Section 3 of 6

Document Information			
Document #	**DOE/ORP-2005-01**	**Revision**	**0**
Title	**INITIAL SINGLE-SHELL TANK SYSTEM PERFORMANCE ASSESSMENT FOR THE HANFORD SITE**		
DATE	**04/18/2005**		
Originator	**CONNELLY MP**	**Originator Co.**	**CH2M**
Recipient			
References			
Keywords			
Projects			
Other Information			

2.0 SITE AND WASTE CHARACTERISTICS

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2.7 DESCRIPTION OF WASTE MANAGEMENT AREA T

This section provides site-specific information for WMA T. It is a summarized from numerous documents that describe present conditions (Hanlon 2005), geology and hydrology (Reidel et al. 2006), subsurface contamination (Wood et al. 2001), and source terms (Kirkbride et al. 2005; Field and Jones 2005; Lambert 2005; Corbin et al. 2005).

2.7.1 Background

WMA T is located in the north-central portion of the 200 West Area. In general, the WMA T boundary is represented by the fenceline surrounding the T tank farm (Figure 2-44). WMA T contains twelve 100-Series SSTs and four 200-Series SSTs that were constructed between 1943 and 1944, put into service in 1944, and initially used to store bismuth phosphate waste from T Plant. Over its operating history, WMA T received waste from a variety of major chemical processing operations including bismuth phosphate fuel processing, uranium recovery, REDOX fuel processing, and fission product recovery. Because of a shortage of tank space during the early years of T tank farm operations, large quantities of liquid waste were intentionally discharged to the soil through a system of cribs and trenches constructed near and within WMA T.

The discovery or assumption of leaking tanks in WMA T between 1959 and 1977 prompted a decision to put the tanks out of service and remove the remaining liquids from the tanks. The last WMA T tank was removed from service in 1979. Currently, the pumpable liquid wastes have been removed from the WMA T tanks and all tanks have been interim stabilized. Table 2-9 lists the estimated volume of waste stored in the WMA T tanks as of November 30, 2004. Interim measures have been implemented at WMA T to minimize the infiltration from manmade water sources. These measures include well decommissioning, capping monitoring wells, testing and isolating water pipelines, and building berms around the tank farm boundaries.

Detailed discussion of T tank farm construction and operations along with historical information on soil surface and vadose zone contamination in WMA T is provided in Williams (2000). A detailed description of contaminant occurrences and environmental conditions at WMA T is provided in Wood et al. (2001).

Vadose zone field characterization activities were initiated at WMA T during fiscal year 2003 in support of RCRA Corrective Action requirements. The investigative approach for this work is described in Crumpler (2001). *Field Investigation Report for Waste Management Areas T and TX-TY* (Myers 2005) documents the results of these investigations.

Figure 2-44. Location Map of Waste Management Area T and Surrounding Facilities

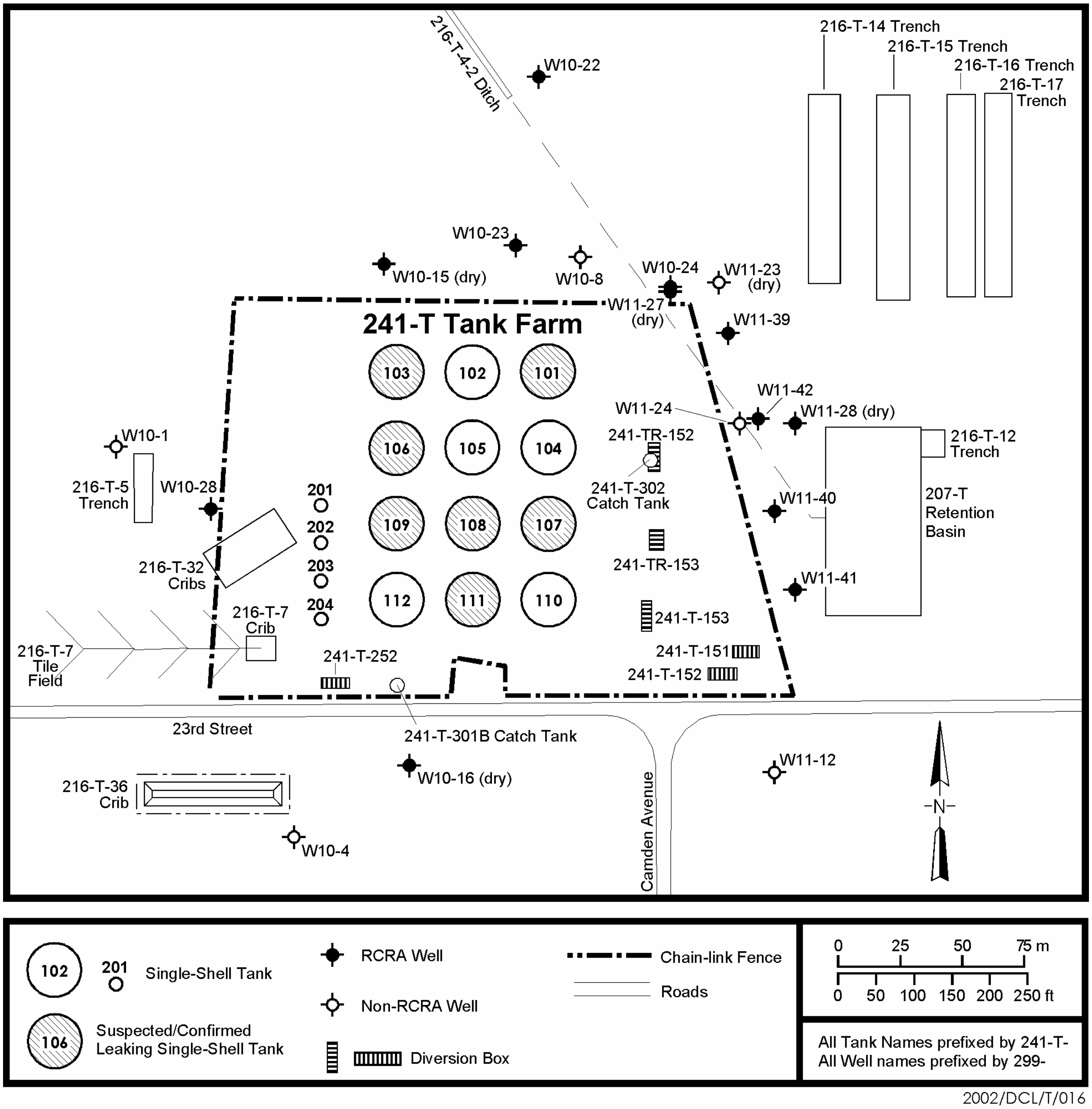


Table 2-9. Waste Volume Estimates as of November 30, 2004, in Waste Management Area T Single-Shell Tanks [a]

Tank	Total waste gal × 1,000	Supernate liquid gal × 1,000	Sludge gal × 1,000	Saltcake gal × 1,000
241-T-101	99	0	37	62
241-T-102	32	13	19	0
241-T-103	27	4	23	0
241-T-104	317	0	317	0
241-T-105	98	0	98	0
241-T-106	22	0	22	0
241-T-107	173	0	173	0
241-T-108	16	0	5	11
241-T-109	62	0	0	62
241-T-110	370	1	369	0
241-T-111	447	0	447	0
241-T-112	67	7	60	0
241-T-201	30	2	28	0
241-T-202	20	0	20	0
241-T-203	36	0	36	0
241-T-204	36	0	36	0

[a] Hanlon (2005).

2.7.2 Infrastructure

This section describes the WMA T infrastructure components that were included in the SST PA and listed in Table 2-10. Reference case inventory development for those components is described in Section 2.7.7. Refer to Section 2.4 for generic infrastructure component descriptions and Section 2.5 for a summary of infrastructure inventory development methods.

2.7.2.1 Single-Shell Tanks

The twelve 100-Series tanks are first generation SSTs that are 75 ft in diameter and approximately 29.75 ft tall from base to dome. Each tank has an operating capacity of 535,000 gal (Wood et al. 2001). The four 200-Series tanks are 20 ft in diameter and approximately 37.25 ft tall from base to dome. Each tank has an operating capacity of 55,000 gal. Typical tank configurations and dimensions are shown in Figure 2-45.

Table 2-10. Operating Period and Capacities for Waste Management Area T Facilities Included in the Performance Assessment [a]

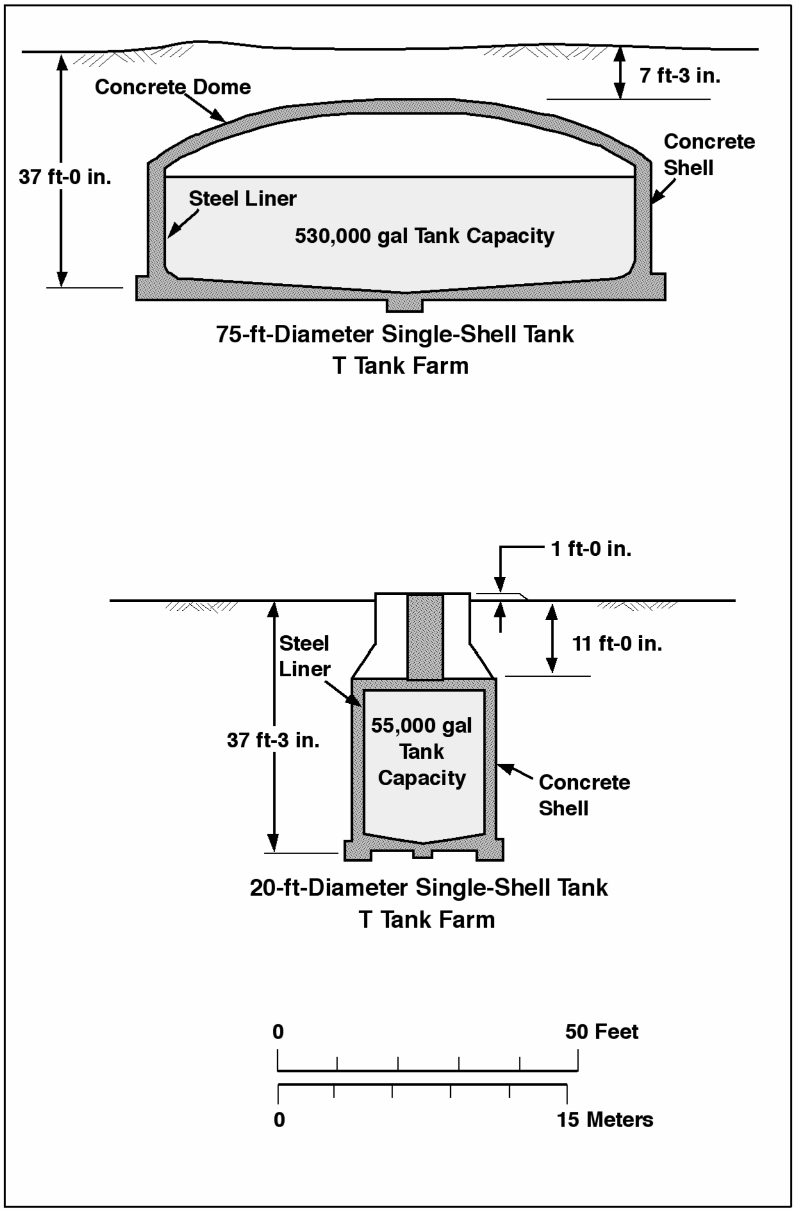
Facility	Removed From Service	Constructed	Operating Capacity gal
Single-Shell Tanks			
241-T-101	1979	1943 to 1944	530,000
241-T-102	1976		
241-T-103	1974		
241-T-104	1974		
241-T-105	1976		
241-T-106	1973		
241-T-107	1976		
241-T-108	1974		
241-T-109	1974		
241-T-110	1976		
241-T-111	1974		
241-T-112	1977		
241-T-201	1976		55,000
241-T-202	1976		
241-T-203	1976		
241-T-204	1976		
Miscellaneous Underground Storage Tanks			
241-T-301B catch tank	1985	1944	36,000
241-T-302 catch tank [b]	NA	NA	NA
Underground Waste Transfer Lines			
241-T tank farm pipelines	NA	1943 to 1944	20,600 (+/-6,800)

[a] Data on the facilities is from DOE-RL (2005) and Field (2003a).

[b] Information in DOE-RL (2005) indicates this tank does not exist.

NA = not applicable

Figure 2-45. Typical Configuration and Dimensions of Single-Shell Tanks in Waste Management Area T



The WMA T SSTs were all constructed in place with carbon steel lining the bottom and sides of a reinforced concrete shell. All of the tanks have a dish-shaped bottom. The sediment cover from the apex of the tank domes to ground surface is 7.3 ft for the 100-Series tanks and 11 ft for the 200-Series tanks (Wood et al. 2001). The 100-Series tanks were constructed with cascade overflow lines in three-tank series to allow gravity flow of liquid waste between the tanks. The cascade overflow height is 15.67 ft from tank bottom. The 200-Series tanks were connected and fed to diversion box 241-T-252.

2.7.2.2 Ancillary Equipment

A complete listing of the WMA T ancillary equipment currently identified for inclusion in the SST system closure is provided in Lee (2004). As discussed in Section 2.5.4, the ancillary components included in the SST PA consist of the underground waste transfer lines and MUSTs located inside each WMA boundary. For WMA T, the ancillary components analyzed consist of the T tank farm waste transfer piping and one MUST (241-T-301B catch tank). Although the 241-T-302 catch tank is listed in HFFACO (Ecology et al. 1989), it has been verified that this tank was never constructed (DOE-RL 2005). Multiple sets of waste transfer piping were installed in WMA T over time. A time line of piping installations is described in Williams (2000). It is estimated that there are approximately 10.6 mi (+/-3.5 mi) of waste transfer piping in WMA T (Field 2003a).

Portions of two intentional discharge facilities (216-T-32 crib, 216-T-7 crib) are located inside the WMA T boundary (Figure 2-44). As discussed in Section 2.5.2, intentional discharge facilities are not included in the SST PA. Those facilities will be evaluated in the future under the integrated regulatory closure process described in Chapter 1.0.

2.7.3 Geology

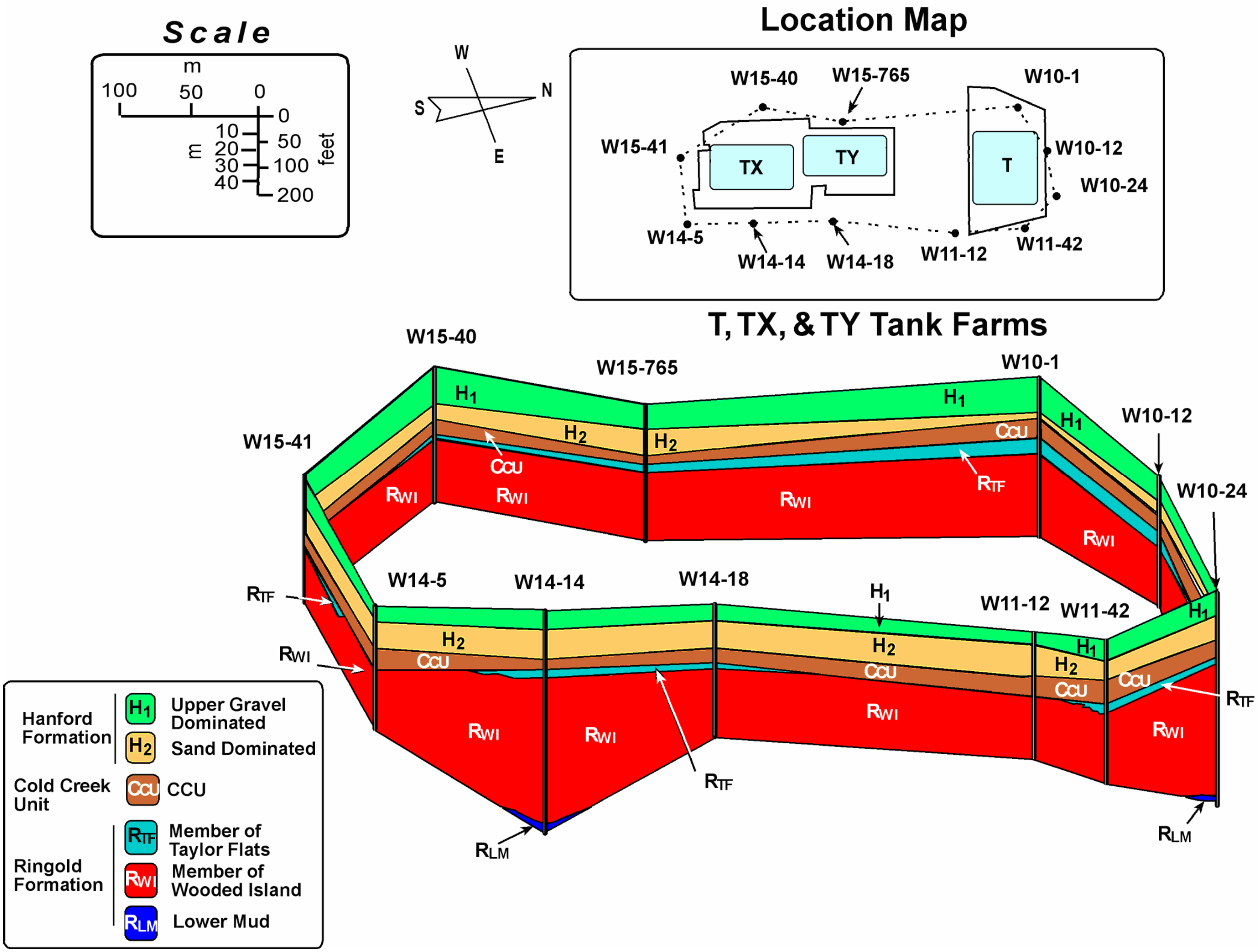
Following is an overview of the geology of WMA T. More detailed information can be found in Reidel et al. (2006) and Wood et al. (2001). A generalized cross-section through WMA T is shown in Figure 2-46. Maps and cross-sections presented in Reidel et al. (2006) illustrate the distribution and thicknesses of these units in additional detail.

Seven stratigraphic units are recognized within WMA T. From oldest to youngest, the primary geologic units are:

- Columbia River Basalt Group
- Ringold Formation – member of Wooded Island
- Ringold Formation – member of Taylor Flat
- Cold Creek unit – lower carbonate-unit and upper silt-rich unit (CCU)
- Hanford formation – sand-dominated sequence (H2 subunit)
- Hanford formation – upper gravel-dominated sequence (H1 subunit)
- Backfill.

The general characteristics of these units are described in Section 2.3.4.1 and in more detail in Reidel et al. (2006). The SSTs at WMA T were emplaced within the Hanford formation sediments of the upper gravel-dominated Hanford (H1) unit. All but the surface of the Hanford formation have a general tendency to dip west to southwest toward the axis of the Cold Creek syncline (Figure 2-8 in Section 2.3). The vadose zone beneath WMA T is approximately 67 m (220 ft) thick. The water table lies in the Ringold Formation, and the unconfined aquifer is located entirely within the Ringold Formation.

Figure 2-46. Fence Diagram Showing Cross-Sections through Waste Management Areas T and TX-TY [a]



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[a] *Reidel et al. (2006)*

2.7.4 Hydrology

Following is an overview of the hydrology of the uppermost, unconfined aquifer beneath WMA T. The general geohydrology of the Hanford Site is summarized in Section 2.3.5.2. More detailed information can be found in Reidel et al. (2006), Wood et al. (2001), and Hartman et al. (2004). Groundwater flow direction in the vicinity of WMA T has been variable because of changes in effluent discharges within the 200 West Area, principally to the 2T Pond system and the U Pond. Currently, the general groundwater flow direction in the unconfined aquifer beneath WMA T is to the east. The estimated hydraulic gradient in this region is 0.001. The general groundwater flow velocity ranges from 0.003 to 0.024 m/day (Hartman et al. 2004).

Between the late 1940s and early 1950s, the water table in the vicinity of WMA T, as measured in wells 299-W10-1, 299-W10-4, and 299-W10-8, rose rapidly due to discharges to the T Pond. The water table was at its highest elevation in about 1956 after having risen about 15 m. Another rise in the water table occurred during the 1970s and 1980s in response to disposal to the U Pond. Water table elevations began to decline in the mid 1980s when discharges to the vadose zone began to be curtailed and that decline is continuing today.

Currently, the water table beneath WMA T lies approximately 136 m amsl with about 71 m of vadose zone. The unconfined aquifer ranges in thickness from 50 to 55 m. The aquifer resides in partially cemented sands and gravels of the Ringold Formation member of Wooded Island (subunit E). Hydraulic conductivity values reported for the aquifer in this area range from 1 to 28 m/day (Hartman et al. 2004). Additional hydraulic property data from aquifer testing at wells near WMA T is provided in Reidel et al. (2006) and Hartman et al. (2004).

2.7.5 Vadose Zone Conditions

This section summarizes WMA T vadose zone monitoring and characterization activities and the current understanding of contamination in the vadose zone.

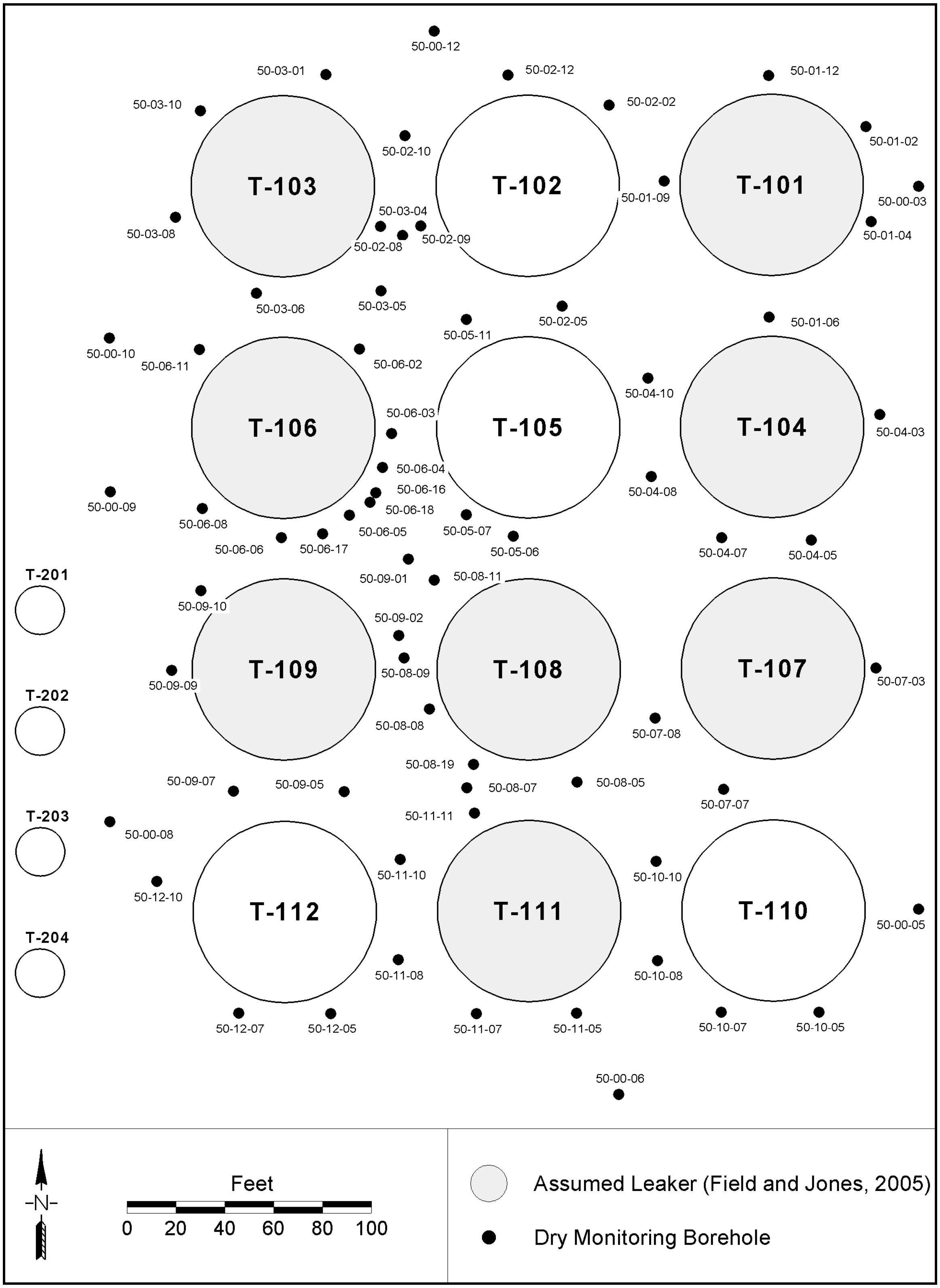
2.7.5.1 Monitoring and Characterization

WMA T has 68 drywells available for leak detection monitoring. These drywells were drilled from 1944 to 1974. The depth ranges for these drywells are between 80 and 150 ft bgs, except for drywell 50-06-18, which is 180 ft bgs. The T tank farm layout showing drywell locations in reference to tanks is shown in Figure 2-47.

