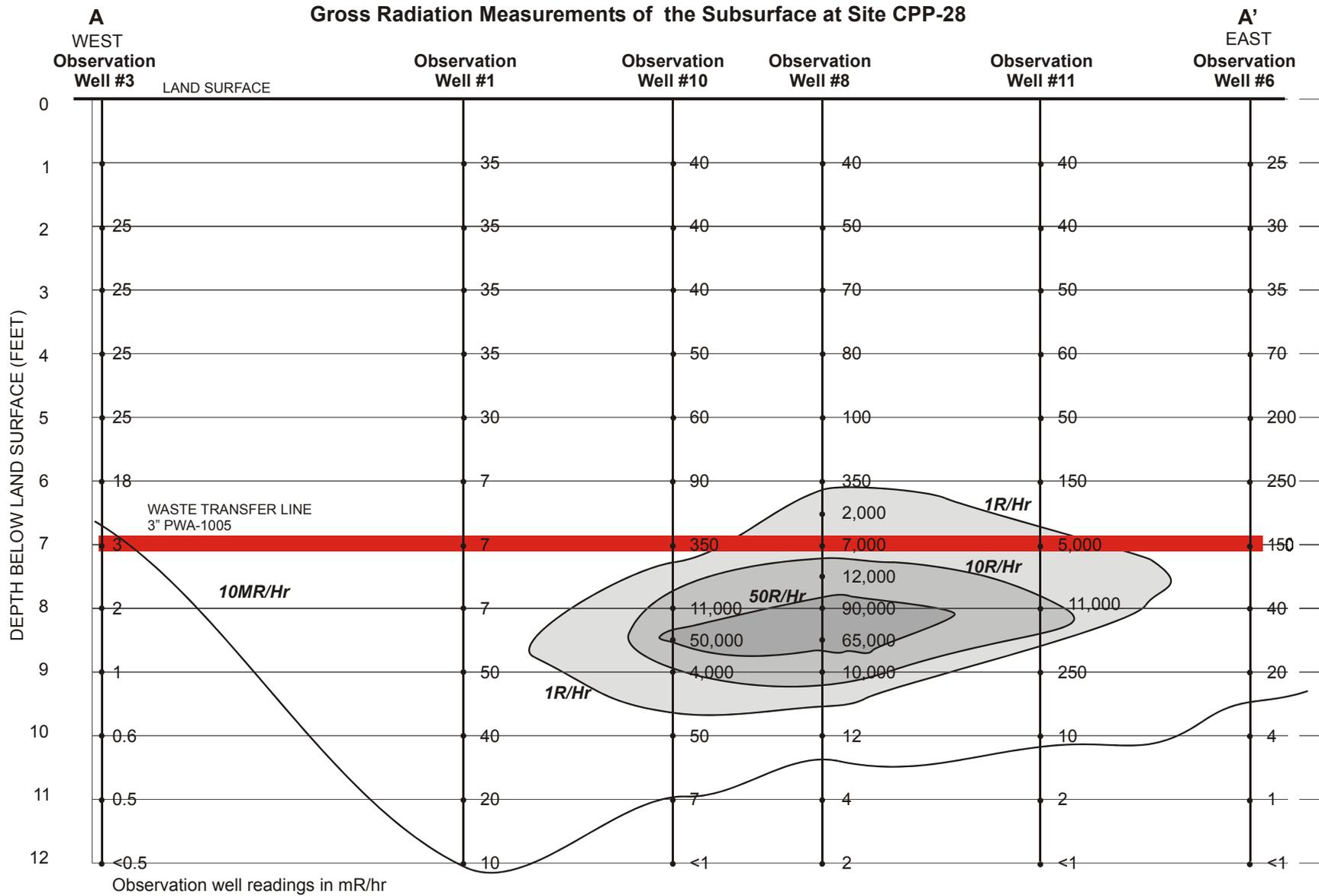


Figure 3-15. East-west fence diagram through the contaminated soil zone at CPP-28.

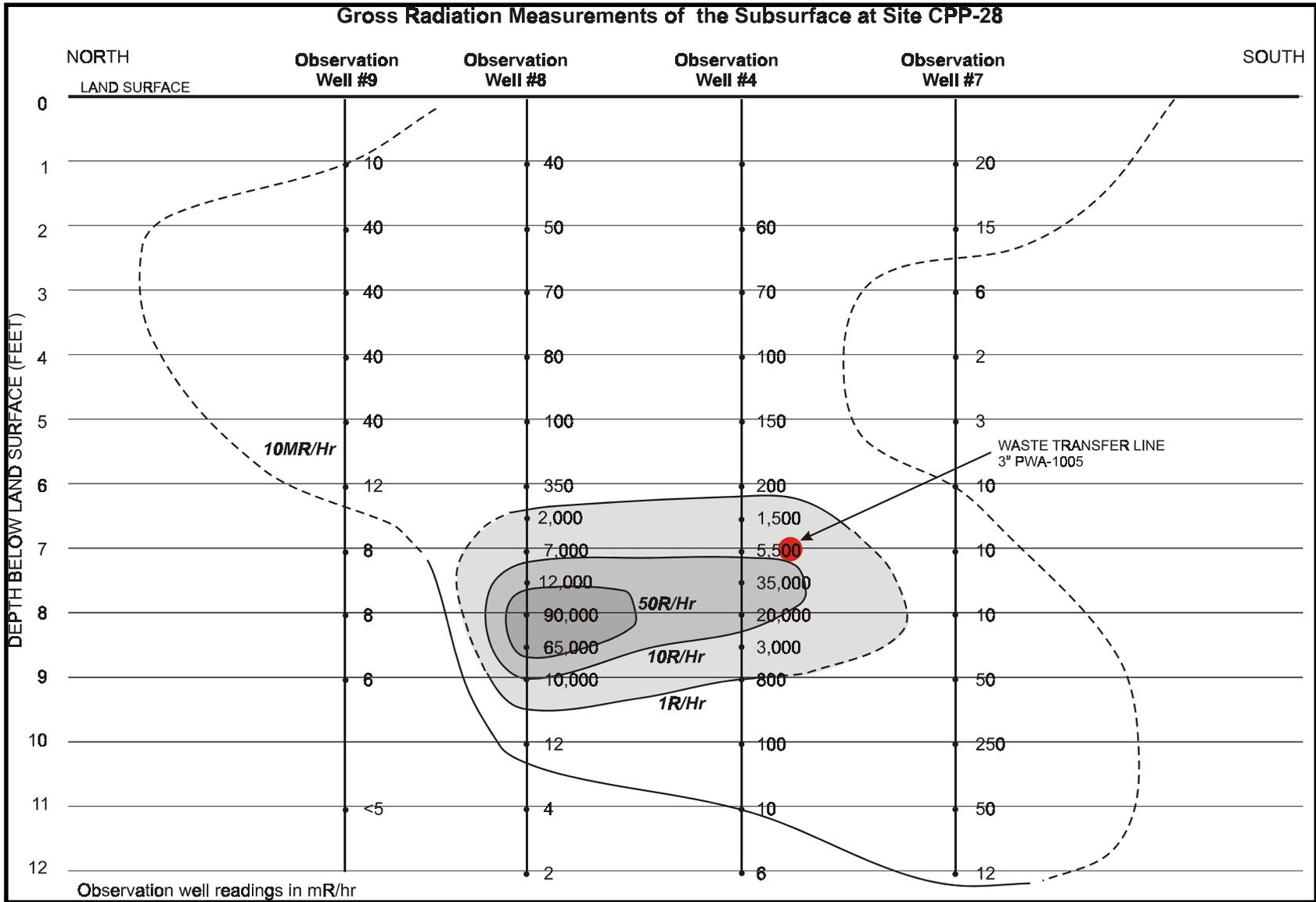


Figure 3-16. North-south fence diagram through the contaminated soil zone at CPP-28.

- The moisture content of the soil was determined experimentally to be 6% by volume.
- Using the volume of contaminated soil determined from the field investigation along with the moisture content and activity of the waste solution, a volume of 7.7 ft<sup>3</sup> (60 gal) would be held by the soil, which equates to approximately 3,000 Ci of activity.

Combining the activity remaining in the soil to that removed during the trenching portion of the investigation totals approximately 120 gal of waste solution that was released to the soil. Since an estimated 3,000 Ci of activity was removed based on radiation readings from the soil containers, a total of 6,000 Ci was estimated to have been released at the CPP-28 release location. It should be noted that the 46 to 50 Ci/gal activity used to estimate curies released included relatively short half-life radionuclides such as Ce-144 (284.6 days).

During the 1992 Track 2 investigation, an attempt was made to locate any of the 11 test pipes so that additional subsurface radiation readings could be collected. The new measurements were intended to update gamma readings in the test pipes and help determine if contaminant migration had occurred since the 1974 investigation. An area measuring 7 by 10 ft was excavated to a depth of 7 ft in an attempt to find the test pipes. The excavation location was selected based on historical photographs, plant drawings, and results of surface geophysical surveys. The test pipes were not found during the excavation activities, and subsequent evaluation determined that the excavation was located too far to the west, missing the test pipe locations. Therefore, it is uncertain whether the test pipes still exist at the site.

During the 1993 to 1996 tank farm upgrades, portions of sites CPP-28, -20, -25, and -79 were excavated. Excavation depths ranged from 0 to 35 ft bgs, with most being completed at approximately 15 ft bgs. Field beta/gamma radiation measurements encountered during excavation ranged from 0 to 5 R/hr. No reported contaminated soils were removed from this site during the construction work.

To estimate the curies of Cs-137 and Sr-90 released at CPP-28, the assumption was made that contaminated liquids were not immediately released to the soil at the start of tank farm operations. It is likely that over a period of years, the acidic nature of the waste eventually corroded the carbon-steel top of the secondary containment. During this corrosion period until failure, released waste would have been contained and directed to tank vaults. After secondary containment failure, waste liquids would migrate into the soil. Therefore, the first-cycle waste activities for Cs-137 from the late 1960s and early 1970s were used to establish Cs-137/Sr-90 curie content of the waste that was released to the soil. Typical Cs-137 activities were 0.75 Ci/L for the period and would be the same for Sr-90. Using these two activities and performing a volumetric conversion results in an activity of 5.68 Ci/gal. This value was rounded to 6 Ci/gal for estimation purposes.

Using the rounded Cs-137/Sr-90 volumetric activity level and multiplying it by the total number of gallons believed to have entered the soil results in a 720 Cs-137/Sr-90 curie content. Assuming that half of the contaminated soil was removed, 360 Ci remain at the CPP-28 release site.

### **3.1.3 Site CPP-79**

Site CPP-79 generally has been defined as soil contaminated in July and August of 1986 by the releases of waste solutions from the WCF and NWCF sump tanks due to improper valve settings in a transfer line buried about 10 ft bgs (Figure 3-17). However, during the Track 2 investigation conducted in 1992, deeper soil contamination was encountered in borehole CPP-79-1 at approximately 30 ft below the tank farm surface elevation. Based on field screening data, it was believed that the deeper contamination was not associated with the soil contamination at shallower depths. Therefore, CPP-79 has been divided into two contamination zones, CPP-79-Shallow and CPP-79-Deep, which are discussed in more detail in following subsections.

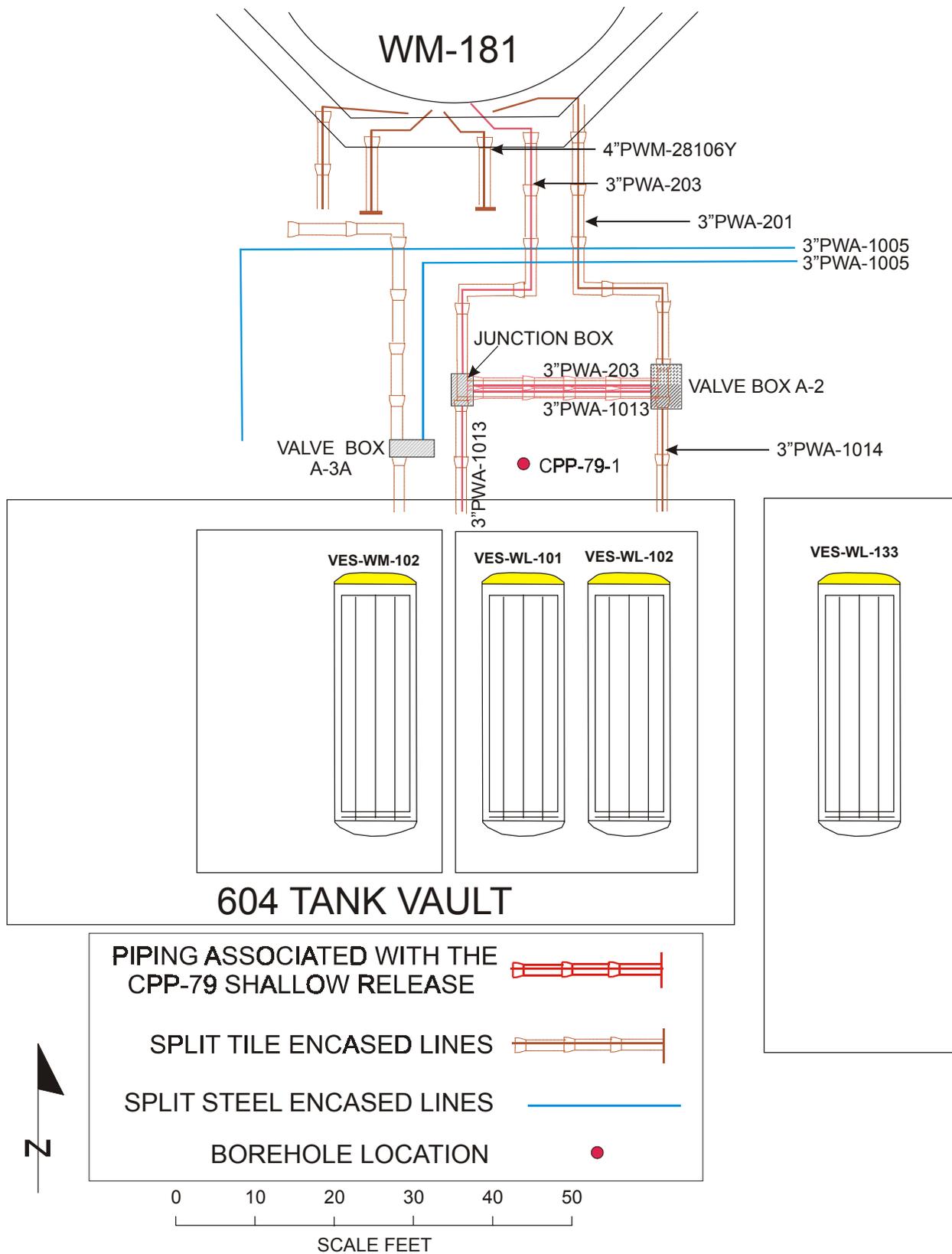


Figure 3-17. CPP-79-Shallow piping configuration.

**3.1.3.1 CPP-79-Shallow Leak Description.** On July 7, 1986, during a transfer from the WCF sump tank (WCF-119) to the PEW evaporator feed tank (WL-102) and again on August 2, 1986, during a transfer from the NWCF decontamination area sump tank (NCD-123), the volume of liquid received at tank WL-102 did not match the volume transferred. A systematic investigation revealed that a valve (PLV-WL-188) in the transfer line (3"PUA-10111) was partially closed, causing waste solutions to back up into valve box A-2. Drawings available at the time of the investigation did not show any connection between valve box A-2 and the waste-transfer line. Further examination of the 1954 construction prints for A-2 indicated that its drain line and valve boxes A3A, A3B, and A3C were tied into the waste-transfer line. The waste-transfer line was originally installed to allow the water used for cooling WM-180 to be transferred to WL-102, located in the CPP-604 tank vault. When A-2 was installed, its drain line was tied into this existing transfer line to WL-102.

A test was run to verify that the drain line from A-2 is actually as shown on the original construction prints and not as shown on the then-current tank farm piping diagrams. Water was placed in valve box A-2 with valve PLV-WL-188 open. An increase in monitored levels in WL-102 was observed, verifying that valve box A-2 does drain to WL-102 through 3"PUA-10111.

In order to determine the pathway of the water out of valve box A-2, a visual inspection of the interior of the valve box was conducted. Water was added to the waste-transfer line with the all of the valves on the transfer line closed. Water was observed entering the valve box through the drain line and exited along the secondary split-tile encasement of two waste-transfer lines, 3"PUA-203 and 3"PUA-1013. Both of these lines pass through a common junction box (Figure 3-17). The lines were constructed so that any liquids in the encasement would drain toward the junction box and then toward the WL-101/102 tank vault.

Based on the results of the investigation, it was concluded that the missing 2,512 gal of waste from the two transfers most likely found its way into the soil through leaks in the split clay-tile encasement after the waste backed up into valve box A-2 and flowed to the west into the encasements of 3"PUA-203 and 3"PUA-1013 (WINCO 1986c).

**3.1.3.2 Extent of Contamination at CPP-79-Shallow.** An estimated 2,512 gal of dilute calciner decontamination solution generated at the WCF and NWCF was released during transfer to the PEW system. This waste contained low-level radioactivity, heavy metals, and traces of organic compounds. The decontamination solution was analyzed shortly after the release and contained the following constituents:

I-129	65 pCi/mL
H-3	18,900 pCi/mL
Gross beta	260,000 pCi/mL
Uranium	8.4 E-2 ± 1.1E-2 mg/L

During the OU 3-07 Track 2 investigation in 1992 (WINCO 1993d), one soil borehole was drilled in the soil near the release site (borehole CPP-79-1; see Figure 3-17). The borehole location was on a berm approximately 8 ft above the ground surface in the tank farm. As a result, the original land surface elevation corresponds to a depth of 8 ft bgs in the borehole. In the subsequent discussions, the depths have been adjusted to correspond to the tank farm land surface and not that of the berm.

Fifteen split-spoon samples were collected from CPP-79-1 and screened for gross beta-gamma radiation. Seven samples were selected from the zones having the highest radiation readings for further analysis. Two of the seven samples were duplicates collected between 24 and 28 ft bgs. One sample collected from the 33.5- to 34-ft interval had significantly higher radiation levels. Based on field monitoring and soil analytical results from borehole CPP-79-1 (Figure 3-18), there appear to be two distinct radionuclide contaminant zones that probably originated from different sources. The uppermost zone was encountered between 14 to 22 ft bgs (CPP-79-Shallow). This zone was characterized by gross alpha emissions slightly in excess of background levels and by gross beta emissions up to eight times the background level. The radionuclides found in this zone are attributed to the release of low-level decontamination solution associated with the CPP-79-Shallow release site. The top of the second radionuclide-contaminated zone was encountered in CPP-79-1 at a depth of approximately 31 ft. This zone is characterized by radionuclide concentrations that are two to three orders of magnitude greater than those detected in the shallow zone and may be the result of a release of first-, second-, and/or third-cycle wastes (Table 3-5). All samples associated with the CPP-79-Shallow release were analyzed for gross alpha-emitting and gross beta-emitting radionuclides. Samples collected above 28 ft bgs had relatively low activities of radionuclides, consistent with a release of WCF and NWCF decontamination solutions. Gross alpha activity was below background levels in samples collected below 16 ft bgs and above 28 ft bgs. Gross beta and Cs-137 activities remained above background levels from 14 to 22 ft bgs. The soil samples collected from 24 to 28 ft bgs contained radionuclides near or below background levels.

The highest gross alpha, beta, and Cs-137 activities observed for the shallow release site were from the sample collected from 14 to 16 ft bgs. The Cs-137 concentration in this sample was  $20.9 \pm 1.5$  pCi/g; the Sr-90 activity was  $54.4 \pm 3.46$  pCi/g. This sample also had detectable levels of U-238 and -235 that were near background levels and Pu-238 and -239 levels that were slightly above background concentrations.

Information on the lateral extent of the contamination around borehole CPP-79-1 is provided by the results of samples from boreholes A-61 and -62 (LMITCO 1995a). These boreholes were drilled to the west and east, respectively, of borehole CPP-79-1 (Figure 3-19).

Soil samples were collected and analyzed from depths of 28.5 to 30.5 ft and 38.5 to 40.3 ft in borehole A-61. The highest gross alpha ( $1,230 \pm 20$  pCi/g), gross beta ( $20,500 \pm 50$  pCi/g), Sr-90 ( $3,360 \pm 30$  pCi/g), and Cs-137 ( $25,000 \pm 2,000$  pCi/g) concentrations were in the 28.5- to 30.5-ft sample from borehole A-61. Other radionuclides detected in this sample include Am-241 ( $46 \pm 4$  pCi/g), Pu-239/240 ( $319 \pm 10$  pCi/g), and U-234 ( $2.1 \pm 0.1$  pCi/g). Concentrations of these same constituents in the 38.5- to 40.3-ft sample were one to four orders of magnitude lower than in the shallower sample.

Samples were obtained from 2 to 4 ft and 40.3 to 41.8 ft in borehole A-62. Concentrations of Sr-90 and Cs-137 in the near-surface soil sample from borehole A-62 were  $305 \pm 3$  pCi/g and  $730 \pm 5$  pCi/g, respectively. Concentrations of these radionuclides were below background in the deeper sample from borehole A-62. A comparison of ratios of the detected radionuclides in the sample from borehole A-61 with the results from samples from borehole 79-1 (Table 3-5) indicate that some similarities exist between the contamination, but not enough to determine if the contamination observed in A-61 originated from the same source as CPP-79-Deep. Well A-61 is farther from the known release location for the shallow contamination present in CPP-79-1 observed at 22 to 24 ft bgs, yet this well had higher concentrations for most contaminants, indicating that the release of dilute calciner decontamination solutions at CPP-79-Shallow is not the source of contamination in A-61.

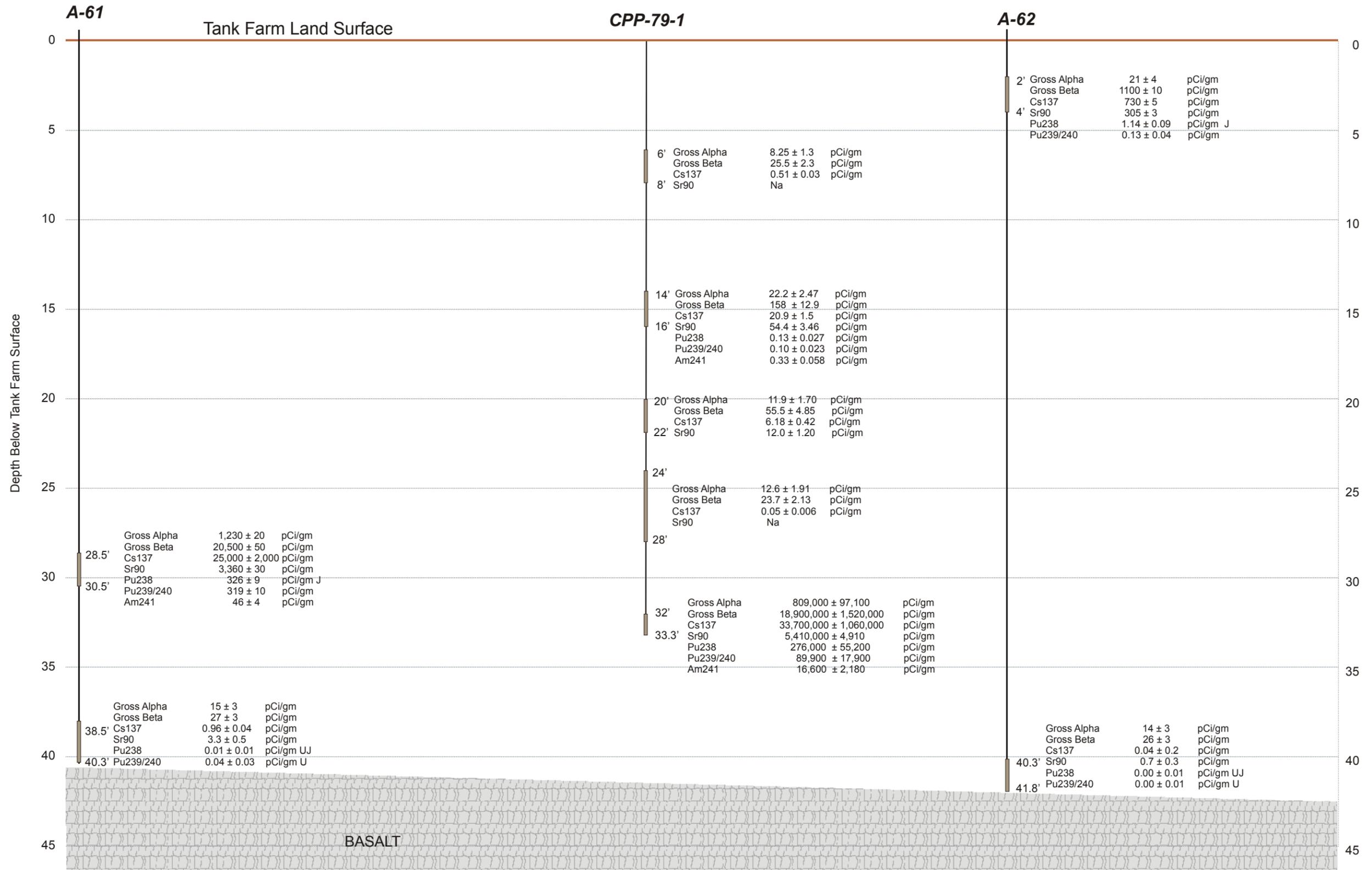


Figure 3-18. West-to-east fence diagram through A-61, CPP-79-1, and A-62 showing soil sample analytical results.

Table 3-5. Borehole sample result comparison table (results in pCi/g).

Radionuclides and Associated Ratios	Borehole CPP-79-1-Shallow (14–16 ft bgs)	Borehole CPP-79-1-Deep (32–2.5 ft bgs)	Borehole A-61 (28.5–30.5 ft bgs)
<b>Radionuclides</b>			
Gross alpha	22.2	809,000	1,230
Gross beta	158	18,900,000	20,500
Cesium-137	20.9	33,700,000	25,000
Sr-90	54.4	5,410,000	3,360
U-234	5.55	ND	2.10
U-238	1.39	ND	1.50
Pu-238	0.13	276,000	326
Pu-239/240	0.10	89,900	319
Am-241	0.33	16,600	46
<b>Ratios of Detected Radionuclides</b>			
Gross beta/gross alpha	7.1	23.4	16.7
Gross beta/Sr-90	2.9	3.5	6.1
Cs-137/Sr-90	0.4	6.2	7.4
Pu-238/Pu-239/240	1.3	3.1	1.0
Sr-90/Pu-238 + Pu-239/240	236	11.8	5.2

ND – Not detected; uranium activity could not be quantified in the presence of the large amounts plutonium isotopes in the sample.