Both gross gamma ray and spectral gamma logging methods have been performed in the WMA T drywells. Gross gamma logging data from the drywells were used as part of the leak detection program until 1994. In 1998, WMA T drywells were logged with a high-resolution spectral gamma logging system and the results were published in DOE-GJO (1999a).

In 2000, repeat logging of selected borehole intervals and enhancements to the original baseline characterization data evaluation process were performed for drywells in WMA T. This updated information is documented in DOE-GJO (2000c). These efforts were part of the baseline characterization for WMA T.

Figure 2-47. Vadose Zone Monitoring Network for Waste Management Area T



Field characterization efforts were initiated at WMA T in fiscal year 2003 in support of RCRA Corrective Action requirements. The investigative approach for this work (Crumpler 2001) was developed based on historical information (Williams 2000), geologic and hydrologic conditions (Wood et al. 2001), and gamma-logging data (DOE-GJO 1999a, 2000c). The characterization efforts include collection of vadose zone sampling data from the following activities:

- Installation of two soil characterization boreholes (C4104 and C4105) around tank T-106
- Shallow vadose zone soil investigation around tank T-101.

A detailed discussion of these investigations and an analysis of the results are included in the FIR for WMA T (Myers 2005).

2.7.5.2 Contamination

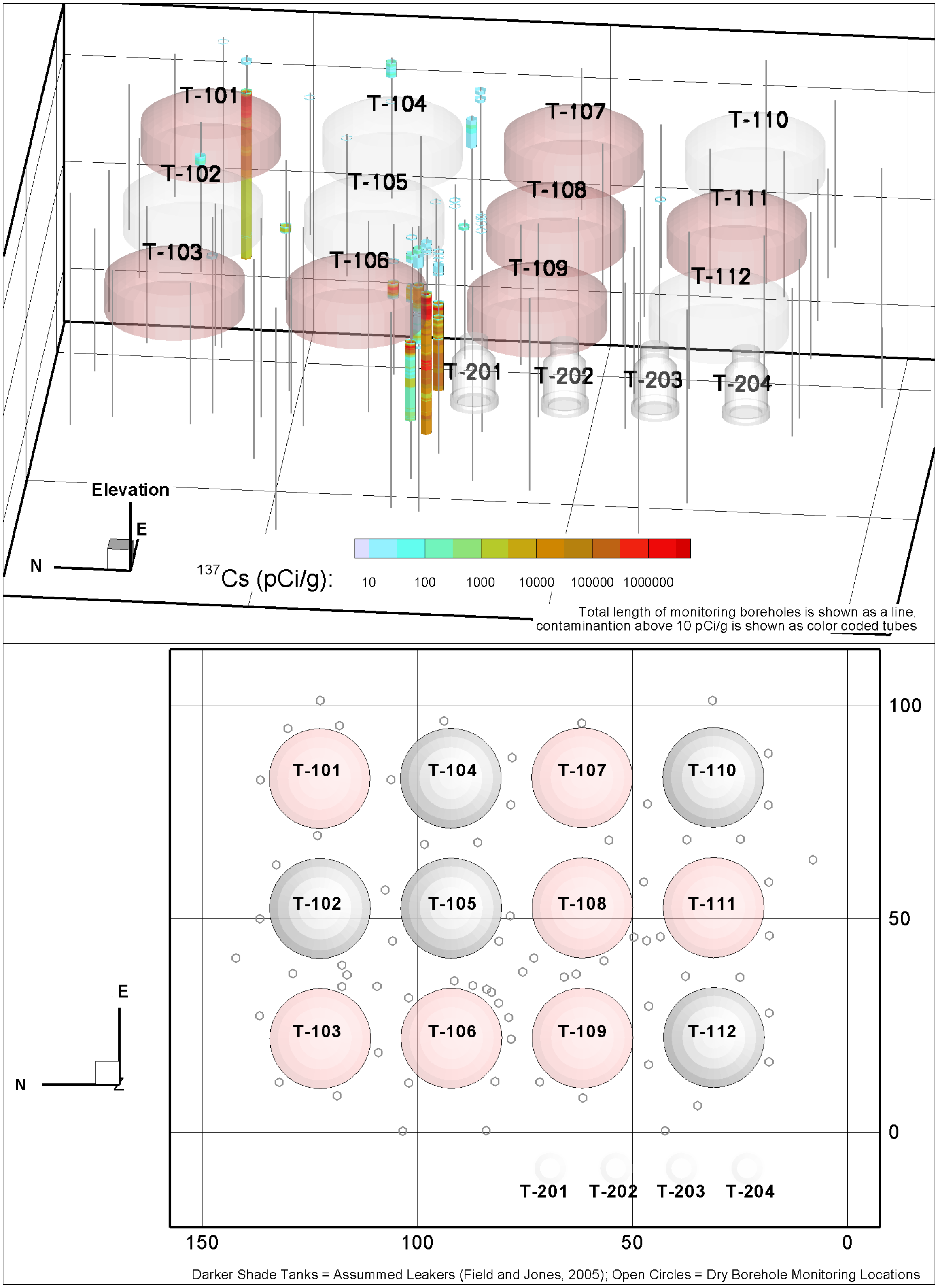
Figure 2-48 provides a visualization of the vadose zone contamination beneath WMA T as represented by cesium-137 data. This figure shows a three-dimensional perspective of WMA T providing locations of tanks and associated drywells. Tanks considered to be assumed leakers based on information in Field and Jones (2005) are shown with darker shading. Each drywell is represented with a single vertical line. Shaded rings around the drywells indicate the level of vadose zone contamination based on spectral gamma logging results. Only the more significant soil contamination zones (>10 pCi/g) are shown. Zones with contamination levels less than 10 pCi/g are not shown.

Detailed interpretation of the historical gross gamma and recent spectral gamma surveying at WMA T is provided in Wood et al. (2001). The primary gamma-emitting contaminants detected in the vadose zone beneath WMA T are cesium-137, cobalt-60, europium isotopes, and ruthenium-106. Minor quantities of antimony-125, niobium-94, and tin-126 are also detected.

The primary areas of elevated gamma readings occur in drywells located around tanks T-101, T-103, and T-106 (Figure 2-47). The presence of contamination in these areas is consistent with the locations of postulated leak events based on the WMA T historical record (Wood et al. 2001). A thick zone of high cesium-137 concentration (10^4 to 10^8 pCi/g) occurs in drywell 50-01-04 on the east side of tank T-101, beginning at a depth of about 25 ft and extending intermittently to the bottom of the drywell at a depth of 125 ft. Two additional tank T-101 drywells (50-01-06, 50-01-09) also show zones of elevated gamma contamination.

Gamma readings from drywell 50-03-04 on the southeast side of tank T-103 indicate the presence of a small zone of cesium-137 contamination (1 to 10 pCi/g) at a depth of 20 ft, along with the presence of cobalt-60, europium isotopes, and other gamma-producing contaminants. Other nearby drywells (50-03-05, 50-02-08, 50-02-09) show similar gamma contamination profiles to those detected in drywell 50-03-04. Interpreted historical gamma data from drywell 50-02-09 indicate migration of ruthenium-106, antimony-125, and europium isotopes at 32 to 48 ft from 1976 through 1985 (Wood et al. 2001).

Figure 2-48. Three-Dimensional Perspective of Waste Management Area T Tanks and Drywells Showing Occurrence of Significant (>10 pCi/g) Cesium-137 Contamination in the Vadose Zone



Total length of monitoring boreholes is shown as a line, contaminantion above 10 pCi/g is shown as color coded tubes

Darker Shade Tanks = Assummed Leakers (Field and Jones, 2005); Open Circles = Dry Borehole Monitoring Locations

The largest grouping of WMA T drywells containing elevated gamma contamination is in the vicinity of tank T-106. The presence of extensive vadose zone contamination in this area is consistent with a 1973 supernate leak from tank T-106 that is the largest (115,000 gal) and most thoroughly documented SST leak in Hanford Site history. The first extensive study of the tank T-106 leak was done shortly after it occurred (ARHCO 1973), and a followup study was completed in 1978 (Routson et al. 1979). In 1994, to provide greater understanding of the nature and extent of vadose contamination, an extensive sampling and analysis program was completed on soil samples taken from a borehole near the center of the tank T-106 leak (Freeman-Pollard et al. 1994). A synthesis of available vadose zone contamination data related to the tank T-106 leak is provided in Wood et al. (2001). These data along with additional data from two soil characterization boreholes installed around tank T-106 during WMA T field characterization efforts was analyzed in depth in Myers (2005).

A large number of drywells contain contamination from the tank T-106 leak because of the large extent of the leak and the high density of drywells constructed to quantify the soil column contamination caused by this leak. Historical gross gamma and spectral gamma data collected in these wells provide the most complete characterization data set of any tank farm leak on the Hanford Site. The gamma data reveal zones of different gamma signatures with increasing distance from the leak source, indicating that extensive lateral as well as vertical spreading of the leak occurred (Wood et al. 2001).

The location of the tank T-106 leak appears to be on the southeast part of the tank wall near the bottom of the tank (Wood et al. 2001). Two drywells adjacent to tank T-106 in this area (50-06-05 and 50-06-17) have zones of very high cesium-137 concentration (10^8 pCi/g) beginning near the tank bottom at 35 ft and extending to a depth of about 100 ft. Cesium-137 concentrations decrease with increasing distance from the inferred source. At the outer margins of the inferred leak area, no cesium-137 is detected. Gamma ray activity in drywells located at the outer margins of the leak is primarily from cobalt-60, which frequently extends to the drywell bottoms (Wood et al. 2001).

Interpretation of the historical gamma data collected from 1975 through 1994 indicates ruthenium-106 and cobalt-60 migration in most of the drywells that intercepted the tank T-106 leak plume (Wood et al. 2001). Downward migration of ruthenium-106 and cobalt-60 at drywells 50-00-09 and 50-09-10 appears to have occurred near the tank bottom around 1980 and again at greater depths (about 60 to 100 ft) in the late 1980s. Cesium-137 migration is indicated in the leak location area in the late 1970s.

Spectral gamma logging data also indicate the presence of generalized near-surface contamination across WMA T. The contamination is typically 1 to 10 pCi/g or less and is largely constrained to the first 10 ft of the soil column (Wood et al. 2001). The contamination is related to minor releases of contaminated fluids during tank farm operations that made relatively insignificant contributions to vadose zone contamination.

2.7.6 Unconfined Aquifer Conditions

This section summarizes WMA T groundwater monitoring and characterization activities and the current understanding of contamination in the unconfined aquifer.

2.7.6.1 Monitoring and Characterization

A detection level RCRA groundwater monitoring program for WMA T was initiated in 1989, and the WMA was placed into assessment status in 1993 because specific conductance limits were exceeded in downgradient monitoring well 299-W10-15 (Caggiano and Chou 1993). Specific conductance values in well 299-W10-15 dropped below the critical mean in 1994; however, before the WMA could be returned to a detection level monitoring program, specific conductance in well 299-W11-27 started a rapid increase in late 1995 and exceeded the critical mean in early 1996. Accordingly, WMA T continues to be monitored under a groundwater quality assessment program.

The increased specific conductance in well 299-W11-27 was accompanied by elevated technetium-99, tritium, nitrate, calcium, magnesium, sulfate, chromium, cobalt-60, and total organic carbon. Results of the initial groundwater quality assessment at WMA T found evidence linking the contaminants in groundwater to the WMA (Hodges 1998). The groundwater monitoring plan governing activities at WMA T is contained in Hodges and Chou (2001a) and its revision (Hodges and Chou 2002). RCRA groundwater assessment monitoring results are included in quarterly reports to Ecology and annually, as required, in the groundwater monitoring annual reports. Monitoring under the assessment-monitoring program will continue until the entire WMA is closed and post-closure monitoring is implemented, or until such time that there is a shift in the monitoring status of the WMA. Changes in the monitoring program status will be documented in an approved groundwater monitoring plan.

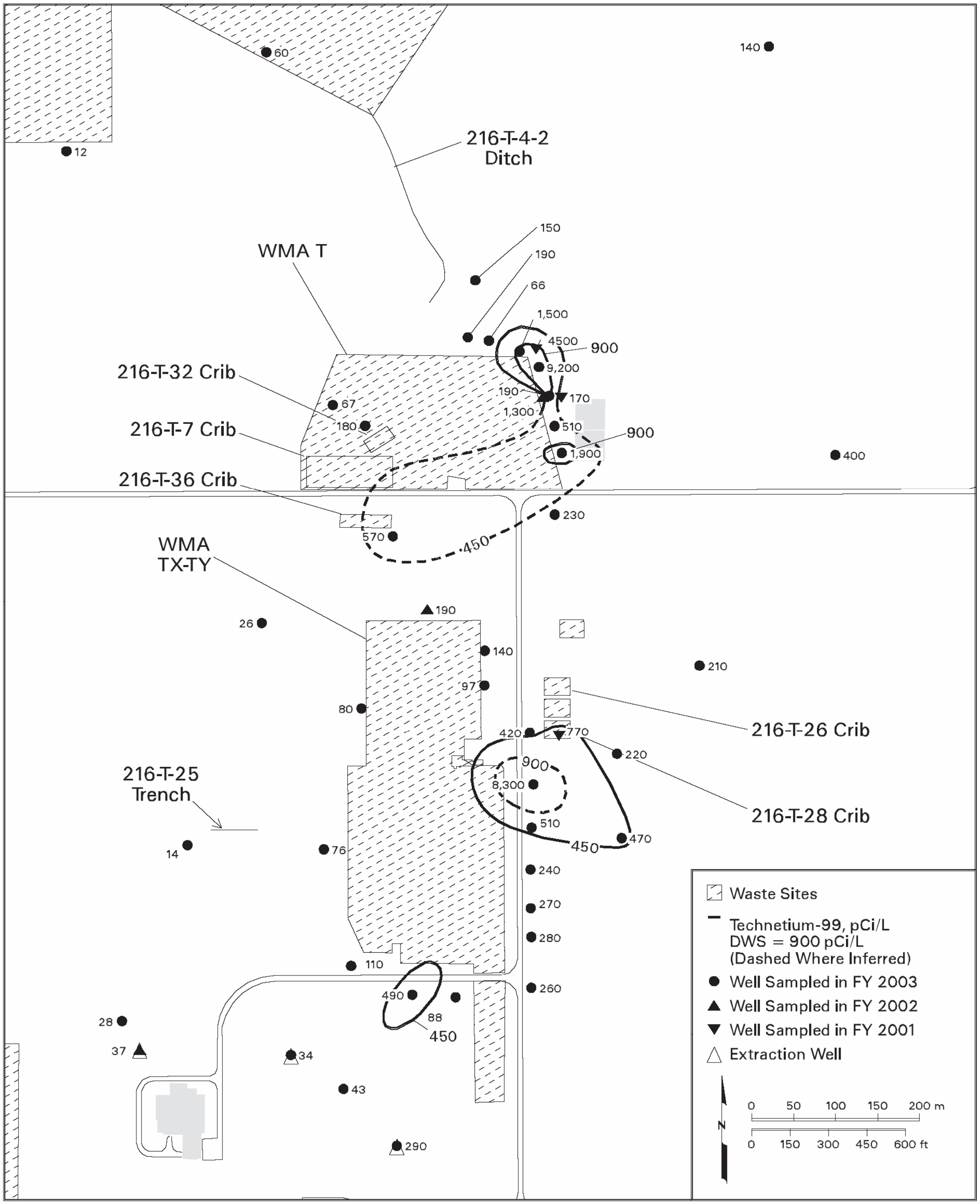
2.7.6.2 Contamination

Groundwater beneath WMA T is contaminated with technetium-99, carbon tetrachloride, trichloroethene, chromium, nitrate, and fluoride (Hartman et al. 2004). Horton et al. (2002) also lists concentrations of gross beta, tritium, and manganese as exceeding the respective MCLs in the groundwater around WMA T. Hartman et al. (2004) provides data for fiscal year 2003 and states that WMA T does not appear to be the source of most of the contamination, except for technetium-99 (and by inference gross beta), in the uppermost aquifer. Carbon tetrachloride and trichloroethene contamination is attributed to Plutonium Finishing Plant operations. Nitrate contamination also is attributed to Plutonium Finishing Plant operations as well as past-practice disposal to cribs and trenches near WMA T. Chromium, fluoride, and tritium contamination is attributed to cribs and trenches upgradient of WMA T. The elevated manganese concentrations are believed to be a consequence of reducing conditions around the monitoring wells. The exceptionally high concentration measured at well 299-W11-24 is believed to have been caused by the very fine particulates in the mud at the bottom of well, which had less than 1 m of water in the well when the sample was taken.

Since late 2000 and early 2001, technetium-99 concentrations in the area have increased substantially. During fiscal year 2003, the highest technetium-99 concentration in those wells was 2,600 pCi/L in well 299-W11-41 (Hartman et al. 2004). Apparently, technetium-99 is migrating toward the south along the east edge of WMA T from the northeast corner of the

WMA (Figure 2-49). This migration is coincident with a shift in groundwater flow direction from northeastward before 1996 to 1997 to eastward or slightly southeastward after 1997 (Hartman et al. 2004). Technetium-99 is also increasing upgradient of WMA T, with corresponding increases in chromium and nitrate, near the 216-T-36 crib, but this increase is attributed to the 216-T-5, 216-T-7, or 216-T-36 cribs.

Figure 2-49. Technetium-99 Distribution in Groundwater at Waste Management Area T [a]



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[a] *Hartman et al. (2004)*

2.7.7 Reference Case Source Terms

The reference case describes a set of assumed post-retrieval conditions that are based on current waste retrieval plans. The reference case analysis for WMA T includes three source terms consisting of past UPRs, residual SST waste, and residual ancillary equipment waste. Table 2-11 provides a listing of the reference case source terms for WMA T, and the inventory data source for that source term.

Source term inventories (reference case) for WMA T are provided in Table 2-12. To simplify the table, only the contaminants that dominate post-closure impacts are shown. All BBI contaminants are included in the reference case modeling analysis. Refer to Section 2.5 for a summary of source term inventory development methods. Complete source term inventory data are provided in Appendix C.

2.7.7.1 Past Unplanned Releases

The WMA T reference case includes six past UPRs associated with SSTs (T-101, T-103, T-106, T-108, T-109, T-111). Volume estimates for those six waste loss events were developed by Field and Jones (2005) and vadose zone contaminant inventories were generated by Corbin et al. (2005) (Section 2.5.2). No volume or inventory estimates were assigned to the waste loss event associated with tank T-107 because of insufficient information to quantify or verify the release (Field and Jones 2005). If new information becomes available to quantify the waste loss event from that tank, the data will be evaluated under the integrated regulatory closure process described in Chapter 1.0.

2.7.7.2 Residual Single-Shell Tank Waste

The WMA T reference case includes residual waste in each of the twelve 100-Series and four 200-Series SSTs in the T tank farm. The HFFACO Milestone M-45-00 goal allows up to 360 ft^3 of waste to remain in the 100-Series tanks after retrieval in the event that retrieval beyond that level becomes impracticable (Ecology et al. 1989). Thus, the analysis included a 360 ft^3 source term associated with residual waste remaining in each of the tanks after retrieval. The inventory estimates were generated with the use of the HTWOS model (Kirkbride et al. 2005), which accounts for the waste retrieval technology and tracks the fate of soluble and insoluble constituents in the waste (Section 2.5.3).

2.7.7.3 Residual Ancillary Equipment Waste

Lambert (2005) identified no plugged and blocked piping in the T tank farm. The reference case ancillary equipment source term for WMA T therefore included one ancillary component, the 241-T-301B catch tank (Section 2.5.4). The estimated volume of residual waste in that tank was calculated by assuming the tank would be retrieved to a residual volume proportional to that required under the HFFACO Milestone M-45-00 for 200-Series tanks (Ecology et al. 1989). Contaminant inventories for the tank were estimated using the average chemical composition of the waste in WMA T SSTs.

Table 2-11. Reference Case Analysis of Waste Management Area T (2 pages)

Inventory and Source Terms					
Sources	**Assumed Retrieval Method**	**Residual Volume**	**Volume Associated with Past Release [a] gal**	**Basis for Contaminant Inventory Estimate**	
				Residual Waste [b]	**Past Release**
241-T-101	Mobile retrieval system	360 ft^3	10,000	HTWOS	Corbin et al. 2005
241-T-102	Sluicing	360 ft^3	None	HTWOS	None
241-T-103	Mobile retrieval system	360 ft^3	3,000	HTWOS	Corbin et al. 2005
241-T-104	Sluicing	360 ft^3	None	HTWOS	None
241-T-105	Sluicing	360 ft^3	None	HTWOS	None
241-T-106	Mobile retrieval system	360 ft^3	115,000	HTWOS	Corbin et al. 2005
241-T-107 [c]	Mobile retrieval system	360 ft^3	NSI [c]	HTWOS	None
241-T-108	Mobile retrieval system	360 ft^3	1,000	HTWOS	Corbin et al. 2005
241-T-109	Mobile retrieval system	360 ft^3	1,000	HTWOS	Corbin et al. 2005
241-T-110	Sluicing	360 ft^3	None	HTWOS	None
241-T-111	Mobile retrieval system	360 ft^3	1,000	HTWOS	Corbin et al. 2005
241-T-112	Sluicing	360 ft^3	None	HTWOS	None
241-T-201	Vacuum	30 ft^3	None	HTWOS	None
241-T-202	Vacuum	30 ft^3	None	HTWOS	None
241-T-203	Vacuum	30 ft^3	None	HTWOS	None
241-T-204	Vacuum	30 ft^3	None	HTWOS	Corbin et al. 2005

Table 2-11. Reference Case Analysis of Waste Management Area T (2 pages)

Inventory and Source Terms					
Sources	**Assumed Retrieval Method**	**Residual Volume**	**Volume Associated with Past Release [a] gal**	**Basis for Contaminant Inventory Estimate**	
				Residual Waste [b]	**Past Release**
241-T-301B catch tank [d]	TBD [d]	19.6 ft^3	None	Average	None
241-T tank farm pipelines [e]	TBD	0	None	Lambert 2005	NA

[a] Past leak volumes listed in Field and Jones (2005).

[b] Residual inventories from HTWOS model output (Kirkbride et al. 2005).

[c] NSI = not sufficient information. Tank T-107 is identified as a “confirmed or suspected” leaker in Hanlon (2005) but both Hanlon (2005) and Field and Jones (2005) state there is insufficient information for developing a leak volume at this time. As information becomes available, a leak volume will be developed.

[d] TBD = to be determined. Final disposition of MUSTs not yet determined; however, MUSTs were carried forward in the assessment assuming MUSTs will be retrieved to at least the HFFACO goal (Ecology et al. 1989, Milestone M-45-00) equivalent to the 200-Series tanks. The residual volume is calculated by ratio of the total volume of the MUST to the 200-Series tanks (e.g., the retrieval goal for the 55,000-gal 200-Series tanks is 30 ft^3; thus, a MUST that is ⅔ the size of the 200-Series tank would have a residual volume of 20 ft^3). Inventory was calculated based on average waste per ft^3 within the WMA calculated from the HTWOS model (Kirkbride et al. 2005).

[e] Final disposition of pipelines is not yet determined; however, pipelines were carried forward in the assessment. Pipeline residual volumes shown represent the volume of waste in plugged or blocked pipelines as determined by Lambert (2005).

NA = not applicable

Table 2-12. Reference Case Inventory Estimates for Waste Management Area T

Source Type	Dominant Contaminants for Groundwater Pathway Impacts [a]							Dominant Contaminants for Inadvertent Intruder Impacts [a]						
	C-14 Ci	Tc-99 Ci	I-129 Ci	Cr(VI) kg	NO_3 kg	NO_2 kg	U kg	Sr-90 Ci	Tc-99 Ci	Sn-126 Ci	Cs-137 Ci	Pu-239 Ci	Pu-240 Ci	Am-241 Ci
Past releases [b]	1.15E+00	3.90E+01	2.60E-02	5.36E+02	3.37E+04	1.53E+04	1.34E+01	6.17E+03	3.90E+01	5.02E-01	1.27E+04	2.22E+00	5.11E-01	7.98E+00
Tank residuals	3.63E-02	1.49E+00	4.20E-04	2.46E+02	4.96E+03	8.30E+02	1.02E+03	4.33E+03	1.49E+00	1.24E-02	8.13E+02	4.19E+01	5.63E+00	9.37E+00
Ancillary equipment residuals [c]	1.60E-04	6.58E-03	1.85E-06	1.08E+00	2.19E+01	3.67E+00	4.52E+00	NA	NA	NA	NA	NA	NA	NA

[a] The reference case analysis included all BBI contaminants. As described in Bowen (2004), the standard analyte list tracked in the BBI contains **25 chemicals** including:

- aluminum
- bismuth
- calcium
- chlorine
- chromium
- fluorine
- total inorganic carbon as carbonate
- iron
- mercury
- potassium
- lanthanum
- manganese
- sodium
- nickel
- nitrite
- nitrate
- oxalate
- lead
- phosphate
- silicon
- sulfate
- strontium
- uranium total
- zirconium
- total organic carbon

and **46 radionuclides** including:

- tritium
- carbon-14
- nickel-59
- cobalt-60
- nickel-63
- selenium-79
- strontium-90
- yttrium-90
- zirconium-93
- niobium-93m
- technetium-99
- ruthenium-106
- cadmium-113m
- antimony-125
- tin-126
- iodine-129
- cesium-134
- cesium-137
- barium 137m
- samarium-151
- europium-152
- europium-154
- europium-155
- radium-226
- actinium-227
- radium-228
- thorium-229
- protactinium-131
- thorium-232
- uranium-232
- uranium-233
- uranium-234
- uranium-235
- uranium-236
- neptunium-237
- plutonium-238
- uranium-238
- plutonium-239
- plutonium-240
- americium-241
- plutonium-241
- curium 242
- plutonium-242
- americium-243
- curium-243
- curium-244

[b] Inventories shown are the combined inventories from SST past releases and ancillary equipment past releases. Both release types were considered for the groundwater pathway analysis; however, only the SST past releases were included in the inadvertent intruder analysis (along with SST residuals).

[c] NA indicates insufficient information is available to make estimates of intruder impacts into ancillary equipment (e.g., pipelines, diversion boxes).

2.8 DESCRIPTION OF WASTE MANAGEMENT AREA TX-TY

This section provides site-specific information for WMA TX-TY. It is a summary from numerous documents that describe present conditions (Hanlon 2005), geology and hydrology (Reidel et al. 2006), subsurface contamination (Wood et al. 2001), and source terms (Kirkbride et al. 2005; Field and Jones 2005; Lambert 2005; Corbin et al. 2005).

2.8.1 Background

WMA TX-TY is located in the north-central portion of the 200 West Area (Figure 2-50) and encompasses the TX and TY tank farms. The TY tank farm is located adjacent to the northern boundary of the TX tank farm and is separated by the T Evaporator along their eastern fenceline. In general, the WMA TX-TY boundary is represented by the north fenceline of the TY tank farm on the north, roughly following the eastern fenceline of each tank farm on the east, the south fenceline of the TX tank farm on the south, and roughly following the western fenceline of each tank farm on the west.

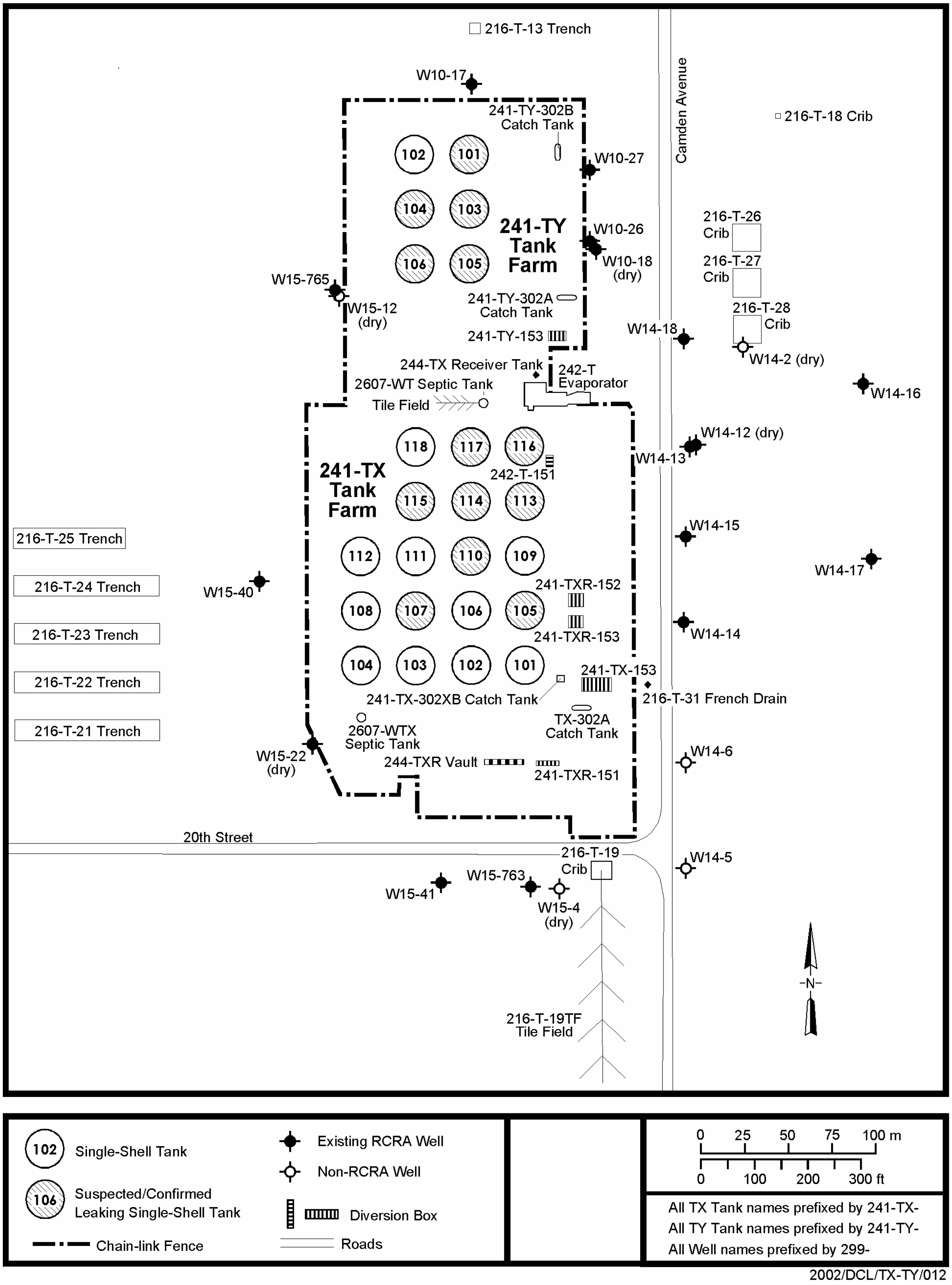
The TX tank farm consists of eighteen 100-Series SSTs constructed between 1947 and 1949. The tanks are arranged in three rows of four and two rows of three tanks. The farm was originally built to provide supplemental tank space for the bismuth phosphate process (Wood et al. 2001). The TX farm received waste beginning in August 1949. Later, the TX tank farm was used as part of the uranium recovery process.

The TY tank farm contains six 100-Series SSTs constructed between 1951 and 1952. The tanks are arranged in three rows of two tanks each with cascade lines providing overflow. The TY tank farm was built to provide supplemental tank space for the uranium recovery process (Wood et al. 2001). The farm first received waste in the second quarter of 1953. Currently, the pumpable liquid wastes have been removed from the tanks in WMA TX-TY and all tanks have been interim stabilized (Hanlon 2005). Table 2-13 lists the estimated volume of waste stored in the WMA TX-TY tanks as of November 30, 2004.

The current understanding of contaminant occurrences and environmental conditions at WMA TX-TY is described in Wood et al. (2001). Detailed discussion of TX and TY tank farm construction and historical information on soil surface and vadose zone contamination in WMA TX-TY is provided in Williams (2000).

Vadose zone field characterization activities were initiated at WMA TX-TY during fiscal year 2003 in support of RCRA Corrective Action process requirements. The investigative approach for this work is described in Crumpler (2001). Myers (2005) documents the results of these investigations.

Figure 2-50. Location Map of TX and TY Tank Farms and Surrounding Facilities [a]



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[a] *Reidel et al. (2006)*

Table 2-13. Waste Volume Estimates as of November 30, 2004, in Waste Management Area TX-TY Single-Shell Tanks [a]

Tank	Total Waste gal × 1,000	Supernate gal × 1,000	Sludge gal × 1,000	Saltcake gal × 1,000
TX Tank Farm				
241-TX-101	91	0	74	17
241-TX-102	217	0	2	215
241-TX-103	145	0	0	145
241-TX-104	69	2	34	33
241-TX-105	576	0	8	568
241-TX-106	348	0	5	343
241-TX-107	29	0	0	29
241-TX-108	127	0	6	121
241-TX-109	363	0	363	0
241-TX-110	467	0	37	430
241-TX-111	364	0	43	321
241-TX-112	634	0	0	634
241-TX-113	638	0	93	545
241-TX-114	532	0	4	528
241-TX-115	553	0	8	545
241-TX-116	599	0	66	533
241-TX-117	480	0	29	451
241-TX-118	247	0	0	247
TY Tank Farm				
241-TY-101	119	0	72	47
241-TY-102	69	0	0	69
241-TY-103	154	0	103	51
241-TY-104	44	1	43	0
241-TY-105	231	0	231	0
241-TY-106	16	0	16	0

[a] Hanlon (2005).

2.8.2 Infrastructure

This section describes the WMA TX-TY infrastructure components that were included in the SST PA. Those components are listed in Table 2-14. Reference case inventory development for those components is described in Section 2.8.7. Refer to Section 2.4 for generic infrastructure component descriptions and Section 2.5 for a summary of infrastructure inventory development methods.

Table 2-14. Operating Period and Capacities for Waste Management Area TX-TY Facilities Included in the Performance Assessment [a] (2 pages)

Facility	Removed From Service	Constructed	Operating Capacity gal
Single-Shell Tanks			
241-TX-101	1980	1947 to 1948	758,000
241-TX-102	1977		
241-TX-103	1980		
241-TX-104	1977		
241-TX-105	1977		
241-TX-106	1977		
241-TX-107	1977		
241-TX-108	1977		
241-TX-109	1977		
241-TX-110	1977		
241-TX-111	1977		
241-TX-112	1974		
241-TX-113	1971		
241-TX-114	1971		
241-TX-115	1977		
241-TX-116	1969		
241-TX-117	1969		
241-TX-118	1980		
241-TY-101	1973	1949 to 1952	758,000
241-TY-102	1979		
241-TY-103	1973		
241-TY-104	1974		
241-TY-105	1980		
241-TY-106	1959		
Miscellaneous Underground Storage Tanks			
241-TX-302A catch tank	1982	1949	17,700
241-TX-302XB catch tank	1985	1950	14,300
241-TY-302A catch tank	1981	1953	17,700
241-TY-302B catch tank	1981	1953	14,300

Table 2-14. Operating Period and Capacities for Waste Management Area TX-TY Facilities Included in the Performance Assessment [a] (2 pages)

Facility	Removed From Service	Constructed	Operating Capacity gal
241-TX DCRT	1981	Active	31,000
241-TXR-001 vault tank	1956 (244-TXR vault)	1951	50,000
241-TXR-002 vault tank		1951	15,000
241-TXR-003 vault tank		1951	15,000
Underground Waste Transfer Lines			
241-TX tank farm pipelines	NA	1947 to 1948	26,300 (+/-5,000)
241-TY tank farm pipelines	NA	1949 to 1952	1,700 (+/-1,000)

[a] Data on the facilities are from DOE-RL (2005) and Field (2003a).

DCRT = double-contained receiver tank

NA = not applicable

2.8.2.1 Single-Shell Tanks

The 100-Series tanks in the TX and TY tank farms are 75 ft in diameter and 32 ft tall. The TX and TY tanks have a 23-ft operating depth and an operating capacity of 758,000 gal. Typical tank configuration and dimensions are shown in Figure 2-51. The tanks sit belowgrade with at least 7 ft of soil cover to provide shielding from radiation exposure to operating personnel. Tank pits are located on top of the tanks and provide access to the tank, pumps, and monitoring equipment.

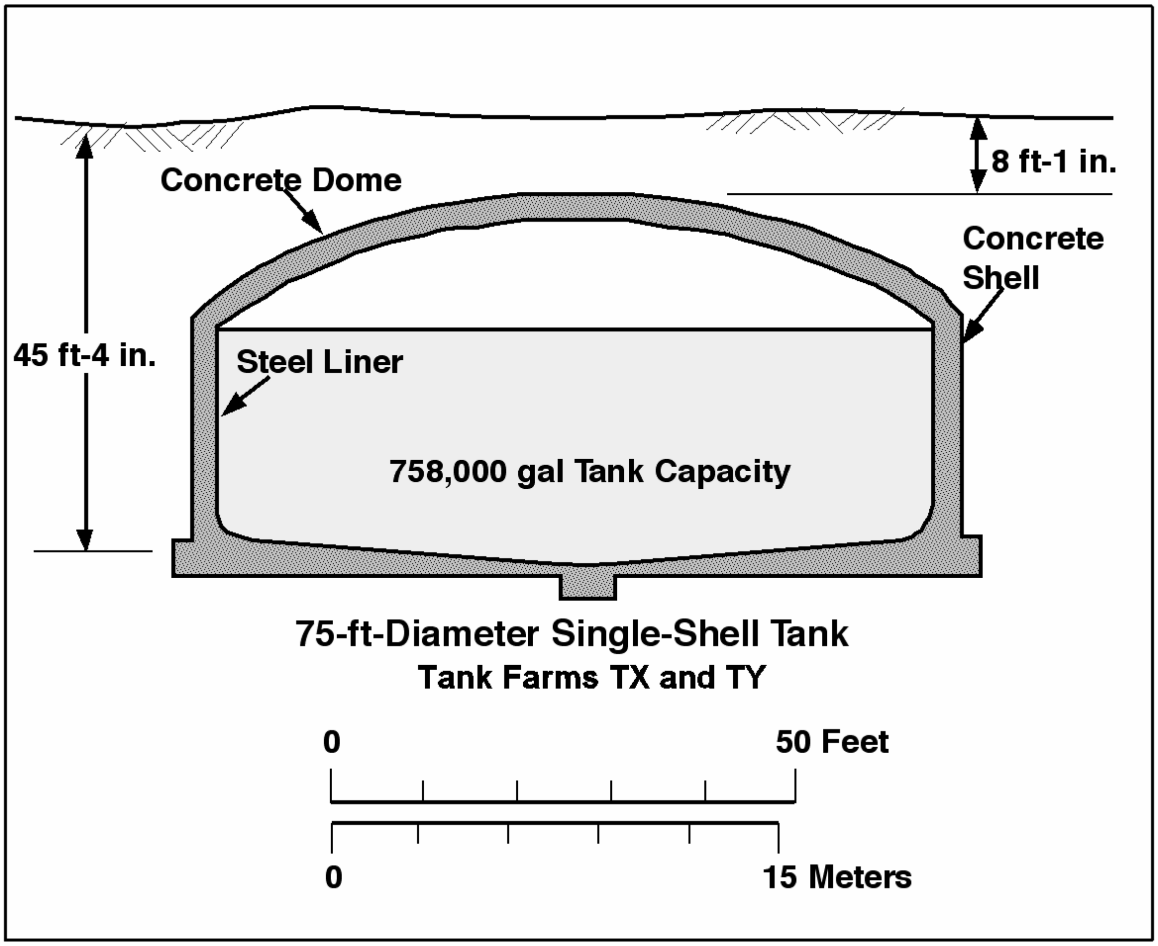
The TX farm tanks were constructed with cascade overflow lines in two 3-tank and three 4-tank series that allowed gravity flow of decanted liquid between tanks, while the TY farm tanks were constructed in three 2-tank cascade series (Wood et al. 2001).

2.8.2.2 Ancillary Equipment

A complete listing of the WMA TX-TY ancillary equipment currently identified for inclusion in the SST system closure is provided in Lee (2004). As discussed in Section 2.5.4, the ancillary components included in the SST PA consists of the underground waste transfer lines and MUSTs located inside each WMA boundary. For WMA TX-TY, the ancillary components analyzed consist of the TX and TY tank farms waste transfer piping and eight MUSTs. The MUSTs consist of four catch tanks (241-TX-302A, 241-TX-302XB, 241-TY-302A, 241-TY-302B), one double-contained receiver tank (244-TX DCRT), and three tanks in the 244-TXR vault (244-TXR-001, 244-TXR-002, 244-TXR-003).

Multiple levels of piping were installed over time in WMA TX-TY. A time line of piping installations is described in Williams (2000). It is estimated that there are approximately 13.6 mi (+/- 2.6 mi) of waste transfer piping in the TX tank farm and 0.9 mi (+/- 0.5 mi) in the TY tank farm (Field 2003a).

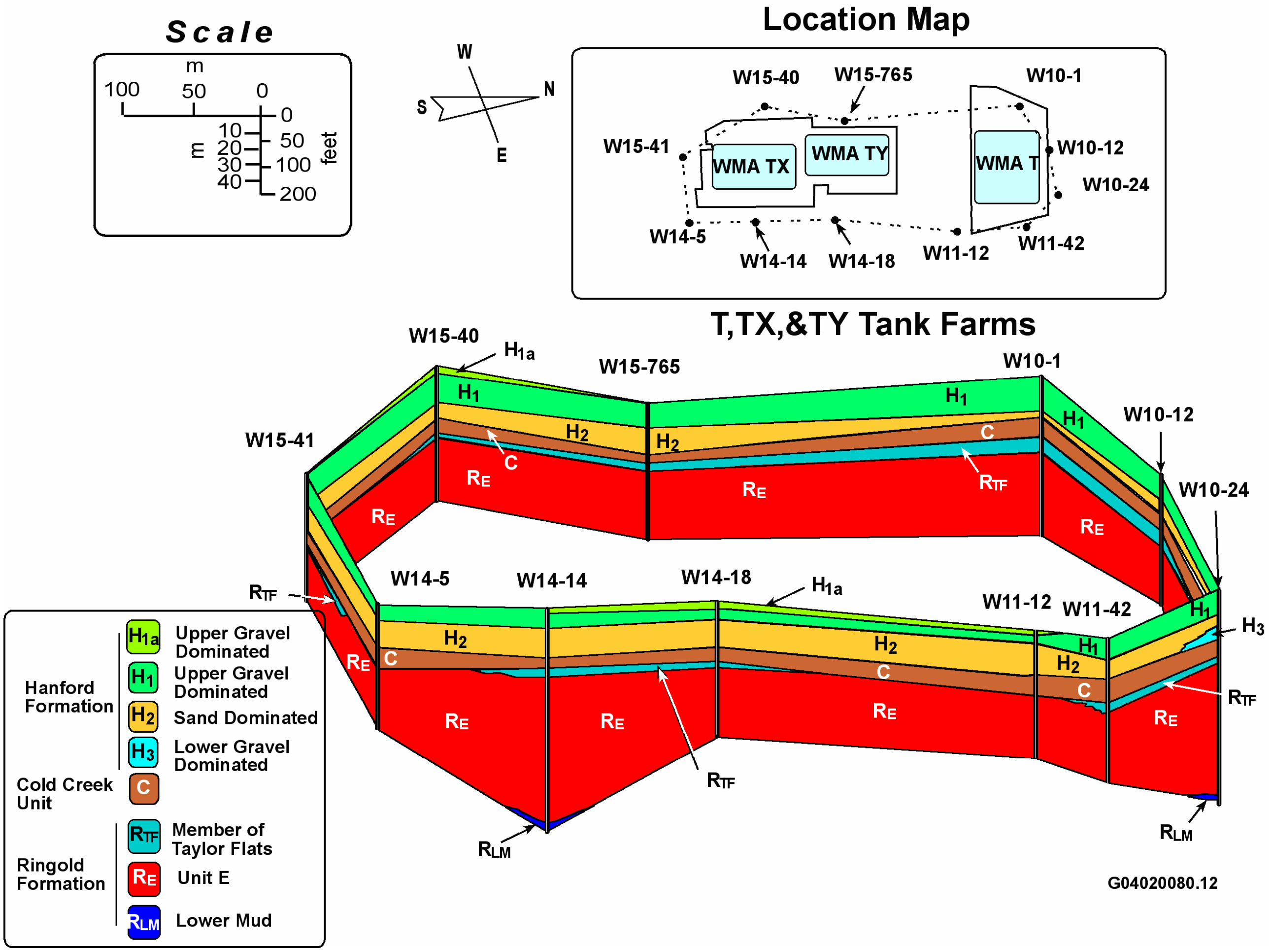
Figure 2-51. Typical Configuration and Dimensions of Single-Shell Tanks in Waste Management Areas T and TX-TY



2.8.3 Geology

Following is an overview of the geology of WMA TX-TY summarized from the information provided in Reidel et al. (2006). Because WMAs T and TX-TY are in close proximity and have similar geologic conditions, they are discussed together in Reidel et al. (2006) and will be discussed together here. A generalized cross-section through WMA TX-TY is shown in Figure 2-52. Maps and cross-sections presented in Reidel et al. (2006) illustrate the distribution and thicknesses of these units in additional detail.