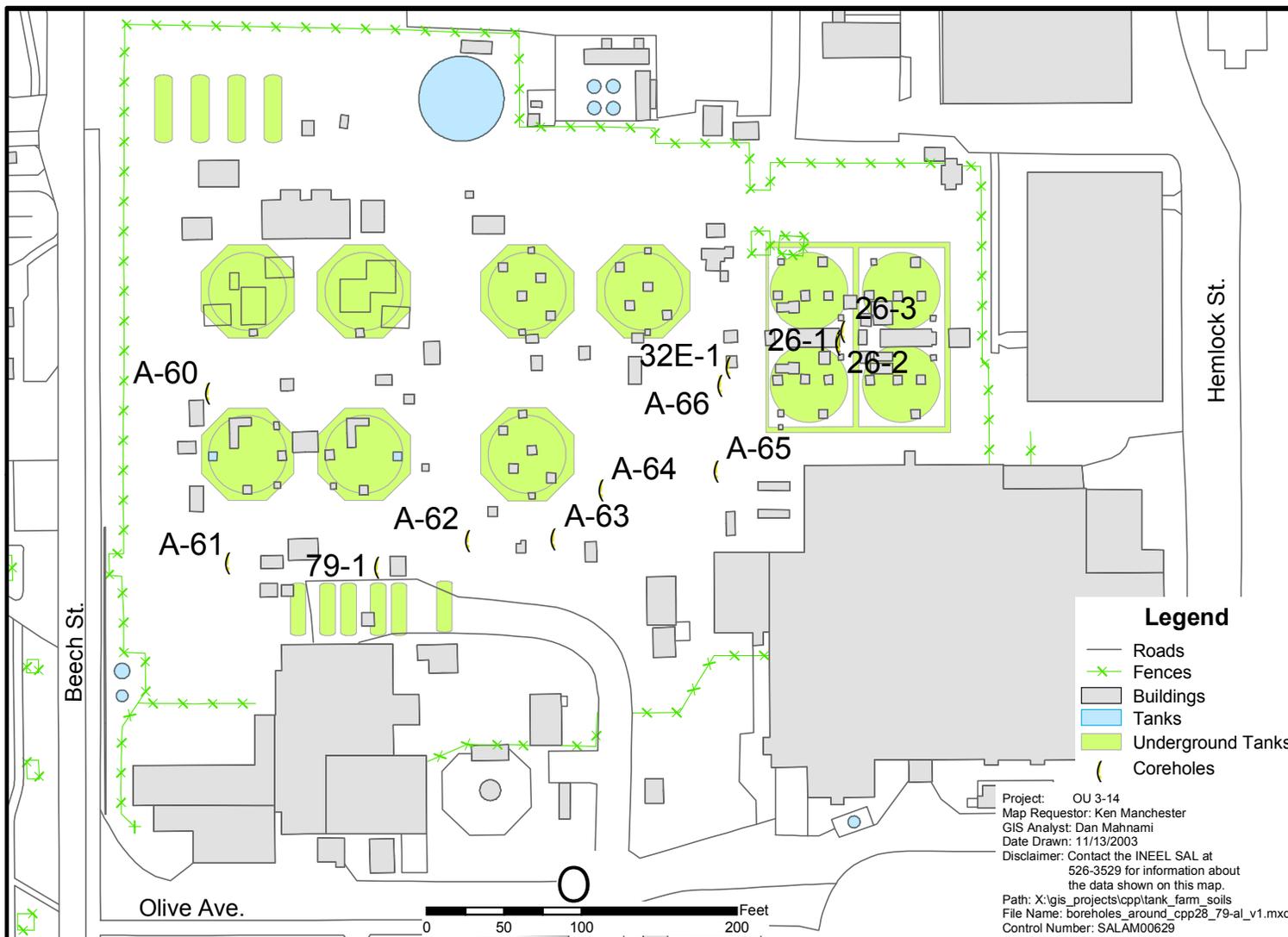


Figure 3-19. Map of the tank farm showing locations of boreholes drilled around sites CPP-28 and -79.

Because the release at site CPP-79-Shallow was from a known source, the source term can be bounded based on knowledge of the volume of liquid lost and the waste stream. The estimated curie content contained in the 2,512-gal release was 7.0 Ci (Cs-137/Sr-90) based on 1986 laboratory analytical data from PEW waste stream acceptance testing completed on the two waste streams.

It is believed that most of the contaminated soil at this site was removed during the 1994 tank farm upgrade project. The amount of activity was not documented during the excavation activities. Figure 3-20 shows a north-south cross section through the CPP-79-Shallow release site. This figure was used for planning purposes, and the shoring shown in the figure may not have been used, opting for sloped sidewalls. Soil was excavated down to an approximate depth of 30 ft below the tank farm surface.

**3.1.3.3 Site CPP-79-Deep Investigation and Leak Description.** As mentioned in the previous subsection, one soil boring, CPP-79-1, was installed near the CPP-79 release site (see Figure 3-17) on a berm approximately 8 ft above the ground surface of the tank farm.

The soil sample collected from 33.5 to 34 ft bgs had significantly higher levels of radiation than shallower samples and was too radioactive to be transported offsite. This sample had a contact surface radiation level of 400 mR/hr beta-gamma. (It should be noted that this radiation level is considerably lower than the 400 R/hr value presented in the *Final Track 2 Summary Report for Operable Unit 3-07* [WINCO 1993a] and the OU 3-14 tank farm soil and groundwater Phase I RI/FS work plan [DOE-ID 2000b]). After careful review of the CPP-79 field logbook, it was concluded that the highest measured radiation level was 1.2 R/hr, which was measured from a sample collected from the 32- to 33.3-ft depth interval at the open end of the split-spoon sampler. Subsequent measurements taken in the laboratory where the split-spoon sampler was disassembled under controlled conditions ranged from 400 to 800 mR/hr beta-gamma and 200 to 300 mR/hr beta. The values documented in the logbook (mR/hr) were reported in subsequent documents as R/hr, leading readers of the reports to believe there was extremely contaminated soil at CPP-79.

The radionuclide analysis of the sample collected from 32 to 32.5 ft bgs measured significantly higher gross alpha ( $8.09\text{E}+5 \pm 9.71\text{E}+4$  pCi/g) and beta ( $1.89\text{E}+7 \pm 1.52\text{E}+6$  pCi/g) activities than were measured in sample intervals above 24 ft bgs (Figure 3-18). Isotopic analysis of this soil also detected significantly higher concentrations of Cs-137 activities ( $3.37\text{E}+7 \pm 1.06\text{E}+6$  pCi/g), Sr-90 ( $5.41\text{E}+6 \pm 4.91\text{E}+3$  pCi/g), Pu-238 ( $2.76\text{E}+05 \pm 5.52\text{E}+04$ ), Pu-239 ( $8.99\text{E}+04 \pm 1.79\text{E}+03$ ), and Am-241 ( $1.66\text{E}+4 \pm 2.18\text{E}+3$  pCi/g) than in shallower sample intervals. It should be noted that the plutonium values presented here were rejected in the Track 2 report. However, they were subsequently determined to be valid and will be used in the RI/FS. The analysis led investigators to conclude that the deeper contamination is not from the reported WCF and NWCF decontamination solutions associated with site CPP-79-Shallow. The deeper zone of contamination appears to be the result of a release of first-, second-, or third-cycle raffinates.

The source of the deeper contamination has not been determined, but one potential leak mechanism was identified for the release of contaminants into the soils. Previous documents have linked the CPP-79-Deep contamination to the CPP-28 release due to the fact that the deeper soil was extremely contaminated. However, three lines of evidence suggest that the two zones of contamination are not associated with each other. First, contaminant concentrations found at the CPP-79-Deep site are not as high as previously documented, suggesting that the source does not necessarily have to be from first-cycle waste, as was released at CPP-28. Second, interviews with tank farm operations staff indicated that during the 1993–1994 tank farm upgrades, the area between CPP-28 and CPP-79 was extensively excavated and, to their knowledge, did not encounter areas or pathways between the two locations having highly contaminated soil, suggesting the two sites are independent. Finally, the extent of contamination at

CPP-28 appears to be reasonably bounded—contained within a relatively small volume beneath the former location of the 3”PWA-1005 waste-transfer line (see Subsection 3.1.2).

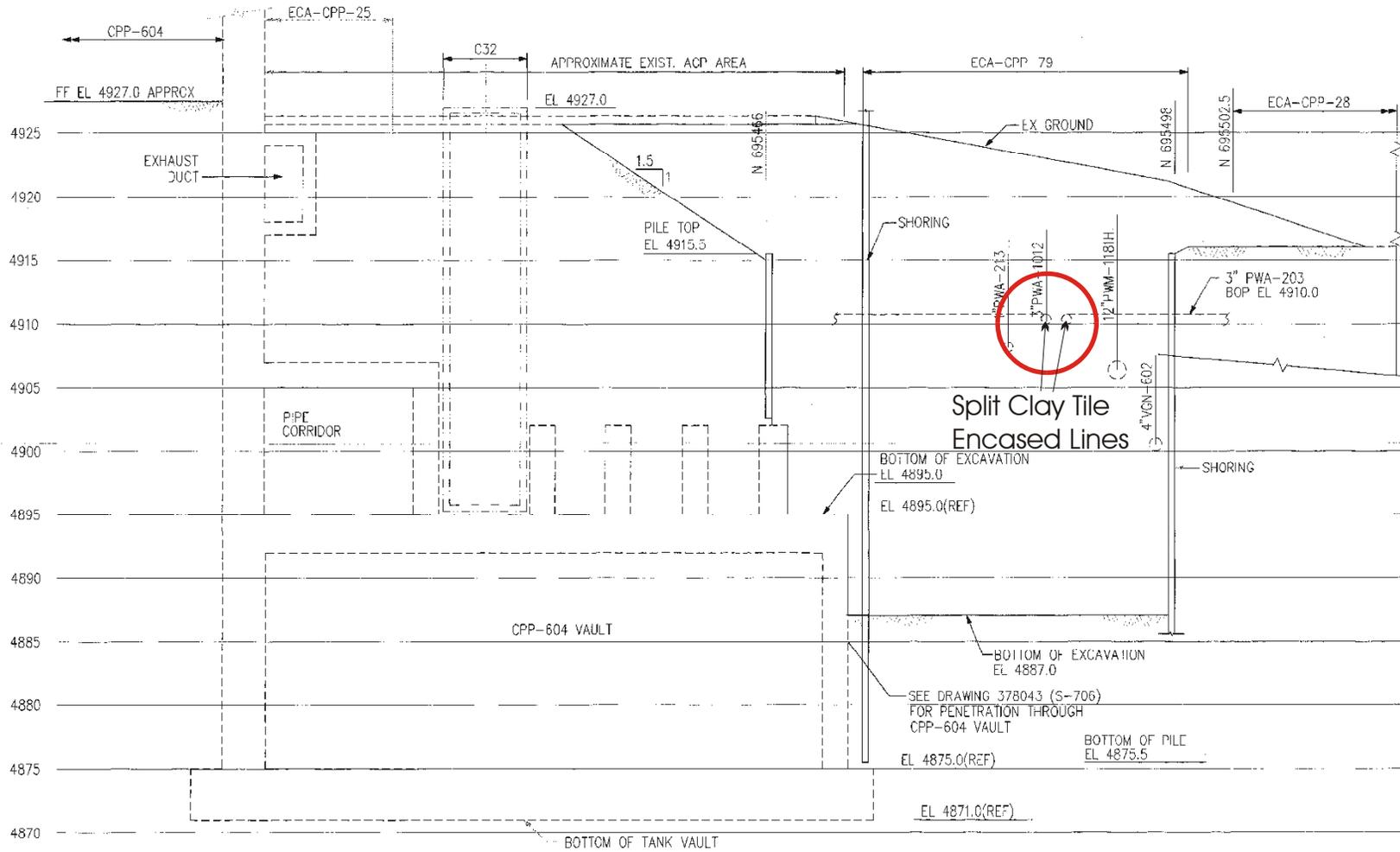


Figure 3-20. Cross section through CPP-79 release site showing planned excavation depths.

The likely leak mechanism for CPP-79-Deep is associated with the A-3A valve box. During the CPP-28 leak investigation, associated piping and valve boxes were inspected for signs of leakage. According to an incident report on contaminated soil at the tank farm, valve box A-3A was examined and found to have 1 to 2 in. of radioactive solution with a reading of 25 R/hr in the bottom, and the bottom drain line to the PEW collection tank was plugged (Allied Chemical 1975). A ring of dried chemical salt residue was readily visible inside the concrete box at the approximate level of the center line for the pipe sleeve for exit pipe line 3”PWA-1030 (the 1975 report incorrectly identified this line as 3”PWM-2016Y), indicating that the liquid had been at that level for some time. Valve and flange gaskets were found to be of Teflon and in a high state of disintegration. The solution in the bottom of the box was sampled, and analysis indicated the solution was first-cycle waste generated from aluminum fuel rod reprocessing.

Secondary containment for 3”PWA-1030Y was the split-clay tile encasement that drained into the CPP-604 tank vault. Leakage from the valve in valve box A-3A may have accumulated inside until the fluid level reached the opening of the tile encasement. With continued leakage, the waste fluid would begin to flow down vertically toward the bottom of the encasement located approximately 26 ft bgs and start to degrade the tile joints on contact, eventually allowing leakage into the surrounding soil. A slightly different possibility exists, allowing waste liquids to pass through the split-clay tile encasement. The design of the concrete-covered split-clay tile encasement created a very rigid structure. If any differential settling of soils occurred, the encasement would be susceptible to cracking, creating pathways for liquid waste to move into the soil. The area in the vicinity of A-3A has been disturbed a number of times, which may have caused differential settling around the valve box. The depth of release is consistent with the deep contamination observed in CPP-79-1.

**3.1.3.4 CPP-79-Deep Extent of Contamination.** Only one soil sample has been collected from the deep contamination zone at CPP-79-Deep. Once contaminated soil was encountered at borehole CPP-79-1 at 32 ft (40 ft from the top of the berm), drilling was halted. Excavations made during tank farm upgrades in the CPP-79 release area have gone as deep as 32 ft below grade and reportedly encountered contaminated soil with radiation levels as high as 5 R/hr.<sup>b</sup> In 1993, two additional boreholes, A-61 and A-62, were installed where contamination was detected, as discussed in Subsection 3.1.3.2. Comparing ratios of the detected contaminants from A-61 to the deep contamination in CPP-79-1, there is no evidence that the two contaminant zones have the same source (LMITCO 1995a). In particular, the ratio for the Pu-238 and Pu-239/240 for CPP-79-1 is 3.1, while the ratio in A-60 is 1.0. If the contamination was the result of the same release, the ratio of the plutonium isotopes would be essentially equal. Additionally, the ratio of Cs-137 to Sr-90 is 6.2 for CPP-79-1 and is 7.4 for A-61. This would only be expected if the contamination was moving from A-61 to CPP-79-1 due to the difference in  $K_d$  values for these two contaminants. But the relative concentrations of radionuclides detected do not support this direction of contaminant transport. The results from A-61 and -62 help bound the extent of contamination in CPP-79-Deep. The contamination encountered at A-61, having contact radiation levels of 10 to 12 mR/hr, is believed to be from contaminated backfill.

Two estimates, an upper and lower, were made to help estimate and bound the Cs-137/Sr-90 curie content of this deep contamination zone. The estimates were made based on the location and depth of the suspected release mechanism located approximately 5 ft above and 15 ft laterally from the contamination observed in borehole CPP-79-1 at 32 to 33.3 ft bgs. The low estimate was made by assuming that the contaminated soil mass formed an oblate dome shape with a radius of 16 ft and a height of 6 ft. The volume associated with this shape was calculated to be 2,827 ft<sup>3</sup>. Because the suspected leak mechanism is located next to the CPP-604 tank vault, only half of the oblate dome volume, or 1,414 ft<sup>3</sup>, would be in soil. The other half would extend into the impervious tank vault structure, limiting the shape of the

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b. Personal communication from D. Machovec, Bechtel BWXT Idaho, LLC, to K. Manchester, MSE Technology Applications, Inc., and A. Bailey, PS2 Associates, September 9, 2003.

release. Assuming 6% soil moisture by volume, the amount of liquid waste contained in the contaminated volume would be 84.8 ft<sup>3</sup> or 634 gal. Assuming that the waste was first-cycle raffinates with a Cs-137/Sr-90 curie content of 6 Ci/gal based on analytical data for first-cycle waste, the lower release estimate becomes 3,804 Ci of combined Cs-137 and Sr-90.

The upper estimate was made based on the release again forming an oblate sphere shape with a radius of 40 ft and a height of 12 ft, extending the contamination to the base of the alluvium. The volume calculated for this waste configuration was 10,053 ft<sup>3</sup>. Again, reducing this volume by half due to the presence of the CPP-604 tank vault results in a volume of 5,027 ft<sup>3</sup>. Assuming 6% soil moisture by volume, the amount of liquid waste contained in the contaminated volume would be 301.6 ft<sup>3</sup> or 2,256 gal. Assuming that the waste was first-cycle raffinates with a Cs-137/Sr-90 curie content of 6 Ci/gal based on analytical data for first-cycle waste, the upper release estimate becomes 13,535 Ci of combined Cs-137 and Sr-90.

### **3.1.4 Site CPP-15**

Site CPP-15 was the location of the Solvent Burner Building (CPP-629) (Figure 3-21). Operation of the facility began in the late 1950s and was dismantled in 1983. The spent organic solvent, either hexone (methyl isobutyl ketone) or TBP and purified kerosene, which was burned in the building, came from the uranium solvent extraction processes. Solvent extraction was used to separate uranium from fission products. The solvent was put in contact with uranium contained in an aqueous solution of uranyl nitrate that was produced in the fuel dissolution process.

The spent solvent was burned in a standard furnace oil burner in a fire-brick-lined enclosure fed by an underground solvent feed tank (LE-102) located below the building. The furnace off-gases were sent unfiltered to the INTEC main stack. During operations, the burner flue routinely leaked combustion products, resulting in contamination in the area east of building CPP-629. A 1977 analysis of soot taken from the flue detected I-129 (6.6.7E-02 pCi/g), Pu-239 (3.85E-00 pCi/g), Am-241 (6.25E-02 pCi/g), Cs-137 (1.32E+01 pCi/g), Ba-137m (2.94E-02 pCi/g), and Ru-106 (3.38E+01 pCi/g).

On March 28, 1974, during maintenance of the solvent burner, liquid was reportedly found on the ground inside and outside the Solvent Burner Building (CPP-629). As part of the construction work for the new PEW evaporator, a section of the drain line from the main INTEC stack had been cut out. Valves had been installed at each end of the cut, and a section of temporary hose was installed between the valves. During the day shift, the valves were closed, and the section of hose was removed, allowing free access to the area. At the end of working hours, the hose section would be replaced and the valves opened, permitting the line to function as a drain during the night. An overlooked jetted line from the solvent feed tank (LE-102) to the stack drain used to transfer water out of the tank was found to exist during the construction activity. Condensate from the stack backed up the jet line to LE-102, causing it to overflow. The leak of the spent solvent was determined to have occurred from the ground surface flange directly above the solvent feed tank. The quantity of spilled liquid is unknown. It was reported that beta and gamma radiation readings as high as 3 R/hr were detected in the contaminated soil outside the building, which was removed and placed in drums. Uncontaminated soil was used to backfill the excavation.

Demolition of the Solvent Burner Building in 1983 included removal of the furnace/burner unit; the furnace duct; the control shed; the piping, valves, and controls within the shed; the piping penetrating the shed; the solvent feed tank (LE-102); and the contaminated soil in the area. Interviews with personnel involved in the demolition indicated that the soil excavation exceeded 10 ft below grade and was very thorough. No post-excavation sampling was performed to confirm the removal of contamination. Site CPP-15 was originally included in OU 3-08, which underwent a Track 2 investigation (WINCO 1993b). The Track 2 investigation was performed on the basis of information about the demolition and removal activities. Sampling and analysis were not performed.

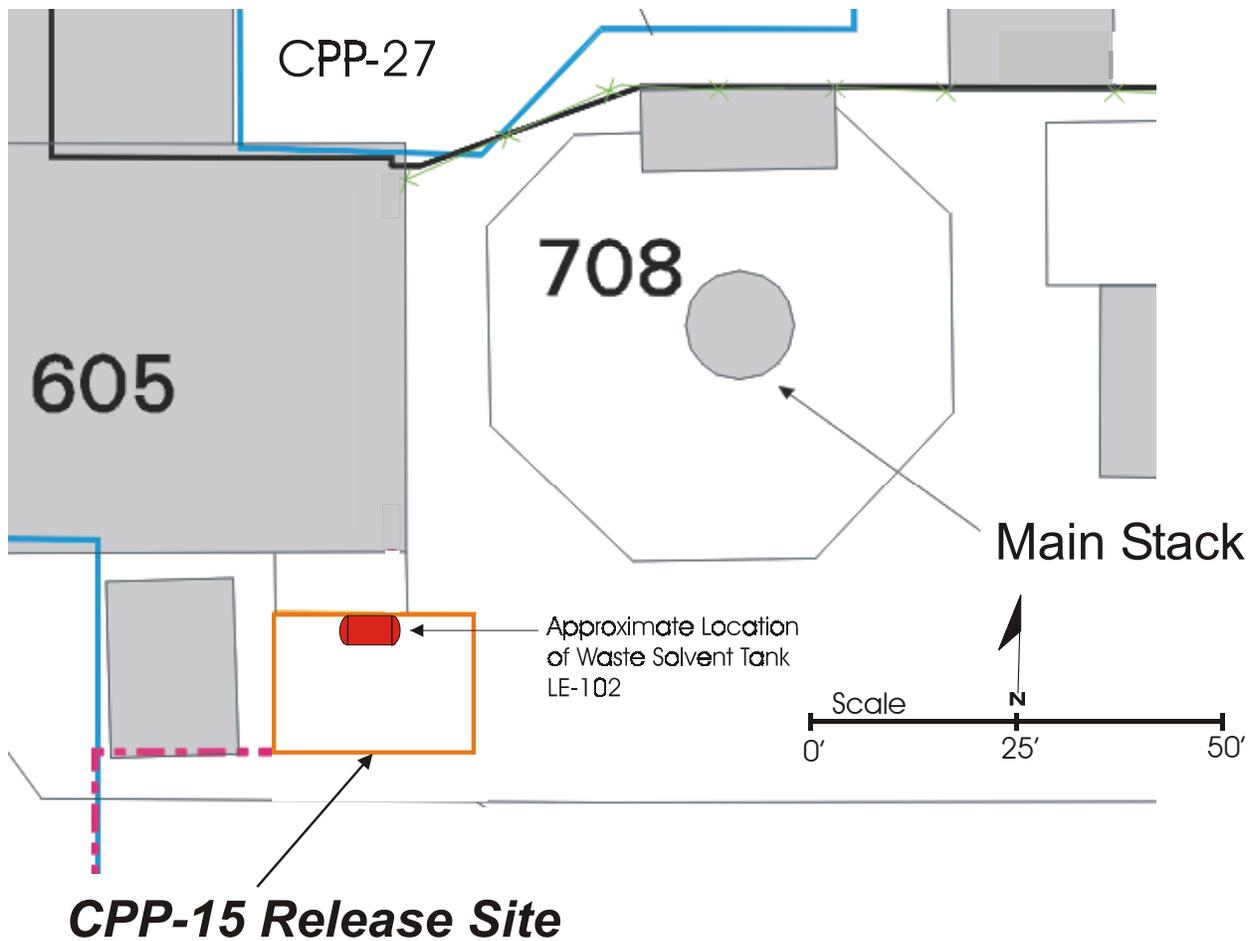


Figure 3-21. Site CPP-15 location map.

Site CPP-15 was recommended for no further action. In September 1995, construction personnel encountered elevated radiological readings while excavating soil in the western portion of the CPP-15 site. The excavation was in support of installation of an electrical duct bank and transformer pad. The contaminated soil was encountered at a depth of 2 ft. One spot on a concrete footing beneath the contaminated soil had a reading of 1.5 R/hr. The footing was a remnant of the old stack pre-heater. Six soil samples were collected in the area of the contaminated footing from the following five locations:

- A stockpile of excavated soil in a dump truck (Sample CPP-15-1)
- Soil approximately 1.5 ft away from the footing at 2 ft bgs (Sample CPP-15-2)
- Soil directly below the footing (Samples CPP-15-3 and CPP-15-5)
- Soil 4 ft below the footing (Sample CPP-15-4)
- Soil 8.5 ft below the footing (Sample CPP-15-6).

The 1995 soil sampling analytical results indicate that the highest levels of radionuclide contamination were present in the samples collected 8.5 ft below the contaminated footer, which is 10.5 ft below grade. This would suggest that not all of the contaminated soil was removed during the 1983

demolition activities and is consistent with the report that the excavation extended only to 10 ft below grade. Cs-137 was the only radionuclide detected in the four shallow soil samples during an analysis for gamma-emitting radionuclides. The detected concentrations ranged from  $2,350 \pm 120$  to  $43,300 \pm 1,800$  pCi/g. In addition to gamma spectroscopy analysis, the sample from 10.5 ft below grade was analyzed for a suite of other radionuclides, including I-129, Np-237, total strontium, Tc-99, plutonium, and uranium isotopes. The Cs-137 activity in the sample was  $586,000 \pm 170,000$  pCi/g. Other radionuclides detected in the sample were Am-241 at  $538 \pm 35$  pCi/g, Eu-154 at  $243 \pm 24$  pCi/g, Np-237 at 0.63 pCi/g, Pu-238 at  $4570 \pm 320$  pCi/g, Pu-239/240 at  $825 \pm 63$  pCi/g, Tc-99 at 36.7 pCi/g, and U-235 at 0.0203 pCi/g. I-129 was not detected.

All of the soil samples were subjected to analysis for metals, cyanide, sodium, potassium, semivolatile organic compounds (SVOCs), percent solids, and volatile organic compounds (VOCs) as well. Zirconium was detected in all six samples at concentrations ranging from 5.13 to 13.97 mg/kg. Thallium was detected in the sample at 4.85 mg/kg from 10.5 ft below grade. The reported results for all other metals in the samples were consistent with background soil concentrations of the metals at the INEEL. In the organic analysis, methylene chloride was detected in all of the samples at very low concentrations (less than 0.01 mg/kg). It was also detected in the method blanks. Trichloroethene was detected in the sample of soil from the dump truck at an estimated concentration of 4.6 µg/kg.

The SVOC analysis of the soil samples indicates the presence of a number of SVOCs that would be expected at the site, given the site history. These SVOCs included tributyl phosphate and some polyaromatic hydrocarbons, which are associated with combustion of kerosene. The detected compounds include tri-n-butyl phosphate, acenaphthene, phenanthrene, anthracene, fluoranthene, benzo(k)fluoranthene, and benzo(b)fluoranthene. The analysis indicated that the compounds are spectrally present but at concentrations below the sample quantitation limit. The "U" flagged sample quantitation limits, called the method detectable limit on the data reports, are what were reported for the compound concentrations in the data packages. Also detected in many of the samples were 3-nitroaniline, azobenzene, 2-methylphenol, bis(2-chlorethyl)ether, 2,6-dinitrotoluene, and numerous tentatively identified compounds. A number of other compounds, including naphthalene, 2-methylnaphthalene, 2-chloronaphthalene, acenaphthylene, dimethylphthalate, dibenzofuran, fluorene, diethylphthalate, carbazole, di-n-butylphthalate, bis(2-ethylhexyl)phthalate, butylbenzylphthalate, and di-n-octylphthalate, were reported present in both the samples and the reagent blank.

Based on the 1995 soil sampling results, the contamination was not totally removed from the site during 1983 demolition. The low levels of Cs-137 in the shallow soil samples suggest that the soil used as backfill may have been contaminated. The higher levels of contamination at 10.5 ft bgs are likely the result of existing contamination that was not removed during the 1983 demolition. To estimate the amount of remaining Cs-137/Sr-90 activity at the site, analytical data from the soil samples were used along with estimates of contaminant extent. The assumed area of contamination was 700 ft<sup>2</sup> extending to a depth of 20 ft bgs, resulting in a volume of 14,000 ft<sup>3</sup>. Assuming that half the site was excavated to a depth of 9 ft bgs during the demolition and removal of the solvent burner system and was replaced with backfill having little or no contamination, the volume was reduced by 3,150 to 10,850 ft<sup>3</sup>. Multiplying the volume by an average Cs-137 soil activity resulted in 180 Ci using a 125 lb/ft<sup>3</sup> mass conversion for the soil. Doubling the Cs-137 activity to account for the Sr-90 activity results in a total Cs-137/Sr-90 activity of 360 Ci.

### **3.1.5 Sites CPP-27 and CPP-33**

The contamination found in the CPP-27 and -33 areas of the tank farm (Figure 3-1) is the result of liquid releases associated with a corroded carbon-steel pressure-relief line running from the underground

waste storage tanks to the INTEC stack. Two areas of contamination were discovered, one in 1974 (CPP-27) and the other in 1983 (CPP-33). Since the contamination associated with these release sites is thought to have originated from the same corroded pressure-relief line, the leak mechanism and extent of contamination for both of these release sites are being combined as a single release site in this work plan.

The original design of the tank farm in 1951 provided two systems for handling off-gas from the storage tanks. The first system connects all but one of the waste tanks (i.e., WM-181) to the vessel off-gas system via a 4-in., stainless-steel, vent line and maintains a slight vacuum on the waste tanks. The second system, which is associated with the contaminant releases, consists of pressure-relief valves installed on each waste tank vent line, allowing high individual tank pressures to be relieved and vented to the INTEC stack via a 12-in., carbon-steel, pressure-relief line. The pressure-relief system was constructed of stainless steel from the waste tanks to and including the pressure-relief valve (located in a valve pit immediately adjacent to the tank vaults), and the system is carbon steel from the relief valves to the stack. Both of the waste off-gas systems were located underground, except for the final 40 ft of the 12-in. pressure-relief line, which exits the ground prior to its aboveground connection with the stack (Figure 3-22).

The 12-in. pressure-relief line reaches its lowest underground elevation east of building CPP-604. This low point occurs just before the line rises aboveground for tie-in to the stack. A 2-in., stainless-steel, drain line was installed on the 12-in. line at the low point and directed to a 3-in. stainless-steel, INTEC stack drain buried 2.3 ft deeper. The drain permitted condensates forming in the pressure-relief line to gravity drain into the 3-in. stack drain, which in turn flowed by gravity to a PEW holding tank (WL-102). In addition to this connection, however, forced-feed process waste-transfer lines from the waste calciner facility, the waste evaporator pump pit, and the waste solvent collection tank were tied into the stack drain near the vicinity of the 12-in. pressure-relief line drain. The pressures resulting from the force-feed transfer of waste in these lines resulted in corrosive solutions being forced into the 12-in., carbon-steel, pressure-relief line, causing the line to corrode and ultimately leak.

The investigation concluded that the single most likely cause of the corrosion leak in the 12-in. carbon-steel line was the WCF waste-transfer line tie-in to the stack drain. Several lines of evidence were used to draw this conclusion. The WCF transfer line required higher steam jet pressures to make waste transfers, which likely forced waste liquid into the 12-in. pressure-relief line, although the pressure was sufficient in any of the three pressure waste systems to overcome the 2.3-ft height differential. Increases in stack activity were also noted during WCF transfers. Of the three waste streams that potentially entered the 12-in. pressure-relief line, WCF solutions were the most corrosive, because they contained highly acidic decontamination and recycle solutions. In addition, WCF involved larger transfers of waste solution that were more frequent than those transferred in the other two lines.

A second corrosion mechanism was also identified that may have contributed to the failure of the 12-in. pressure-relief line. The crossover connection and valve between the 12-in. pressure-relief line and the 4-in. vent line was left open for 11 years due to an inaccurate as-built drawing, allowing corrosive gas to flow through the pressure-relief line.

The investigation also concluded that all of the contamination came from the corroded 12-in., carbon-steel, pressure-relief line based on the fact that the soil contaminant activity was traceable to the same area, activity levels were similar across the contaminated zone, radioisotope and chemical analyses found similar isotopic ratios at the major points, and no other leaking pipes or source terms were found.

3-45

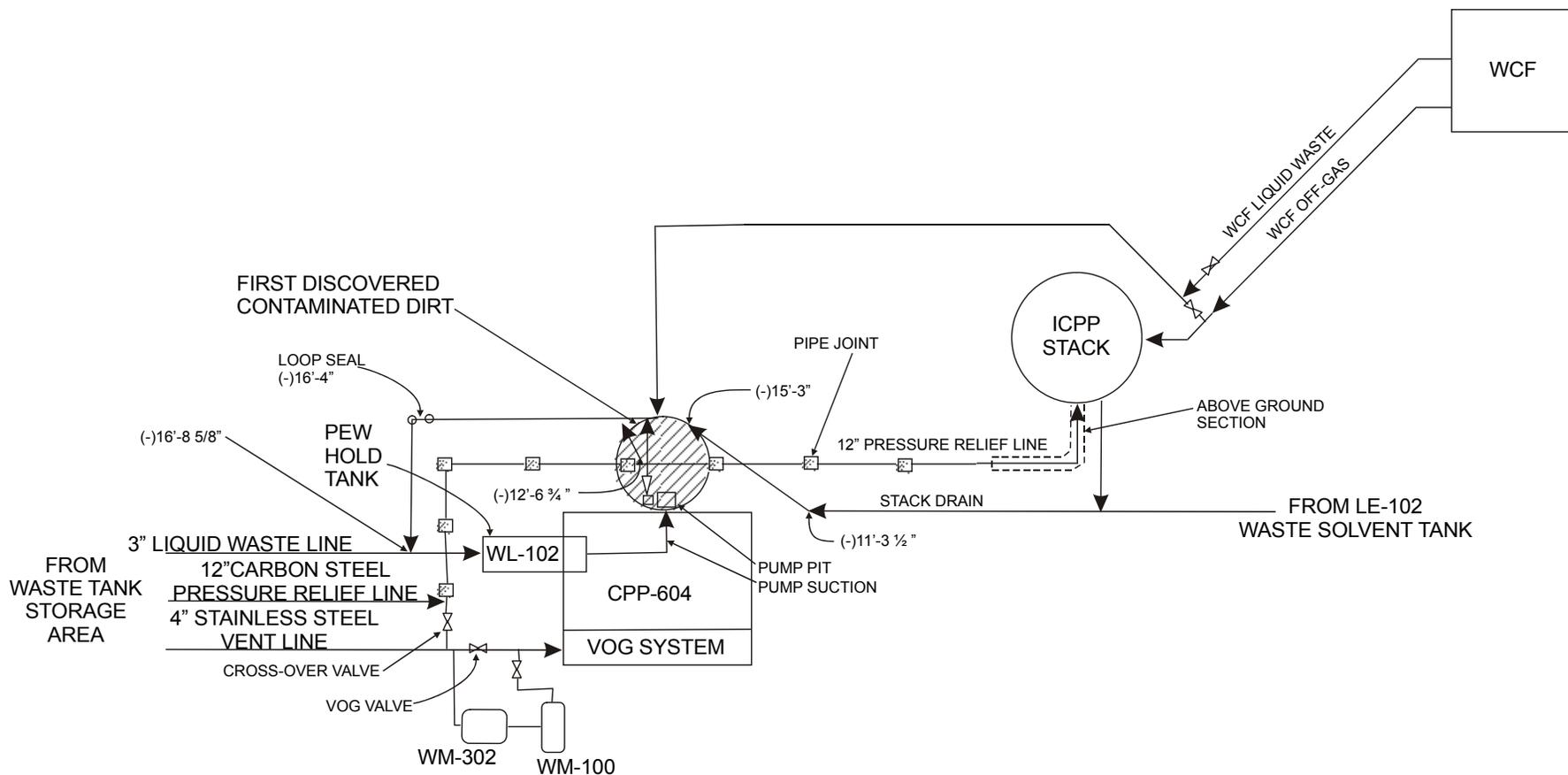


Figure 3-22. Schematic diagram showing piping layout in release area CPP-27/33.

Based on process knowledge, it is believed that two types of waste may have leaked at this location. From February 24, 1964, to August 30, 1974, approximately 115,000 gal of acidic waste solution that leaked onto the calciner cell floor during calcination of first-cycle aluminum waste (mostly from tank WM-185) was transferred from the WCF to the PEW collection tank. The concentration of Cs-137 and Sr-90 in this waste was estimated to be about 3,000  $\mu\text{Ci/mL}$ . It was estimated that less than 100 gal of this waste plus 100 to 300 gal of other waste (rain water, pump-leaked PEW solution, or water from the solvent hold tank) having considerably lower concentrations of radionuclides were leaked to the soil. An estimated total of 1,000 to 3,000 Ci of activity was released.

In April 1974, during excavation of a construction site adjacent to and east of CPP-604, contaminated soil was first discovered (CPP-27) below a badly corroded and leaking 12-in., carbon-steel, pressure-relief line located 12 ft bgs. When excavation of the pipe was complete, the soil surrounding the corroded pipe had radiation readings up to 25 R/hr. The contamination leaked from a 7- to 8-ft section of corroded pipe into soil between the concrete joint support vaults and diffused vertically downward to a depth of 16 ft below the pipe (28 ft bgs) and laterally as far as 20 ft. It was suspected that the line had been leaking since approximately 1961.

The contaminated soil was excavated and boxed and sent to the Radioactive Waste Management Complex. This soil came from the area labeled as the 1974 excavation in Figure 3-23. A total of approximately 275  $\text{yd}^3$  of soil was removed from the site. Analysis of samples collected from the site in 1974 indicated Cs-134, Cs-137, Sr-90, Eu-154, Sb-125, Ru-106, and Pu-239/240 were present in the contaminated soil. Cs-137 activities in the four samples collected over nearly a 3-month period ranged from  $2.89\text{E}+4$  to  $3.03\text{E}+6$  pCi/g. The Sr-90 activities in three samples ranged from  $9.45\text{E}+4$  to  $8.59\text{E}+4$  pCi/g, and Pu-239/240 activities in two samples were  $4.59\text{E}+2$  to  $2.97\text{E}+3$  pCi/g. It was estimated that after removal of the contaminated soil, only 25 mCi of radioactivity was left at the site.

In 1983, additional contaminated soil attributed to the corroded line was encountered in the same general area while excavating soil to replace tank WL-102. This contamination is thought to be the result of a separate release from the same 12-in., carbon-steel, pressure-relief line. The contamination was designated as CPP-33 in the FFA/CO (DOE-ID 1991). Approximately 14,000  $\text{yd}^3$  of soil were removed from the site in 1983 (see Figures 3-23 and 3-24). Of this total, approximately 2,000  $\text{yd}^3$  had contact beta-gamma radiation levels exceeding 30 mR/hr. This soil was removed and disposed of at the Radioactive Waste Management Complex. The remaining 12,000  $\text{yd}^3$  were disposed of in trenches located in the northeast corner of INTEC. The excavated area was backfilled, and a portion of the area was covered by an asphalt road. Reportedly, some residual contamination remained below and to the sides of the excavated area (WINCO 1993c).

In 1987, 10 observation boreholes were drilled to the top of basalt in the CPP-27/33 area to determine the extent of contamination (see Figure 3-25). Direct radiation readings were taken in the observation boreholes using field instruments. No samples were collected from the boreholes for laboratory analysis. Information on the total depth of each borehole is also unavailable. Beta-gamma radiation readings in the boreholes ranged from none detected to 50,000 counts per minute (cpm).

In 1990, a 113-ft-deep borehole was made in the area (completed as monitoring well CPP-33-1, see Figure 3-25), 16 soil samples were collected from the soil above the basalt, and two soil samples were collected from the 110-ft interbed. The samples were analyzed for a full suite of constituents, including VOCs, SVOCs, metals, dioxins and furans, cyanide, and radionuclides. The primary contaminants detected in the soil were Cs-137 and Sr-90. The depth of the highest activities found were between 7 and 29 ft bgs. The maximum activities detected were  $608\pm 3$  pCi/g and  $328\pm 1.8$  pCi/g, respectively, for Cs-137 and Sr-90.

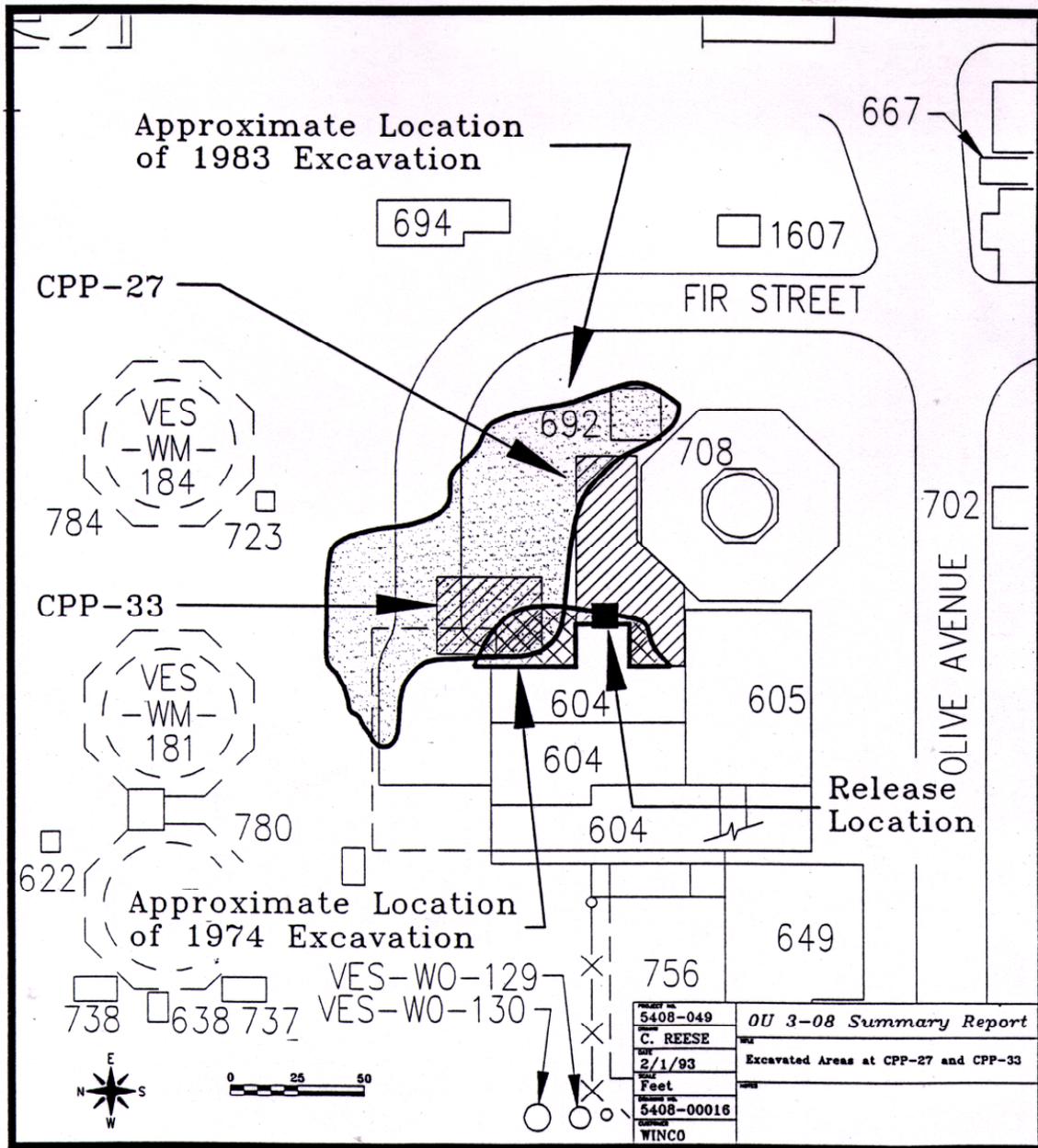


Figure 3-23. Map of sites CPP-27 and -33 showing the boundaries of the sites and the locations of previous excavations.



Figure 3-24. Photo showing the amount of soil removed from the CPP-27/33 release area during 1983 excavation.

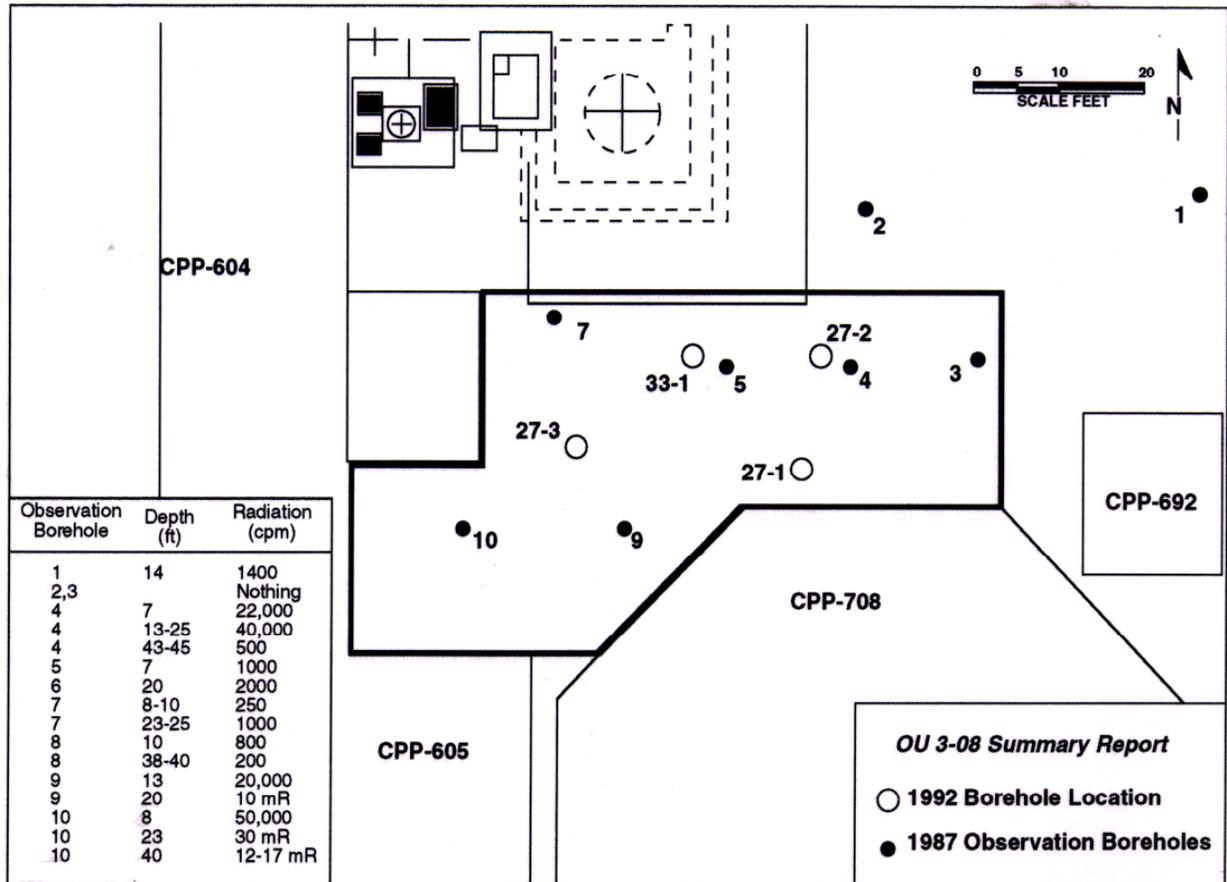


Figure 3-25. Map of site CPP-27 showing the locations of previously drilled boreholes.

Sites CPP-27 and -33 were additionally characterized as part of the OU 3-08 Track 2 investigation in 1992 (WINCO 1993b). Three boreholes labeled CPP-27-1, CPP-27-2, and CPP-27-3 were made at the site (see Figure 3-25). Borehole CPP-27-1 was drilled to 46 ft bgs, and the other two boreholes were drilled to 12 ft bgs. Twenty soil samples were collected and analyzed for VOCs, metals, selected anions, pH, and radionuclides. The selection of the appropriate depths to collect the soil samples from each borehole was based on the highest measured radiation reading on soil collected as the borehole was drilled. Sixteen of 20 samples analyzed by gamma spectroscopy had Cs-137 activities above expected background levels. Elevated Cs-137 was measured in borehole CPP-27-1 at depths from 2 to 22.5 ft bgs, in borehole CPP-27-2 at depths from 4 ft to 10 ft bgs, and in borehole CPP-27-3 at depths from 4 to 6 ft bgs. Slightly elevated alpha activities were found in boreholes CPP-27-1 and CPP-27-3 at depths from 6 to 16 ft bgs and 4 to 12 ft bgs, respectively.

The subsurface radiation levels measured in 1987 and from boreholes CPP-27-1 through CPP-27-3 and from CPP-33-1 were evaluated to estimate the extent of residual contamination at this site. Based on the 1987 subsurface radiation profiles, it appears that most of the contamination is located in the southwest portion of the site, where radiation levels as high as 30 mrem were measured below a depth of 20 ft (WINCO 1993b). The contamination detected in boreholes #9 and #10 is likely to have originated from the 12-in., carbon-steel, pressure-relief line.

The contamination detected in boreholes #4, CPP-27-2, and CPP-33-1 is likely related to the contaminated soil that was used as backfill. According to project records, contaminated soil with radiation

levels of 25 mrem/hr was used as backfill in the excavation. The contamination encountered in these boreholes was initially encountered at a depth of 7 ft, approximately 5 ft higher than the elevation of the release from the pressure-relief line.

The contamination detected in borehole CPP-27-1 is probably from a different source than the corroded pressure-relief line. This borehole encountered contamination at a depth of 6 ft bgs—approximately 6 ft higher than the reported release—and was drilled in an area that was not previously excavated (Figure 3-26). The shallow contamination observed might be from stack condensate that was known to seep through cracks and joints in the INTEC stack when the stack condensate drain was not functioning.



Figure 3-26. Extent of 1983 excavation within the CPP-27/33 release sites.

The northern and eastern limits of contamination appear to be bounded by the 1983 excavation, as determined by the lack of radioactivity detected in boreholes #2 and #3, and low levels of radioactivity detected in borehole #6. These boreholes were drilled in or near the excavated area.

The subsurface radiation profiles indicate that low levels of beta-gamma contamination are present at depths typically greater than 7 ft bgs. Levels of beta-gamma radiation below background were again encountered at depths greater than 20 ft bgs and continued to the top of the basalt for CPP-27-1; levels of beta-gamma radiation below background were also encountered at depths greater than 38 ft and continued to the top of the basalt in borehole CPP-33-1. From the 1987 data, however, higher levels of beta-gamma radiation were measured at the bottom of the boreholes located in the southwest portion of the site. It is uncertain whether the contamination continues below this depth, since the depths of the boreholes installed in 1987 were not reported.

The extent of soil contamination at this site generally appears to be limited to the north and east by the 1983 excavations, to the west by building CPP-604, and to the south by building CPP-605 and the INTEC stack (CPP-708). To estimate the Cs-137/Sr-90 activity still remaining at the site, the total square area of CPP-27 (2000 ft<sup>2</sup>) was multiplied by a depth of 25 ft, resulting in a volume of 50,000 ft<sup>3</sup>. Using an average Cs-137 activity of 214 pCi/g, based on past soil sampling analytical data, results in a total Cs-137 activity of 0.6 Ci. Adding an equal amount of activity to account for Sr-90 results in a total Cs-137/Sr-90 activity of 1.2 Ci.

### **3.1.6 Site CPP-26**

On the morning of May 10, 1964, preparations were made to steam and purge tank farm waste lines PUA 1220, 1222, and 1223 to reduce internal contamination preparatory to connecting these lines to piping associated with then-new 300,000-gal waste tanks WM-189 and -190 (Figure 3-27). A steam line was run from building CPP-635 to a decontamination header riser. Associated valves on the waste lines were then identified and positioned per the operation checklist to purge line PUA 1223 and the connecting lines to tank WM-186. Valve 86 on PUA 1223 appeared to be "frozen" shut, so the decision was made to use steam to purge line PUA 1222 and its connecting line to WM-186. The necessary valve changes were made to steam the new line.

Steam was then directed into the steam supply line, allowing pressure to build to 35 pounds per square inch (psi). At that point, the steam was shut in via a control valve. Valve DCV-109 was then opened on the decontamination header, allowing steam to enter the waste line and lowering the line steam pressure. The steam supply valve was then opened and allowed to pressure up to 35 psi. The steam line and aboveground lines were checked visually, and no problems were detected. During the visual check, the steam pressure rose to 75 psi. The steam valve was throttled back until the pressures returned to 35 psi and stabilized. After approximately 10 minutes, tank farm personnel noticed that the pressure had risen to 140 psi. The steam valve was shut off, and the pressure slowly dropped to 80 psi. Steam pressure was then slowly increased, and an additional check was made to verify that all valves were open. Concurrently, a steam leak was observed at a hose coupling that connected the steam line to the decontamination header. Radiation-detection instrumentation showed that the spray coming from the steam hose coupling was radioactive.

To release pressure on the line, the proper valve configuration was identified and positioned, allowing the line to vent to WM-184. Once the pressure was released, tank farm personnel were able to approach the steam release site and close valve DCV-109 on the decontamination header. It was reported that liquid then dripped from the failed coupling for several hours.

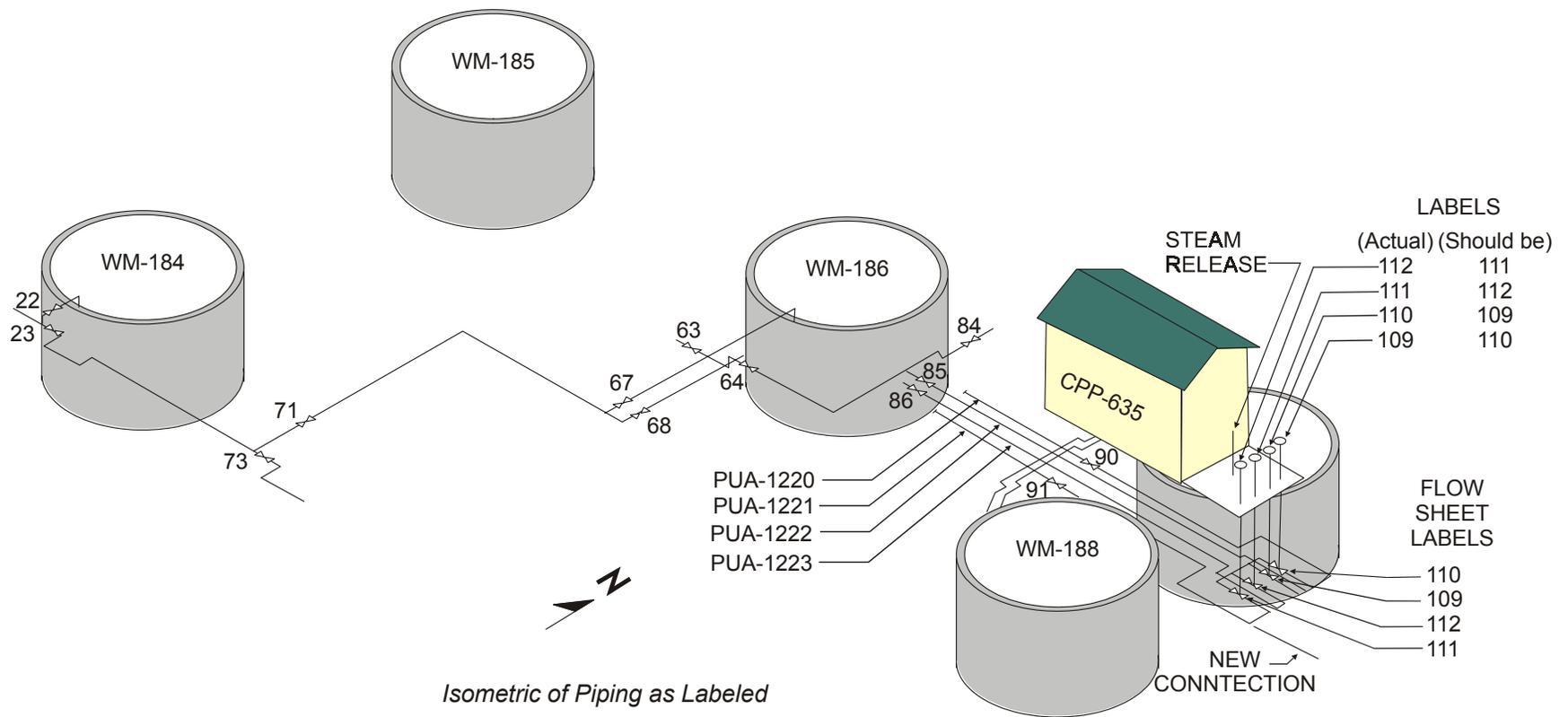


Figure 3-27. Isometric view of piping associated with the CPP-26 steam release.