Figure 2-52. Fence Diagram Showing Cross-Sections through Waste Management Areas T and TX-TY [a]



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[a] *Reidel et al. (2006)*

A number of stratigraphic units lie within WMA TX-TY. From oldest to youngest, the primary geologic units are:

- Columbia River Basalt Group
- Ringold Formation (fine-grained and coarse-grained sequences)
- Cold Creek unit (calcic and silty sequences)
- Undifferentiated Hanford formation and Cold creek unit transition
- Hanford formation – sand sequence (H2 unit)
- Hanford formation – upper gravelly sequence (H1 unit)
- Recent deposits (wind deposited material and backfill material placed during construction).

The general characteristics of these units are described in Section 2.3.4.1 and in more detail in Reidel et al. (2006). The SSTs at WMA TX-TY were emplaced within the Hanford formation sediments of the upper, gravel-dominated (H1) unit, and may locally intercept the upper portions of the sand-dominated Hanford (H2) unit. The water table or potentiometric surface lies approximately 60 m (200 ft) below the bottom of the tank farms excavations within the Ringold Formation unit E.

2.8.4 Hydrology

Following is an overview of the hydrology of the uppermost, unconfined aquifer beneath WMA TX-TY. The general geohydrology of the Hanford Site is summarized in Section 2.3.5.2. More detailed information can be found in Reidel et al. (2006), Wood et al. (2001), and Hartman et al. (2004). Currently, the general groundwater flow in the unconfined aquifer beneath WMA TX-TY varies across the WMA. In the southern part, flow is generally south to south-southwest. While in the northern part, the groundwater flow generally is between south and southeast. The water table is very flat overall, with an estimated hydraulic gradient of 0.001 throughout the WMA. The estimated groundwater flow velocity ranges from 0.0007 to 0.246 m/day in the northern section and around 0.29 m/day in the southern section (Reidel et al. 2006).

The shift in discharge of large volumes of wastewater to the T Pond in the late 1940s and early 1950s raised the water table in the vicinity of WMA TX-TY as much as 49 ft above the pre-Hanford Site operations level (Reidel et al. 2006). Water levels began to decline in the late 1980s when wastewater discharges were reduced. The decline has become even more pronounced since other effluent discharges throughout the 200 Areas ceased in 1995.

Currently, the water table beneath WMA TX-TY lies at approximately 135 m (443 ft) amsl with about 230 ft of vadose zone (Hodges and Chou 2001b). The aquifer thickness, based on the top of basalt at 355 ft, varies from 164 to 190 ft. The aquifer materials consist dominantly of variably cemented and compacted, coarse sands and gravels of the Ringold Formation. Hydraulic conductivity values reported for the aquifer in this area vary considerably, ranging from 0.00073 to 0.00140 m/day. Additional hydraulic property data from aquifer testing at wells near WMA TX-TY is provided in Reidel et al. (2006) and Hartman et al. (2004).

2.8.5 Vadose Zone Conditions

This section summarizes WMA TX-TY vadose zone monitoring and characterization activities and the current understanding of contamination in the vadose zone.

2.8.5.1 Monitoring and Characterization

The TX tank farm has 96 leak detection drywells available for leak detection monitoring and to provide access for limited vadose zone characterization (e.g., geophysical logging). These drywells were drilled from 1947 to 1977. The depth ranges for these drywells are between 75 and 150 ft bgs. The TX tank farm layout showing drywell locations in reference to tanks is shown in Figure 2-53.

The TY tank farm has 70 leak detection wells available for leak detection monitoring and to provide access for limited vadose zone characterization (e.g., geophysical logging). These drywells were drilled from 1951 to 1977. The depth ranges for these drywells are between 100 and 150 ft bgs. The TY tank farm layout showing drywell locations in reference to tanks is shown in Figure 2-54.

Limitations of estimates on the extent of contamination include the following:

- No data are available from directly under the tanks.
- No data are available below the survey depth. The maximum logged depth in TX farm is 150 ft in drywell 51-00-03. The maximum logged depth in TY farm is 235 ft bgs in drywell 52-06-07.
- Gamma logging only provides information for contamination within 12 to 18 in. of the drywell being evaluated.
- Data may be made inaccurate due to uncertainties associated with distinguishing contamination on the well casings or surrounding soils.

Additional information on manmade radionuclide and chemical distribution and movement is discussed in the FIR resulting from WMAs T and TX-TY Phase I field investigation (Myers 2005). Collection of field characterization data to support the FIR was conducted in fiscal years 2002 and 2003 (Crumpler 2001).

Figure 2-53. Vadose Zone Monitoring Network for TX Tank Farm in Waste Management Area TX-TY

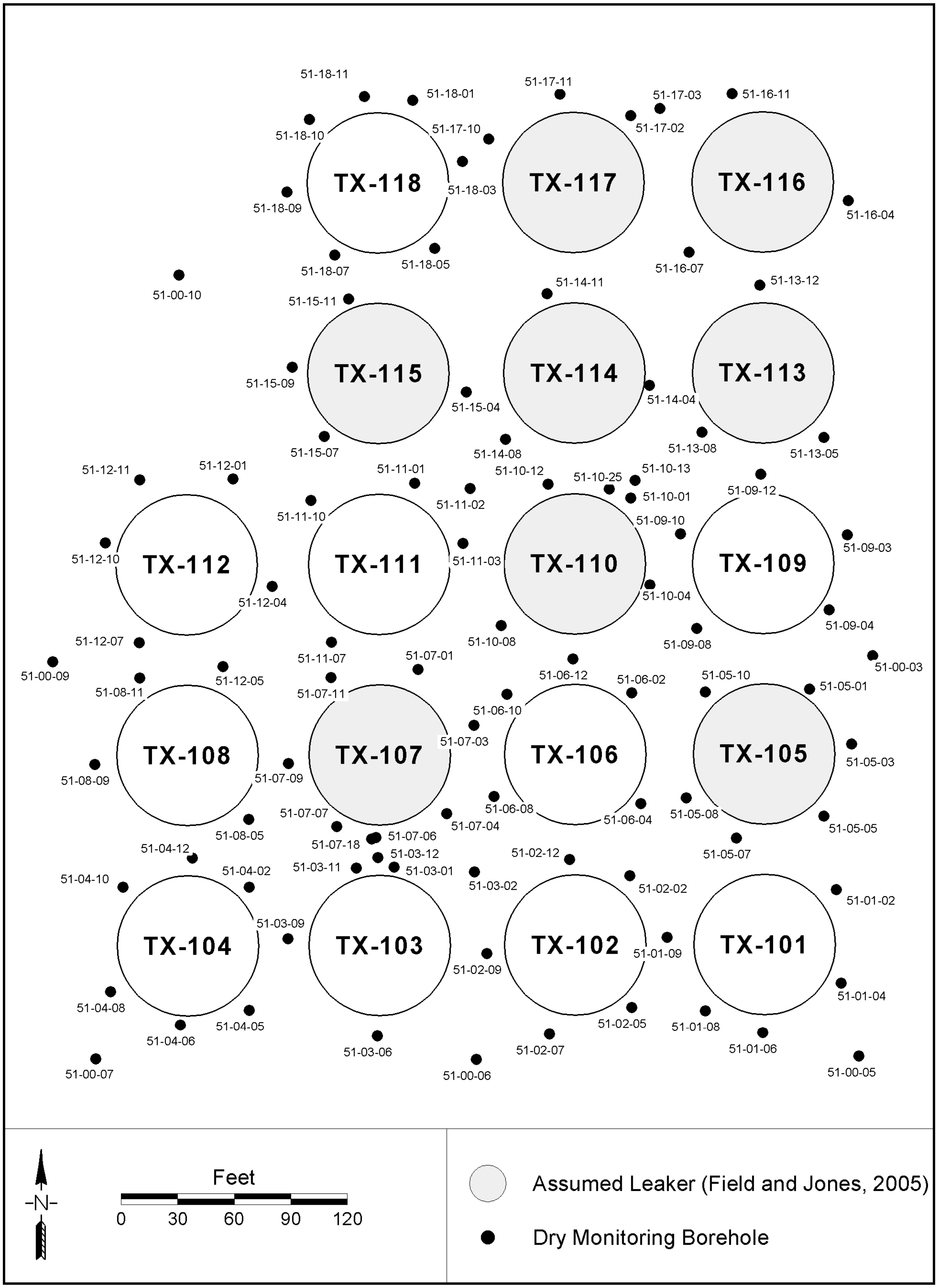
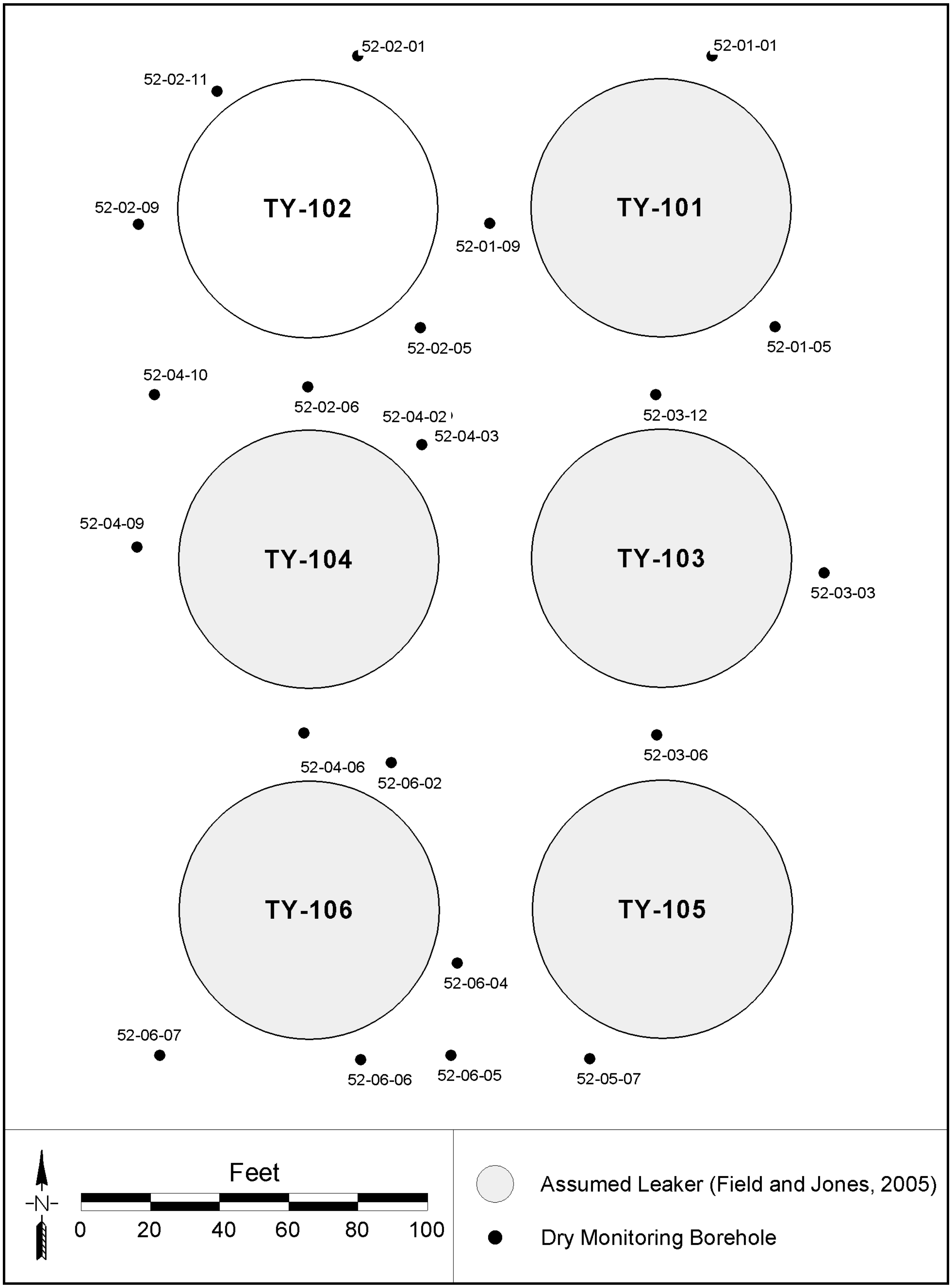


Figure 2-54. Vadose Zone Monitoring Network for TY Tank Farm in Waste Management Area TX-TY



2.8.5.2 Contamination

Figures 2-55 and 2-56 provide a visualization of the vadose zone contamination beneath WMA TX-TY as represented by cesium-137 data. These figures show a three-dimensional perspective of the two tank farms providing locations of tanks and associated drywells. Tanks considered to be assumed leakers in Field and Jones (2005) are shown with darker shading. Each drywell is represented with a single vertical line. Shaded rings around the drywells indicate the level of vadose zone contamination based on spectral gamma logging results. Only the more significant soil contamination zones (>5 pCi/g) are shown. Zones with contamination levels less than 5 pCi/g are not shown.

Gamma logging took place in WMA TX-TY over two decades allowing evaluation of the time-dependent behavior of the gamma-emitting radionuclides. Between 1997 and 1999, spectral gamma logging was used to evaluate WMA TX-TY. This effort was part of the baseline characterization for WMA TX-TY. Results are documented in DOE-GJO (1997a, 1998b, 2000d, 2000e).

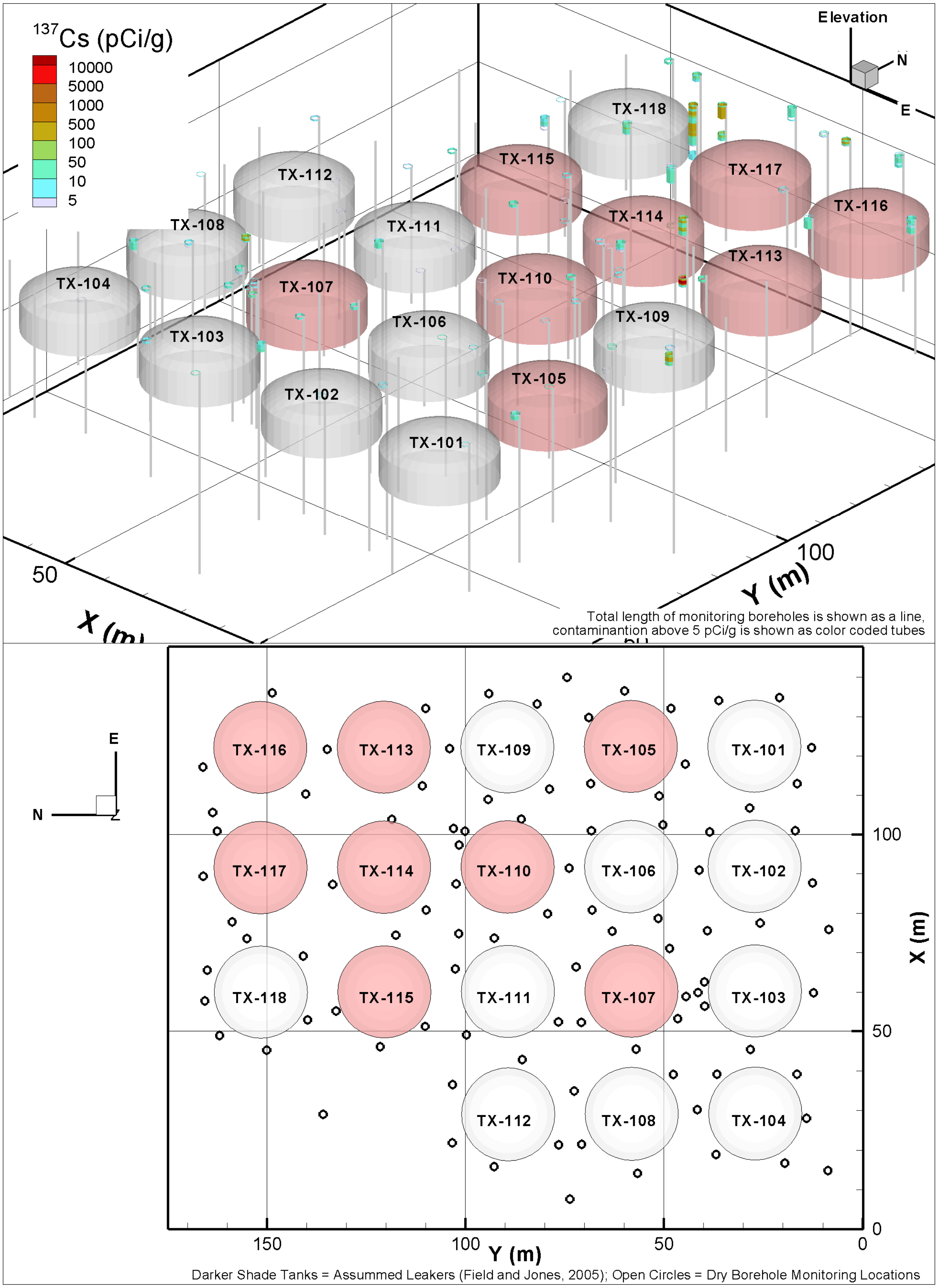
The primary areas of elevated gamma readings for the TX tank farm occur in the drywells located around tanks (TX-105, TX-107, TX-110, TX-113, TX-114, TX-115, TX-116, TX-117, TY-101, TY-103, TY-104, TY-105, TY-106). The presence of contamination in these areas has provided or supported the determinations of postulated leaks based on the WMA TX-TY historical record (Wood et al. 2001). The major gamma-emitting contaminants associated with WMA TX-TY are cesium-137, cobalt-60, antimony-125, and uranium-235/238.

As there are two decades of temporal distribution of gamma activity data available, it is possible to evaluate any changes in estimated distributions. Fifteen drywells in TX tank farm and five drywells in TY tank farm show “instability,” changes over the duration of the monitoring activity (Wood et al. 2001). It is believed that the areas of instability in the TX tank farm are associated with the postulated leak from TX-107 and the postulated leaks from TX-110, TX-114, and TX-113 (Wood et al. 2001). The areas of instability for TY tank farm are associated with the postulated leaks from TY-105 and TY-106. The highest observed isolated readings are seen in drywells 52-03-03 (associated with tank TY-103) and 52-14-04 (associated with tank TX-114) (Wood et al. 2001).

The drywells associated with the postulated TX-107 leak (51-03-01, 51-03-11, 51-03-12, 51-03-18, 51-07-07, 51-07-09, 51-04-05) demonstrate a commonality of data beginning in 1975. This data indicates that cobalt-60 is the primary gamma emitter from 45 to 70 ft with europium-154 also present from 50 to 60 ft in all but two drywells. Evaluation of the historic data shows a migration of cobalt-60 contamination from northeast to southwest between 1977 and 1992 (Wood et al. 2001).

The drywells associated with the postulated TX-110, TX-114, and TX-113 leaks (51-10-01, 51-10-13, 51-10-25, and 51-14-04) contain readings of cesium-137 at the tank bottom depth. TX-114 is believed to be the most likely to have leaked (Wood et al. 2001). Historical data also shows a ruthenium-106 migration between 1978 and 1985.

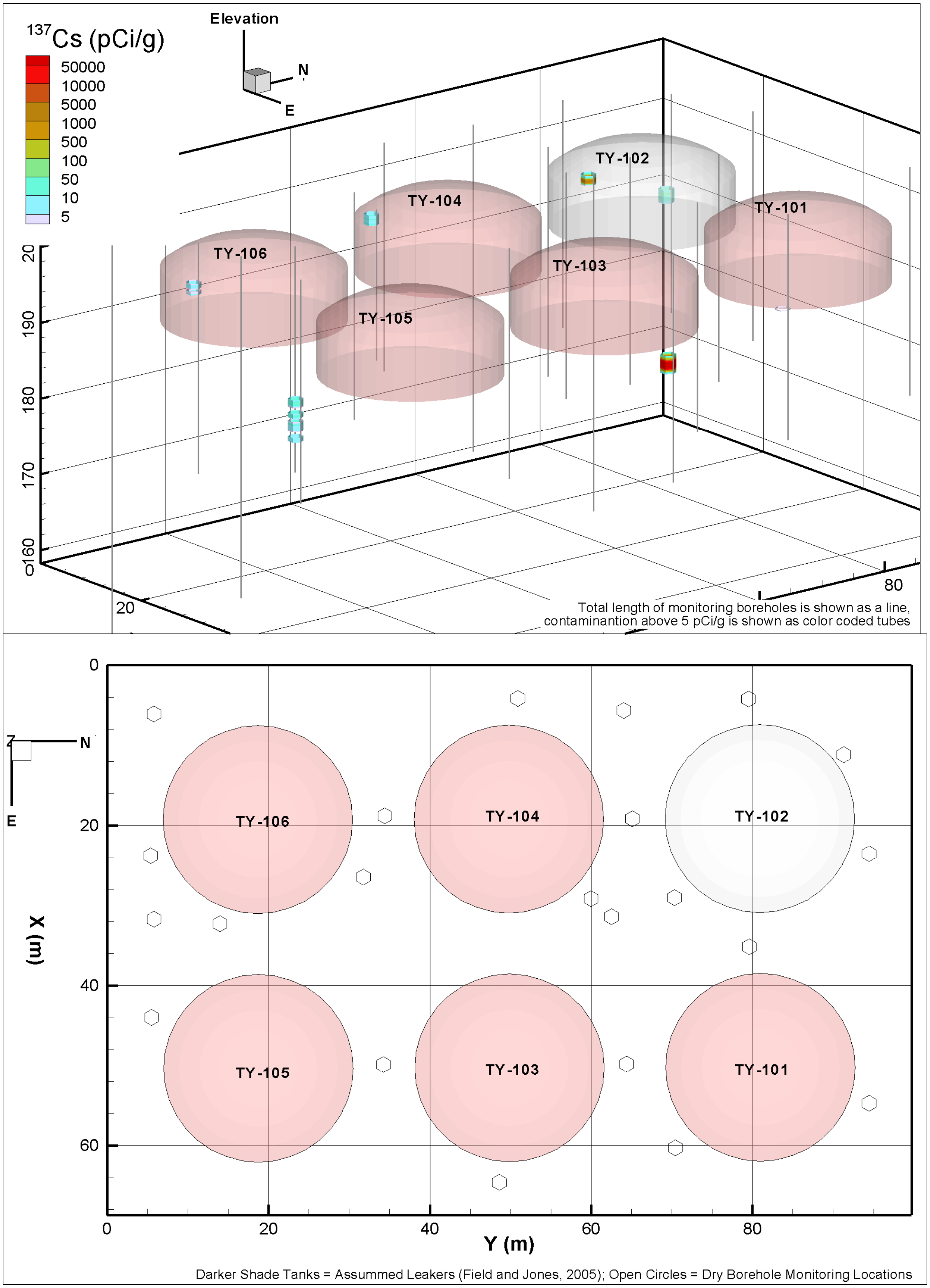
Figure 2-55. Three-Dimensional Perspective of TX Tank Farm Tanks and Drywells Showing Occurrence of Significant (>5 pCi/g) Cesium-137 Contamination in the Vadose Zone



Total length of monitoring boreholes is shown as a line, contaminantion above 5 pCi/g is shown as color coded tubes

Darker Shade Tanks = Assummed Leakers (Field and Jones, 2005); Open Circles = Dry Borehole Monitoring Locations

Figure 2-56. Three-Dimensional Perspective of TX Tank Farm Tanks and Drywells Showing Occurrence of Significant (>5 pCi/g) Cesium-137 Contamination in the Vadose Zone



Total length of monitoring boreholes is shown as a line, contaminantion above 5 pCi/g is shown as color coded tubes

Darker Shade Tanks = Assummed Leakers (Field and Jones, 2005); Open Circles = Dry Borehole Monitoring Locations

Even though it is believed that tanks TY-101, TY-103, and TY-104 did not leak or leaked a very small amount (Wood et al. 2001), there has been observed gamma activity surrounding the tanks. For the potential leak from tank TY-101, elevated gross gamma readings were observed in 1973 at 53 ft in drywell 52-01-09 and at 44 ft in drywell 52-01-05, as well as an observed elevated reading in 1978 at approximately the same depth in drywell 52-01-05. For the potential leak from TY-103, elevated readings in drywell 52-03-06 in 1974 were used as an indicator. Current readings indicate a small amount of cesium-137 and cobalt-60 approximately 50 ft from the bottom of the well. A small zone of elevated cesium-137 is currently observed between 45 and 50 ft. Tanks TY-102 and TY-106 have indications of leaks with no drywell data to support these conjectures (Wood et al. 2001).