The subsequent investigation revealed that the valves on the decontamination header were incorrectly tagged. As a consequence, steam had been applied to blocked line PUA 1220 through valve DCV-110 instead of PUA-1222 through valve DCV-109, as intended. No leak was noticed in the hose coupling when it was initially pressurized, indicating that it failed sometime after line decontamination operations began. After the incident, portions of the seat and collar of the coupling were found to be badly damaged.

The wind at the time of the release accounted for the large area of contamination. Meteorological data for the day from the U.S. Weather Bureau documented that the instantaneous wind at 11:45 a.m. was from 246° at 27 mph. The mean wind from 11:00 a.m. to 2:00 p.m. was from 244° at 30 mph. Fluctuations in the wind from 11:45 a.m. to 2:00 p.m. varied over a 78° sector from 237° to 315° (U.S. Weather Bureau Office Memorandum, June 12, 1964, DIRC Reference #003702).

A maximum volume of first-cycle waste contained in the 3-in. line was calculated to be 15 gal, based on the length of the piping run and the slope of the pipe. The slope of the pipe was to the east, causing the first-cycle waste to accumulate in the eastern portion of the pipe. When the steam pressure blew the steam coupling, the liquid waste was forced up the decontamination line and released to the environment, most likely as a combination of liquid and steam. Based on analysis of first-cycle tank waste in 1964, the Cs-137/Sr-90 curie content of the waste in the line was estimated to be 3 Ci/gal. Multiplying the waste volume by the curie content results in a value of 45 Ci, providing an upper limit to the total curies that could have been released.

The weather conditions at the time of the release, as described above, included high winds, which resulted in a cloud of steam contaminating an estimated 13 acres to the northeast of the release location. Ten acres were outside the INTEC security fence present at that time. Currently, only about 1 acre of the original 13 acres is outside the INTEC facility fence (see Figures 3-28 and 3-29). While the areal extent of contamination is large, the area under investigation in the OU 3-14 RI/FS work plan includes only the portion of the CPP-26 release site that lies within the tank farm fence.

The steam release occurred during the construction of the last two storage tanks, WM-189 and WM-190. The existence of surficial contamination from the release posed an exposure risk to construction workers working inside the tank farm security fence. This risk was mitigated by wetting down the area where the release occurred. It was reported that lawn sprinklers were used to wet the area for one to two days, after which construction activities resumed.

After the release, a sample of mud was collected near the decontamination header. The mud was found to contain 520 pCi/g of Cs-137, 3.3 pCi/g of Cs-134, 22,400 pCi/g of Ce-144, 3,600 pCi/g of Ru-106, 810 pCi/g of Ru-103, and 0.03 pCi/g of Pu-242. Reportedly, the liquid present near the header was cleaned up, solidified, and sent to the Radioactive Waste Management Complex for disposal. A surface radiation survey after the 1964 incident detected between 2 and 10 mR/hr in the soil, with one area as high as 200 mR/hr of gross radiation.

The entire CPP-26 site has been disturbed extensively since the release. A portion of the release site nearest to the decontamination header was excavated during the construction of buildings CPP-699 and CPP-654 and Bin Sets 4, 5, and 6 at the CSSF. Any remaining contamination from the release that is within the current tank farm boundaries has been covered with 2 ft of soil, a 20-mil-thick membrane liner, and an additional 6 in. of soil to prevent the liner from blowing away. Therefore, the contamination from the steam release would be expected to be approximately 2.5 ft bgs in the tank farm area.

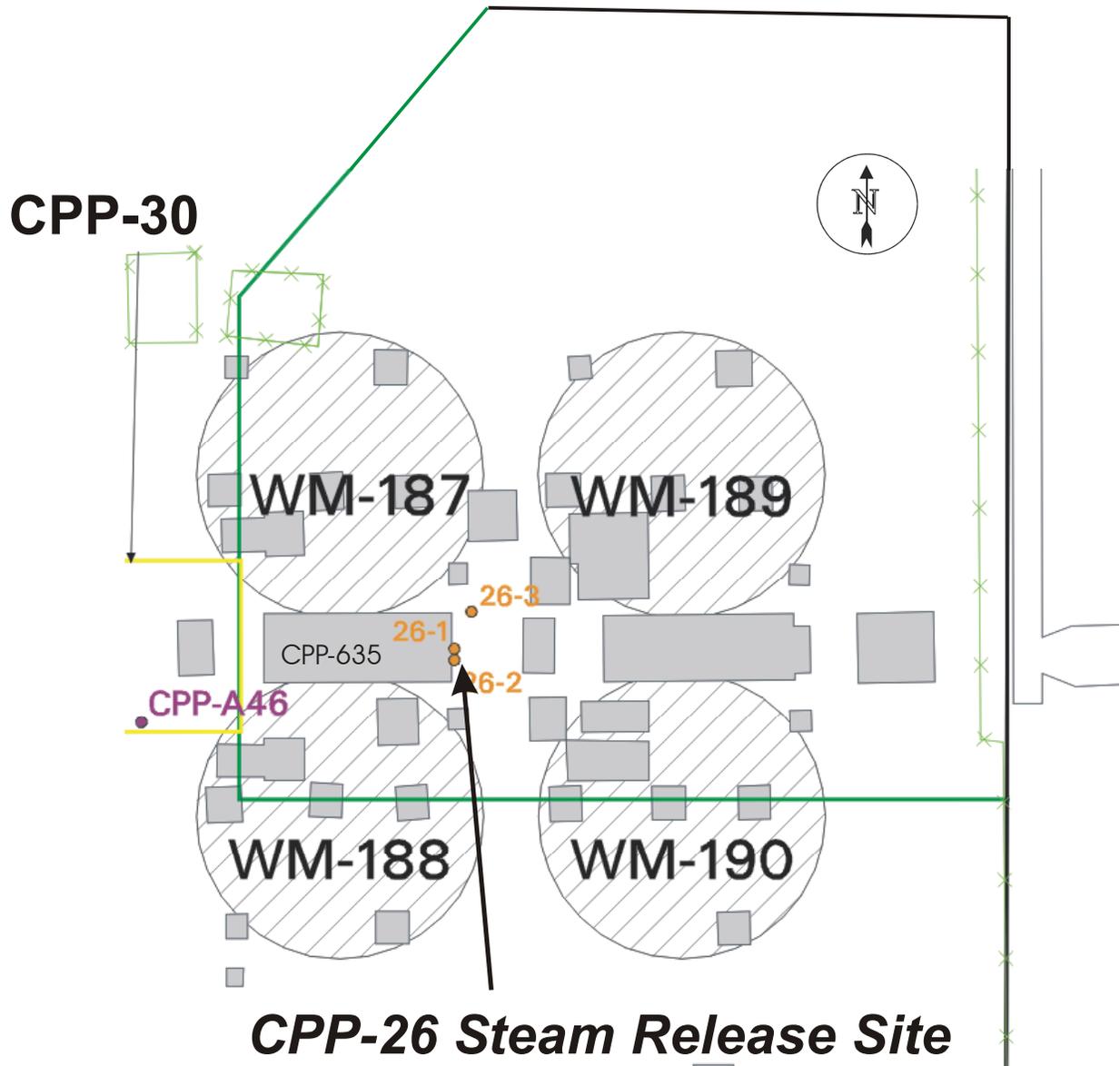


Figure 3-28. Location of the existing boreholes at site CPP-26.

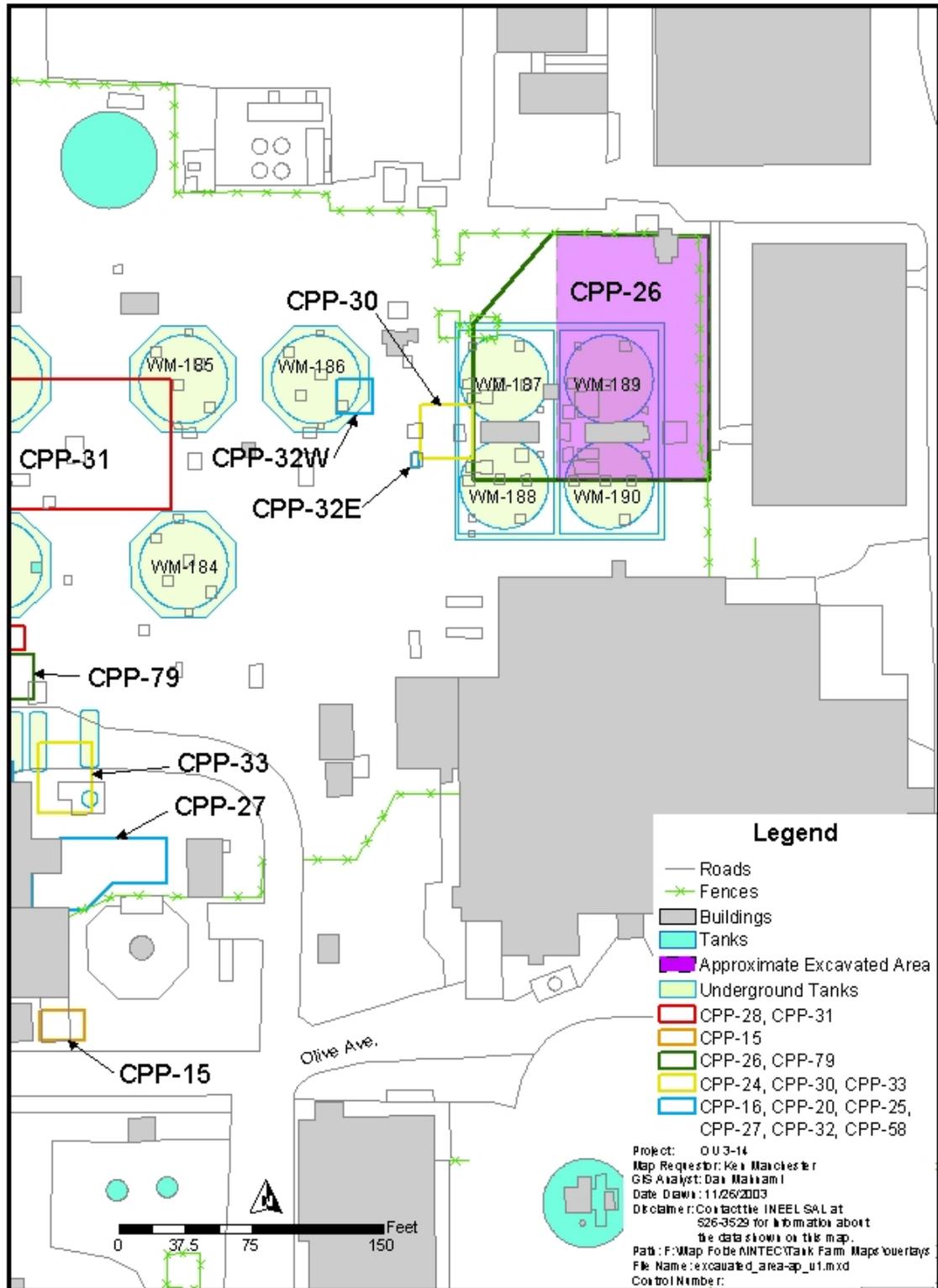


Figure 3-29. Location of the excavated area within site CPP-26.

In 1991, a surface radiation survey of the area was performed. No elevated beta/gamma radiation was detected on the surface outside of the tank farm on areas undisturbed since the steam release incident. Site CPP-26 was characterized as part of the OU 3-07 Track 2 investigation in 1992 (WINCO 1993d). A stainless-steel hand auger was used to drill three boreholes in the tank farm soil near the location of the steam release to determine the nature and extent of residual contamination. These three boreholes were located to the east and northeast of building CPP-635 (Figure 3-28). Two boreholes were drilled to approximately 6 ft below the tank farm liner; the third borehole was abandoned at 4 ft below the liner because of the presence of concrete. Nine soil samples, including three duplicate samples, were collected from the three boreholes. The selection of the appropriate depths to collect the soil samples from the boreholes was based on the highest measured radiation reading on soil collected as the borehole was drilled. The collected samples were analyzed for VOCs, selected metals, fluoride, nitrate, nitrite, pH, and radionuclides.

The radionuclides detected in the soil during the Track 2 investigation consist primarily of Sr-90, Cs-137, Eu-154, and lower levels of Pu-238, Pu-239, and Am-241. The highest concentrations (Sr-90 up to 15,800 pCi/g and Cs-137 ranging from  $108 \pm 9.08$  to  $6460 \pm 465$  pCi/g) were measured in samples collected between 4 and 5 ft bgs (WINCO 1993d).

### **3.1.7 Site CPP-32**

Sites CPP-32E (east) and -32W (west) are two areas of localized contamination near valve box B-4 (Figure 3-30). The contamination at CPP-32E (southwest of valve box B-4) appears to have originated from the condensation of contaminated water vapor in valve box B-4 that was released to the ground surface from the standpipe (air vent tube and view port pipe), which extends out of the valve box. This area is approximately 8 ft<sup>2</sup> and extends to a depth of about 1 ft bgs.

Site CPP-32W is approximately 50 ft northwest of valve box B-4, and the source of the release is suspected to be a result of a leak of radioactive liquid from a 2-in.-diameter aboveground transfer line used to pump water from tank sumps to the PEW evaporator. This area is approximately 6 ft<sup>2</sup> and extends to a depth of about 1 ft. Both sites were identified in December 1976 and described as having surface radiation levels up to 2 R/hr. It is unknown if any cleanup of the sites occurred after they were identified in 1976. Both of these surface releases have since been covered with 2.5 ft of soil and the tank farm membrane, which was installed in 1977.

During the OU 3-07 Track 2 investigation in 1992 (WINCO 1993a), only soil samples from site CPP-32E were collected. Not knowing the exact release location and desiring not to penetrate the tank farm membrane unnecessarily, the field team took no samples from CPP-32W. The concrete valve box was encountered when a soil borehole was drilled adjacent to the vent tube to a depth of 5 ft below the tank farm membrane. Therefore, the field team was unable to drill the borehole to the projected depth of 6 ft. The sample results from site CPP-32E are assumed to be representative of the contaminant concentrations at site CPP-32W.

During field screening, the highest beta/gamma radiation reading, 900 cpm above background, was detected between 1.4 and 2.9 ft below the membrane about 2.5 ft below the current ground surface. This depth is roughly equivalent to the ground surface at the time of the release. At the bottom of the borehole, the beta-gamma radiation had decreased to 250 cpm above background. Based on the field radiation measurements, one soil sample was collected at a depth of 1.4 to 2.3 ft, and two soil samples were collected at a depth of 2.2 to 2.9 ft below the membrane. The samples were analyzed for VOCs, two metals (mercury and cadmium), gamma-emitting radionuclides, gross alpha and gross beta radiation, and Sr-90.

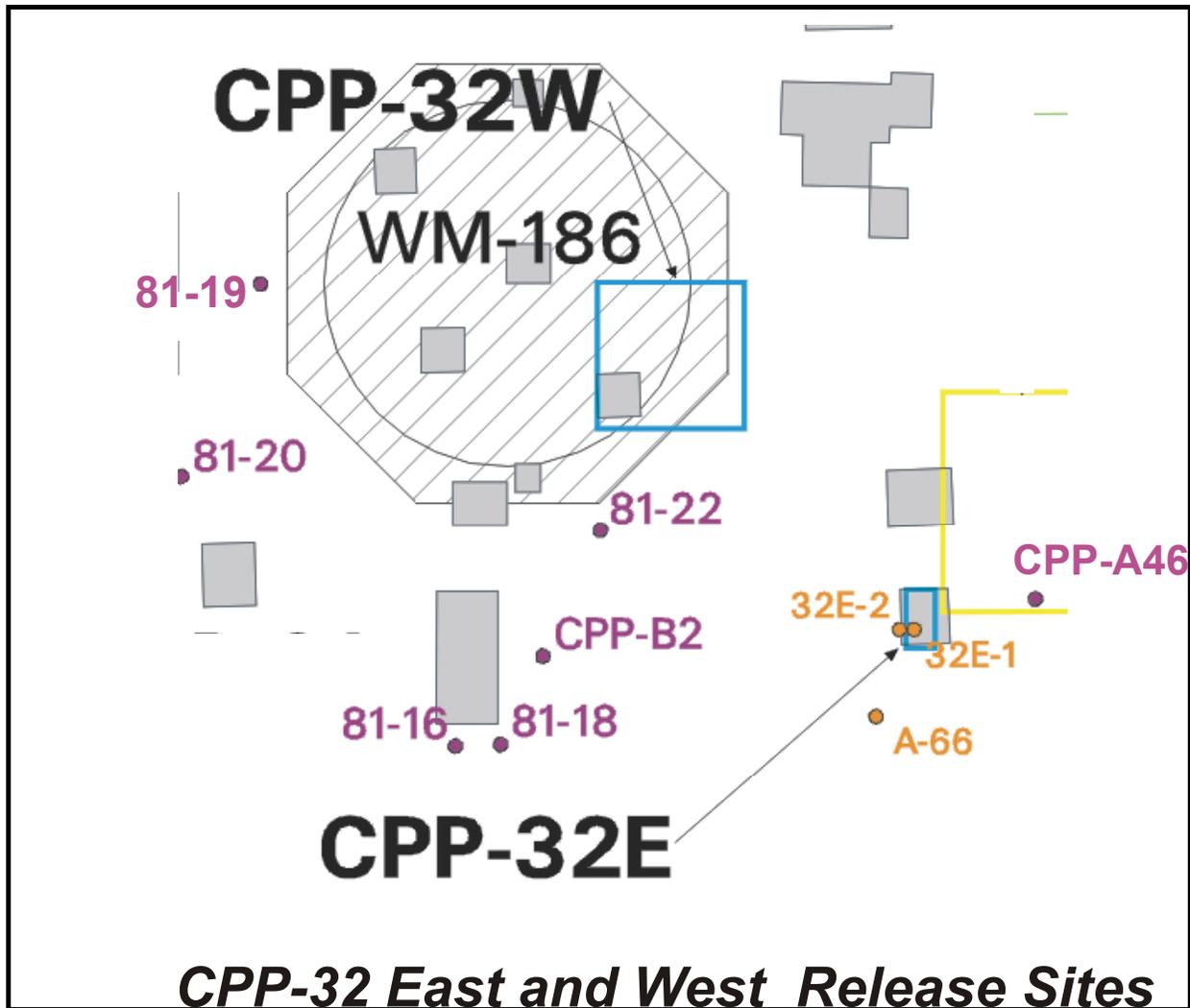


Figure 3-30. CPP-32 east and west release sites.

The gross alpha concentrations from the three samples ranged from 14.8 to 21.5 pCi/g and were within normal background concentrations. Therefore, no isotopic analysis of the alpha-emitting radionuclides was performed. The gross beta concentrations from the three samples ranged from 350 to 724 pCi/g, with the subsequent isotopic analysis of Sr-90 ranging from 153 to 278 pCi/g. Of the anthropogenic gamma-emitting radionuclides, only Cs-137 at concentrations ranging from 133 to 277 pCi/g and Eu-154 at concentrations ranging from 0.456 to 0.811 pCi/g were detected.

An estimate of Cs-137/Sr-90 activity remaining was made for each of the release sites using the area of contamination and depth. The contaminated area and depth for CPP-32W was 6 ft<sup>2</sup> and 5 ft, respectively, resulting in a contaminated volume of 30 ft<sup>3</sup>. Performing the mass conversion for soil and multiplying it by the average Cs-137 activity level (187 pCi/g) from the samples collected at two boreholes installed at CPP-32E results in a total Cs-137 activity of  $3.2 \times 10^{-4}$  Ci. The contaminated area and depth for CPP-32E was 14 ft<sup>2</sup> and 5 ft, respectively, resulting in a contaminated volume of 70 ft<sup>3</sup>. Performing the mass conversion for soil and multiplying it by the average Cs-137 activity level from the CPP-32E borehole results in a total Cs-137 activity of  $7.4 \times 10^{-4}$  Ci.



Soil samples indicate the contamination did not penetrate the soil beneath the valve box to depths greater than 3 ft. Therefore, the depth of contamination extends from 5.7 to 8.7 ft. The amount of soil contaminated during the spill is estimated at 1604 ft<sup>3</sup> containing 1.2 Ci of Cs-137 from the 3,500 gal released (WINCO 1991). From historical information, estimated contaminants are Cs-137, Sr-90, uranium and plutonium isotopes, and some inorganic constituents (WINCO 1991).

Process knowledge was used to estimate the upper limit of the Cs-137/Sr-90 curie content remaining at the site. The Cs-137/Sr-90 curie content of the liquid lost through the valve box was 0.3 mCi/gal, based on analytical data for the diverted service waste. Multiplying the curie content per gallon by the total gallons released results in a total Cs-137/Sr-90 activity of 1.1 Ci.

### **3.1.9 Site CPP-20**

Site CPP-20 is a location north of building CPP-604 (Figure 3-1) to which acidic (i.e., pH <2) radioactive liquid waste from INEEL facilities was transported and unloaded via transfer hoses to an underground storage tank. The unloading area was used for this purpose until 1978. The waste was destined for treatment in the PEW evaporator. Small spills would occasionally occur through holes in the pressurized transfer line as waste was being unloaded, resulting in soil contamination. It has been reported that the spills were cleaned up as they occurred, but no records exist documenting the types, quantities, and locations of the spills or verifying the effectiveness of cleanup activities.

The entire CPP-20 area was excavated down to the top of the CPP-604 tank vault (approximately 30 ft below the building access door) and to 40 ft off the north edge of the vault in 1982 as part of Phase I of the Fuel Processing Facility Upgrade Project (Figures 3-32 and 3-33). Personnel involved in the project indicated that the bottom 10 ft of the excavation was backfilled with contaminated soil that had contact radiation levels of 5 mR/hr or less. The source of the contaminated soil is unknown, but the source is likely within the tank farm. The remaining 30 ft of the excavation was reportedly backfilled with clean (i.e., not radiologically contaminated) soil. Portions of the area were excavated a second time as part of the Fuel Processing Facility Upgrade Project in the 1983–1984 timeframe. Reportedly, the eastern portion of CPP-20 was excavated to a depth of 40 ft. At the location of valve box C-30, contaminated soil was encountered and removed. The bottom 10 ft of the excavation was reportedly backfilled with contaminated soil that had contact radiation levels of 3 mR/hr or less, and the remainder of the excavation was backfilled with clean soil from the Central Facilities Area.

Site CPP-20 was originally included in OU 3-07, which underwent a Track 2 investigation in 1992 (WINCO 1993a). On the basis of the information indicating contaminated soil had been removed from the site during the Fuel Processing Facility Upgrade Project, the site was recommended for no further action, contingent on an evaluation of the contaminated backfill as part of the OU 3-13 BRA (DOE-ID 1997a). As part of the OU 3-13 BRA, the site was evaluated using analytical results obtained from the Fuel Processing Facility Upgrade Project.

No sampling and analysis of the contaminated backfill, reportedly present between 30 and 40 ft below grade, have been performed. The sampling and analysis of other excavated tank farm soil as part of the Fuel Processing Facility Upgrade Project were used in the OU 3-13 BRA evaluation. The maximum detected concentration of arsenic, 5.9 mg/kg, is just above the background level (5.8 mg/kg) found in INEEL surface soil. The radionuclides detected at the highest activities, Sr-90 and Cs-137, were analyzed at  $330 \pm 3$  and  $114 \pm 1$  pCi/g, respectively. Other detected radionuclides had maximum activities no greater than 2.2 pCi/g (WINCO 1993a).



Figure 3-32. Excavation in 1982 north of building CPP-604 showing the soil that was removed.



Figure 3-33. Closeup view of 1982 excavation north of building CPP-604 showing the soil that was removed.

### 3.1.10 Site CPP-25

Site CPP-25 is located in the same general area as CPP-20 and overlaps the CPP-20 site on the eastern edge (Figure 3-1). CPP-25 is the location of a ruptured transfer line that was being used to transfer liquid waste from tank WC-119 to the PEW evaporator feed tank (WL-102). The rupture resulted in a release of an unknown quantity of liquid waste adjacent to the north side of building CPP-604 in August 1960. At the time of the incident, radiation readings in the contaminated soil reportedly ranged from 2 to 4 R/hr. Approximately 9 yd<sup>3</sup> of soil was removed after the spill, and the side of the building was washed to remove contamination. No records exist to verify the effectiveness of these cleanup activities.

As described for CPP-20, the area where CPP-25 is located was excavated during the 1981 and 1983 to 1984 Fuel Processing Facility Upgrade Project. The excavations were reportedly filled with clean fill in the upper 30 ft and with soil that had radiation levels of 3 to 5 mR from 30 to 40 ft. Site CPP-25 underwent a Track 2 investigation in 1992 (WINCO 1993a). On the basis of the information indicating contaminated soil had been removed from the site during the Fuel Processing Facility Upgrade Project, the site was recommended for no further action, contingent on an evaluation of the contaminated backfill as part of the OU 3-13 RI/FS.

### **3.1.11 Site CPP-58**

Site CPP-58 was previously partitioned into two separate units (CPP-58E and CPP-58W) for evaluation, because it was composed of two separate areas of soil contaminated by leaks of PEW evaporator condensate (Figure 3-1). Site CPP-58W is now located beneath building CPP-649. The presence of the building precluded the collection of soil samples at site CPP-58W. Samples from site CPP-58E were used for assessing the nature of contamination at site CPP-58W for the OU 3-13 BRA (DOE-ID 1997a).

During the 2001 Group 1 TFIA field activities, however, two new areas of contamination were discovered along Olive Avenue. First, a moist brown material (nitric acid contamination) was uncovered while excavating a trench for the TFIA drainage system along Olive Avenue. Second, elevated levels of radiological contamination were discovered in soil while excavating the TFIA drainage system lift station near the intersection of Olive Avenue and Beech Street.

The text that follows is broken into discussions on CPP-58E, CPP-58W, and CPP-58 new site information to document all that is known about CPP-58.

**3.1.11.1 Unit CPP-58E Leak Description and Extent of Contamination.** Unit CPP-58E has contamination resulting from a 1976 subsurface release of PEW evaporator condensate. The PEW evaporator was used to concentrate all dilute low- and intermediate-level radioactive liquid waste. The concentrated “bottoms” solution from the PEW evaporator were sent to the tank farm as incidental liquid waste, and the “overhead” condensates were sent to the service waste system. An estimated 20,000 gal of condensate was released due to a failure of a transfer line between the PEW evaporator and the service waste diversion system in building CPP-751. The release occurred at a point in the transfer pipe where it makes a 90° turn and the diameter of the line narrows from 3 to 2 in. The line is buried 6 ft bgs. An estimated 51 mCi of H-3, 2 mCi of Sr-90, 4 mCi of Ru-106, 2 mCi of Cs-137, and 1 mCi of Ce-144 were released. Though the damaged line was repaired, the contaminated soil was reportedly left in place and covered with clean soil.