Drywells associated with TY-105 (52-03-06, 52-05-07, 52-06-06) support the conclusion that the tank did leak. Drywell 52-03-06 is described above. Drywell 52-05-07 shows a zone of 1 to 30 pCi/g of cesium-137 between 50 and 90 ft, and 1 to 10 pCi/g of cobalt-60 between 50 and 98 ft. Drywell 52-06-06 also shows elevated levels of cesium-137 and cobalt-60 between 50 and 150 ft (Wood et al. 2001).

Spectral gamma logging data also indicate the presence of generalized near-surface contamination across WMA TX-TY. The contamination readings are commonly 10 to 100 pCi/g (Wood et al. 2001) across the TX tank farm, with lower levels typically between 1 and 10 pCi/g found in TY tank farm.

2.8.6 Unconfined Aquifer Conditions

This section summarizes WMA TX-TY groundwater monitoring and characterization activities and the current understanding of contamination in the unconfined aquifer.

2.8.6.1 Monitoring and Characterization

Nine RCRA groundwater monitoring wells associated with WMA TX-TY are located outside the WMA TX-TY boundary (Figure 2-50). The wells are intended to monitor groundwater contamination attributable to the entire WMA rather than individual components. The initial background-monitoring program for WMA TX-TY is complete and monitoring is currently conducted under an interim status assessment program.

The contaminant assessment and the statistical evaluation methodology for the WMA TX-TY groundwater assessment program are described in Hodges and Chou (2001b) and updated in Horton (2002). The assessment plan was last modified in 2001. Results of the groundwater assessment program are published annually. Monitoring under the assessment will continue until the entire WMA is closed. Two new wells were installed in fiscal year 2003 to improve the capability of the detection network to monitor the site.

A detection level RCRA groundwater monitoring program for WMA TX-TY was initiated in 1989, and the WMA was placed into assessment status in 1993 because specific conductance limits were exceeded in downgradient monitoring wells 299-W10-17 and 299-W14-12 (Hodges and Chou 2001b). Hodges (1998) concluded that the contaminants observed in the groundwater were consistent with a source within the WMA, but that an upgradient source (the 216-T-25 trench) is possible. However, without direct evidence for an upgradient source, the default conclusion is that observed contamination from well 200-W14-12 is derived from within the WMA. Accordingly, WMA TX-TY continues to be monitored under an interim status assessment program.

The increased specific conductance in well 299-W14-12 was accompanied by elevated technetium-99, iodine-129, tritium, nitrate, calcium, magnesium, sulfate, and chromium. Technetium-99, chromium, iodine-129, and tritium are the principal contaminants (Hodges and Chou 2001b). RCRA groundwater assessment monitoring results are included in quarterly reports to Ecology and annually, as required, in the groundwater monitoring annual reports. Monitoring under the assessment-monitoring program will continue until the entire WMA is closed and post-closure monitoring is implemented, or until such time that there is a shift in the monitoring status of the WMA. Changes in the monitoring program status will be documented in an approved groundwater monitoring plan.

2.8.6.2 Contamination

The most recently published groundwater monitoring results for WMA TX-TY are for fiscal year 2003 in Hartman et al. (2004). Following is a summary of the fiscal year 2003 results adapted from Hartman et al. (2004). Additional detail on groundwater contamination and geochemistry at WMA TX-TY can be found in Hartman et al. (2004) and Reidel et al. (2006).

A number of contaminants were detected at or above their respective DWS levels in 2003. Elevated nitrate on the east side of WMA TX-TY is correlated with elevated chromium, tritium, iodine-129, and technetium-99. While the nitrate contamination is interpreted as being from a nearby source and not WMA TX-TY, the WMA appears to be the most likely source of the chromium, tritium, iodine-129, and technetium-99; however, the series of cribs (216-T-26 through 216-T-28) located east of the WMA is also a potential source for the contamination. A plume containing trichloroethene and carbon tetrachloride extends north to the vicinity of WMA TX-TY from the region of the Plutonium Finishing Plant, but the source is not associated with WMA TX-TY. Details regarding the measurements, levels found, and the wells showing contamination can be found in Hartman et al. (2004).

2.8.7 Reference Case Source Terms

The reference case describes a set of assumed post-retrieval conditions that are based on current waste retrieval plans. The reference case analysis for WMA TX-TY includes three source terms consisting of past UPRs, residual SST waste, and residual ancillary equipment waste. Table 2-15 provides a listing of the reference case source terms for WMA TX-TY, and the inventory data source for that source term.

Source term inventories (reference case) for WMA TX-TY are provided in Table 2-16. To simplify the table, only the contaminants that dominate post-closure impacts are shown. All BBI contaminants are included in the reference case modeling analysis. Refer to Section 2.5 for a summary of source term inventory development methods. Complete source term inventory data are provided in Appendix C.

2.8.7.1 Past Unplanned Releases

The WMA TX-TY reference case includes six past UPRs associated with SSTs (TX-107, TY-101, TY-103, TY-104, TY-105, TY-106) and two past UPRs associated with ancillary equipment (UPR-200-W-12, UPR-200-W-100). Volume estimates for those eight waste loss events were developed by Field and Jones (2005) and vadose zone contaminant inventories were generated by Corbin et al. (2005) (Section 2.5.2). No volume or inventory estimates were assigned to the waste loss events associated with tanks TX-105, TX-110, TX-113, TX-114, TX-115, TX-116, and TX-117 because of insufficient information to quantify or verify the releases (Field and Jones 2005). If new information becomes available to quantify the waste loss events from those tanks, the data will be evaluated under the integrated regulatory closure process described in Chapter 1.0.

2.8.7.2 Residual Single-Shell Tank Waste

The WMA TX-TY reference case includes residual waste in each of the 24 100-Series SSTs in the TX and TY tank farms. The HFFACO Milestone M-45-00 goal allows up to 360 ft^3 of waste to remain in the 100-Series tanks after retrieval in the event that retrieval beyond that level becomes impracticable (Ecology et al. 1989). Thus, the analysis includes a 360 ft^3 source term associated with residual waste remaining in each of the tanks after retrieval. The inventory estimates were generated with the use of the HTWOS model (Kirkbride et al. 2005), which accounts for the waste retrieval technology and tracks the fate of soluble and insoluble constituents in the waste (Section 2.5.3).

2.8.7.3 Residual Ancillary Equipment Waste

The WMA TX-TY reference case includes the plugged and blocked piping in the TX and TY tank farms and the residual waste in eight MUSTs consisting of four catch tanks (241-TX-302A, 241-TX-302XB, 241-TY-302A, 241-TY-302B), one double-contained receiver tank (244-TX DCRT), and the three tanks in the 244-TXR vault (244-TXR-001, 244-TXR-002, 244-TXR-003) (Section 2.5.4). Volume and inventory estimates for the waste in the plugged and blocked piping (102 L in TX farm, none in TY farm) were developed by Lambert (2005). Volume estimates for the residual waste in the MUSTs was calculated by assuming each tank would be retrieved to a residual volume proportional to that required under the HFFACO Milestone M-45-00 for 200-Series tanks (Ecology et al. 1989). Contaminant inventories associated with the residual ancillary equipment waste were estimated using the average chemical composition of the waste in the WMA TX-TY SSTs.

Table 2-15. Reference Case Analysis of Waste Management Area TX-TY (2 pages)

Inventory and Source Terms					
Sources	**Assumed Retrieval Method**	**Residual Volume**	**Volume Associated with Past Release [a] gal**	**Basis for Contaminant Inventory Estimate**	
				Residual Waste [b]	**Past Release**
241-TX-101	Sluicing	360 ft^3	None	HTWOS	None
241-TX-102	Sluicing	360 ft^3	None	HTWOS	None
241-TX-103	Sluicing	360 ft^3	None	HTWOS	None
241-TX-104	Sluicing	360 ft^3	None	HTWOS	None
241-TX-105 [c]	Mobile retrieval system	360 ft^3	NSI [c]	HTWOS	None
241-TX-106	Sluicing	360 ft^3	None	HTWOS	None
241-TX-107	Mobile retrieval system	360 ft^3	8,000	HTWOS	Corbin et al. 2005
241-TX-108	Sluicing	360 ft^3	None	HTWOS	None
241-TX-109	Sluicing	360 ft^3	None	HTWOS	None
241-TX-110 [c]	Mobile retrieval system	360 ft^3	NSI [c]	HTWOS	None
241-TX-111	Sluicing	360 ft^3	None	HTWOS	None
241-TX-112	Sluicing	360 ft^3	None	HTWOS	None
241-TX-113 [c]	Mobile retrieval system	360 ft^3	NSI [c]	HTWOS	None
241-TX-114 [c]	Mobile retrieval system	360 ft^3	NSI [c]	HTWOS	None
241-TX-115 [c]	Mobile retrieval system	360 ft^3	NSI [c]	HTWOS	None
241-TX-116 [c]	Mobile retrieval system	360 ft^3	NSI [c]	HTWOS	None
241-TX-117 [c]	Mobile retrieval system	360 ft^3	NSI [c]	HTWOS	None
241-TX-118	Sluicing	360 ft^3	None	HTWOS	None
241-TY-101	Mobile retrieval system	360 ft^3	1,000	HTWOS	Corbin et al. 2005
241-TY-102	Sluicing	360 ft^3	None	HTWOS	None

Table 2-15. Reference Case Analysis of Waste Management Area TX-TY (2 pages)

Inventory and Source Terms

Sources	Assumed Retrieval Method	Residual Volume	Volume Associated with Past Release [a] gal	Basis for Contaminant Inventory Estimate	
				Residual Waste [b]	**Past Release**
241-TY-103	Mobile retrieval system	360 ft^3	3,000	HTWOS	Corbin et al. 2005
241-TY-104	Mobile retrieval system	360 ft^3	1,400	HTWOS	Corbin et al. 2005
241-TY-105	Mobile retrieval system	360 ft^3	35,000	HTWOS	Corbin et al. 2005
241-TY-106	Mobile retrieval system	360 ft^3	20,000	HTWOS	Corbin et al. 2005
UPR-200-W-12	NA	NA	5	NA	Corbin et al. 2005
UPR-200-W-100	NA	NA	2,540	NA	Corbin et al. 2005
241-TX-302A catch tank [d]	TBD [d]	10 ft^3	None	Average	None
241-TX-302XB catch tank [d]	TBD [d]	10 ft^3	None	Average	None
241-TY-302A catch tank [d]	TBD [d]	10 ft^3	None	Average	None
241-TY-302B catch tank [d]	TBD [d]	8 ft^3	None	Average	None
244-TX DCRT [d]	TBD [d]	17 ft^3	None	Average	None
244-TXR-001 vault tank [d]	TBD [d]	27 ft^3	None	Average	None
244-TXR-002 vault tank [d]	TBD [d]	8 ft^3	None	Average	None
244-TXR-003 vault tank [d]	TBD [d]	8 ft^3	None	Average	None
241-TX tank farm pipelines [e]	TBD	102 L	None	Lambert 2005	NA
241-TY tank farm pipelines [e]	TBD	None	None	Lambert 2005	NA

[a] Past leak volumes listed in Field and Jones (2005).

[b]. Residual inventories from HTWOS model output (Kirkbride et al. 2005).

[c] NSI = not sufficient information. Tanks TX-105, TX-110, TX-113, TX-114, TX-115, TX-116, and TX-117 are identified as a "confirmed or suspected" leaker in Hanlon (2005) but Field and Jones (2005) state there is insufficient information for developing a leak volume at this time. As information becomes available, a leak volume will be developed.

[d] TBD = to be determined. Final disposition of MUSTs not yet determined; however, MUSTs were carried forward in the assessment assuming MUSTs will be retrieved to at least the HFFACO goal (Ecology et al. 1989, Milestone M-45-00) equivalent to the 200-Series tanks. The residual volume is calculated by ratio of the total volume of the MUST to the 200-Series tanks (e.g., the retrieval goal for the 55,000-gal 200-Series tanks is 30 ft^3; thus, a MUST that is ⅔ the size of the 200-Series tank would have a residual volume of 20 ft^3). Inventory was calculated based on average waste per ft^3 within the WMA calculated from the HTWOS model (Kirkbride et al. 2005).

[e] Final disposition of pipelines is not yet determined; however, pipelines were carried forward in the assessment. Pipeline residual volumes shown represent the volume of waste in plugged or blocked pipelines as determined by Lambert (2005).

NA = not applicable

Table 2-16. Reference Case Inventory Estimates for Waste Management Area TX-TY

Source Type	Dominant Contaminants for Groundwater Pathway Impacts [a]							Dominant Contaminants for Inadvertent Intruder Impacts [a]							
	C-14 Ci	Tc-99 Ci	I-129 Ci	Cr(VI) kg	NO_3 kg	NO_2 kg	U kg	Sr-90 Ci	Tc-99 Ci	Sn-126 Ci	Cs-137 Ci	Pu-239 Ci	Pu-240 Ci	Am-241 Ci
Past releases [b]	2.70E-01	7.24E+00	8.13E-03	1.66E+02	4.86E+04	5.26E+03	8.15E+00	6.29E+02	7.24E+00	8.94E-02	1.43E+04	8.45E-01	1.15E-01	6.47E-01
Tank residuals	2.33E-01	4.70E+01	3.76E-03	9.47E+02	1.87E+04	1.45E+03	3.68E+03	4.22E+04	4.70E+01	1.02E+00	2.29E+04	4.31E+02	8.87E+01	7.23E+02
Ancillary equipment residuals [c]	2.62E-03	4.64E-01	4.76E-05	9.90E+00	2.14E+02	2.33E+01	3.44E+01	NA	NA	NA	NA	NA	NA	NA

[a] The reference case analysis included all BBI contaminants. As described in Bowen (2004), the standard analyte list tracked in the BBI contains **25 chemicals** including:

- aluminum
- bismuth
- calcium
- chlorine
- chromium
- fluorine
- total inorganic carbon as carbonate
- iron
- mercury
- potassium
- lanthanum
- manganese
- sodium
- nickel
- nitrite
- nitrate
- oxalate
- lead
- phosphate
- silicon
- sulfate
- strontium
- uranium total
- zirconium
- total organic carbon

and **46 radionuclides** including:

- tritium
- carbon-14
- nickel-59
- cobalt-60
- nickel-63
- selenium-79
- strontium-90
- yttrium-90
- zirconium-93
- niobium-93m
- technetium-99
- ruthenium-106
- cadmium-113m
- antimony-125
- tin-126
- iodine-129
- cesium-134
- cesium-137
- barium 137m
- samarium-151
- europium-152
- europium-154
- europium-155
- radium-226
- actinium-227
- radium-228
- thorium-229
- protactinium-131
- thorium-232
- uranium-232
- uranium-233
- uranium-234
- uranium-235
- uranium-236
- neptunium-237
- plutonium-238
- uranium-238
- plutonium-239
- plutonium-240
- americium-241
- plutonium-241
- curium 242
- plutonium-242
- americium-243
- curium-243
- curium-244

[b] Inventories shown are the combined inventories from SST past releases and ancillary equipment past releases. Both release types were considered for the groundwater pathway analysis; however, only the SST past releases were included in the inadvertent intruder analysis (along with SST residuals).

[c] NA indicates insufficient information is available to make estimates of intruder impacts into ancillary equipment (e.g., pipelines, diversion boxes).

2.9 DESCRIPTION OF WASTE MANAGEMENT AREA U

This section provides site-specific information for WMA U. It is a summary from numerous documents that describe present conditions (Hanlon 2005), geology and hydrology (Reidel et al. 2006), subsurface contamination (Wood and Jones 2003), and source terms (Kirkbride et al. 2005; Field and Jones 2005; Lambert 2005; Corbin et al. 2005).

2.9.1 Background

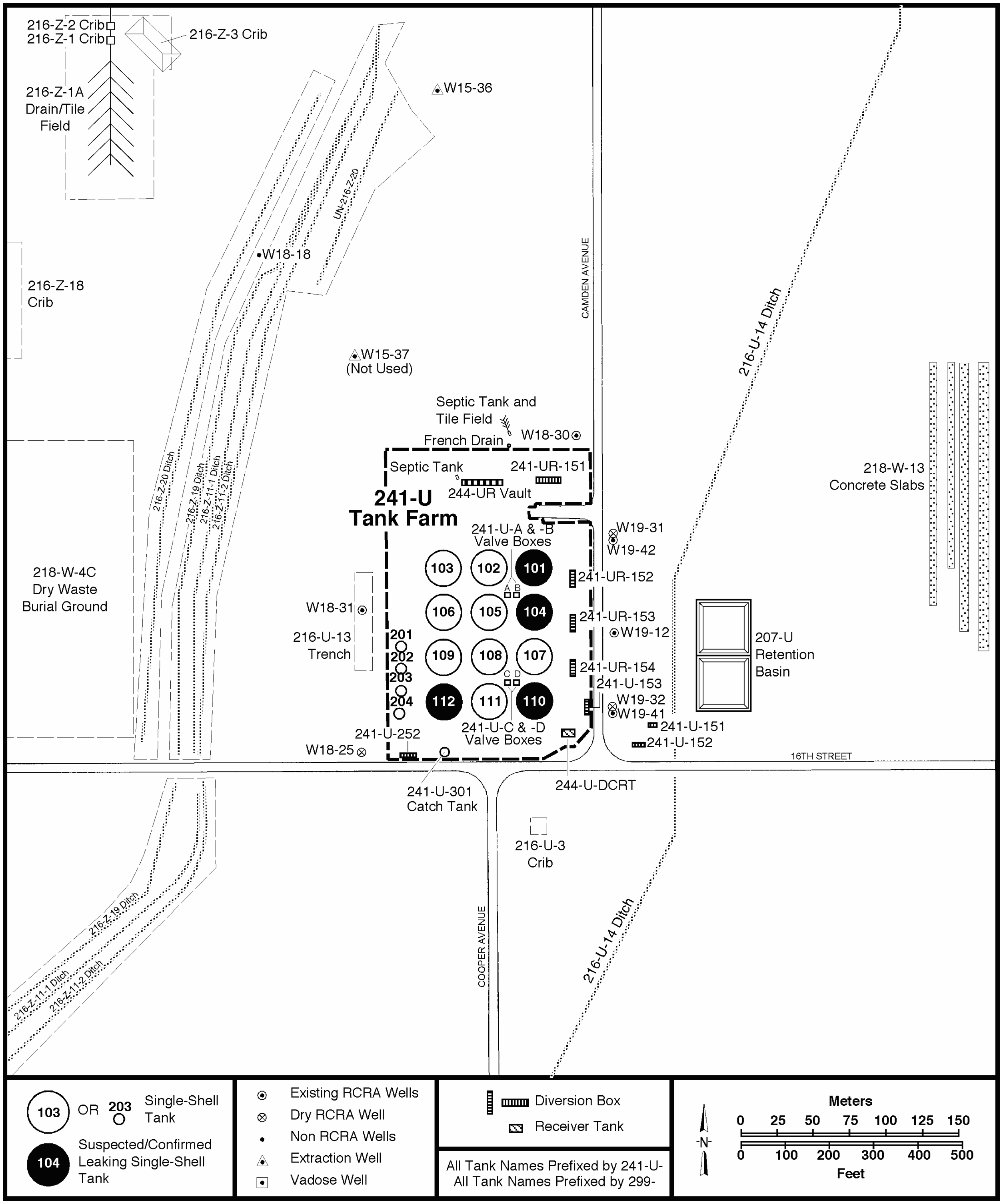
WMA U is located in the central portion of 200 West Area of the Hanford Site (Figure 2-57). WMA U contains twelve 100-Series SSTs and four 200-Series SSTs that were constructed from 1943 through 1944, put into service in 1944, and used to store and transfer waste until 1980. Because of its long operational history, the U tank farm received waste generated by essentially all of the Hanford Site major chemical processing operations including bismuth phosphate fuel processing, uranium recovery, PUREX fuel processing, and fission product recovery (Wood and Jones 2003).

During its operational history, there were a number of confirmed or suspected waste loss events in WMA U. These included suspected tank leaks and known waste losses from diversion boxes, pipelines, and the 244-UR vault. In addition, uncontaminated and slightly contaminated water from facilities outside WMA U were discharged to several nearby ditches, particularly 216-U-14. Currently, the pumpable liquid wastes have been removed from the U farm tanks and all tanks have been interim stabilized (Hanlon 2005). Table 2-17 lists the estimated volume of waste stored in the WMA U tanks as of November 30, 2004.

The current understanding of contaminant occurrences and environmental conditions at WMA U is described in Wood and Jones (2003). The primary contamination zones currently identified in WMA U are a uranium-rich zone from metal waste at tank U-104 and a localized high cesium-137 activity zone near the bottom of tanks U-110 and U-112.

A draft FIR for WMA U is scheduled to be issued in fiscal year 2006. Field characterization data to support the WMA U FIR is scheduled to be collected in fiscal year 2005 as outlined in Crumpler (2004). Planned WMA U closure and post-closure actions identified at the present time are described in Lee (2004).