As part of the 1992 Track 2 investigation for OU 3-11 (WINCO 1993e), two boreholes were made at the CPP-58E site (see Figure 3-34). The locations of the boreholes were selected so that underground utilities would not be damaged. One borehole was drilled to a depth of 12 ft bgs and was located approximately 30 ft southwest of the release. The other borehole was drilled to a total depth of 46 ft bgs and was located within 12 ft of the release site. Plans called for samples to be collected from intervals exhibiting the highest gamma/beta radiation fields as measured with field instruments. However, no radiation above background was detected in either borehole; therefore, samples that were representative of the entire drilled intervals were collected. Thirteen samples were collected from the two boreholes and analyzed for VOCs, selected metals (mercury and cadmium), fluoride, nitrate, nitrite, pH, and radionuclides.

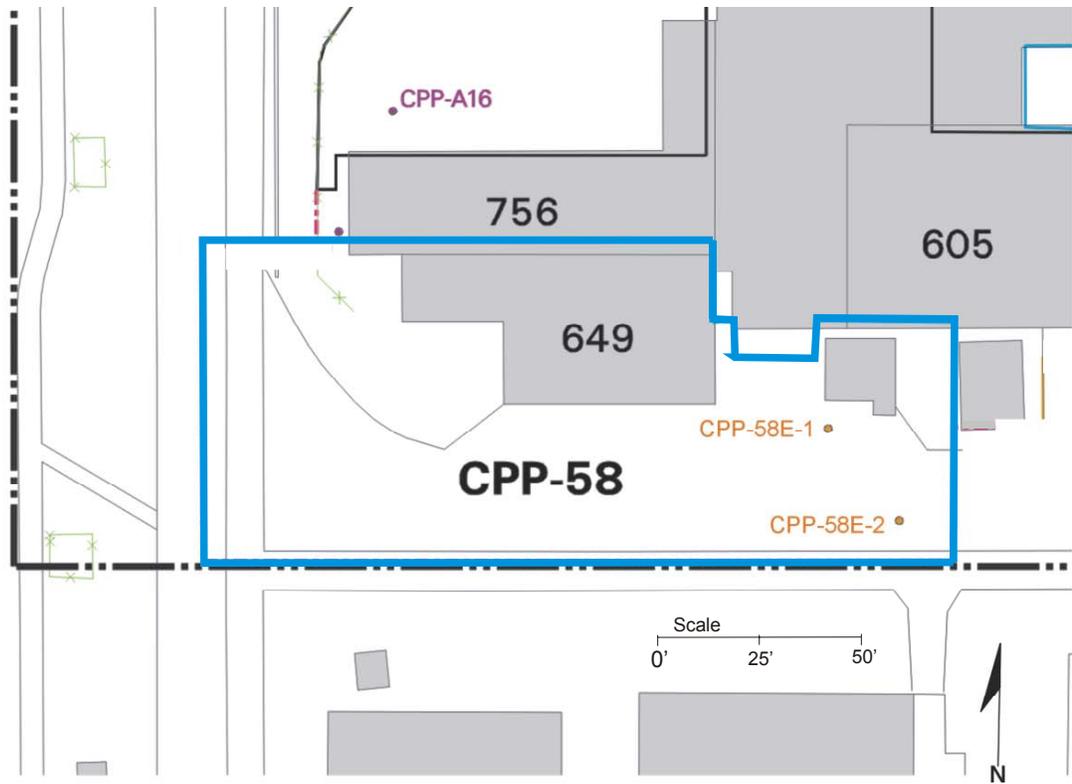


Figure 3-34. Site CPP-58 soil boring location map.

Sampling and analysis showed gross alpha activity ranged from  $3.92 \pm 0.67$  to  $24.4 \pm 3.28$  pCi/g. Only the sample collected from 8 to 10 ft in borehole CPP-58E-1 exceeded the background activity of 20 pCi/g. Subsequent isotopic analyses for alpha-emitting radionuclides on this sample detected U-234 and -238 below background concentrations and Pu-238, U-235, Pu-239, and Am-241 above background concentrations.

Sampling and analysis showed Cs-137 and Sr-90 as present above background levels. The gross beta activity ranged from  $31.3 \pm 2.78$  to  $271 \pm 22.1$  pCi/g, with all samples exceeding background activity of 30 pCi/g. Subsequent isotopic analysis for Sr-90 detected concentrations ranging from  $0.877 \pm 0.276$  to  $33.4 \pm 3.17$  pCi/g. In general, lower concentrations of Sr-90 were measured in borehole CPP-58E-2 than in CPP-58E-1. This is consistent with borehole CPP-58E-1 being closer to the location of the release. The results of the gamma analysis detected only Cs-137 and K-40. The concentrations of K-40 are within normal background ranges. Cs-137 activities ranged from  $0.269 \pm 0.0211$  to  $63.1 \pm 4.57$  pCi/g, with the higher concentrations detected at a depth of less than 22 ft in borehole CPP-58E-1 and at depths less than 10 ft in borehole CPP-58E-2.

Below 6 ft bgs, the primary contaminants detected were Cs-137 and Sr-90. This is consistent with the waste stream that was reportedly released. Cs-137 concentrations are generally higher than Sr-90 concentrations above 22 ft in borehole CPP-58E-1 and above 12 ft in borehole CPP-58E-2. Below these depths, Sr-90 concentrations are higher than Cs-137 concentrations. This relationship is believed to be the result of the greater mobility of Sr-90 relative to Cs-137, given that these two radionuclides were likely in roughly equal concentrations in the released condensate. The contaminated zone for this site is estimated as being present from 6 to 46 ft bgs. The volume of contaminated soil is estimated as  $272,000 \text{ ft}^3$ .

**3.1.11.2 Unit CPP-58W Leak Description and Extent of Contamination.** Unit CPP-58W consists of soil (now under building CPP-649) affected by a release of PEW evaporator condensate in 1954. The PEW evaporator was used to concentrate all dilute low- and intermediate-level radioactive liquid waste. The concentrated bottoms solution from the PEW evaporator was sent to the tank farm as incidental liquid waste, and the overhead condensate was sent to the service waste system. The condensate leaked from a transfer line buried 6 to 8 ft bgs between buildings CPP-604 and CPP-601. No information is available on how often the transfer line was used, how long the pipe leaked, the quantity of condensate released, or the length, width, or depth of contamination.

Since the time of the release, building CPP-649 was constructed on top of the area where the spill occurred. If the contaminated soil was not removed during excavation for the building footers, this soil is believed to still lie underneath the building.

**3.1.11.3 CPP-58 New Site Information.** In April 2001, during Group 1 TFIA field activities, a moist brown material (nitric acid contamination) was uncovered while excavating a trench for the TFIA drainage system along Olive Avenue, and elevated levels of radiological contamination were discovered in soil while excavating a TFIA drainage system lift station near the intersection of Olive Avenue and Beech Street (DOE-ID 2002c).

The area where the moist brown material was discovered is within the area previously identified as CPP-58E and, after evaluation, is believed to be part of that site. The material was slowly seeping into the north wall of the trench as it was being excavated. The top of the seepage/stained area was approximately 6 ft bgs on the north trench wall and extended to the bottom of the trench at that time, a depth of approximately 7 ft.

Preliminary sampling and characterization identified the material as being nitric acid, which exhibited a low pH (2.41) and the presence of nitrates (3.67 mg/mL). Other contaminants included 0.639 mg/kg of mercury and 6.98 pCi/g of Cs-137. The contaminants are consistent with that which could have been released from the PEW overheads, as discussed with CPP-58E.

An attempt was made to trace this “seep” back to a source by excavating the areas having moist soil. However, the moist soils were removed without leading to any source of contamination. The extent of the area excavated is bounded by the utility tunnels on the south and east, by the building/utilities on the north, and the long trench excavation on the west (part of the TFIA) (drawing entitled “New Site Identification – Operable Unit (OU) 3-14, Chemical Processing Plant 58 (CPP-58) – Nitric Acid Contamination in Proximity to Group 1 Interim Action (IA) Trench near CPP-604”). In review of the excavation and drawing, the source of the contamination was not evident, since no active nitric acid lines or known abandoned lines were in the immediate area. In addition, an assessment identified no other release from the active systems in the area that might contribute to this release of nitric acid. To provide an indication of contamination remaining in the excavation after completion of the attempt to trace the “seep,” composite samples of the dry soils were taken and tested for pH. The results ranged from pH of 1.9 to 8.7. No evidence of any further seepage was observed in the excavated area.

While excavating the lift station near the intersection of Olive Avenue and Beech Street, radiological contamination activities were typically between 200 and 300 cpm with a high of 500 cpm. The area of this excavation is to the south and west of CPP-58W. The highest project-measured level of contamination was 5,000 decays per minute, based on the 10% efficiency of the field meters. Because it is unknown whether the contamination at CPP-58W was removed during the construction of CPP-649 and because of the discovered moist soil (discussed above), the boundary of CPP-58 has been revised to include the area of CPP-58E, CPP-58W, and the area in the proximity of the lift station. Additional

investigation of the extent of contamination in this larger area called CPP-58 is recommended in the OU 3-14 RI/FS.

**3.1.11.4 Amount of Cs-137/Sr-90 Activity Remaining.** The entire footprint of CPP-58 was used to estimate the amount of Cs-137/Sr-90 remaining at the release site and totaled 13,000 ft<sup>2</sup>. Because of the large volume of water released at the site, the entire alluvium thickness was assumed to be contaminated with low levels of radionuclides. The total volume used in the calculation was 520,000 ft<sup>3</sup>. Mean Cs-137 and Sr-90 activity levels of 18.3 and 25.0 pCi/g, respectively, were used for the entire volume of soil based on analytical results for samples collected in boreholes CPP-58E-1 and CPP-58E-2. The calculation resulted in a total Cs-137/Sr-90 activity of 1.3 Ci.

### **3.1.12 Site CPP-24**

Site CPP-24 is a contaminated soil site in the tank farm area resulting from the accidental dumping of a bucket in 1954. Approximately 1 gal of liquid radioactive waste with radiation levels of 400 mR/hr was spilled while work was being conducted in the vicinity of a tank riser at WM-180 (Figure 3-1) (WINCO 1993a). The spill covered a 3- × 6-ft area. The liquid would have contained mercuric nitrate, nitric acid, and radionuclides. The contamination from the spill was reportedly cleaned up (logbooks indicate that the spilled material was removed) and documented in a radioactivity incident report. Though the exact location of this spill is unknown, radiation surveys in the area revealed no radiation levels above background (WINCO 1993a; DOE-ID 1994).

This site was recommended in a Track 2 investigation as a no further action site, because the source was documented as having been removed, and any residual contamination would be addressed during the OU 3-13 RI/FS (WINCO 1993a). Site CPP-24 is being reinvestigated, because consolidation of all tank farm soil and sites within CPP-96 subjects CPP-24 to OU 3-14 RI/FS activities.

### **3.1.13 Site CPP-30**

Site CPP-30 is an area of radioactively contaminated soil near valve box B-9 and was discovered by maintenance personnel in 1975 (Figure 3-1). The contamination covered 400 ft<sup>2</sup> and produced radiation levels up to 1 R/hr. The area was contaminated during a one-time preventative maintenance activity in which residual decontamination solution from the floor of the valve box contaminated personnel clothing and equipment, which were brought to the surface and inadvertently placed on blotter paper that covered the ground surface.

The contamination spread to the soil either through handling or tears in the blotter paper. The contaminated soil was removed, placed in 55-gal drums, and disposed of at the Radioactive Waste Management Complex (WINCO 1993a; DOE-ID 1994). Subsequent surface radiation surveys in the area performed in 1991, 1992, and 2001 have shown no radiation levels above background.

This site was recommended in a Track 2 investigation as a no further action site, because the entire area has been excavated in the past and the contaminated soil was removed (WINCO 1993a). Site CPP-30 is being reinvestigated because consolidation of all tank farm soil and sites within CPP-96 subjects CPP-30 to OU 3-14 RI/FS activities.

### 3.1.14 Site CPP-96

As discussed in Section 1, site CPP-96 incorporates tank farm soil sites as defined in the OU 3-13 ROD: CPP-15, -20, -25, -26, -27, -28, -31, -32, -33, -58, -79, and -96, as well as CPP-16, -24, and -30, which were screened out for further action in the OU 3-13 RI/FS. In the OU 3-13 ROD, all tank farm soils and CERCLA sites were consolidated into CPP-96.

Data on known tank farm releases that are incorporated into site CPP-96 are presented in the previous subsections for each site. The backfill soil used throughout the tank farm area during maintenance and construction activities has not been characterized for contaminants. Backfill soil used in the bottom 10 ft of deeper excavations typically had contact radiation levels of 3 to 5 mR/hr. However, unpublished reports indicated that during the 1992 to 1994 High Level Waste Tank Farm Replacement Upgrade Project, soils were segregated by their activity. Low-level contaminated soils were encountered early in the excavations and were sent to a low-level contamination stockpile (radiation readings greater than 100 counts above background but less than 3 mR/hr). As the excavation progressed, soils with higher radiation readings were unearthed, and this soil was either boxed or transported to the 3 to 50 mR/hr stockpile, depending on activity. Contaminated soil with radiation levels above 50 mR/hr was boxed. Once the tank farm upgrades were complete, the backfilling process was started, and it was decided that all of the boxed contaminated soil would be placed back in the lower portions of the excavation as backfill. The rationale for backfilling was to place the highest contaminated soil in the excavation first so that subsequent layers of lower level soils could cover it and provide shielding.

A screening-level uncalibrated surface gamma survey was conducted over the main portion of the tank farm in August 2001. Results of this survey are shown in Figure 3-35. Gamma radiation ranged from <5,000 to 20,000 counts per second. Results of this survey were inconclusive due to the fact that the instrument was not calibrated. However, the survey did indicate that most of the readings were at or near what are assumed to be background levels. Small areas were found to have elevated gamma counts, but no quantification of these locations could be performed. Taking the highest readings for those areas and converting them resulted in approximate radiation levels between 2 and 3 mR/hr, making general assumptions for the instrument efficiency and detector area.

Based on radiation attenuation models, a properly conducted gamma survey using a calibrated instrument would be able to detect gamma radiation from a 5 to 10 R/hr hot spot contained in the top 3 ft of soil. A hot spot having radiation levels in the tens of R/hr may be detectable if it was contained in the upper 5 ft of soil. Any deeper contamination of significant activity would not be detected due to shielding of the overlying soils. The use of future tank farm surface gamma surveys may include post-ROD surveys to determine worker exposure values.

Figure 3-36 shows site boundaries and well, soil-probe, characterization-borehole, and cathodic-protection borehole locations from previous investigations and tank farm upgrades. The number of penetrations into the tank farm area is large and reasonably distributed across the CPP-96 boundary. If any additional major waste releases occurred at the tank farm, it is likely that the penetrations would have encountered the contamination. The probes and boreholes help to screen areas in the tank farm for previously undiscovered release sites.

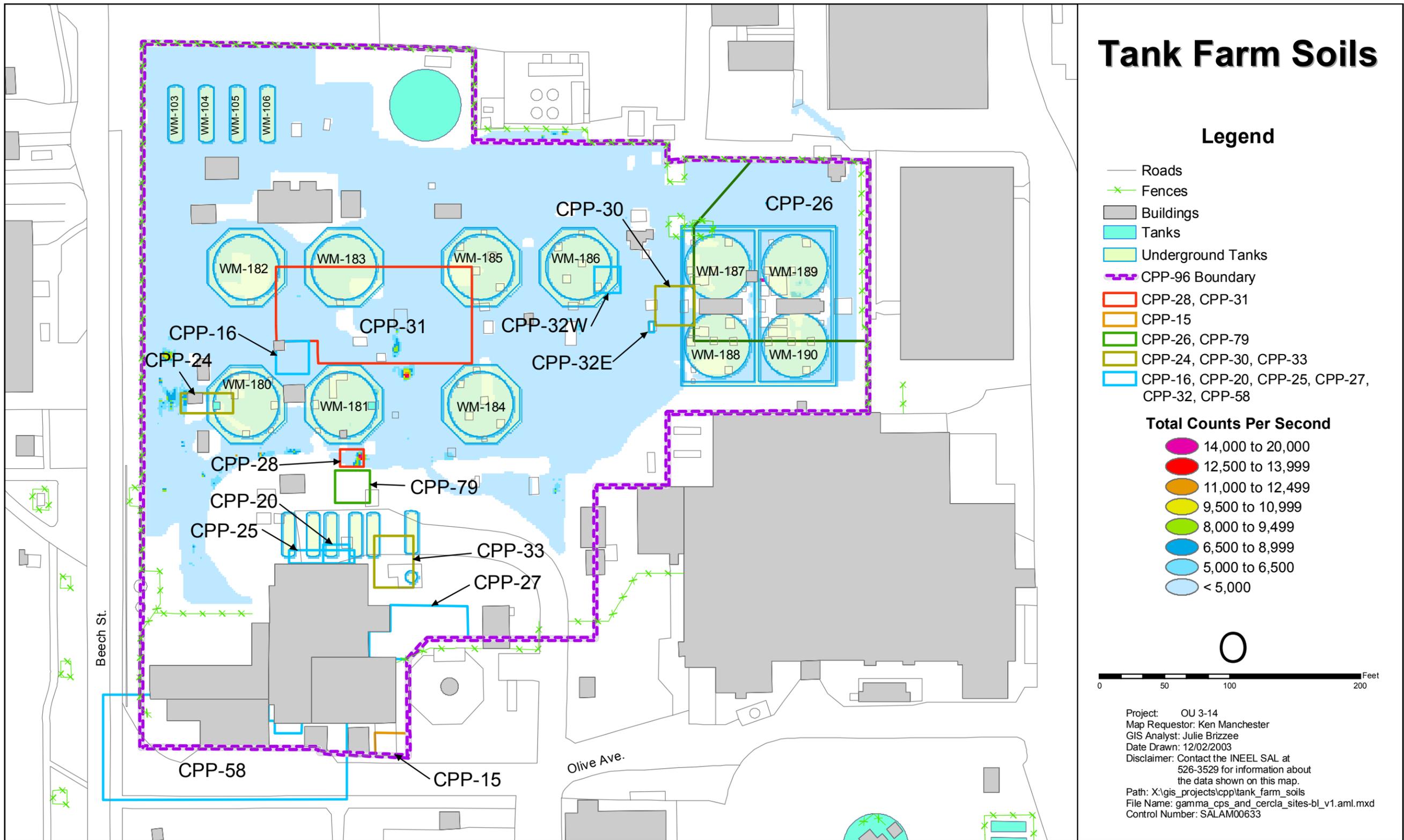


Figure 3-35. Tank farm map showing gamma survey results and well, probe, borehole, and cathodic-protection anode drilling locations.

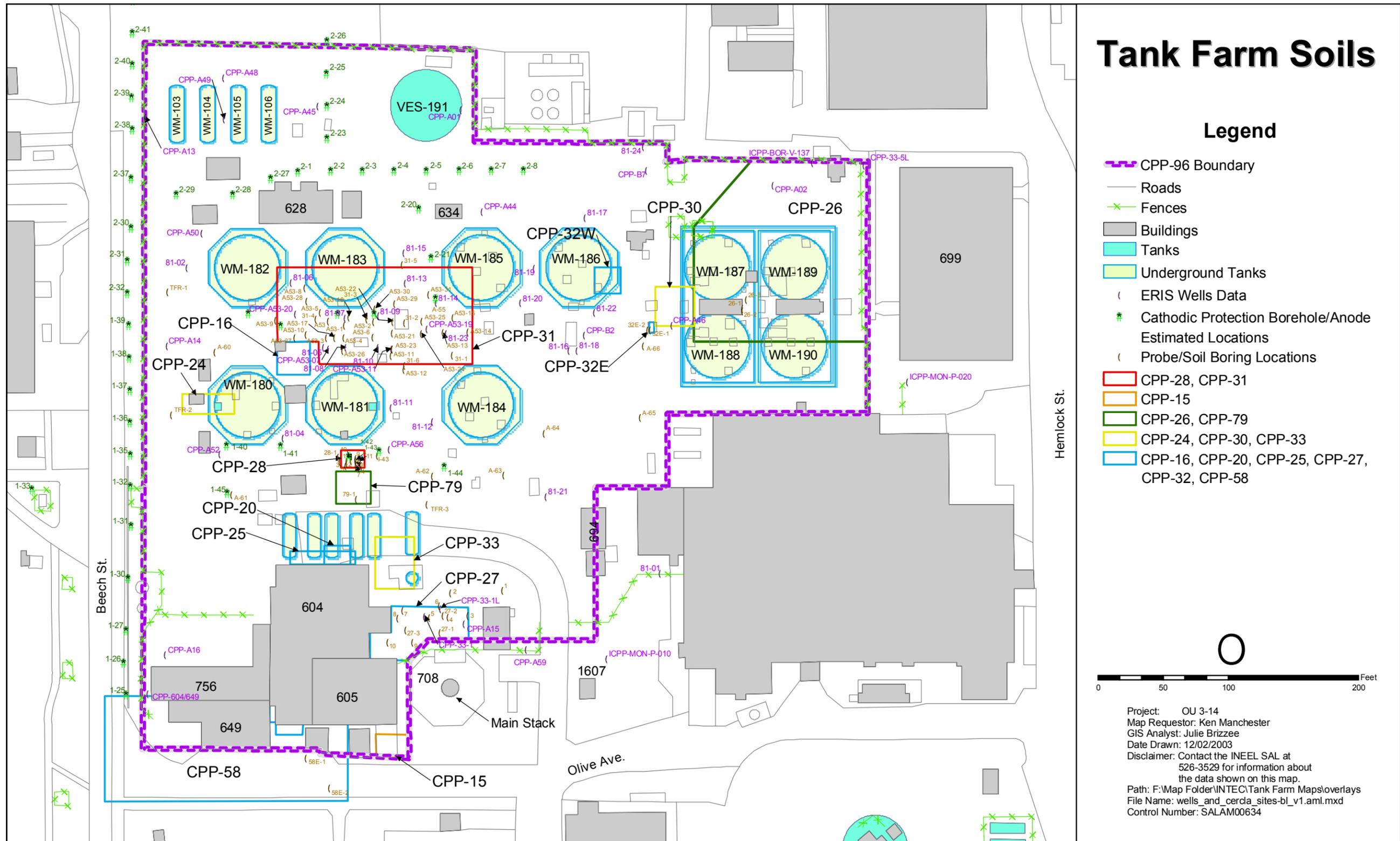


Figure 3-36. Tank farm map showing wells, cathodic-protection boreholes/anode estimated locations, and probe/soil-boring locations.

### **3.1.15 Suspect Piping**

Due to the high numbers of piping runs and different designs used to transfer waste within the tank farm facility, piping integrity becomes an important consideration in the RI/FS process. Some piping/encasement designs proved to be very reliable over the years of operation; others did not. Generally, the stainless-steel pipe-in-a-pipe design has been trouble-free, with both the inner and outer material being compatible with the acidic wastes. The stainless-steel-lined concrete-trough system has also experienced few problems. The split-tile- and split-steel-encased lines, on the other hand, had containment problems due to incompatibility with the acidic waste and/or structural stability. Additionally, carbon-steel lines installed in the tank farm had the potential to come into contact with waste via valves that were improperly set, which could cause corrosion.

Based on the release mechanisms of the known release sites, it can be concluded that the releases were a result of using carbon-steel piping at inappropriate locations, containment failure of split-tile or split-steel encasements, or valve leaks associated with the split-tile or split-steel encasements. The use of split-tile encasement was limited to waste-transfer lines associated with the construction of tanks WM-180 and -181. Therefore, the area between the CPP-604 tank vault and WM-180 and -181 was generally the only area within the tank farm to use the split-tile encasement. Because this area has been excavated extensively during tank farm improvement projects, any significant releases associated with the piping would have most likely been discovered. Tanks WM-180 and -181 both have short sections of split-tile-encased lines on the north side of the tanks. These lines were originally stubbed out of the tank and capped for future use. Two lines, one on each tank, were subsequently connected to the waste transfer system and used to handle waste (Figure 2-11). Because a short section of split-tile encasement was actively used, the piping was listed as suspect. However, no known leaks or unusual occurrences are associated with the use of these two lines, and a release is unlikely.

The split-steel encasement also had limited use in the same area between the CPP-604 tank vault and WM-180 and -181. Approximately 160 ft of the piping/encasement was used and has since been abandoned or removed. The excavation activity in the area where the piping was used would have uncovered any leaks in addition to the one discovered at CPP-28.

The largest contaminant release within the tank farm has been the release at CPP-31, where a carbon-steel drain line came into contact with acidic waste solution. The intended use of the line was a drain line for cooling water in the event cooling water became contaminated. An incorrectly positioned valve allowed waste solution to back into the carbon-steel drain line, causing corrosion and failure of the line. Because of this piping configuration, tank farm personnel checked all of the piping flow sheets in 1975 for the entire tank farm to determine whether other previously unsuspected leak mechanisms exist. Particular attention was paid to interfaces with encased waste-transfer lines. One connection of a carbon-steel line to a transfer line from WM-181 to the dilute waste evaporator feed tank was discovered. This line was disconnected, and a blind was installed on the stainless-steel line (Allied Chemical 1975).

In summary, waste transfer piping having the inferior encasement designs serviced only small portions of the tank farm. Only a few carbon-steel lines that could have come into contact with liquid wastes exist, but these are in areas that have already been excavated, or the lines have had strict administrative controls.

### **3.1.16 Summary of Operable Unit 3-14 Site Contamination**

Based on past field investigations and process knowledge, a Cs-137/Sr-90 Ci inventory was determined for each release site, as discussed in previous subsections. The curie inventory is summarized

in Table 3-6. The inventory is based on Cs-137 and Sr-90 activities only using the time of release or soil sample dates, depending on how the inventory was determined. Other radionuclides were not considered in the inventory because of their short half-lives or low-activity levels. Ce-144, for example, contributes to the early overall activity of waste. Because of its relatively short half-life of 284.6 days, however, it decays relatively quickly and is not a concern after a few years. In determining the curie content for some of the waste streams, only the Cs-137 activity was measured. In those cases, the Sr-90 activity was assumed to be the same as the Cs-137 activity.

The Cs-137/Sr-90 activity inventory for each release site was estimated either by using process knowledge or past field characterization data. Process knowledge was used for releases where the volume of a defined waste stream was known. A Cs-137/Sr-90 waste stream activity was determined by looking up waste analytical results for the time of release in appendix data tables that are presented in the 2003 calcined waste inventory report (Staiger 2003). By knowing the volume released and associated activity, a loss inventory could be calculated.

In the case where the volume of a release was unknown, field characterization data were used. A volume of contaminated soil was estimated by using the reported footprint of the release site multiplied by the thickness of the contaminated soil body. Laboratory analytical results for soil samples collected at each particular site were used to calculate an arithmetic mean value of the Cs-137 and Sr-90 activities. The mean values were then used with the volume to develop a Cs-137/Sr-90 inventory for the respective release site.