Figure 2-57. Location Map of U Tank Farm and Surrounding Facilities



2001/DCL/U/007

Table 2-17. Waste Volume Estimates as of November 30, 2004, in Waste Management Area U Single-Shell Tanks [a]

Tank	Total waste gal × 1,000	Supernate gal × 1,000	Sludge gal × 1,000	Saltcake gal × 1,000
241-U-101	23	0	23	0
241-U-102	327	1	43	283
241-U-103	417	1	12	404
241-U-104	122	0	122	0
241-U-105	353	0	32	321
241-U-106	170	2	0	168
241-U-107	294	0	15	279
241-U-108	434	0	29	405
241-U-109	401	0	35	366
241-U-110	176	0	176	0
241-U-111	222	0	26	196
241-U-112	45	0	45	0
241-U-201	4	1	3	0
241-U-202	4	1	3	0
241-U-203	3	1	2	0
241-U-204	3	1	2	0

[a] Hanlon (2005).

2.9.2 Infrastructure

This section describes the WMA U infrastructure components that were included in the SST PA and listed in Table 2-18. Reference case inventory development for those components is described in Section 2.9.7. Refer to Section 2.4 for generic infrastructure component descriptions and Section 2.5 for a summary of infrastructure inventory development methods.

2.9.2.1 Single-Shell Tanks

The 100-Series tanks are 75 ft in diameter and 30 ft tall. The tanks have a 15-ft operating depth, and an operating capacity of 530,000 gal each. The 200-Series tanks are 20 ft in diameter and 37 ft tall from base to dome. The tanks have a 24-ft operating depth and an operating capacity of 55,000 gal each. Typical tank configuration and dimensions are shown in Figure 2-58. The 100-Series tanks and 200-Series tanks sit belowgrade with 7 ft and 11 ft of soil cover, respectively, to provide shielding from radiation exposure to operating personnel. Tank pits are located on top of the tanks and provide access to the tank, pumps, and monitoring equipment.

Table 2-18. Operating Period and Capacities for Waste Management Area U Facilities Included in the Performance Assessment [a]

Facility	Removed From Service	Constructed	Operating Capacity gal
Single-Shell Tanks			
241-U-101	1960	1943 to 1944	530,000
241-U-102	1979		
241-U-103	1978		
241-U-104	1951		
241-U-105	1978		
241-U-106	1977		
241-U-107	1980		
241-U-108	1979		
241-U-109	1978		
241-U-110	1975		
241-U-111	1980		
241-U-112	1970		
241-U-201	1977		55,000
241-U-202	1977		
241-U-203	1977		
241-U-204	1977		
Miscellaneous Underground Storage Tanks			
241-U-301 catch tank	Active	1946	To be determined
244-U DCRT [b]	Active	1987	21,000
244-UR-001 vault tank	1975 (244-UR vault)	1952	50,000
244-UR-002 vault tank			15,000
244-UR-003 vault tank			15,000
244-UR-004 vault tank			8,230
Underground Waste Transfer Lines			
241-U tank farm pipelines	NA	1943 to 1944	13,900 (+/-2,500)

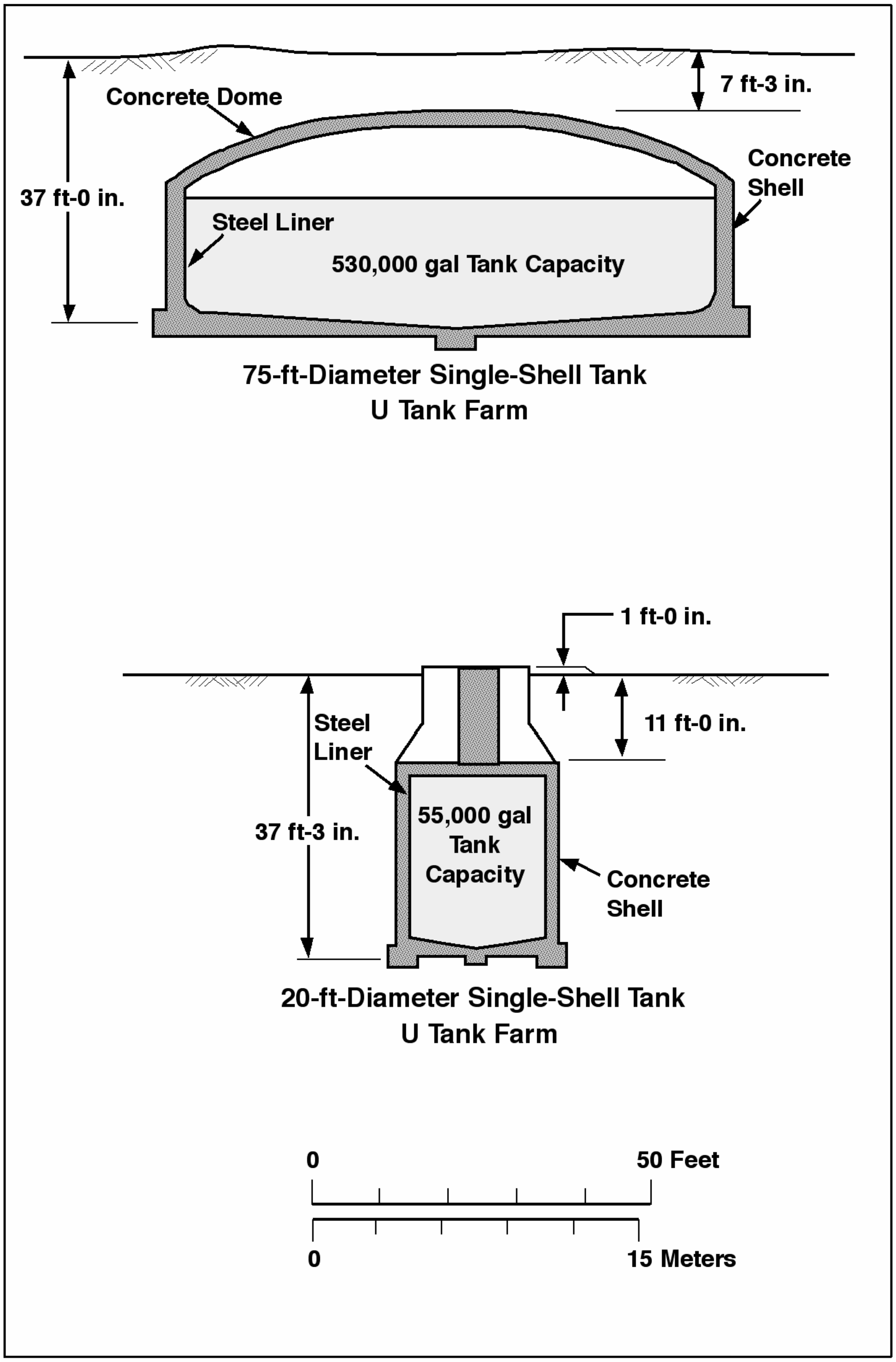
[a] Data on the facilities are from DOE-RL (2005) and Field (2003a).

[b] Tank contains water from operational test procedures but does not contain waste (DOE-RL 2005).

DCRT = double-contained receiver tank

NA = not applicable

Figure 2-58. Typical Configuration and Dimensions of Single-Shell Tanks in Waste Management Area U



The SSTs were constructed in place with carbon steel (ASTM 2005) lining the bottom and sides of a reinforced concrete shell. The tanks have concave bottoms (i.e., center of tanks lower than the perimeter) and a curving intersection of the sides and bottom (Crumpler 2004). The inlet and outlet lines are located near the top of the liners. The 100-Series tanks were constructed with cascade overflow lines in a 3-tank series that allowed gravity flow of liquid between tanks. The 200-Series tanks also contain cascade lines that are piped to diversion box 241-U-252 (Williams 2001b).

2.9.2.2 Ancillary Equipment

A complete listing of the WMA U ancillary equipment currently identified for inclusion in the SST system closure is provided in Lee (2004). As discussed in Section 2.5.4, the ancillary components included in the SST PA consist of the underground waste transfer lines and MUSTs located inside each WMA boundary. For WMA U, the ancillary components analyzed consist of the U tank farm waste transfer piping and five MUSTs. The MUSTs consist of one catch tank (241-U-301) and four tanks in the 244-UR vault (244-UR-001, 244-UR-002, 244-UR-003, 244-UR-004).

WMA U contains a double-contained receiver tank (244-U DCRT) that was used only for testing procedures (DOE-RL 2005). That tank contains no waste and was not included in the SST PA.

Multiple levels of piping were installed over time in WMA U. A time line of piping installations is described in Williams (2001b). It is estimated that there are approximately 7.1 mi (+/- 1.3 mi) of waste transfer piping in WMA U (Field 2003a).

2.9.3 Geology

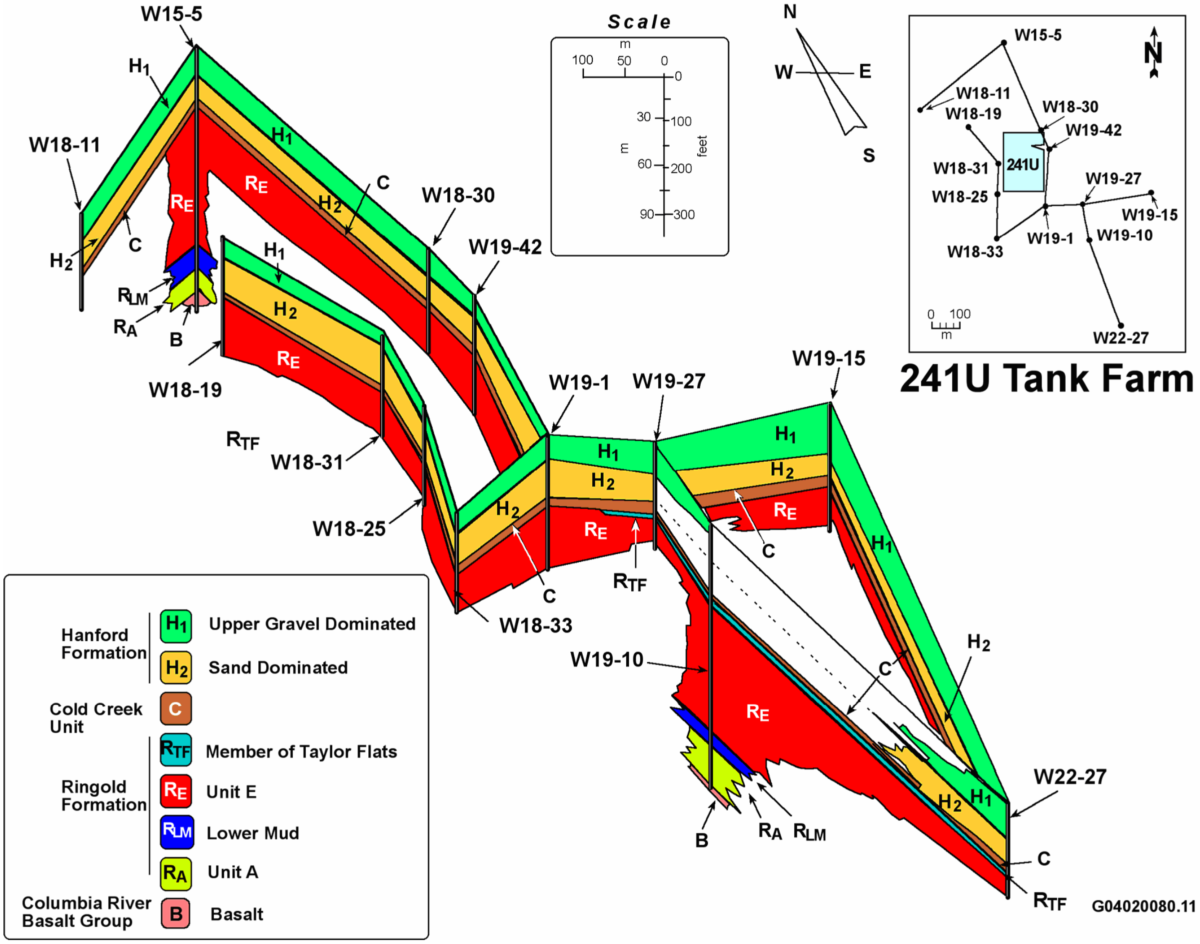
Following is an overview of the geology of WMA U summarized from the information provided in Riedel et al. (2005). A generalized cross-section through WMA U is shown in Figure 2-59. Maps and cross-sections presented in Riedel et al. (2005) illustrate the distribution and thicknesses of these units in additional detail.

Six stratigraphic units lie within WMA U. From oldest to youngest, the primary geologic units are:

- Columbia River Basalt Group
- Ringold Formation
- Cold Creek unit
- Hanford formation – sand sequence (H2 unit)
- Hanford formation – upper gravelly sequence (H1 unit)
- Recent deposits.

The general characteristics of these units are described in Section 2.3.4.1 and in more detail in Wood and Jones (2003) and Reidel et al. (2006). The SSTs at WMA U were emplaced within the Hanford formation sediments of the upper, gravel-dominated (H1) unit, and may locally intercept the upper portions of the sand-dominated Hanford (H2) unit. The water table or potentiometric surface lies 67 m below the ground surface and within the Ringold Formation.

Figure 2-59. Fence Diagram Showing Cross-Sections through Waste Management Area U[a]



[a] *Reidel et al. (2006)*

2.9.4 Hydrology

Following is an overview of the hydrology of the uppermost, unconfined aquifer beneath WMA U. The general geohydrology of the Hanford Site is summarized in Section 2.3.5.2. More detailed information can be found in Reidel et al. (2006), Wood and Jones (2003), and Hartman et al. (2004). General groundwater flow directions under WMA U have changed substantially because of Hanford Site operations. Before the initiation of fuel processing activities at the Hanford Site, the regional flow across the site was generally west to east. The first significant perturbation to groundwater flow was probably discharge to T Pond north of WMA U in the late 1940s, which would have had the effect of diverting flow more southerly under WMA U and perhaps raising the water table (Crumpler 2004).

The next significant perturbation created by Hanford Site operations was the development of U Pond and wastewater discharge to the unconfined aquifer. A water mound developed and groundwater flow direction was altered beginning in the mid 1950s. At WMA U, elevation of the water table was measured at groundwater monitoring well 299-W19-1. Given the location of the 216-U-10 Pond to the southwest of WMA U and the radial flow induced by the expansion of the groundwater mound underneath the pond, groundwater flow changed northeasterly under WMA U. This directional control continued through 1985 when discharge to the pond ceased, at which point both the water table began to drop and the general flow direction began to move toward the pre-Hanford Site operations easterly orientation (Crumpler 2004).

The most recent perturbation to local flow direction was caused by the short-term, large volume (1.9×10^9 L) discharge of wastewater from the U/UO_3 plant into the 216-U-14 ditch in 1991 just east of WMA U (Singleton and Lindsey 1994). In response to the U/UO_3 plant high discharge, the local flow direction changed from easterly to northerly and westerly in 1993. This gradient reversal lasted until early 1996, at which time a reversal to predominantly easterly reoccurred. The gradient reversals are indicated by the relative changes in the water levels of the RCRA monitoring wells around WMA U over time. Recognizing that water levels are closer to the surface at upgradient wells, the figure shows that northern and western wells (299-W18-30, 299-W18-31, 299-W18-25) compared to the eastern wells (299-W19-31, 299-W19-32) were upgradient between 1990 and mid 1993, downgradient between mid 1993 and late 1995, and finally upgradient again beginning in 1996 until present (Crumpler 2004).

Measurements of aquifer properties (Smith et al. 2001) in WMA U RCRA monitoring wells indicate that hydraulic conductivity and effective porosity around well 299-19-42 are about 6.12 m/day and 0.17, respectively. The hydraulic gradient is about 0.002 based on water level measurements from nearby wells. Using these data, a flow velocity of about 30 m/yr is calculated. The flow across WMA U shows a generally easterly orientation. This suggests that the impact of the U Pond groundwater mound has not completely dissipated but these effects are diminishing as indicated by the steady decrease in water levels at all local wells. Additional water table decreases of 20 to 25 ft at a rate of about 2 ft per year were estimated to return to pre-Hanford Site operations values at WMA S-SX just to the south. If so, pre-Hanford Site conditions should be achieved 10 to 20 years from now (Crumpler 2004).

2.9.5 Vadose Zone Conditions

This section summarizes WMA U vadose zone monitoring and characterization activities and the current understanding of contamination in the vadose zone.

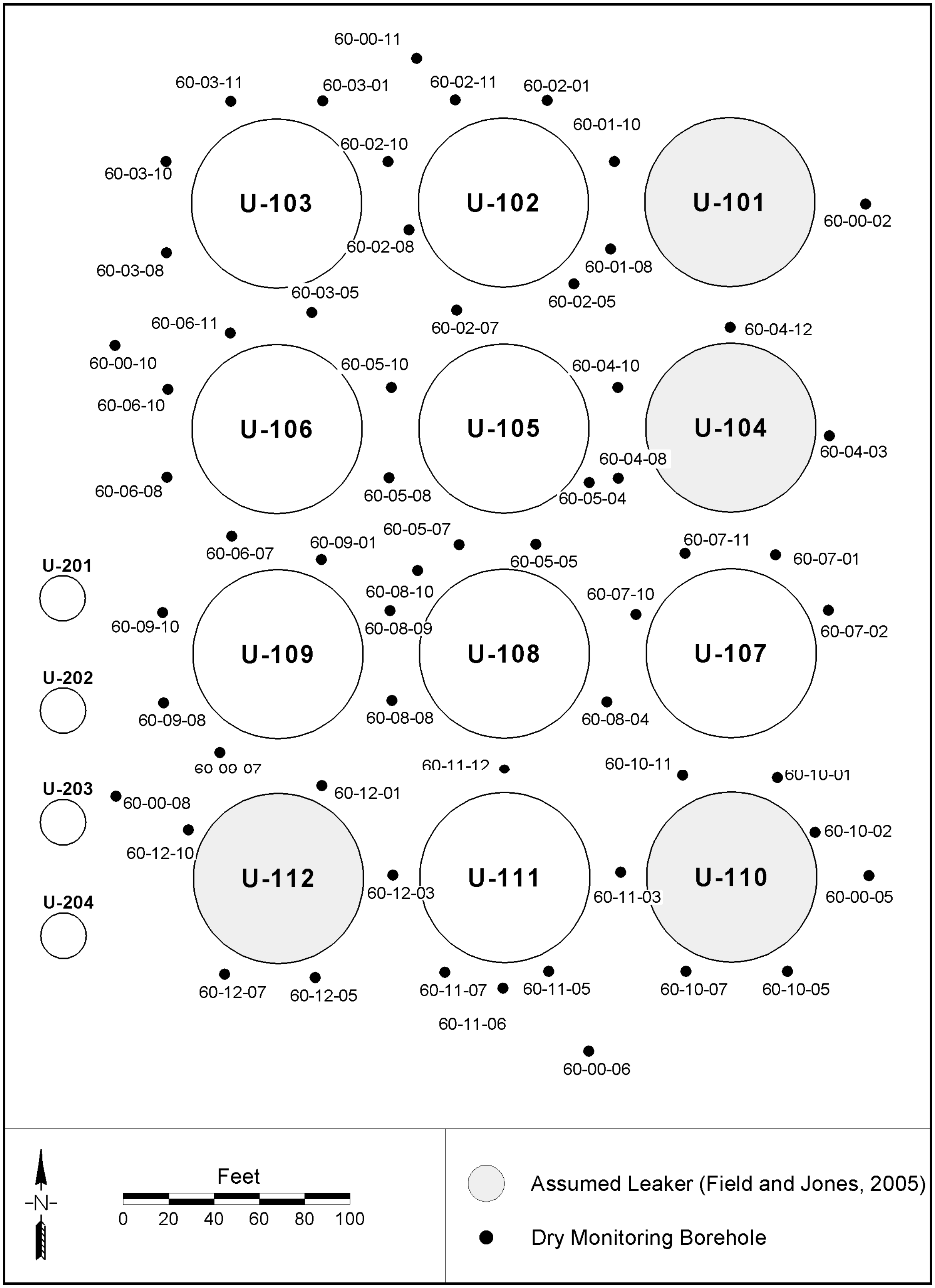
2.9.5.1 Monitoring and Characterization

The U tank farm has 59 leak detection drywells available for leak detection monitoring (Figure 2-60). These drywells were drilled from 1944 to 1979. The depth ranges for most of these drywells are between 80 and 150 ft bgs.

In 1997, U tank farm drywells were logged using a high-resolution spectral gamma logging system. This effort was part of the baseline characterization for WMA U. Results are documented in DOE-GJO (1997b) and its associated addendum (DOE-GJO 2000f).

The major contaminants associated with WMA U are cesium-137 and uranium. These contaminants are located mostly in and around areas of confirmed or suspected tank, pipeline, 244-UR vault, and diversion box leaks (Crumpler 2004).

Figure 2-60. Vadose Zone Monitoring Network for Waste Management Area U



Limitations of estimates on the extent of contamination include the following:

- No data are available from directly under the tanks.
- No data are available below the bottoms of drywells. The deepest drywell in WMA U is 150 ft bgs.

Additional information on manmade radionuclide distribution and movement resulting from the WMA U Phase I field investigation will be discussed in the FIR for WMA U. Collection of field characterization data to support the FIR is scheduled to begin in fiscal year 2005 (Crumpler 2004). The draft FIR for WMA U is scheduled to be issued in fiscal year 2006.

2.9.5.2 Contamination

Figure 2-61 provides a visualization of the vadose zone contamination beneath WMA U as represented by cesium-137 data. This figure shows a three-dimensional perspective of WMA U providing locations of tanks and associated drywells. Tanks considered to be assumed leakers based on Field and Jones (2005) are shown with darker shading. Each drywell is represented with a single vertical line. Shaded rings around the drywells indicate the level of vadose zone contamination based on spectral gamma logging results. Only the more significant soil contamination zones (>10 pCi/g) are shown. Zones with contamination levels less than 10 pCi/g are not shown.