The updated release site curie inventory presented in Table 3-6 was used to help rank individual release sites in terms of significance. Using the lower limit value for CPP-79-Deep in the total remaining value for Cs-137/Sr-90 activity resulted in 28,373 Ci. Four sites—CPP-15, -28, -31, and -79-Deep—contribute 99.8% of the total. CPP-31 is the by far the biggest contributor, with 23,800 Ci, or 83.9%, of the total. CPP-79-Deep is estimated to be the second-largest contributor, with 3,804 Ci, or 13.4%, of the total. CPP-28 and -15 each contributed 1.3% to the total, with 360 Ci (a total of 720 Ci) of Cs-137/Sr-90 activity.

## **3.2 Tank Farm Residual Contamination**

The conceptual model presented in Subsection 4.1 assumes that the preferred tank closure alternative will be closure in place to minimize radiological exposure to on-site workers. Based on the assumption that the tank heels will be grouted in place, the residual internal contamination left in the tank heels, sand pads, and piping will be included in the overall source term combining the residual tank system contamination with the external contamination existing in the tank farm soils.

### **3.2.1 Tank Heels**

The heel is defined as the liquid and solid residue left in a tank after all possible waste has been removed using existing transfer jets. In each tank at the tank farm, the depth of the liquid heel typically varies from 3 to 10 in. The solid heel results from precipitation of solids and other material to the bottom of a vessel. At the tank farm, the solid heel typically comprises 1 to 4 in. of solids at the bottom of the tank and is likely composed of solids precipitation, lesser amounts of undissolved process solids, and traces of dirt and debris. The balance of the heel is liquid up to the level of the jet suction. During the cleaning phase of the closure, the heels will be reduced to a thickness of 1 in. or less.

Table 3-6. Estimated curies remaining at CPP-96 release sites.

Site	Method used to Estimate Amount of Cs-137/Sr-90 Activity Remaining												Curies Remaining	
	Process Knowledge					Field Characterization							Estimated Curies Remaining at Release Site	Date Estimate Applies
	Volume Released (gal)	Type of Waste	Curie Content of Liquid <sup>a</sup> (Ci/gal)	Curies (Year of Release)	Excavation of Contamination	Area of Contamination (ft <sup>2</sup> )	Thickness of Contamination (ft)	Volume of Contamination (ft <sup>3</sup> )	Lowest Cs-137 Activity in Soil (pCi/g)	Highest Cs-137 Activity in Soil (pCi/g)	Arithmetic Mean Cs-137 Activity to Calculate Curies in Soil (pCi/g)	Year Sample Collected		
CPP-15	Unknown	Radioactive spent solvent	Unknown	NA (1974)	1974 partially removed	700	20	10,850 <sup>b</sup>	44.5	586,000	293,022	1995	360 <sup>c</sup>	1995
CPP-16	3,500	Diverted service waste	0.3 mCi	1.1 (1976)	Incomplete excavation records								1.1	1976
CPP-20	Unknown amounts of small spills	Acidic radiological waste for PEW	Unknown	NA	1982, 1993, 1994 contamination removed								<1	NA
CPP-24	1.0	1 <sup>st</sup> cycle	30 (estimated)	30 (1954)	1954 contamination removed								<1	NA
CPP-25	Unknown	PEW	Unknown	NA (1960)	1960, 1993, 1994 contamination removed								<1	NA
CPP-26	15	1 <sup>st</sup> cycle	3.0 <sup>b</sup>	45 (1964)	1964 contamination partially removed								45	1964
CPP-27	Unknown	Calcliner decontamination waste	Unknown	NA	1974 contamination partially removed	2000	25	50,000	0.12	1370	214	1992	1.2 <sup>c</sup>	1992
CPP-28	120	1 <sup>st</sup> cycle	6 <sup>b</sup>	720 (1974)	Half of contamination removed								360	1974
CPP-30	Unknown	1 <sup>st</sup> cycle	Unknown	NA	1974 contamination removed								<1	NA
CPP-31	14,000	2 <sup>nd</sup> cycle, 3 <sup>rd</sup> cycle, evaporator bottoms	1.70	23,800 (1972)	No soil removal documented								23,800	1972
CPP-32 West	Unknown	Tank sump liquid	Unknown	NA (1976)	None	6	5	30	133	277	187	1992	<1	NA
CPP-32 East	Unknown	1 <sup>st</sup> cycle condensate	Unknown	NA (1976)	None	14	5	70	133	277	187	1992	<1	NA

Site	Method used to Estimate Amount of Cs-137/Sr-90 Activity Remaining												Curies Remaining	
	Process Knowledge					Field Characterization							Estimated Curies Remaining at Release Site	Date Estimate Applies
	Volume Released (gal)	Type of Waste	Curie Content of Liquid <sup>a</sup> (Ci/gal)	Curies (Year of Release)	Excavation of Contamination	Area of Contamination (ft <sup>2</sup> )	Thickness of Contamination (ft)	Volume of Contamination (ft <sup>3</sup> )	Lowest Cs-137 Activity in Soil (pCi/g)	Highest Cs-137 Activity in Soil (pCi/g)	Arithmetic Mean Cs-137 Activity to Calculate Curies in Soil (pCi/g)	Year Sample Collected		
CPP-33	Unknown	Calcliner decontamination waste	Unknown	NA (1983)	1983 contamination removed								<1	NA
CPP-58	Unknown, >20,000	PEW overhead condensate	Very low	NA		13,000	40	520,000	0.269	63.6	18.3	1992	1.28 <sup>d</sup>	1992
CPP-79- Shallow <sup>e</sup>	1,830 (WCF)	Dilute calcliner decontamination solutions	0.0038	7.0 (1986)	1994 contamination partially removed								<1	NA
	682 (NWCF)		0.000008	0.005 (1986)										
CPP-79- Deep <sup>f</sup> Lower Limit <sup>g</sup>	634	1 <sup>st</sup> cycle	6 <sup>h</sup>	3,804 (1970)	None								3,804	1970
CPP-79- Deep <sup>f</sup> Upper Limit <sup>i</sup>	2,256	1 <sup>st</sup> cycle	6 <sup>h</sup>	13,535 (1970)	None								13,535	1970
Totals												Low estimate	28,373 Ci	
												High estimate	38,104 Ci	

a. Curie content based on Cs-137 and Sr-90 activities of waste analyses performed on appropriate waste at the time of the release.  
b. Volume reflects the amount of soil (3,150 ft<sup>3</sup>) previously removed during the removal of the solvent burning system and replaced with clean or slightly contaminated soil.  
c. Curie content at time of release based on Cs-137 activity. Sr-90 was assumed to have the same activity at the time of release. Actual sample analysis for Sr-90 activities, where available, is typically less due to the more mobile nature of strontium.  
d. Curie content based on both Cs-137 (in table) and Sr-90 (25 pCi/g) arithmetic average activities.  
e. Two waste streams combined to create this release: 1,830 gal from the WCF at 0.0038 Ci/gal and 682 gal from NWCF at 0.000008 Ci/gal.  
f. CPP-79-Deep only has one sample point at 32 to 33.3 ft bgs. Therefore, a high and low estimate are provided to help bound the release.  
g. Lower limit: assumes the waste formed a half oblate-dome configuration (30-ft diameter by 6-ft height) due to the existence of the CPP-604 tank vault and does not exist all the way to bedrock, resulting in a volume of 1,414 ft<sup>3</sup>. Using a 6% soil moisture equivalent results in a volume of 634 gal.  
h. Curie content of first-cycle waste based on average Cs-137 activities measured during operation from the late 1960s and early 1970s. The activity of Cs-137 was doubled to account for Sr-90 activity.  
i. Upper limit: assumes the waste infiltrated the soil from the release point down to basalt. The shape of the contaminated zone is again a half-oblate dome, with a diameter of 40 ft and a height of 12 ft, resulting in a volume of 5,027 ft<sup>3</sup>. Using a 6% soil moisture equivalent results in a volume of 2,256 gal.  
NA- Not applicable.

 --- Information unknown or not applicable.  
 --- Information known but not used in determining estimated curies remaining.

Based on the performance assessment for the tank farm (DOE-ID 2003c), this subsection provides the estimate of the radionuclide inventory that will remain in the tank farm system after closure. This estimate is based on the most recent analytical results from sampling of tanks WM-182, -183, and -188 and from historical data regarding the contents of the eleven 300,000-gal tanks (DOE-ID 2001a). The radionuclide inventory for the tank farm system includes residual contamination remaining in ten 300,000-gal tanks (WM-190 was never used), two sand pads, piping, and the four 30,000-gal tanks. The concentrations for radionuclides lacking current analytical data have been estimated using the ORIGEN2 model (Croff 1980). The model used SBW as the nuclear fuel waste stream and radionuclide concentrations based on closure in 2016. The inventory was designed to be conservative based on data of liquid and solid tank contents and recent sampling data. The conservative approach was maintained by using the highest radionuclide concentrations in the radionuclide inventory calculations, rather than averaging the recently sampled tanks (DOE-ID 2002b).

Radionuclide concentrations in WM-188 were the highest of the three tanks and were used to calculate the bounding tank system radioactivity levels (Patterson 1999; Portage Environmental 2002; Tyson 2002). Cs-137 was used as an indicator for residual radionuclide concentrations in the tanks during preparation of this source term. Historically, Cs-137 has been used in conjunction with ORIGEN2 modeling software to characterize waste for treatment in the NWCF. Cs-137 was used as the indicator radionuclide, because it is detected accurately and easily using gamma spectroscopy. Data for solids and liquids are accurately produced using this method. Cs-137 has been monitored consistently during fuel reprocessing operations, and its gamma energy (0.662 Mev) is high enough to provide good detection.

The radionuclide inventory for closure of the 300,000-gal tanks is based on the slurry heel volumes for solids and liquid stated in Tyson (2002). The following assumptions were used in the development of the bounding source inventory (Staiger and Millet 2000):

- A waste consisting of the highest measured concentration of the radionuclides found in any of the solutions or solids currently stored in WM-182, -183, and -188 represents the concentration of residual species in the worst-case inventory.
- Estimates of non-measured residuals are based on the highest calculated amounts conforming to those estimated by D. R. Wenzel,<sup>c</sup> normalized to the highest Cs-137 concentration.
- The tank internals are flushed with water to clean material from all internal surfaces.
- The acid concentration in the liquid heel after flushing is > pH 2.
- Residuals associated with the solids heel are neither dissolved nor diluted.
- Closure operations are successful in removing the liquid heel to a final volume of 1,318 gal of waste.
- The solids heel is thoroughly mixed, leaving the interstitial liquid with a chemistry equivalent to the liquid heel.
- The makeup of the solids heel is 27% solid-interstitial liquid and 73% free liquid.
- The solids heel is removed from the tank down to a level of 1 in.

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c. Letter from D. R. Wenzel, INEEL, to N. E. Russel, INEEL, "Calculation of Radionuclide Inventories for Sodium-Bearing Wastes," WEN-23-97, November 26, 1997.

Based on ORIGEN2 and analytical sampling results, the bounding single tank source inventory in 2016 will be 24,102 Ci. Activity in the solids portion accounts for 92% (22,133 Ci) of the total curies. Only a small number of the total nuclides contribute significantly to the radionuclide inventory. Pu-238 and Pu-241 are major contributors to the TRU activity; Sr-90, Y-90, Cs-137, Ba-137m, and Sm-151 are major contributors to fission product activity. Cs-137 contributes 4,000 Ci to the total, and Sr-90 contributes 8,000 Ci. The conservative tank inventory at the assumed time of facility closure (2016) is provided in Table 3-7 (major contributors to TRU and fission-product activity are shown in red).

Table 3-7. Single tank heels inventory at the assumed time of facility closure in 2016 (DOE-ID 2003b).

Nuclide	Liquid Activity (Ci)	Solid Activity (Ci)	Total Activity (Ci)	Nuclide	Liquid Activity (Ci)	Solid Activity (Ci)	Total Activity (Ci)
Ac-225	5.7E-09	3.4E-08	4.0E-08	Pb-212	3.0E-05	1.8E-04	2.1E-04
Ac-227	8.6E-07	5.2E-06	6.0E-06	Pb-214	2.0E-07	1.2E-06	1.4E-06
Ac-228	1.0E-11	6.2E-11	7.2E-11	Pd-107	2.5E-04	1.5E-03	1.7E-03
Ag-108m	6.3E-09	3.8E-08	4.4E-08	Pm-146	1.5E-04	8.9E-04	1.0E-03
Am-241	1.8E-01	4.4E-01	6.2E-01	Pm-147	8.6E-02	5.2E-01	6.0E-01
Am-242	2.2E-04	1.3E-03	1.6E-03	Po-210	8.6E-08	5.2E-07	6.0E-07
Am-242m	2.2E-04	1.3E-03	1.6E-03	Po-211	0.0E+00	0.0E+00	0.0E+00
Am-243	3.2E-04	1.9E-03	2.2E-03	Po-212	1.8E-05	1.1E-04	1.3E-04
At-217	5.7E-09	3.4E-08	4.0E-08	Po-213	5.7E-09	3.4E-08	4.0E-08
Ba-137m	5.7E+02	3.4E+03	4.0E+03	Po-214	2.0E-07	1.2E-06	1.4E-06
Be-10	4.6E-08	2.8E-07	3.2E-07	Po-215	8.6E-07	5.2E-06	6.0E-06
Bi-210	8.6E-08	5.2E-07	6.0E-07	Po-216	3.0E-05	1.8E-04	2.1E-04
Bi-210m	3.3E-21	2.0E-20	2.3E-20	Po-218	2.0E-07	1.2E-06	1.4E-06
Bi-211	8.6E-07	5.2E-06	6.0E-06	Pr-144	9.1E-08	5.5E-07	6.4E-07
Bi-212	2.9E-05	1.7E-04	2.0E-04	Pr-144m	1.1E-09	6.5E-09	7.6E-09
Bi-213	5.7E-09	3.4E-08	4.0E-08	Pu-236	1.7E-06	1.0E-05	1.2E-05
Bi-214	2.0E-07	1.2E-06	1.4E-06	Pu-238	2.8E+00	1.4E+01	1.7E+01
C-14	4.9E-01	1.1E-05	4.9E-01	Pu-239	3.5E-01	9.0E-01	1.2E+00
Cd-113m	2.7E-02	1.7E-01	1.9E-01	Pu-240	1.6E-01	9.6E-01	1.1E+00
Ce-142	4.6E-07	2.8E-06	3.2E-06	Pu-241	2.1E+00	1.3E+01	1.5E+01
Ce-144	9.1E-08	5.5E-07	6.4E-07	Pu-242	1.2E-04	7.2E-04	8.4E-04
Cf-249	2.6E-13	1.5E-12	1.8E-12	Pu-244	1.0E-11	6.2E-11	7.2E-11
Cf-250	1.1E-13	6.5E-13	7.6E-13	Ra-223	8.6E-07	5.2E-06	6.0E-06
Cf-251	4.1E-15	2.4E-14	2.8E-14	Ra-224	3.0E-05	1.8E-04	2.1E-04
Cm-242	1.8E-04	1.1E-03	1.3E-03	Ra-225	5.7E-09	3.4E-08	4.0E-08
Cm-243	3.2E-04	1.9E-03	2.2E-03	Ra-226	2.0E-07	1.2E-06	1.4E-06
Cm-244	1.6E-02	9.6E-02	1.1E-01	Ra-228	1.0E-11	6.2E-11	7.2E-11
Cm-245	4.6E-06	2.8E-05	3.2E-05	Rb-87	4.5E-07	2.7E-06	3.1E-06
Cm-246	3.0E-07	1.8E-06	2.1E-06	Rh-102	5.7E-07	3.4E-06	4.0E-06
Cm-247	3.3E-13	2.0E-12	2.3E-12	Rh-106	1.8E-06	1.1E-05	1.3E-05
Cm-248	3.6E-13	2.2E-12	2.5E-12	Rn-219	8.6E-07	5.2E-06	6.0E-06
Co-60	7.0E-02	1.4E-01	2.1E-01	Rn-220	3.0E-05	1.8E-04	2.1E-04
Cs-134	6.0E-03	4.7E-02	5.3E-02	Rn-222	2.0E-07	1.2E-06	1.4E-06

Table 3-7. (continued).

Nuclide	Liquid Activity (Ci)	Solid Activity (Ci)	Total Activity (Ci)	Nuclide	Liquid Activity (Ci)	Solid Activity (Ci)	Total Activity (Ci)
Cs-135	1.4E-02	8.3E-02	9.6E-02	Se-79	6.9E-03	4.1E-02	4.8E-02
<b>Cs-137</b>	<b>5.7E+02</b>	<b>3.4E+03</b>	<b>4.0E+03</b>	Sm-146	4.2E-09	2.5E-08	3.0E-08
Eu-150	1.7E-07	1.0E-06	1.2E-06	Sm-147	1.1E-07	6.9E-07	8.0E-07
Eu-152	2.0E-02	1.2E-01	1.4E-01	Sm-148	5.7E-13	3.4E-12	4.0E-12
Eu-154	9.1E-01	3.0E-01	1.2E+00	Sm-149	5.2E-14	3.1E-13	3.6E-13
Eu-155	1.1E-01	2.4E+00	2.6E+00	<b>Sm-151</b>	<b>4.7E+00</b>	<b>2.8E+01</b>	<b>3.3E+01</b>
Fr-221	5.7E-09	3.4E-08	4.0E-08	Sn-121m	7.3E-4	4.5E-03	5.2E-03
Fr-223	1.2E-08	7.2E-08	8.4E-08	Sn-126	6.3E-03	3.8E-02	4.4E-02
Gd-152	2.2E-14	1.3E-13	1.6E-13	<b>Sr-90</b>	<b>4.1E+02</b>	<b>7.6E+03</b>	<b>8.0E+03</b>
H-3	8.0E-02	4.8E-01	5.6E-01	Tc-98	3.9E-08	2.4E-07	2.8E-07
Ho-166m	6.9E-07	4.1E-06	4.8E-06	Tc-99	1.5E-01	9.0E-01	1.0E+00
I-129	3.7E-04	2.2E-03	2.6E-03	Te-123	5.7E-15	3.4E-14	4.0E-14
In-115	1.5E-12	8.9E-12	1.0E-11	Te-125m	1.9E-03	1.1E-02	1.3E-02
La-138	3.0E-12	1.8E-11	2.1E-11	Th-227	8.6E-07	5.2E-06	6.0E-06
Nb-93m	2.9E-02	1.7E-01	2.0E-01	Th-228	3.0E-05	1.8E-04	2.1E-04
Nb-94	1.7E-02	7.7E+00	7.7E+00	Th-229	5.7E-09	3.4E-08	4.0E-08
Nd-144	2.5E-11	1.5E-10	1.7E-10	Th-230	1.4E-05	8.3E-05	9.6E-05
Ni-59	1.3E-02	1.6E-01	1.7E-01	Th-231	3.2E-04	1.9E-03	2.2E-03
Ni-63	4.3E-01	2.6E+00	3.0E+00	Th-232	1.1E-11	6.5E-11	7.6E-11
Np-237	1.7E-03	5.9E-03	7.6E-03	Th-234	3.2E-04	1.9E-03	2.2E-03
Np-238	1.1E-06	6.5E-06	7.6E-06	Tl-207	8.6E-07	5.2E-06	6.0E-06
Np-239	3.2E-04	1.9E-03	2.2E-03	Tl-208	1.0E-05	6.2E-05	7.2E-05
Np-240m	1.0E-11	6.2E-11	7.2E-11	Tl-209	1.3E-10	7.6E-10	8.8E-10
Pa-233	4.5E-02	2.7E-01	3.1E-01	Tm-171	6.9E-14	4.1E-13	4.8E-13
Pa-231	1.5E-06	8.9E-06	1.0E-05	U-232	2.9E-05	1.7E-04	2.0E-04
Pa-234	4.1E-07	2.4E-06	2.8E-06	U-233	3.7E-06	2.2E-05	2.6E-05
Pa-234m	3.2E-04	1.9E-03	2.2E-03	U-234	1.3E-02	7.6E-02	8.8E-02
Pb-209	5.7E-09	3.4E-08	4.0E-08	U-235	6.0E-05	4.1E-04	4.7E-04
Pb-210	8.6E-08	5.2E-07	6.0E-07	U-236	3.2E-05	3.1E-03	3.1E-03
Pb-211	8.6E-07	5.2E-06	6.0E-06	U-237	5.3E-05	3.2E-04	3.7E-04
Ru-106	1.8E-06	1.1E-05	1.3E-05	U-238	8.2E-05	2.4E-04	3.3E-04
Sb-125	7.4E-03	4.5E-02	5.2E-02	U-240	1.0E-11	6.2E-11	7.2E-11
Sb-126	8.6E-04	5.2E-03	6.0E-03	<b>Y-90</b>	<b>4.1E+02</b>	<b>7.6E+03</b>	<b>8.0E+03</b>
Sb-126m	6.3E-03	3.8E-02	4.4E-02	Zr-93	3.3E-02	2.0E-01	2.3E-01
Ru-106	1.8E-06	1.1E-05	1.3E-05	Totals	1.9E+03	2.2E+04	2.41E+04

The tank farm also has four belowground 30,000-gal stainless-steel tanks designated as tanks WM-103, -104, -105, and -106. These tanks last stored HLW in 1974 and stored evaporator condensate until 1983. The tanks were taken out of service in 1983, and the tank inlets have been cut and capped (INEEL 1999). The contents of these tanks were sampled for RCRA constituents in 1990 and then emptied. The sampling analysis provided limited radionuclide information.

Using the same analogy that was used to develop the conservative tank inventory for the 300,000-gal tanks, the total Cs-137 activity in a 30,000-gal tank was estimated using the data from Staiger and Millet (2000):

- The 30,000-gal tanks have the same composition in terms of the contributions to activity for liquid and solids as the 300,000-gal tanks.
- The 30,000-gal tanks contain 10% of the residuals contained in the 300,000-gal tanks.
- The 300,000-gal tanks have 4.9E+06 mL of liquids and 1.25E+06 mL of solids. Therefore, the 30,000-gal tanks contain 4.9E+05 mL of liquids and 1.25E+05 mL of solids for a total volume of 6.2E+05 mL of residual contamination.
- The maximum Cs-137 content of a given 30,000-gal tank was calculated based on the sample for WM-104, with a Cs-137 concentration of 75 nCi/mL.

These assumptions result in a maximum combined Cs-137 tank content of 0.046 Ci for the 30,000-gal tanks.

A comparison of the Cs-137 activity calculated for the 30,000-gal tanks (i.e., 0.046 Ci) with the Cs-137 content of the 300,000-gal tanks from the inventory indicates that the contamination levels in the 30,000-gal tanks are insignificant by comparison. Therefore, the inventory for the 300,000-gal tanks is considered to bound any additional contamination that may be released from the 30,000-gal tanks.

The discussion above determining the radiological inventory for the tank farm heels made the assumption that the tank heels would be 1-in. thick. However, as of November 2003, four of the large tanks (WM-182, -183, -185, and -186) have been cleaned. WM-182 had an average heel thickness of 1/8 in. after cleaning, while WM-183, -185, and -186 all had heel thicknesses of 1/16 in. or less. The tank cleaning process has proven to be successful, and the remaining tanks, all similar to the first four in terms of access and construction, should not pose any cleaning new problems. Based on these results, the source term for the tank heels can be reduced to more accurately reflect the actual residual contamination that will remain in the tanks. Reducing the tank heels' thickness from 1 to 1/8 in. will reduce the radionuclide inventory by a factor of eight. The resulting individual tank heel inventory at the time of facility closure in 2016 would be 3,013 total Ci. The curies for 10 tanks would then total 30,130 Ci. Separating out the Cs-137/Sr-90 activity and reducing by a factor of eight results in 1,500 Ci per tank or 15,000 Ci for 10 tanks.

### **3.2.2 Sand Pad Contamination**

The sand pads in tanks WM-185 and -187 are contaminated from accidental releases into the vaults in 1962. A description of the leakage into the tank vaults is available in Latchum et al. (1962). After the releases, the mass of each radionuclide in the sand pad was assumed to be impacted by radioactive decay and flushing. These processes were modeled by assuming the mass of radionuclides in the sand pad undergoes radioactive decay for a period of time representing the length of time between flushing events. Then the system is flushed. During flushing, the sand pad is assumed to be saturated, and the radionuclides are partitioned at equilibrium between the liquid and solid phase according to their  $K_d$  values. The flushing is assumed to remove all liquid and radionuclides that have partitioned into the liquid phase from the sand pad except for the residual liquid. Thus, the radionuclides remaining in the sand pad are contained in the residual liquid and sorbed onto the sand. The mass of radionuclides in the sand pad is then calculated again, assuming radioactive decay occurs over a period of time between flushing events. The cycle of modeling radioactive decay and flushing is repeated until target date activities were computed (DOE-ID 2003b).

Based on the decay/flushing model, the suite of radionuclides and their predicted activities remaining as a contaminate source in the sand pads were modeled. Model results were believed to be conservative in that available data were used in the model where possible. When data were not available, conservative assumptions were made. Using the conservative assumptions and the available data, the analysis is expected to provide a reasonable and conservative estimate of the mass of each radionuclide contained in the sand pad. Table 3-8 lists a summary of results from the diffusion, radioactive decay, and flushing modeling (major contributors to TRU and fission-product activity are shown in red). Totaling individual radionuclide activities, the source inventory for the sand pads in 2016 would be 3,500 total Ci. The Cs-137/Sr-90 activity for the sand pads totaled 1,726 Ci.

Table 3-8. Inventory for the sand pads at the time of facility closure (2016).

Nuclide	Ci	Nuclide	Ci	Nuclide	Ci	Nuclide	Ci
Ac-225	2.23E-08	Eu-154	1.29E+00	Po-214	1.13E-05	Th-228	1.93E-05
Ac-227	1.40E-05	Fr-221	2.23E-08	Po-215	1.40E-05	Th-229	2.23E-08
Ac-228	2.33E-01	Fr-223	1.93E-07	Po-216	2.03E-05	Th-230	5.49E-04
Ag-108	2.86E-09	Gd-152	3.23E-14	Po-218	1.13E-05	Th-231	8.41E-03
Ag-108m	2.86E-09	H-3	2.47E-22	Pu-236	4.23E-11	Th-232	4.44E-12
Am-241	1.89E+00	Ho-166m	4.15E-07	Pu-238	2.00E+00	Th-234	8.99E-05
Am-242	1.64E-05	I-129	1.08E-06	Pu-239	1.57E+00	Tl-207	1.40E-05
Am-242m	1.64E-05	In-115	3.71E-12	Pu-240	3.54E-01	Tl-208	7.33E-06
Am-243	1.47E-04	La-138	5.33E-11	Pu-241	1.88E+00	Tl-209	4.82E-10
At-217	2.23E-08	Nb-93m	1.98E-01	Pu-242	5.69E-05	Tl-210	1.13E-05
Ba-137m	1.50E+03	Nb-94	2.29E-02	Pu-243	4.11E-16	U-232	1.88E-05
Be-10	1.80E-07	Ni-63	1.64E-10	Pu-244	5.99E-12	U-233	1.35E-06
Bi-210	5.74E-06	Np-235	1.79E-24	Ra-223	1.40E-05	U-234	3.13E-01
Bi-211	1.40E-05	Np-237	3.72E-04	Ra-224	2.03E-05	U-235	8.41E-03
Bi-212	2.03E-05	Np-238	7.77E-08	Ra-225	2.23E-08	U-236	1.06E-02
Bi-213	2.23E-08	Np-239	1.47E-04	Ra-226	1.13E-05	U-237	3.75E-05
Bi-214	1.13E-05	Np-240	6.59E-15	Ra-228	2.33E-01	U-238	8.99E-05
C-14	3.90E-07	Np-240m	5.99E-12	Rb-87	7.69E-07	U-240	5.99E-12
Cd-113m	1.60E-02	Pa-231	2.02E-05	Rn-219	1.40E-05	Y-90	2.26E+02
Cf-249	2.42E-16	Pa-233	3.72E-04	Rn-220	2.03E-05	<u>Zr-93</u>	<u>2.11E-01</u>
Cf-250	1.37E-17	Pa-234	1.44E-07	Rn-222	1.13E-05	Total	3.50E+03
Cf-251	5.95E-19	Pa-234m	8.99E-05	Sb-126	1.65E-02		
Cf-252	2.79E-25	Pb-209	2.23E-08	Sb-126m	1.65E-02		
Cm-242	1.35E-05	Pb-210	5.74E-06	Se-79	2.00E-02		
Cm-243	7.91E-07	Pb-211	1.40E-05	Sm-146	3.77E-10		
Cm-244	2.21E-04	Pb-212	2.03E-05	Sm-147	2.53E-06		
Cm-245	5.11E-08	Pb-214	1.13E-05	Sm-151	3.76E+01		
Cm-246	1.14E-09	Pb-107	4.21E-04	Sn-121m	2.06E-03		
Cm-247	4.11E-16	Pm-146	1.71E-05	Sn-126	1.65E-02		
Cm-248	1.26E-16	Pm-147	3.23E-03	<b>Sr-90</b>	<b>2.26E+02</b>		
Co-60	1.60E-03	Po-210	5.74E-06	Tc-98	6.18E-20		
Cs-135	5.99E-03	Po-211	3.83E-08	Tc-99	2.02E-12		
<b>Cs-137</b>	<b>1.50E+03</b>	Po-212	1.30E-05	Te-123	4.93E-16		
Eu-152	9.28E-03	Po-213	2.19E-08	Th-227	1.40E-05		

### 3.2.3 Residual Radionuclide Inventory in Piping

Residual metal contamination in process waste piping was recently analyzed. The estimate discussed in this subsection is for piping that will be abandoned as part of the RCRA closure of the tanks and does not include previously abandoned piping. The radionuclide inventory estimate for piping has been based on the metal contamination data collected in 2002. The calculations determined a total ancillary piping residual mass of 15.5 kg. The estimate used for the compliance scenario is based on analytical data (DOE-ID 2003b).

The *Sampling and Analysis Plan for the Post-Decontamination Characterization of the WM-182 and WM-183 Tank Residuals* (Portage Environmental 2001) was prepared to define the data collection steps for residual contamination in piping. The process waste lines in the tank farm have carried acidic waste in solution and have routinely been flushed after waste transfer with acid or acid plus a water flush. During closure of the tank systems, the piping was triple rinsed with water to remove loose residual waste.

Sections of horizontal and vertical process waste line have been removed from WM-182. Samples from the decontaminated process waste lines were collected; these data are used to represent the effectiveness of triple rinsing all of the lines remaining in the WM-182 and -183 tank systems. The piping was removed from the system, and 2- to 6-in.-long sections of the pipe were removed from each end using a wheel pipe cutter. Rinsate samples from the pipes were collected and analyzed for metals. The piping was filled with water (sealed at one end with an inert cap), allowed to equilibrate for a minimum of 30 min, decanted, and analyzed for total metals.

The concentration (mg/L) of metals in liquid SBW is greater than the concentration of radionuclides (mg/L). Therefore, the residual metal concentration in piping is a conservative estimate of residual radionuclide concentration. The maximum concentration of each metal in the piping rinsate samples was summed with 23 additional sampling data points. This yielded a total metals concentration of 2,922  $\mu\text{g/L}$ . The rinsate was collected from 18-in. lengths of the 2.5-in.-outside-diameter pipe. Several conservative assumptions were made to ensure the estimate of the piping residuals is conservative:

- The concentration of total metals was assumed to be for 1 ft of piping rather than the tested 1.5 ft of pipe sections. Therefore, the starting value was one-third greater than indicated by the analysis.
- The sample rinsate volumes were less than 1 L (less than 300 mL). The data were not adjusted downward to correspond with the actual sample volumes.
- A safety factor of 500 was applied to the data. This safety factor was used to provide a conservative estimate and provide for the possibility of greater concentrations being found in other piping.

This estimation process yielded 15.5 kg of SBW solid in the residual piping. The SBW in the conservative inventory was then apportioned to mass. Table 3-9 shows the total curies by radionuclide for the piping (major contributors to TRU and fission-product activity are shown in red). Total activity by mass equaled 109 Ci, of which 82 Ci are from the Cs-137/Sr-90 activity. As noted above, this estimate does not include previously abandoned piping.

Table 3-9. Estimated radionuclide inventory for piping at facility closure in 2016.

Nuclide	Ci	Nuclide	Ci	Nuclide	Ci	Nuclide	Ci
Ac-225	2.6E-10	<b>Cs-137</b>	<b>2.6E+01</b>	Po-210	3.8E-09	Sm-148	2.6E-14
Ac-227	3.8E-08	Eu-150	7.7E-09	Po-212	8.2E-07	Sm-149	2.3E-15
Ac-228	4.6E-13	Eu-152	9.0E-04	Po-213	2.6E-10	Sm-151	2.1E-01
Ag-108m	2.8E-10	Eu-154	2.2E-03	Po-214	9.0E-09	Sn-121m	3.3E-05
Am-241	3.3E-03	Eu-155	1.8E-02	Po-215	3.8E-08	Sn-126	2.8E-04
Am-242	1.0E-05	Fr-221	2.6E-10	Po-216	1.3E-06	<b>Sr-90</b>	<b>5.6E+01</b>
Am-242m	1.0E-05	Fr-223	5.4E-10	Po-218	9.0E-09	Tc-98	1.8E-09
Am-243	1.4E-05	Gd-152	1.0E-15	Pr-144	4.1E-09	Tc-99	7.0E-02
At-217	2.6E-10	H-3	3.6E-03	Pr-144m	4.9E-11	Te-123	2.6E-16
Ba-137m	2.6E+01	Ho-166m	3.1E-08	Pu-236	7.7E-08	Te-125m	8.4E-05
Be-10	2.0E-09	I-129	3.6E-05	Pu-238	1.0E-01	Th-227	3.8E-08
Bi-210	3.8E-09	In-115	6.6E-14	Pu-239	6.7E-03	Th-228	1.3E-06
Bi-210m	1.5E-22	La-138	1.3E-13	Pu-240	7.2E-03	Th-229	2.6E-10
Bi-211	3.8E-08	Nb-93m	1.3E-03	Pu-241	9.5E-02	Th-230	6.1E-07
Bi-212	1.3E-06	Nb-94	5.7E-02	Pu-242	5.4E-06	Th-231	1.4E-05
Bi-213	2.6E-10	Nb-144	1.1E-12	Pu-244	4.6E-13	Th-232	4.9E-13
Bi-214	9.0E-09	Ni-59	1.2E-03	Ra-223	3.8E-08	Th-234	1.4E-05
C-14	8.2E-08	Ni-63	1.9E-02	Ra-224	1.3E-06	Tl-207	3.8E-08
Cd-113m	1.2E-03	Np-237	4.4E-05	Ra-225	2.6E-10	Tl-208	4.6E-07
Ce-142	2.0E-08	Np-238	4.9E-08	Ra-226	9.0E-09	Tl-209	5.6E-12
Ce-144	4.1E-09	Np-239	1.4E-05	Ra-228	4.6E-13	Tm-171	3.1E-15
Cf-249	1.2E-14	Np-240m	4.6E-13	Rb-87	2.0E-08	U-232	1.3E-06
Cf-250	4.9E-15	Pa-233	2.0E-03	Rh-102	2.6E-08	U-233	1.7E-07
Cf-251	1.8E-16	Pa-231	6.6E-08	Rh-106	8.2E-08	U-234	5.6E-04
Cm-242	8.2E-06	Pa-234	1.8E-08	Rn-219	3.8E-08	U-235	3.1E-06
Cm-243	1.4E-05	Pa-234m	1.4E-05	Rn-220	1.3E-06	U-236	2.3E-05
Cm-244	7.2E-04	Pb-209	2.6E-10	Rn-222	9.0E-09	U-237	2.4E-06
Cm-245	2.0E-07	Pb-210	3.8E-09	Ru-106	8.2E-08	U-238	1.8E-06
Cm-246	1.3E-08	Pb-211	3.8E-08	Sb-125	3.3E-04	U-240	4.6E-13
Cm-247	1.5E-14	Pb-212	1.3E-06	Sb-126	3.8E-05	Y-90	5.6E-01
Cm-248	1.6E-14	Pb-214	9.0E-09	Sb-126m	2.8E-04	<u>Zr-93</u>	<u>1.5E-03</u>
Co-60	1.0E-03	Pb-107	1.1E-05	Se-79	3.1E-04	Total	1.09E+02
Cs-134	3.5E-04	Pm-146	6.6E-06	Sm-146	1.9E-10		
Cs-135	6.1E-04	Pm-147	3.8E-03	Sm-147	5.1E-09		

### **3.3 OU 3-13 Risk Assessment Summary**

The OU 3-13 remedial investigation (DOE-ID 1997a) presented the available data for WAG 3 concerning site conditions and the nature and extent of contamination as of 1997. The remedial investigation examined 92 of the then-known 94 designated release sites (CPP-84 and -94 were not investigated in the RI/BRA) and the windblown area for human health and ecological receptors. Because OU 3-14 involves only the risk assessment results for the tank farm surface soil pathway and the groundwater pathway within the INTEC security fence, only the applicable portions of the OU 3-13 RI/BRA are summarized here. The OU 3-13 COCs identified for both the soil and groundwater pathways are derived from the OU 3-13 COPCs developed for each release site.

#### **3.3.1 Summary of the OU 3-13 Tank Farm Surface Soil Pathway**

The results of the OU 3-13 RI/BRA indicate that the potential exists for adverse health effects from exposure to the tank farm soils contaminated with Cs-137, Eu-154, U-235, and Sr-90. Site characterization was limited during the OU 3-13 RI/FS (DOE-ID 1997a, 1997b), primarily because the tank farm is an active operational facility. Assumptions about the horizontal and vertical distribution of contaminated soils were made to calculate the area-weighted soil concentrations; however, the boundaries of the release sites are not well known. Assumptions about the concentration in the perched water are of concern, because perched water may contribute to elevated concentrations in the SRPA. The OU 3-13 feasibility study supplement (DOE-ID 1998c) presented important tank farm soil characteristics such as the contaminated area, OU 3-13 COCs, preliminary remediation goals (PRGs), and the required period of performance for each site. The characteristics are summarized in Table 3-10 (DOE-ID 1998c).

As shown in Table 3-10, the primary risk contributors (i.e., the OU 3-13 COCs) identified in the OU 3-13 RI/BRA for the tank farm surface soils were Cs-137, Eu-154, Pu-238, Pu-239/240, Pu-241, Sr-90, and U-235. Though plutonium did not present an unacceptable risk, it was added to the OU 3-13 COC list because of uncertainty about the amount of plutonium released in the tank farm area. The uncertainty in the distribution of contaminants in the surface soils stems from the lack of documentation of all of the potential historical contaminant releases at the tank farm and the limited site characterization during the OU 3-13 field investigation.

#### **3.3.2 Summary of the OU 3-13 Groundwater Pathway Modeling and Risk Assessment**

There are two sources of existing or future contamination in the SRPA. These consist of (1) the historical use of the injection well and (2) surface-soil sources leaching through the vadose zone into the perched water and subsequently into the SRPA. The OU 3-13 BRA simulated the vadose zone/aquifer/groundwater system at INTEC. Simulations were performed to predict water infiltration and transport through the vadose zone. The predicted water and contaminant mass fluxes from the vadose zone model were then used as input to a separate aquifer model.

Predictions of contaminant transport from land surface to the SRPA and south to the INEEL boundary were focused on obtaining future groundwater concentrations in the year 2095. These predictions were used to support the 100-year risk scenario (DOE-ID 1996) for the WAG 3 comprehensive BRA (DOE-ID 1997a) and to evaluate potential health impacts to a hypothetical future resident.

Table 3-10. Summary of OU 3-13 tank farm surface soil release sites, OU 3-13 COCs, and PRGs (DOE-ID 1998a).

Release Site	Area <sup>a</sup> (ft <sup>2</sup> )	Major COCs	PRG (pCi/g)	Time Required to Achieve PRG <sup>b</sup> (years)
CPP-15	700	Cs-137	23	443
CPP-20	225	Cs-137	23	173
CPP-25	500	Cs-137	23	173
CPP-26	12,850	Cs-137	11.5	360
		Sr-90	111	120
CPP-27/33 <sup>c</sup>	2,000	Cs-137	23	293
CPP-28/79 <sup>d</sup>	4,950	Cs-137	4.6	781
		Eu-154	1,040	172
		Pu-238	134	880
		Pu-239/240	50	137,000
		Pu-241	11,200	174
		Sr-90	44.5	464
CPP-31	10,550	Cs-137	4.6	575
		Pu-239/240	50	50,800
		Sr-90	44.5	268
		U-235	2.6	6.4 billion
CPP-32 <sup>e</sup>	14	Cs-137	23	223
CPP-58 <sup>f</sup>	6,800	Cs-137	23	147
CPP-96 (additional soils) <sup>g</sup>	79,696	Unknown	Unknown	Unknown

a. All of the release-site areas were obtained from the OU 3-13 RI/BRA (DOE-ID 1997a, Figures 9-1 and 10-1) except for the contaminated soil stockpile, which was surveyed, and the area of additional soils, which was estimated in the OU 3-13 feasibility study (DOE-ID 1997b).

b. The time required to achieve the PRGs, which are risk-based concentrations (RBCs), was obtained from interdepartmental correspondence from D. E. Burns to R. D. Greenwell, Lockheed Martin Idaho Technologies Company, January 31, 1997. This column refers to the amount of time required for the COCs to decay naturally to an activity less than the 1E-04 RBC. The RBC corresponds to a concentration that yields a 1E-04 incremental lifetime cancer incidence risk.

c. Sites CPP-27 and -33 are considered together, because they were derived from the same transfer line leak and were considered together in the OU 3-13 RI/BRA and all Track 2 investigations.

d. Sites CPP-28 and -79 are considered together, because an area of high concentration that probably originated from site CPP-28 is contained within CPP-79.

e. This site was formerly designated as CPP-32W. It was combined with a similar site, CPP-32E, and designated as CPP-32.

f. This site is designated as CPP-58E and -58W, which represent the eastern and western portions of the CPP-58. The eastern portion originated from a spill, and the western portion originated from a leak, both from the same source.

g. Site CPP-96 refers to surface soils surrounding the tank farm vaults that are assumed to be contaminated because of the uncertainty in the tank farm site characterization. The volume of additional soils was estimated using the excavation footprint shown in the OU 3-13 feasibility study (DOE-ID 1997a, Figure 5-1) less the volume occupied by the tank vaults and the soil volumes at known release sites. The soils surrounding the tank vaults were assumed to be contaminated to a depth of 40 ft.

The risks calculated for the SRPA are risks on the INEEL Site. No projections of impact off of the INEEL Site have been completed for downgradient SRPA users. Concentrations were reported as a function of time over a simulation period extending well beyond 2095 until the peak concentrations were identified. In the contaminant transport analysis of groundwater, all tank farm release contaminants were assumed to move immediately from the surface soil to the underlying basalt after release from a tank farm facility. This assumption was conservative for the groundwater pathway, because the assumption maximizes concentrations and reduces transit time.

The determination of the OU 3-13 COPCs for the groundwater pathway is discussed in Subsection 5.2 of Appendix F of the OU 3-13 RI/BRA (DOE-ID 1997a). Table 3-11 presents the OU 3-13 COPCs that were evaluated for the groundwater pathway. These include the three nonradionuclides (arsenic, chromium, and mercury) and the 10 radionuclides (Am-241, Co-60, Cs-137, H-3, I-129, Np-237, Sr-90, Tc-99, total plutonium, and total uranium). These originate either at the land surface (current soil inventory), historical waste process water discharge streams (i.e., service waste ponds or percolation ponds), accidental releases, and/or past use of the INTEC injection well (site CPP-23). The injection well source includes the period during which the well failed and introduced contamination to the vadose zone rather than the SRPA. In addition, because the Test Reactor Area and INTEC contaminant plumes could overlap downgradient, the two primary contaminants identified in the Test Reactor Area remedial investigation (chromium and H-3) were included as SRPA source terms.

Table 3-11. Summary of the identified groundwater COPCs for OU 3-13 (DOE-ID 1999b).

OU 3-13 COPCs Based on Water Samples				
COPCs Based on the SRPA	Additional COPCs Based on Perched Water	Additional COPCs Based on Soil Contamination	Additional COPCs Based on Other Considerations	Final List of the COPCs for the Groundwater Pathway
Am-241	None	Arsenic	Cs-137	Arsenic
H-3		Chromium	Mercury	Chromium
I-129		Co-60		Mercury
Np-237		U-235 <sup>a</sup>		Am-241
Sr-90		Pu-238 <sup>a</sup>		Co-60
Tc-99		Pu-239 <sup>a</sup>		Cs-137
U-234 <sup>a</sup>		Pu-240 <sup>a</sup>		H-3
U-238 <sup>a</sup>				I-129
				Np-237
				Total plutonium <sup>a</sup>
				Sr-90
				Tc-99
				Total uranium <sup>a</sup>

a. The isotopes were identified as COPCs, but in the OU 3-13 modeling, they were lumped together and simulated as totals.

Concentrations were reported as a function of time over a simulation period extending well beyond 2095 to identify peak concentrations. The OU 3-13 BRA determined a simulation time of 3,804 years when the peak total plutonium concentration was identified (in the year 3585). Table 3-12 summarizes the maximum and peak concentrations at various periods. Based on the information in this table, the following conclusions can be drawn:

- Arsenic, Co-60, Cs-137, Tc-99, total uranium and Am-241 were not expected to exceed their MCL and risk-based concentrations (RBCs) (target risk=1E-04). Recent monitoring in a new well (CPP-MON-230) located immediately north of the tank farm has detected Tc-99 at concentrations exceeding the MCL. However, it is unclear whether the recent well drilling is responsible for bringing down perched water Tc-99 or the well represents the longer-term aquifer conditions. Current investigations are under way to determine the true nature of the Tc-99 in the SRPA at this well.
- Chromium, tritium, and Np-237 exceed their MCL or the RBC before the year 2095 but not after 2095. Therefore, these contaminant concentrations will not pose an unacceptable risk to future residents.
- Mercury, I-129, Sr-90, and total plutonium exceed their MCLs or RBCs before 2095 (except total plutonium) and also after 2095. These contaminants are predicted to pose an unacceptable risk to the future residents (see Table 3-13).

Contaminant discharges to the INTEC injection well are the primary contributors to the aquifer peak concentrations of mercury, I-129, Sr-90, and total plutonium (see Table 27-2 in the OU 3-13 RI/BRA [DOE-ID 1997a]). From an interpretation of the OU 3-13 RI/BRA results (DOE-ID 1997a, Subsection 6.6), it is possible to identify the source that led to the contaminant plumes of interest that exceed MCLs or the RBC:

- For mercury, interpretation indicates that the INTEC injection well is the main source.
- The primary I-129 flux to the aquifer was from direct input of injection well sources into the SRPA. The I-129 surface sources represent a small contribution (less than 9%) to the OU 3-13 BRA SRPA peak concentration as compared to the injection well sources of I-129.
- For Sr-90, the injection well provides most of the pre-2095 contribution, but after 2095, the vadose zone contribution is more significant.
- For total plutonium, the injection well is the early contributor, but later, the contribution from the vadose zone becomes most significant.

Modeling to support the OU 3-13 RI/FS indicated that tank farm contaminants released to the soil will cause unacceptable degradation of the SRPA in the future (DOE-ID 1997a, 1997b, 1998a). Specifically, estimated levels of Sr-90 and plutonium in the SRPA were predicted to exceed MCLs in years 2172 and 3585, respectively. Strontium-90 from tank farm soils was not expected to reach the SRPA for dozens of years, whereas plutonium isotopes were not expected to reach the SRPA for hundreds of years. The SRPA should not be adversely affected by tank farm Sr-90 and plutonium in the timeframe of the OU 3-13 tank farm soils interim action (DOE-ID 1999b).

Table 3-12. Summary of the OU 3-13 maximum and peak simulated contaminant concentrations for the entire aquifer domain<sup>a</sup> (DOE-ID 1997a, 1997b).

OU 3-13 COPC	Sediment and Interbed $K_d$ ( $\text{cm}^3/\text{g}$ )	MCL ( $\text{mg/L}$ or $\text{pCi/L}$ )	1E-04 RBC	Maximum Aquifer Concentration at Year 2025 ( $\text{mg/L}$ or $\text{pCi/L}$ )	Maximum Aquifer Concentration at Year 2095 ( $\text{mg/L}$ or $\text{pCi/L}$ )	Peak Aquifer Concentration after Year 2095 ( $\text{mg/L}$ or $\text{pCi/L}$ )	Peak Aquifer Concentration through Total Simulation Time ( $\text{mg/L}$ or $\text{pCi/L}$ )
Arsenic <sup>b</sup>	3	0.05 <sup>c</sup>	0.006	9.4E-05	1.2E-03	1.95E-03 (2479) <sup>d</sup>	1.95E-03 (2479) <sup>d</sup>
Chromium <sup>b,e</sup>	1.2	0.1 <sup>c</sup>	0.18 <sup>f</sup>	0.07	0.03	0.03 (2095)	0.9 (1971)
Mercury <sup>b</sup>	100	0.002 <sup>c</sup>	0.003 <sup>f</sup>	0.006	0.004	<b>0.004 (2095)</b>	<b>0.007 (1984)</b>
Total uranium <sup>b</sup> (inorganic)	6	0.02 <sup>c</sup>	0.11 <sup>f</sup>	0.003	0.001	0.01 (2468)	0.014 (1986)
Co-60	10	100 <sup>g</sup>	254	0.03	0.0	0.0 (2095)	25.9 (1986)
Cs-137	500	200 <sup>g</sup>	152	32.0	5.9	5.9 (2095)	86.2 (1979)
H-3	0	20,000 <sup>g</sup>	67,100	4,240.0	89.2	89.2 (2095)	2.6E+06 (1960)
I-129	0	1 <sup>g</sup>	26	9.0	4.68	<b>4.68 (2095)</b>	<b>97.1 (1986)</b>
Np-237 <sup>h</sup>	8	<15	16	8.03	3.76	3.76 (2095)	30.5 (1986)
Sr-90	12	8 <sup>g</sup>	86	35.4	8.08	<b>16.1 (2172)</b>	<b>1,200.0 (1967)</b>
Tc-99	0.15	900 <sup>g</sup>	3,430	55.1	23.9	23.9 (2095)	203.0 (1997)
Am-241 <sup>i</sup>	340	<15	15	00.8	0.63	0.63 (2095)	0.9 (1986)
Total plutonium	22	<15	NA	0.32	0.14	<b>36.2 (3585)</b>	<b>36.2 (3585)</b>
Total uranium	6	14	77	2.1	1	7.3 (2468)	10.1 (1986)

a. Entire aquifer domain is the area within INTEC and that which is south of the southern security fence.

b. Concentrations are provided in  $\text{mg/L}$ .

c. Drinking Water Regulations and Health Advisories, May 1995.

d. Values in parentheses denote the year when the peak occurs.

e. All peak aquifer concentrations are in and downstream of the Test Reactor Area. INTEC concentrations are significantly lower.

f. Values based on hazard quotient of 1.

g. Water concentration that will result in a dose rate of 4 mrem/yr if the contaminant is the only one present, based on an ingestion of 2 L/d using ICRP-2 methods.

h. Np-237 predictions have subsequently been reduced (DOE-ID 2003d) based on revised injection well disposal estimates.

i. Am-241 numbers do not include decay from Pu-241 to Am-241 in this table.

NA – Not applicable.

NOTE: Peak aquifer concentrations highlighted in bold text indicate that the value exceeds the respective MCL.

Table 3-13. OU 3-13 groundwater ingestion cancer risk and noncancer hazard quotients in the year 2095 and for the peak concentration if it occurs beyond the year 2095 (DOE-ID 1997a, 1997b, 1998a).

Contaminant	MCL (mg/L or pCi/L)	Predicted Concentration in the Year 2095 (mg/L or pCi/L)	Groundwater Ingestion Cancer Risk in Hazard Quotient in the Year 2095	Peak Aquifer Concentration if beyond the Year 2095 (mg/L or pCi/L)	Year of Peak Aquifer Concentration	Peak Aquifer Risk or Hazard Quotient
Arsenic (mg/L)	5.0E-02	1.25E-03	2E-05 (5E-02) <sup>a</sup>	1.95E-03	2479	3E-05
Chromium <sup>c</sup> (mg/L)	1.0E-01	0.03	0.2 <sup>a</sup>	—	—	—
Mercury (mg/L)	2.0E-03	<b>4.17E-03</b>	<b>1.33<sup>a</sup></b>	—	—	—
Uranium (inorganic) (mg/L)	2.0E-02	1.31E-03	1E-2 <sup>a</sup>	1.0E-02	2468	5.0E-01 <sup>a</sup>
Total Am-241 <sup>b</sup>	<1.5E+01	8.72E-01	6E-06	—	—	—
Co-60	1.0E+02	0	NA	—	—	—
Cs-137	2.0E+02	5.91E+00	4E-06	—	—	—
H-3	2.0E+04	8.92E+01	1E-07	—	—	—
I-129	1.0E+00	<b>4.68E+00<sup>c</sup></b>	<b>2E-05</b>	—	—	—
Np-237	<1.5E+01	3.76E+00	2E-05	—	—	—
Total plutonium	<1.5E+01	1.39E-01	1E-06	<b>3.62E+01</b>	3585	<b>2E-04</b>
Sr-90	8.0E+00	8.08E+00	9E-06	<b>1.61E+01</b>	2172	<b>2E-05</b>
Tc-99	9.0E+02	2.39E+01	7E-07	—	—	—
Total uranium	1.4E+01	9.57E-01	1E-06	7.3E+00 <sup>d</sup>	2468	7E-06

a. The value given is a hazard quotient.

b. All peak aquifer concentrations are in and downstream of the Test Reactor Area. The INTEC area concentrations are significantly lower.

c. The value includes decay from Pu-241.

d. The value given is based on groundwater modeling assuming a 25-ft open interval for production well. The assumption was made in the OU 3-13 feasibility study supplement (DOE-ID 1998a) that a 50-ft open interval for the same well resulted in a peak aquifer concentration of 1.41 pCi/L in the year 2106.

e. The value given is for total uranium.

NA – Not applicable.

NOTE: Peak aquifer concentrations highlighted in bold text indicate that the value exceeds the respective MCL.

## 3.4 Contaminant Data Review Summary

Initially, OU 3-14 was created to address release sites and any other OUs where available information was insufficient to select a final remedy under OU 3-13. Interim actions were developed for implementation in the OU 3-13 ROD, with the final remedy relegated to OU 3-14. Subsequently, OU 3-14 was modified to exclude the INTEC injection well and the additional contaminated INTEC soil sites.

Results of the OU 3-13 RI/FS BRA (DOE-ID 1997a) showed that contaminated tank farm soil (Group 1) poses an unacceptable risk at the surface pathway. In addition, the tank farm soil and the INTEC injection well (Group 5) were determined in the OU 3-13 BRA to account for most of the contamination potentially threatening the aquifer within the INTEC security fence and were found to contribute most of the risk to future groundwater users.