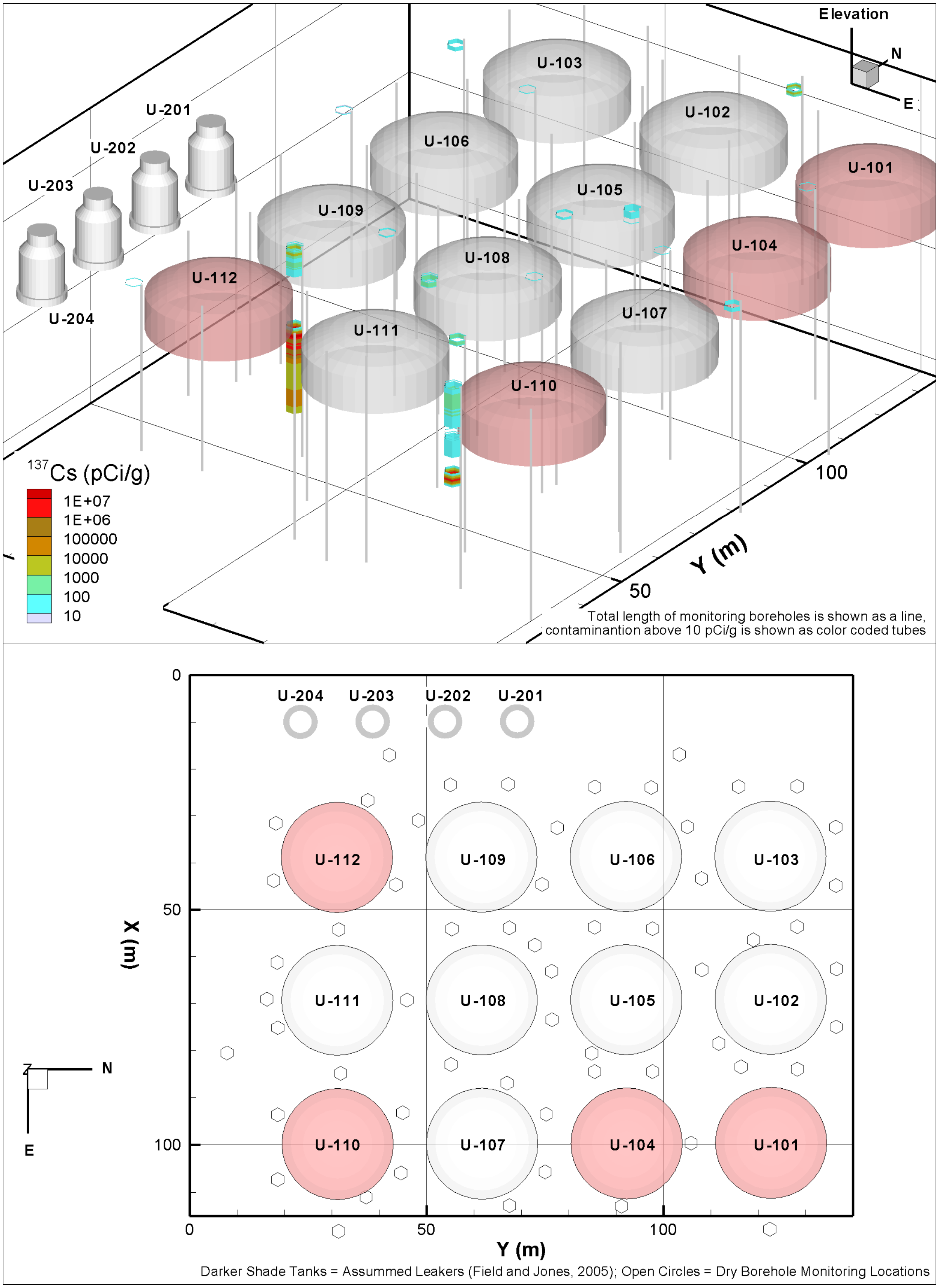
Spectral gamma uranium activity data in 10 drywells around tank U-104 and to the southwest indicate the occurrence of a metal waste leak. Maximum uranium concentrations over the largest depth intervals occur in drywells 60-07-11, 60-07-10, and 60-04-08 on the south and southwest side of tank U-104. In these drywells, contamination occurs just below the tank U-104 tank bottom (about 52 ft bgs) and extends to as much as 92 ft bgs. Uranium-235 concentrations up to 100 pCi/g and uranium-238 concentrations approaching 1,000 pCi/g have been measured near the tank bottom depth. These drywells were located closest to the leak location (Crumpler 2004).

As the plume extended further to the southwest, the peak concentrations and contaminated depth intervals decreased. Other drywells containing uranium contamination include 60-04-10, 60-07-01, 60-05-04, 60-05-05, 60-08-04, 60-11-12, and 60-11-07. In all the drywells, uranium contamination began between 50 and 55 ft bgs at the tank bottom. These drywell locations and the uranium distribution constrain the size of the uranium plume reasonably well to a roughly oval shape oriented toward the south-southwest with a long axis of about 225 ft and a short axis of about 100 ft. This oval shape is identified by the black line in Figure 2-62 (Crumpler 2004).

2.9.6 Unconfined Aquifer Conditions

This section summarizes WMA U groundwater monitoring and characterization activities and the current understanding of contamination in the unconfined aquifer.

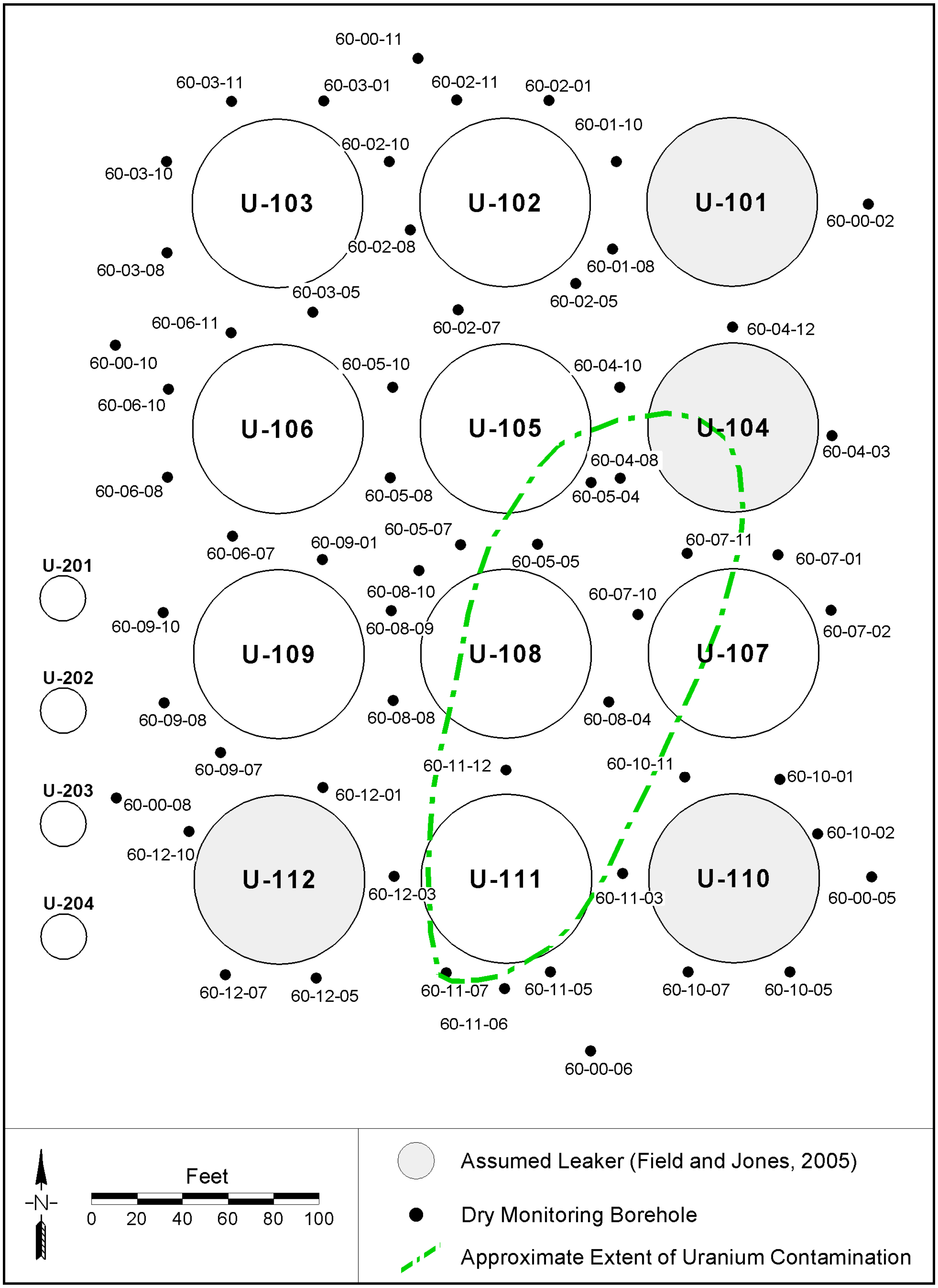
Figure 2-61. Three-Dimensional Perspective of Waste Management Area U Tanks and Drywells Showing Occurrence of Significant (>10 pCi/g) Cesium-137 Contamination in the Vadose Zone



Total length of monitoring boreholes is shown as a line, contaminantion above 10 pCi/g is shown as color coded tubes

Darker Shade Tanks = Assummed Leakers (Field and Jones, 2005); Open Circles = Dry Borehole Monitoring Locations

1 Figure 2-62. Tank U-104 Uranium Plume in Waste Management Area U [a]



2

3 [a] *Crumpler (2004)*

2.9.6.1 Monitoring and Characterization

Eight groundwater monitoring wells have provided the most useful groundwater contaminant data near WMA U. Before the installation of RCRA groundwater monitoring wells, the nearest sampled well was 299-W19-12, which was installed in 1983, and is located just east of tanks U-104 and U-107. To satisfy RCRA monitoring requirements for WMA U, two upgradient wells (299-W18-25, 299-W18-31) on the west side of the U tank farm and three downgradient wells (299-W19-30, 299-W19-31, 299-W19-32) located on the northeast and east side of U tank farm were installed in 1991 and 1992 (Wood and Jones 2003). Since then, water table subsidence eliminated sampling capability at some wells, necessitating the installation of replacement wells, including 299-W-42, to replace 299-W19-31, 299-W19-41 to replace 299-W19-32 in 1999, and 299-W18-40 to replace 299-W18-25 in 2001 (Wood and Jones 2003). When functional, these wells have been sampled and analyzed regularly since installation.

Groundwater flows easterly to northeasterly. However, the upgradient/downgradient relationship was temporarily reversed between mid 1993 and early 1996 because of large liquid discharge events in the 216-U-14 ditch just east of the U tank farm in 1991 and 1993 (Singleton and Lindsey 1994). The discharge volume over a short period (about 1.9×10^9 L) in 1991 was sufficient to affect local groundwater flow (Smith et al. 2001).

2.9.6.2 Contamination

WMA U was placed into assessment status in 2000 when specific conductance in groundwater monitoring wells downgradient of the WMA exceeded upgradient levels (Hodges and Chou 2000b). An assessment of that finding determined that the WMA had affected groundwater quality with elevated concentrations of nitrate and possibly chromium in wells downgradient of the WMA (Hodges and Chou 2000a). The contaminant concentrations did not exceed their respective DWS levels, and the area affected appeared to be limited to the southeast corner of the WMA. A groundwater quality assessment plan (Smith et al. 2001) was prepared in 2001. The plan was modified in 2003 (Smith et al. 2003). The most recently published groundwater monitoring results for WMA U are for fiscal year 2003 (Hartman et al. 2004). Following is a summary of the fiscal year 2003 results adapted from Hartman et al. (2004). Additional detail on groundwater contamination and geochemistry at WMA U can be found in Hartman et al. (2004) and Reidel et al. (2006).

The WMA has been identified as the source for a small contaminant plume that is limited to the south half of the downgradient (east) side of the site. Nitrate and carbon tetrachloride are the only contaminants in groundwater beneath WMA U that exceed their respective MCLs. WMA U is believed to be the source of the local nitrate plume that includes only one well (299-W19-41) above the MCL. The carbon tetrachloride arrived from disposal sites associated with the Plutonium Finishing Plant and not associated with WMA U. Other contaminants associated with releases from the WMA, such as chromium and technetium-99, are below the MCL in groundwater. The regional carbon tetrachloride, technetium-99, and nitrate plumes with upgradient sources are entering the area around WMA U, as evidenced by their appearance or concentration increase in the upgradient monitoring wells.

2.9.7 Reference Case Source Terms

The reference case describes a set of assumed post-retrieval conditions that are based on current waste retrieval plans. The reference case analysis for WMA U includes three source terms consisting of past UPRs, residual SST waste, and residual ancillary equipment waste. Table 2-19 provides a listing of the reference case source terms for WMA U, and the inventory data source for that source term.

Source term inventories (reference case) for WMA U are provided in Table 2-20. To simplify the table, only the contaminants that dominate post-closure impacts are shown. All BBI contaminants are included in the reference case modeling analysis. Refer to Section 2.5 for a summary of source term inventory development methods. Complete source term inventory data are provided in Appendix C.

2.9.7.1 Past Unplanned Releases

The WMA U reference case includes four past UPRs associated with SSTs (U-101, U-104, U-110, U-112) and two past UPRs associated with ancillary equipment (UPR-200-W-24, UPR-200-W-132). Volume estimates for those six waste loss events were developed by Field and Jones (2005) and vadose zone contaminant inventories were generated by Corbin et al. (2005) (Section 2.5.2).

2.9.7.2 Residual Single-Shell Tank Waste

The WMA U reference case includes residual waste in each of the twelve 100-Series and four 200-Series SSTs in the U tank farm. The HFFACO Milestone M-45-00 goal allows up to 360 ft^3 of waste to remain in the 100-Series tanks after retrieval in the event that retrieval beyond that level becomes impracticable (Ecology et al. 1989). Thus, the analysis includes a 360 ft^3 source term associated with residual waste remaining in each of the tanks after retrieval. The inventory estimates were generated with the use of the HTWOS model (Kirkbride et al. 2005), which accounts for the waste retrieval technology and tracks the fate of soluble and insoluble constituents in the waste (Section 2.5.3).

2.9.7.3 Residual Ancillary Equipment Waste

The WMA U reference case includes the plugged and blocked piping in the U tank farm and the residual waste in five MUSTs consisting of one catch tank (241-U-301) and the four tanks in the 244-UR vault (244-UR-001, 244-UR-002, 244-UR-003, 244-UR-004) (Section 2.5.4). Volume and inventory estimates for the waste in the plugged and blocked piping (705.9 L) were developed by Lambert (2005). Volume estimates for the residual waste in the MUSTs were calculated by assuming each tank would be retrieved to a residual volume proportional to that required under the HFFACO Milestone M-45-00 for 200-Series tanks (Ecology et al. 1989). Contaminant inventories associated with the residual ancillary equipment waste were estimated using the average chemical composition of the waste in the WMA U SSTs.

Table 2-19. Reference Case Analysis of Waste Management Area U (2 pages)

Inventory and Source Terms					
Sources	**Assumed Retrieval Method**	**Residual Volume**	**Volume Associated with Past Release [a] gal**	**Basis for Contaminant Inventory Estimate**	
				Residual Waste [b]	**Past Release**
241-U-101	Mobile retrieval system	360 ft^3	5,000	HTWOS	Corbin et al. 2005
241-U-102	Sluicing	360 ft^3	None	HTWOS	None
241-U-103	Sluicing	360 ft^3	None	HTWOS	None
241-U-104	Mobile retrieval system	360 ft^3	55,000	HTWOS	Corbin et al. 2005
241-U-105	Sluicing	360 ft^3	None	HTWOS	None
241-U-106	Sluicing	360 ft^3	None	HTWOS	None
241-U-107	Sluicing	360 ft^3	None	HTWOS	None
241-U-108	Sluicing	360 ft^3	None	HTWOS	None
241-U-109	Sluicing	360 ft^3	None	HTWOS	None
241-U-110	Mobile retrieval system	360 ft^3	6,500	HTWOS	Corbin et al. 2005
241-U-111	Sluicing	360 ft^3	None	HTWOS	None
241-U-112	Mobile retrieval system	360 ft^3	8,500	HTWOS	Corbin et al. 2005
241-U-201	Vacuum	30 ft^3	None	HTWOS	Corbin et al. 2005
241-U-202	Vacuum	30 ft^3	None	HTWOS	Corbin et al. 2005
241-U-203	Vacuum	30 ft^3	None	HTWOS	Corbin et al. 2005
241-U-204	Vacuum	30 ft^3	None	HTWOS	Corbin et al. 2005
UPR-200-W-24	NA	NA	36	NA	Corbin et al. 2005
UPR-200-W-132	NA	NA	500	NA	Corbin et al. 2005
241-U-301 catch tank [c]	TBD [c]	TBD [c]	None	Average	None
244-UR-001 vault tank [c]	TBD [c]	27 ft^3	None	Average	None
244-UR-002 vault tank [c]	TBD [c]	8 ft^3	None	Average	None

Table 2-19. Reference Case Analysis of Waste Management Area U (2 pages)

Inventory and Source Terms					
Sources	**Assumed Retrieval Method**	**Residual Volume**	**Volume Associated with Past Release [a] gal**	**Basis for Contaminant Inventory Estimate**	
				Residual Waste [b]	**Past Release**
244-UR-003 vault tank [c]	TBD [c]	8 ft^3	None	Average	None
244-UR-004 vault tank [c]	TBD [c]	4.5 ft^3	None	Average	None
241-U tank farm pipelines [d]	TBD	705.9 L	None	Lambert 2005	NA

[a] Past leak volumes listed in Field and Jones (2005).

[b] Residual inventories from HTWOS model output (Kirkbride et al. 2005).

[c] TBD = to be determined. Final disposition of MUSTs not yet determined; however, MUSTs were carried forward in the assessment assuming MUSTs will be retrieved to at least the HFFACO goal (Ecology et al. 1989, Milestone M-45-00) equivalent to the 200-Series tanks. The residual volume is calculated by ratio of the total volume of the MUST to the 200-Series tanks (e.g., the retrieval goal for the 55,000-gal 200-Series tanks is 30 ft^3; thus, a MUST that is ⅔ the size of the 200-Series tank would have a residual volume of 20 ft^3). Inventory was calculated based on average waste per ft^3 within the WMA calculated from the HTWOS model (Kirkbride et al. 2005).

[d] Final disposition of pipelines is not yet determined; however, pipelines were carried forward in the assessment. Pipeline residual volume shown represents the volume of waste in plugged or blocked pipelines as determined by Lambert (2005).

NA = not applicable

Table 2-20. Reference Case Inventory Estimates for Waste Management Area U

Source Type	Dominant Contaminants for Groundwater Pathway Impacts [a]							Dominant Contaminants for Inadvertent Intruder Impacts [a]						
	C-14 Ci	Tc-99 Ci	I-129 Ci	Cr(VI) kg	NO_3 kg	NO_2 kg	U kg	Sr-90 Ci	Tc-99 Ci	Sn-126 Ci	Cs-137 Ci	Pu-239 Ci	Pu-240 Ci	Am-241 Ci
Past releases [b]	1.60E-01	3.59E+00	4.52E-03	1.61E+02	8.87E+03	2.06E+03	1.84E+02	5.84E+02	3.59E+00	3.32E-02	8.63E+03	1.23E+00	1.68E-01	1.15E+00
Tank residuals	1.33E-01	2.90E+01	3.97E-03	2.21E+03	6.40E+03	1.22E+03	1.23E+03	4.79E+04	2.90E+01	8.28E-01	1.56E+04	1.02E+02	2.13E+01	1.92E+02
Ancillary equipment residuals [c]	1.07E-02	4.87E-01	2.03E-04	3.17E+01	2.04E+02	7.07E+01	1.64E+01	NA	NA	NA	NA	NA	NA	NA

[a] The reference case analysis included all BBI contaminants. As described in Bowen (2004), the standard analyte list tracked in the BBI contains **25 chemicals** including:

- aluminum
- bismuth
- calcium
- chlorine
- chromium
- fluorine
- total inorganic carbon as carbonate
- iron
- mercury
- potassium
- lanthanum
- manganese
- sodium
- nickel
- nitrite
- nitrate
- oxalate
- lead
- phosphate
- silicon
- sulfate
- strontium
- uranium total
- zirconium
- total organic carbon

and **46 radionuclides** including:

- tritium
- carbon-14
- nickel-59
- cobalt-60
- nickel-63
- selenium-79
- strontium-90
- yttrium-90
- zirconium-93
- niobium-93m
- technetium-99
- ruthenium-106
- cadmium-113m
- antimony-125
- tin-126
- iodine-129
- cesium-134
- cesium-137
- barium 137m
- samarium-151
- europium-152
- europium-154
- europium-155
- radium-226
- actinium-227
- radium-228
- thorium-229
- protactinium-131
- thorium-232
- uranium-232
- uranium-233
- uranium-234
- uranium-235
- uranium-236
- neptunium-237
- plutonium-238
- uranium-238
- plutonium-239
- plutonium-240
- americium-241
- plutonium-241
- curium 242
- plutonium-242
- americium-243
- curium-243
- curium-244

[b] Inventories shown are the combined inventories from SST past releases and ancillary equipment past releases. Both release types were considered for the groundwater pathway analysis; however, only the SST past releases were included in the inadvertent intruder analysis (along with SST residuals).

[c] NA indicates insufficient information is available to make estimates of intruder impacts into ancillary equipment (e.g., pipelines, diversion boxes).

2.10 DESCRIPTION OF WASTE MANAGEMENT AREA C

This section provides site-specific information for WMA C. It is a summary from numerous documents that describe present conditions (Hanlon 2005), geology and hydrology (Reidel et al. 2006), subsurface contamination (Wood et al. 2003), and source terms (Kirkbride et al. 2005; Field and Jones 2005; Lambert 2005; Corbin et al. 2005).

2.10.1 Background

WMA C is located in the east central portion of the 200 East Area (Figure 2-63). In general, the WMA C boundary is represented by the fenceline surrounding the C tank farm. WMA C contains twelve 100-Series SSTs and four 200-Series SSTs that were constructed in 1943 to 1944, put into service in 1946, and used to store and transfer waste until 1980. Because of its long operational history, the C tank farm received waste generated by essentially all of the Hanford Site major chemical processing operations including bismuth phosphate fuel processing, uranium recovery, PUREX fuel processing, Hot Semi-Works Facility pilot plant operations, fission product recovery, and tank farm interim stabilization and isolation activities.