The final action for the tank farm soil (Group 1) and SRPA (Group 5) within the INTEC security fence were assigned to OU 3-14 in the OU 3-13 ROD (DOE-ID 1999a), because DOE-ID, EPA, and IDEQ determined that available or collected data from past investigations were inadequate to select remediation alternatives for the sites

### 3.4.1 OU 3-13 Risk Assessment Uncertainties

The OU 3-13 ROD (DOE-ID-1999a) determined that the tank farm soils represent a risk resulting from direct radiation exposure and from leaching and transport of contaminants to the SRPA within the INTEC security fence. However, significant uncertainties remaining after completion of the OU 3-13 RI/FS prevented identification of a preferred remedial alternative. The work scope presented in this work plan is based in part on the risk assessment uncertainties identified in the OU 3-13 BRA and ROD in the extent, distribution, and composition of contamination present in the tank farm soils and in the extent of contaminant transport from the soils to the SRPA within the INTEC security fence. This subsection summarizes those identified uncertainty issues. The data collection activities presented in Section 4 are designed to address these issues.

**3.4.1.1 *Uncertainties in the Evaluation of Direct Exposure to Surface Soil Contamination.*** The magnitude of risk from surface exposure is large enough that the addition of small sites containing less than 1% of the tank farm inventory of radionuclides will not significantly affect this risk pathway. In addition, because the risk is well above the levels that drive remediation, further refinement of this risk serves no purpose. Uncertainties in evaluation of risk due to direct exposure to surface soil contamination are relatively small. Resolution of these uncertainties will not affect the need for remediation or the type of remedial action selected.

**3.4.1.2 *Uncertainties in the Evaluation of Risk from the Groundwater Pathway.*** Prediction of the exposure to contaminants in groundwater is based on numerical modeling of contaminant transport. The OU 3-13 ROD (DOE-ID 1999a) determined that the SRPA within the INTEC security fence might represent a risk to future groundwater users. Operable Unit 3-13 BRA risk estimates (DOE-ID 1997a) associated with predicted concentrations in the SRPA were deemed by the Agencies to be unacceptable because of modeling uncertainties. Therefore, a final remedial alternative for the SRPA within the INTEC security fence was not selected in the OU 3-13 RI/FS (DOE-ID 1997a, 1997b, 1998a). The uncertainties in the groundwater modeling that affect the calculated risk are discussed below.

A major factor in accurate prediction of contamination in the SRPA is the transport of contaminants through the vadose zone. This is especially important in terms of velocity of travel through the vadose zone for radionuclides with relatively short half-lives such as Sr-90, because the vadose zone

travel time is several half-lives and the risk via the groundwater pathway can vary by orders of magnitude by changes in transport time. Several factors affect transport time through the vadose zone. These factors include the following items:

- **Transport Time through Surface Sediments to Basalt**—The OU 3-13 BRA assumed that contaminants from tank farm soils were all instantaneously present at the top of basalt, and that there was no retention of contaminants in the tank farm soils. This was assumed because almost all of the liquid released to the tank farm soils was very acidic, the large amount of hydrogen ion may reduce sorption, and the many sites are located deep in the surface alluvium near the basalt. An alternative approach is appropriate, because sufficient carbonates are present in the alluvium soil to neutralize the acid.
- **Location and Thickness of Interbeds in the Vadose Zone**—The OU 3-13 RI/BRA numerical model simplified the vadose zone by combining the 13 or more interbeds into four effective interbeds separated by fractured basalt. The effective interbed structure was much more continuous than the observed structure, and the model predicted percolation pond water would spread laterally and recharge the perched water beneath the tank farm. The INTEC vadose zone tracer test and geochemical analysis (DOE-ID 2003a) indicate this may not be occurring. Additional data from Group 4 perched water investigations are available for a more accurate depiction of the interbeds and parameterization of the hydraulic properties.
- **$K_d$ s for COCs Sr-90 and Pu-239/240 in the Vadose Zone**—The  $K_d$ s used in the OU 3-13 BRA were extremely conservative and were based on the Track 2 guidance documents. Additional  $K_d$  data for these constituents in INEEL soils has been obtained since the OU 3-13 BRA modeling. The impact of  $K_d$  on the transport time for Sr-90 is very significant, because the half-life of Sr-90 (30 years) is relatively short, and the amount of Sr-90 modeled to be in the SRPA can vary by orders of magnitude with small changes in the  $K_d$  and resulting Sr-90 vadose zone travel time. The impact of  $K_d$  on the transport time of Pu-239/240 is also very significant, because the modeled risk from plutonium is within an order of magnitude of acceptable risk. The plutonium  $K_d$  used in OU 3-13 was 1 to 3 orders of magnitude smaller than the  $K_d$  used for vadose zone transport at other INEEL OUs, and the literature indicates that higher values are justified.
- **Surface Recharge Rate**—Infiltrating water moving down through the contaminated soils, mobilizing contaminants and eventually transporting them to the SRPA, is one of the most realistic scenarios for aquifer contamination beneath the INTEC. Therefore, infiltration is an important factor controlling contaminant migration, because infiltration is primarily responsible for the amount of dissolution and transport of contaminants from the contaminated tank farm soil. The OU 3-13 analysis used infiltration rates estimated at the INEEL's Subsurface Disposal Area, where soil and surface conditions are very different from the tank farm.
- **Source Term Uncertainty**—The knowledge of the nature and extent of contamination in the tank farm soils is partially bounded by existing data. Due to the high radiation fields associated with the contaminated soils, analysis of the soils has been difficult. However, the two sites that make up 99% of the known contamination have been defined. The further definition of small sources (1% of the total contamination) likely will not have a major impact on the need for remediation or the type of remediation selected.

### 3.4.2 Tank Farm Soil Contaminants of Potential Concern

This subsection presents the approach that will be used to identify tank farm soil COPCs. COPCs may be identified based on potential risks to human health and the environment or based on ARARs. The conceptual approach for identifying COPCs for specific sites is described below and shown in Figure 3-37:

1. Potentially complete exposure pathways for OU 3-14 are identified in the conceptual site model (CSM) shown in Figure 3-38. These include direct soil exposure to future workers and groundwater exposure to future residents at the downgradient boundary of the INEEL CERCLA Disposal Facility (ICDF).
2. The COPCs for those exposure pathways are identified based on screening results reported in the OU 3-13 RI/BRA report (DOE-ID 1997a), as discussed in Subsection 3.3 of this work plan and as identified in Tables 3-10 and 3-11 for soil exposure and groundwater exposure pathways, respectively. COPCs identified subsequent to publication of the OU 3-13 BRA, including nitrate and C-14, are included.
3. Analytes that have already been determined during previous investigations are identified for specific sites.
4. The site-by-site COPC lists are used as inputs to the DQO process. The DQO process, as described in Section 5, is used to design the field investigation. DQO Step 2 describes the approach used to determine the required rigor of the investigation at specific sites, based on the estimated fraction of total tank farm contamination released that is estimated to be present at a specific site. In DQO Step 7, some sites are determined on this basis to have sufficient data to adequately resolve the DQO decision statements and to require no further characterization for COPCs. Additionally, analytes previously determined at sites requiring further investigation may or may not be screened out at DQO Step 7 based on the rigor of the investigation.
5. The results of the DQO process identifying specific sites to be sampled for specific COPCs are used as inputs to the FSP.
6. Samples are collected.
7. Screening is performed before alpha- and beta-specific isotope analyses. Gross alpha readings of less than 20 pCi/g and gross beta readings of less than 30 pCi/g are less than INEEL background readings, and no further specific isotope analyses are typically performed.<sup>d</sup>

Preliminary COPCs required to be determined for specific sites to meet BRA data needs are shown in Tables 3-14 through 3-15.

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d. Personal communication from Beth McIlwain, INEEL Sample and Analysis Management, to John Keck, North Wind Environmental, Inc., November 17, 2003.

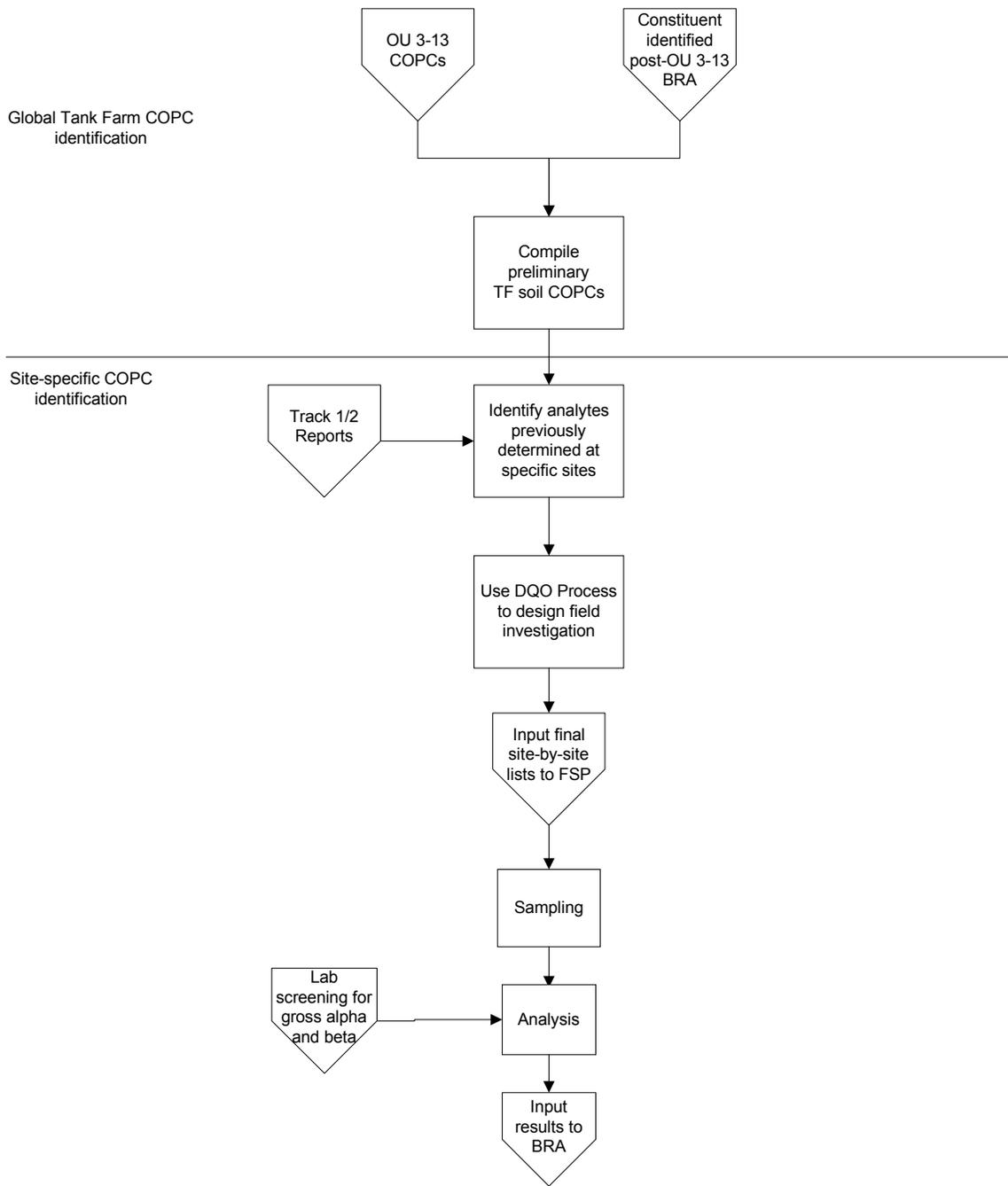


Figure 3-37. Decision logic for tank farm soil COPC identification.

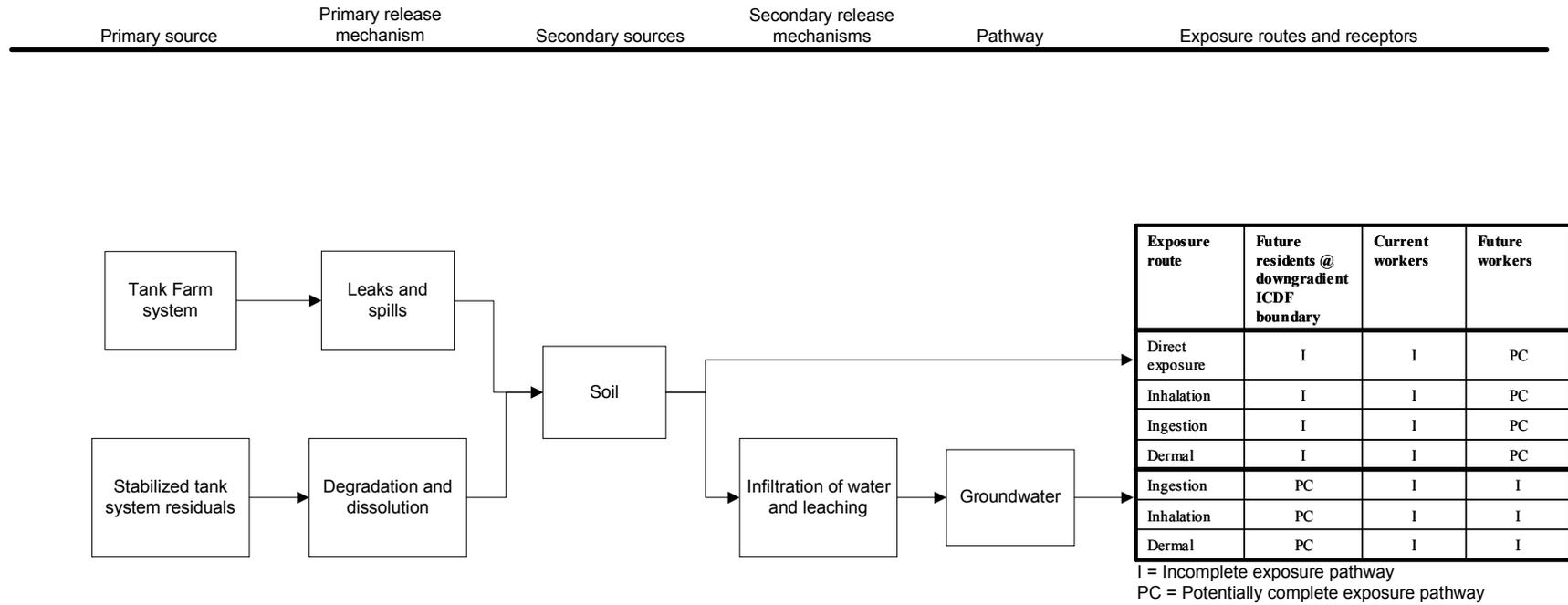


Figure 3-38. CSM for OU 3-14.

Table 3-14. Site-by-site preliminary summary of radionuclide analyses required to meet BRA data needs for OU 3-14 tank farm soil release sites. An asterisk indicates that the COPC has not been analyzed for at the site.

COPCs	CPP-15	CPP-20	CPP-25	CPP-26	CP-27	CPP-28	CPP-31	CPP-32(E)	CPP-32(W)	CPP-33	CPP-58(E)	CPP-58(W)	CPP-79
Radionuclide													
Am-241 <sup>g</sup>		*	*			*	*		*		*	*	
C-14 <sup>o</sup>	*	*	*	*	*	*	*	*	*	*	*	*	*
Cs-137 <sup>s,g</sup>		*	*			*	*		*			*	
Eu-154 <sup>s</sup>	*	*	*	*	*	*	*	*	*	*	*	*	*
H-3 <sup>g</sup>	*	*	*	*	*	*	*	*	*	*	*	*	*
I-129 <sup>g</sup>		*	*	*	*	*	*	*	*		*	*	*
Np-237 <sup>g</sup>		*	*	*	*	*	*	*	*		*	*	*
Pu-238 <sup>s,g</sup>		*	*			*	*		*			*	
Pu-239 <sup>s,g</sup>		*	*			*	*		*			*	
Pu-240 <sup>s,g</sup>		*	*			*	*		*		*	*	
Sr-90 <sup>s,g</sup>		*	*			*			*			*	
Tc-99 <sup>g</sup>		*	*	*	*	*	*	*	*	*	*	*	*
U-234 <sup>g</sup>		*	*			*	*		*			*	
U-235 <sup>s,g</sup>		*	*			*			*			*	
U-238 <sup>g</sup>		*	*			*	*		*			*	

g = groundwater COPC  
o = constituent identified post-OU 3-13 BRA  
s = soil exposure COPC

Table 3-15. Site-by-site summary of inorganic analyses required to meet BRA data needs for OU 3-14 tank farm soil release sites. An asterisk indicates that the COPC has not been analyzed for at the site.

Inorganics	CPP-15	CPP-20	CPP-25	CPP-26	CPP-27	CPP-28	CPP-31	CPP-32(E)	CPP-32(W)	CPP-33	CPP-58(E)	CPP-58(W)
Arsenic <sup>g</sup>	*	*	*	*	*	*	*	*	*		*	*
Chromium <sup>g</sup>	*	*	*		*	*	*		*		*	*
Mercury <sup>g</sup>		*	*			*	*		*			*
Nitrate <sup>o</sup>	*	*	*	*	*	*	*	*	*	*	*	*

g = groundwater COPC  
o = constituent identified post-OU 3-13 BRA

### 3.4.3 OU 3-14 BRA COPC Screening

Additional COPC screening will be performed during the OU 3-14 BRA using the approach outlined in DOE-ID (1997a) and discussed below.

**3.4.3.1 Background Comparison.** The chemical will be eliminated from quantitative evaluation in the RI/BRA if the maximum concentration for a given chemical is less than or equal to background concentrations (i.e., the 95/95 upper tolerance limit of composite background samples) as presented in *Background Dose Equivalent Rates and Surficial Soil Metal and Radionuclide Concentrations for the Idaho National Engineering Laboratory* (Rood et al. 1995).

**3.4.3.2 Concentration-Toxicity Evaluation.** The objective of a concentration-toxicity screen is to identify the chemicals that are based on concentration and toxicity and are most likely to contribute significantly to risks. The inputs used in this screening step include the inherent toxicity of individual

chemicals and the maximum detected concentrations at specific release sites (EPA 1989). Toxicity values used to calculate individual risk factors are slope factors (SFs) for carcinogens or the reciprocal of the reference dose (1/RfD) for noncarcinogens as shown in Equation (3-1). Thus, the risk factor for carcinogenic effects is the maximum detected concentration (or activity) multiplied by the SF for that chemical. The risk factor for noncarcinogenic effects is the maximum detected concentration divided by the RfD for that chemical:

$$R_i = C_i H T_i \quad (3-1)$$

where

- $R_i$  = chemical-specific risk factor for chemical
- $C_i$  = maximum detected concentration of chemical
- $T_i$  = toxicity value (either the SF or 1/RfD) for chemical.

For chemicals with separate oral and inhalation toxicity values, the most conservative value is used in the concentration-toxicity screen step. Chemicals without EPA-derived toxicity values cannot be screened out by this procedure, nor can specific health risks be estimated quantitatively. As a result, such chemicals will remain COPCs and will be discussed qualitatively in the uncertainty analysis. Radionuclides were not subject to the concentration-toxicity screen step.

To avoid eliminating chemicals prematurely, the concentration-toxicity evaluation for WAG 3 will be implemented on a basis that is specific to the contaminant group (i.e., inorganics and organics). Chemicals having carcinogenic and noncarcinogenic effects within the inorganic and organic groups are evaluated separately. Some analytes, such as arsenic, have both noncarcinogenic and carcinogenic effects and, as a result, are included in both the carcinogenic and noncarcinogenic screens.

After calculating individual chemical risk factors, they are summed to obtain the total risk factor ( $R_j$ ) for all chemicals in a medium. Individual chemical risk factors will then be divided by the total risk factor to derive a chemical-specific ratio ( $R_i/R_j$ ), which provides an index of the relative risk contributed by each chemical. All chemicals that contribute less than 1% (ratio of 0.01) of the overall risk factor will be eliminated from quantitative consideration in the RI/BRA. Consequently, chemicals advanced into the quantitative risk assessment will represent the COPCs expected to provide the most significant contribution to the risk at a particular site.

**3.4.3.3 Comparison Against Risk-Based Concentrations.** The last step in the chemical screening process is to compare COPC concentrations to RBCs. The comparison is limited to metals, inorganics, and organics. If the maximum concentration or 95% upper confidence level (UCL), whichever is less, for a given chemical is less than or equal to the most conservative RBC, as presented in the most current EPA Region 9 Risk-Based Concentration Table, the chemical will be eliminated from quantitative evaluation in the RI/BRA.

Because lead does not have an EPA Region 9 RBC, lead concentrations will be compared to the residential soil screening level of 400 mg/kg, as presented in EPA (1994).

## 3.5 Conceptual Site Model for Risk Assessment

This subsection discusses development of the OU 3-14 CSM, based on the site features and characteristics discussed previously, and the risk assessment summary presented in Subsection 3.2. The purpose of the CSM is to identify site-specific contaminant sources, exposure pathways, and receptors. The CSM is then used to do the following:

- Develop DQOs. The CSM is used to help define the principal study questions (PSQs) that the field investigation must help resolve (e.g., “Does a specific exposure pathway produce risks to a specific receptor above allowable levels?). The CSM is also used to help define decision inputs, define study boundaries, and design the investigation.
- Evaluate risks. The BRA uses data obtained from the field investigation and other sources to determine whether exposure pathways shown in the CSM are potentially complete and to quantitatively evaluate risks for each.
- Develop and evaluate remedial alternatives. The CSM helps to identify ways to reduce risks to allowable levels, including sources that can be removed or treated, exposure pathways and routes that can be eliminated or controlled, and receptors that can be protected through administrative controls.

### 3.5.1 Contaminant Sources and Pathways

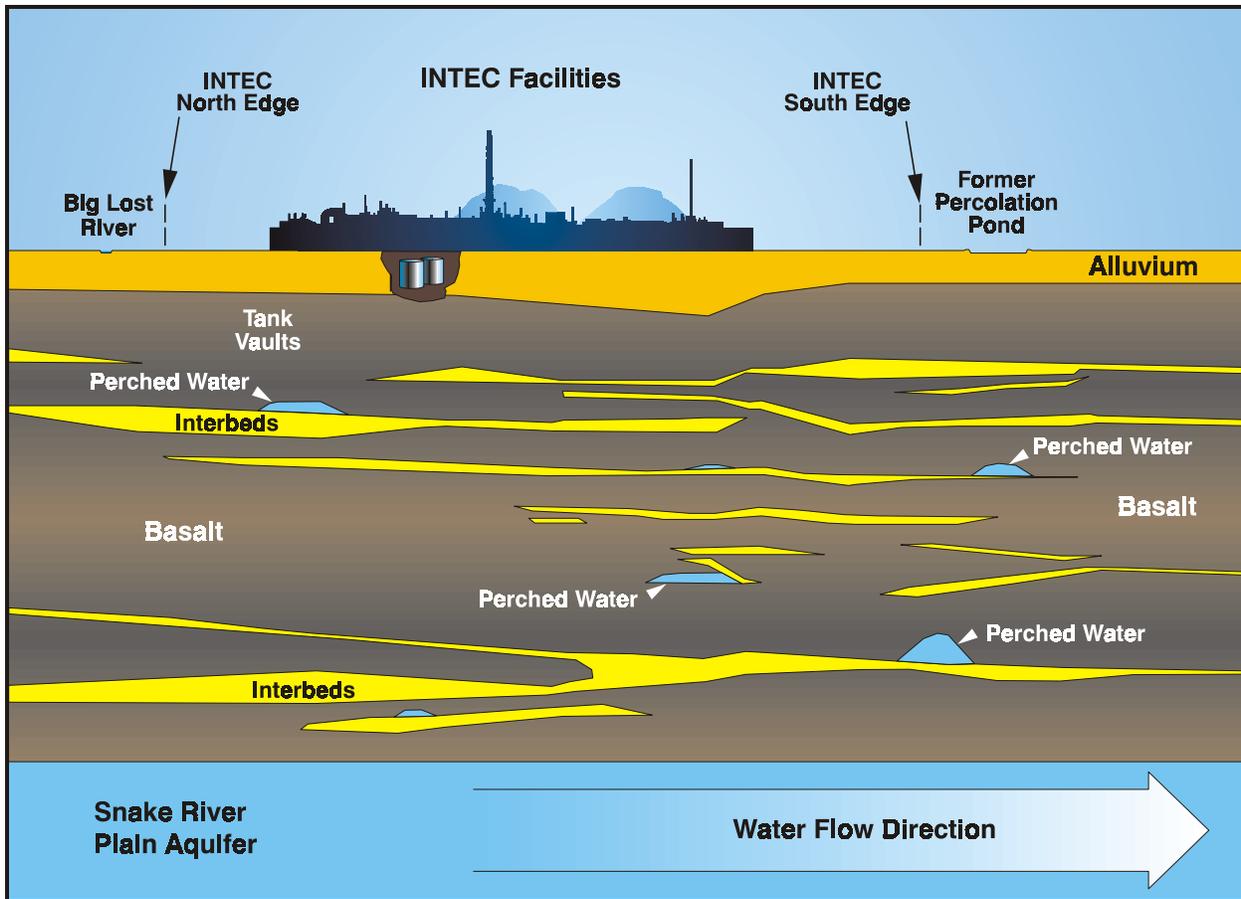
This subsection introduces the OU 3-14 conceptual model, which combines the site physical, chemical, and hydrologic features in the context of contaminant transport from sources to receptors. In addition, this subsection discusses the OU 3-14 CSM, which is based on the conceptual model and the risk assessment summary presented in Subsection 3.2. The conceptual model is further developed and discussed in detail in Section 4 of this work plan.

Features of the OU 3-14 conceptual model are shown in Figure 3-39. Significant features include the following:

- The INTEC facilities, which include the tank farm and other primary contaminant sources
- The alluvium underlying the INTEC facilities, which is a secondary contaminant source resulting from leaks and spills from the liquid waste transfer system
- The basalts, interbeds, and perched water underlying the alluvium; the physical and chemical properties of these media control contaminant transport rates from the secondary sources to the SRPA, as discussed in Sections 3 and 4
- The SRPA underlying the INTEC; given that the basalts, interbeds, and perched water are not accessible to human or environmental receptors, the SRPA is a primary exposure route of concern.

### 3.5.2 Surface Soil Exposure Routes and Receptors

Figure 3-38 identifies incomplete and potentially complete exposure pathways for current workers, hypothetical future workers, and hypothetical future residents at the downgradient ICDF boundary. Future workers are the only potential surface soil exposure pathway receptors, based on future land use assumptions described in Subsection 5.1.3. Future residents and all other users would be prohibited from accessing the tank farm in perpetuity, as described in Subsection 5.1.3.



G1020-01

Figure 3-39. INTEC conceptual model features.

Workers after 2095 could potentially occupy the site under industrial-use scenarios and excavate no deeper than 4 ft bgs to construct footings or other infrastructure supports. Exposure to soils contaminated by releases of liquid waste from the tank system could occur through direct exposure to radiation ingestion, dust inhalation, or dermal contact. Workers would not be exposed to stabilized tank residuals, since these are located below the 4-ft maximum depth of excavation, with adequate shielding provided by overlying soil to prevent direct radiation exposures above allowable levels.

### 3.5.3 Groundwater Exposure Routes and Receptors

Figure 3-38 identifies only future residents as potential groundwater exposure pathway receptors, based on future land use assumptions. The maximally exposed future resident would reside no closer than the downgradient ICDF boundary and would potentially be exposed to contamination from the tank farm via culinary or irrigation water obtained from a well completed in the SRPA at that location.

The future worker, however, is assumed to have a monitored and administratively controlled water supply from outside the SRPA area affected by OU 3-14 releases.