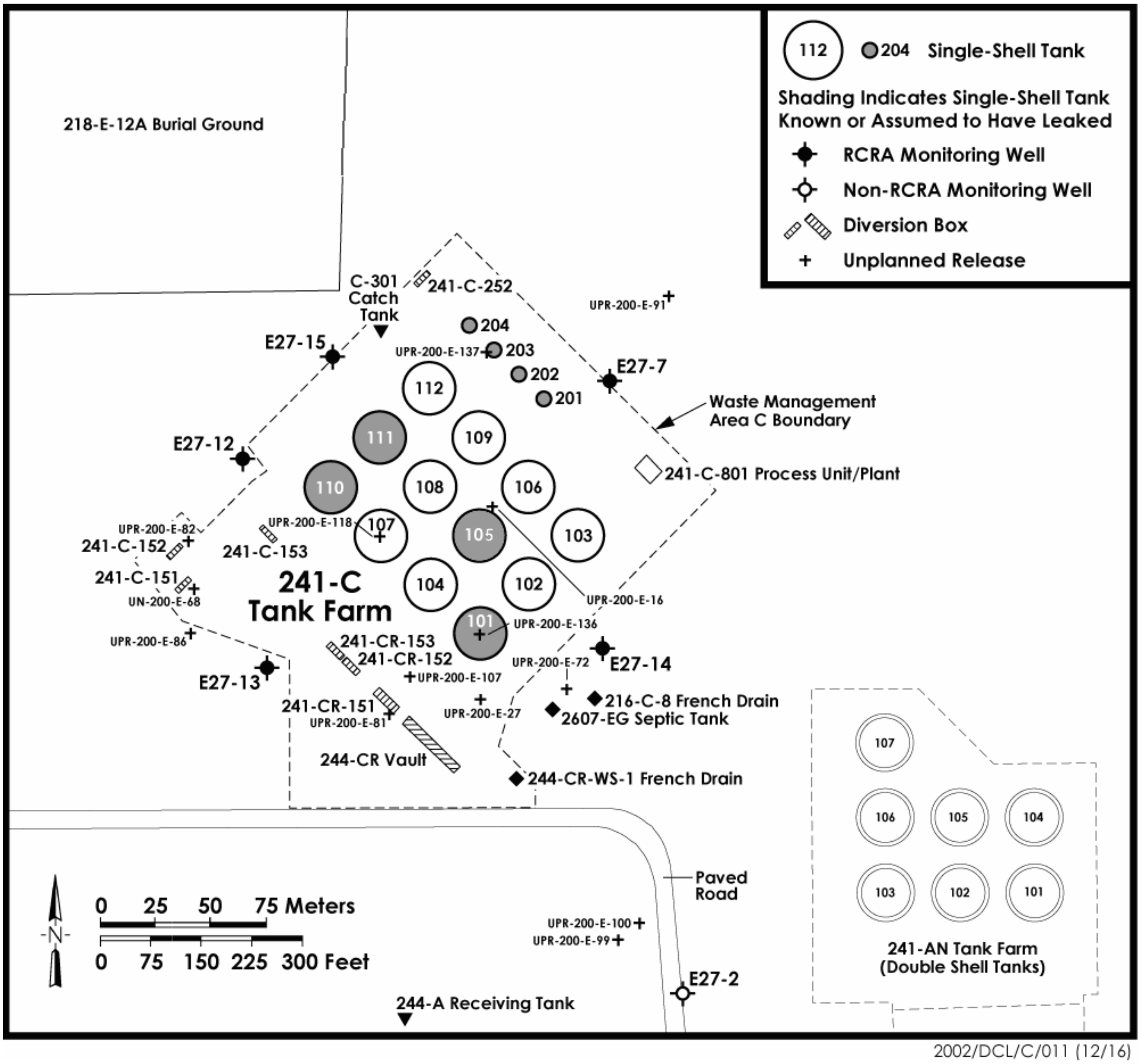
During its operational history, there were a number of confirmed or suspected waste loss events in WMA C. These included suspected tank leaks and known waste losses from piping systems. Pumping of liquid waste in preparation for removing the tanks from service began in 1976. Currently, the pumpable liquid wastes have been removed from the C farm tanks and all tanks have been interim stabilized. Table 2-21 lists the estimated volume of waste stored in the WMA C tanks as of November 30, 2004.

A waste retrieval campaign was completed for tank C-106 in December 2003. The campaign was conducted as a retrieval technology demonstration under the HFFACO (Ecology et al. 1989), and used modified sluicing and acid dissolution to pump waste from tank C-106 to a DST in the AN tank farm. A regulatory assessment of the residual waste remaining in tank C-106 is currently being conducted as described in Sams (2004a).

The current understanding of contaminant occurrences and environmental conditions at WMA C is described in Wood et al. (2003). Historical information on soils and vadose zone contamination in WMA C is provided in Williams (2001c). The primary contamination zones currently identified in WMA C are a localized high cesium-137 activity zone near the bottom of the southwest part of tank C-105 and three UPRs near pipelines and diversion boxes in the southwest part of WMA C.

A FIR for WMA C is scheduled to be issued in fiscal year 2006. Field characterization data to support the FIR is scheduled to be collected in fiscal years 2004 and 2005 as outlined in Crumpler (2004). Planned WMA C closure and post-closure actions that can be identified at the present time are described in Appendix C of Lee (2004).

Figure 2-63. Location Map of C Tank Farm and Surrounding Facilities[a]



[a] *Modified from Reidel et al. (2006)*

Table 2-21. Waste Volume Estimates as of November 30, 2004, in Waste Management Area C Single-Shell Tanks [a]

Tank	Total Waste Volume gal × 1,000	Supernate gal × 1,000	Saltcake gal × 1,000	Sludge gal × 1,000
241-C-101	88	0	0	88
241-C-102	316	0	0	316
241-C-103	72	1	0	71
241-C-104	259	0	0	259
241-C-105	132	0	0	132
241-C-106	3 [b]	0	0	3 [b]
241-C-107	247	0	0	247
241-C-108	66	0	0	66
241-C-109	63	0	0	63
241-C-110	178	1	0	177
241-C-111	57	0	0	57
241-C-112	104	0	0	104
241-C-201	1	0	0	1
241-C-202	0 [c]	0	0	0
241-C-203	1 [d]	0	0	1
241-C-204	2	0	0	2

[a] Hanlon (2005)

[b] Retrieval completed December 31, 2003. Total tank residue remaining volume is 2,777 gal (85 gal of which is liquid) per *Calculation for the Post Retrieval Volume Determination for Tank 241-C-106* (Wimett et al. 2004).

[c] C-202: Volumes: total waste is 490 gal, and sludge is 490 gal.

[d] C-203: Retrieval in progress.

2.10.2 Infrastructure

This section describes the WMA C infrastructure components that were included in the SST PA and listed in Table 2-22. Reference case inventory development for those components is described in Section 2.10.7. Refer to Section 2.4 for generic infrastructure component descriptions and Section 2.5 for a summary of infrastructure inventory development methods.

Table 2-22. Operating Period and Capacities for Waste Management Area C Facilities Included in the Performance Assessment [a]

Facility	Removed From Service	Constructed	Operating Capacity gal
Single-Shell Tanks			
241-C-101	1970	1943 to 1944	530,000
241-C-102	1976	1943 to 1944	
241-C-103	1979	1943 to 1944	
241-C-104	1980	1943 to 1944	
241-C-105	1979	1943 to 1944	
241-C-106	1979	1943 to 1944	
241-C-107	1978	1943 to 1944	
241-C-108	1976	1943 to 1944	
241-C-109	1976	1943 to 1944	
241-C-110	1976	1943 to 1944	
241-C-111	1978	1943 to 1944	
241-C-112	1976	1943 to 1944	
241-C-201	1977	1943 to 1944	55,000
241-C-202	1977	1943 to 1944	
241-C-203	1977	1943 to 1944	
241-C-204	1977	1943 to 1944	
Miscellaneous Underground Storage Tanks			
241-C-301 catch tank	1988	1946	36,000
244-CR-001 vault tank	1988 (244-CR vault)	1946	50,000
244-CR-002 vault tank		1946	15,000
244-CR-003 vault tank		1946	15,000
244-CR-011 vault tank		1946	50,000
Underground Waste Transfer Lines			
241-C tank farm pipelines	NA	1943 to 1944	18,100 (+/-5,100)

[a] Data on the facilities are from DOE-RL (2005) and Field (2003a).

NA = not applicable

2.10.2.1 Single-Shell Tanks

The 100-Series tanks are 75 ft in diameter and 32 ft tall. The tanks have a 15-ft operating depth, and an operating capacity of 530,000 gal each. The 200-Series tanks are 20 ft in diameter and 25 ft tall. The tanks have a 24-ft operating depth and an operating capacity of 55,000 gal each. Typical tank configuration and dimensions are shown in Figure 2-64. The 100-Series tanks sit belowgrade with at least 7 ft of soil cover to provide shielding from radiation exposure to operating personnel. Tank pits are located on top of the 100-Series tanks and provide access to the tank, pumps, and monitoring equipment.

The SSTs were constructed in place with carbon steel (ASTM 2005) lining the bottom and sides of a reinforced concrete shell. The tanks have concave bottoms (i.e., center of tanks lower than the perimeter) and a curving intersection of the sides and bottom. The inlet and outlet lines are located near the top of the liners (Figure 2-64). The 100-Series tanks were constructed with cascade overflow lines in a 3-tank series that allowed gravity flow of liquid between tanks. The 200-Series tanks were connected and fed to diversion box C-252 (Crumpler 2004).

2.10.2.2 Ancillary Equipment

A complete listing of the WMA C ancillary equipment currently identified for inclusion in the SST system closure is provided in Lee (2004). As discussed in Section 2.5.4, the ancillary components included in the SST PA consist of the underground waste transfer lines and MUSTs located inside each WMA boundary. For WMA C, the ancillary components analyzed consist of the C tank farm waste transfer piping and five MUSTs. The MUSTs consist of one catch tank (241-C-301) and the four tanks in the 244-CR vault (244-CR-001, 244-CR-002, 244-CR-003, 244-CR-011).

Multiple levels of piping were installed over time in WMA C. A time line of piping installations is described in Williams (2001c). It is estimated that there are approximately 9.3 mi (+/- 2.7 mi) of waste transfer piping in the C tank farm (Field 2003a).

2.10.3 Geology

Following is an overview of the geology of WMA C summarized from the information provided in Reidel et al. (2006). Because WMAs A-AX and C are in close proximity (Figure 2-2 in Section 2.3) and have similar geologic conditions, they are discussed together in Reidel et al. (2006) and will be discussed together here. A generalized cross-section through WMAs A-AX and C is shown in Figure 2-65. Maps and cross-sections presented in Reidel et al. (2006) illustrate the distribution and thicknesses of these units in additional detail.

Figure 2-64. Typical Configuration and Dimensions of Single-Shell Tanks in Waste Management Area C

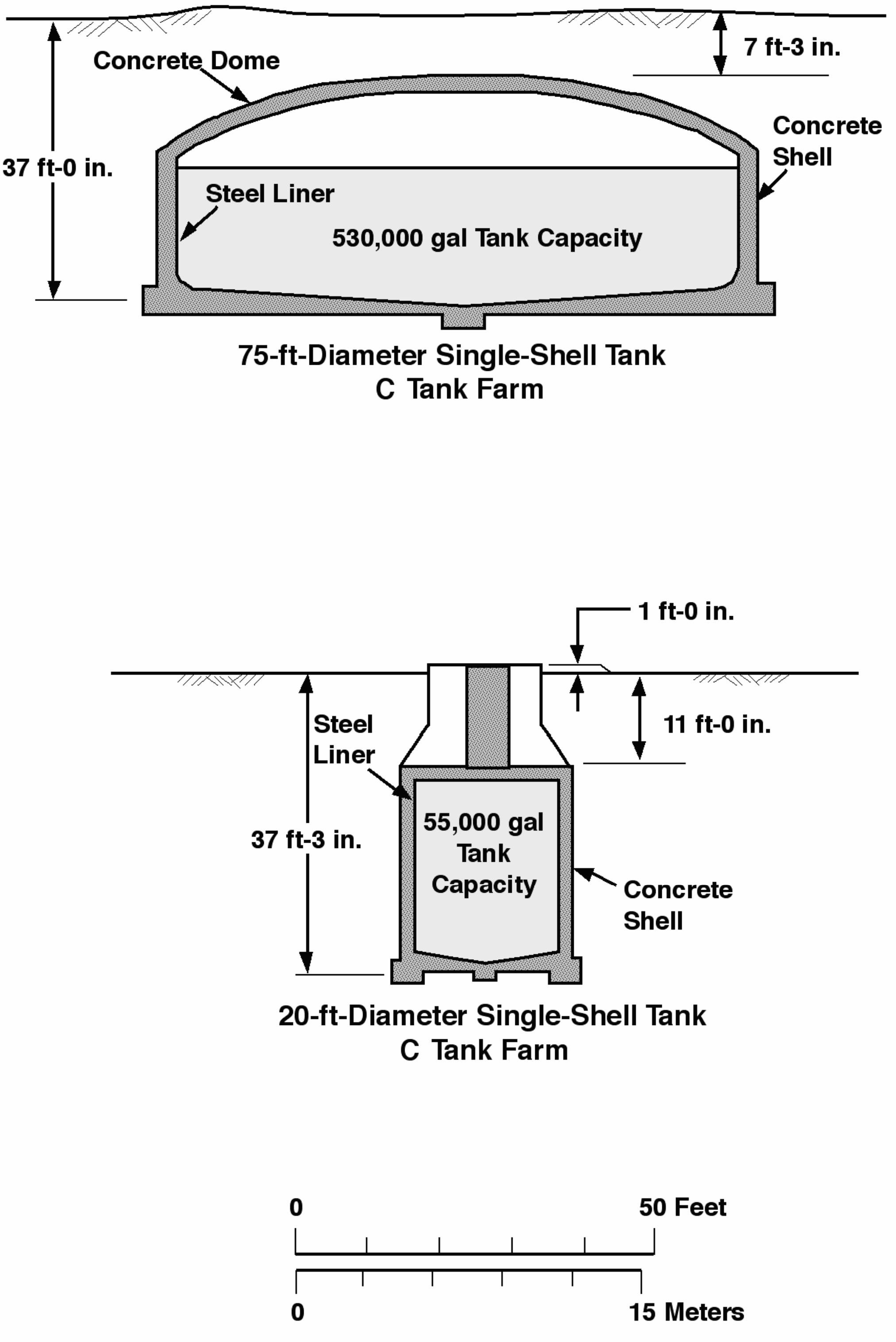
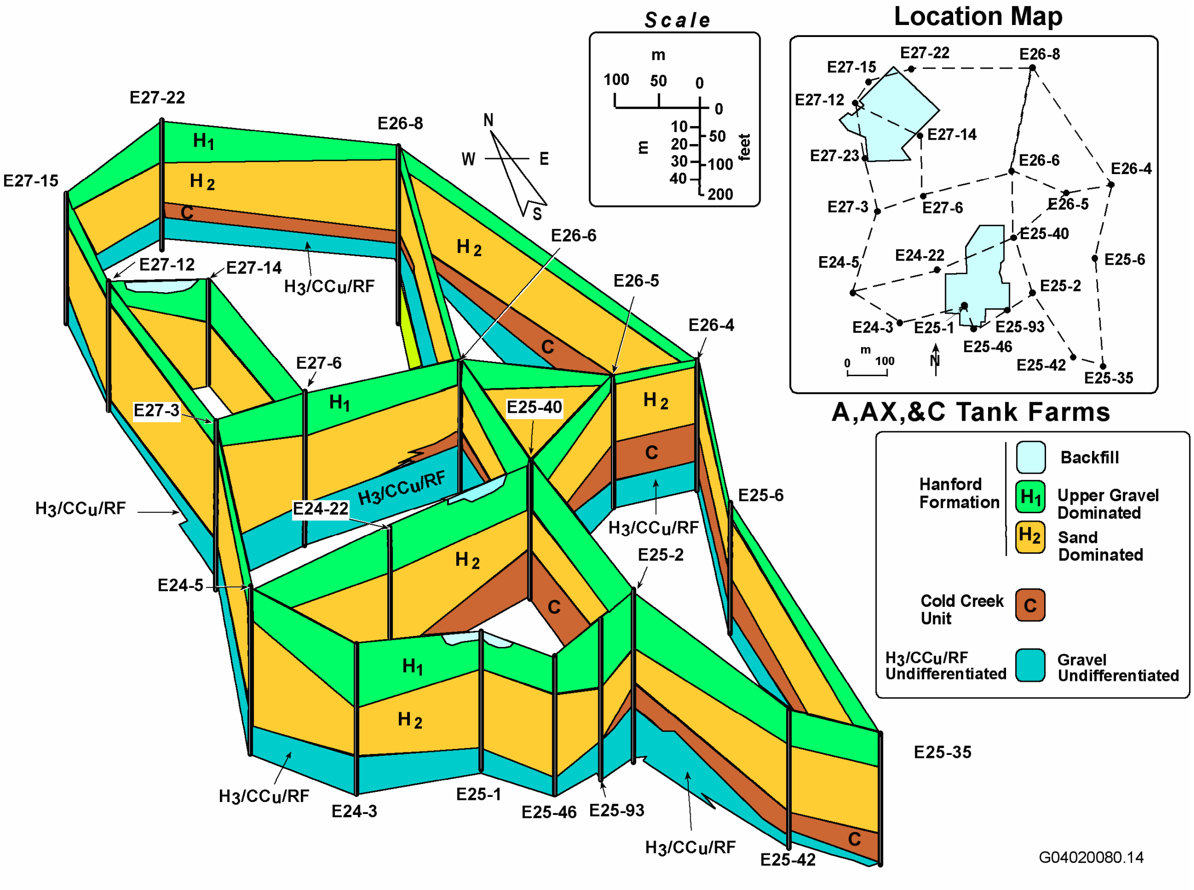


Figure 2-65. Fence Diagram Showing Cross-Sections through Waste Management Areas A-AX and C [a]



[a] *Reidel et al. (2006)*

Seven stratigraphic units lie within WMAs A-AX and C. From oldest to youngest, the primary geologic units are:

- Columbia River Basalt Group
- Undifferentiated Cold Creek unit fine unit and/or Ringold Formation
- Undifferentiated Cold Creek unit gravel and/or Ringold Formation Unit A?
- Hanford formation – lower gravelly sequence (H3 unit)
- Hanford formation – sand sequence (H2 unit)
- Hanford formation – upper gravelly sequence (H1 unit)
- Recent deposits.

The general characteristics of these units are described in Section 2.3.4.1 and in more detail in Reidel et al. (2006). The SSTs at WMAs A-AX and C were emplaced within the Hanford formation sediments of the upper, gravel-dominated (H1) unit, and may locally intercept the upper portions of the sand-dominated Hanford (H2) unit. The water table or potentiometric surface lies approximately 60 m (approximately 200 ft) below the bottom of the tank farms excavations at the basal portion of the Hanford formation (i.e., lower sand/silt dominated) H3 unit, or within the uppermost portions of the Cold Creek unit or Ringold Formation.

2.10.4 Hydrology

Following is an overview of the hydrology of the uppermost, unconfined aquifer beneath WMA C. The general geohydrology of the Hanford Site is summarized in Section 2.3.5.2. More detailed information supporting this section can be found in Reidel et al. (2006), Wood et al. (2003), and Hartman et al. (2004). Currently, the general groundwater flow direction in the unconfined aquifer beneath WMA C is to the southwest. The water table is very flat overall, with an estimated hydraulic gradient of 0.00033. The estimated groundwater flow velocity ranges from 1.2 to 2.3 m/day (Hartman et al. 2004).

The shift in discharge of large volumes of wastewater in the early 1950s to B Pond raised the water table in the vicinity of WMAs C and A-AX as much as 4.9 m (16 ft) above the pre-Hanford Site operations level (Hartman et al. 2004). Water levels began to decline in the late 1980s when wastewater discharges were reduced. The decline has become even more pronounced since other effluent discharges throughout the 200 Areas ceased in 1995. Water levels are expected to continue declining within the region surrounding WMAs A-AX and C. It is expected the water table will return to pre-Hanford Site conditions, the hydraulic gradient will decrease to 1.0E-5 m/m, and the flow direction will be to the east (Cole et al. 2001a)

Currently, the water table beneath WMA C lies 122 m (400 ft) amsl with about 77 m (255 ft) of vadose zone. The aquifer thickness, based on the top of basalt at 108 m (355 ft), is approximately 13.4 m (44 ft). The aquifer materials consist dominantly of sandy gravel or silty sandy gravel. Hydraulic conductivity values reported for the aquifer in this area vary considerably, ranging from 0.04 (silt lenses within the sandy gravel) to 6,900 m/day. Additional hydraulic property data from aquifer testing at wells near WMA C is provided in Reidel et al. (2006) and Hartman et al. (2004).

2.10.5 Vadose Zone Conditions

This section summarizes WMA C vadose zone monitoring and characterization activities and the current understanding of contamination in the vadose zone.

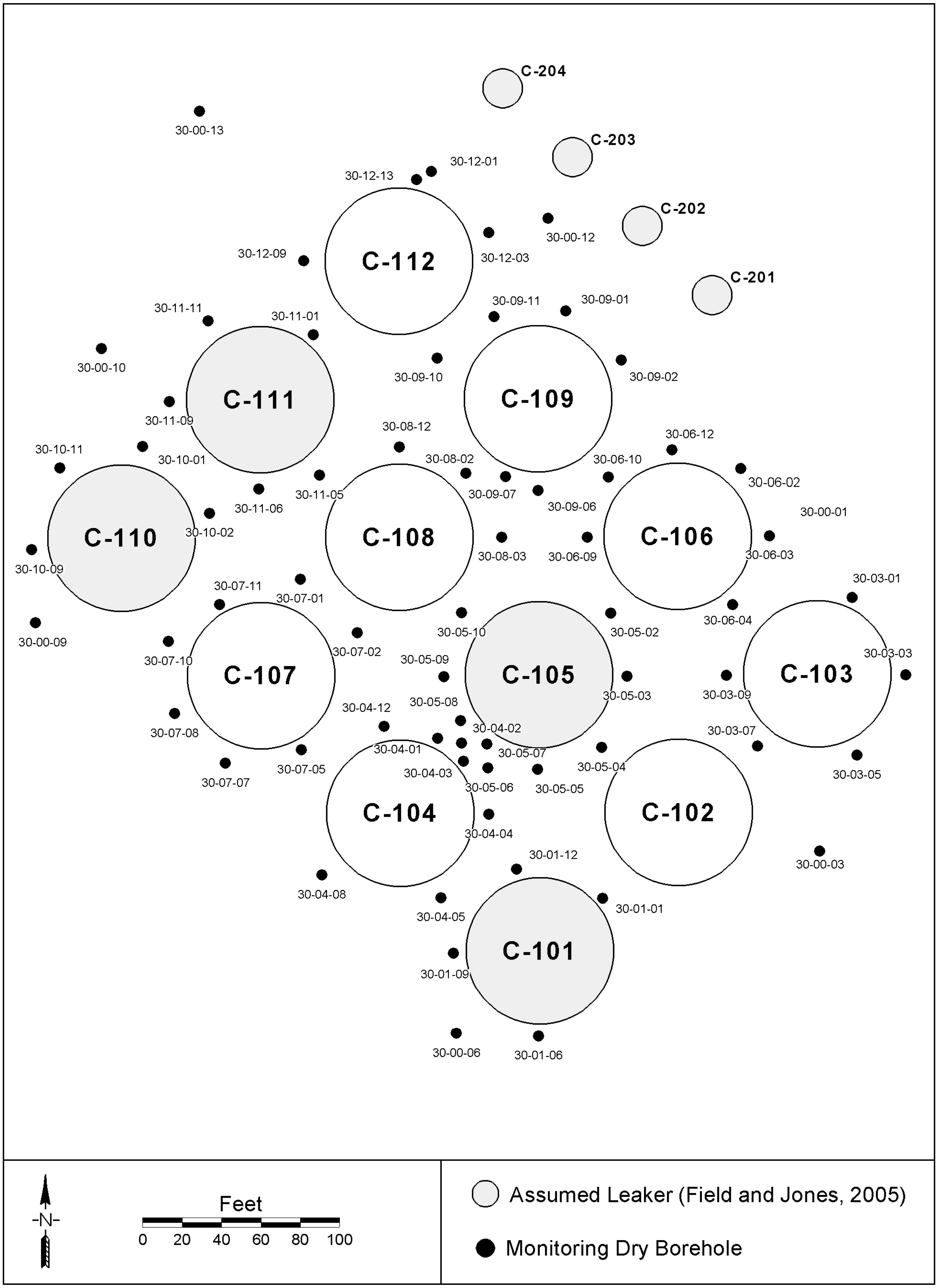
2.10.5.1 Monitoring and Characterization

WMA C has 70 leak detection wells (Figure 2-66) available for leak detection monitoring and to provide access for limited vadose zone characterization (e.g., geophysical logging). These drywells were drilled from 1944 to 1982. The depth ranges for most of these drywells is between 100 and 150 ft bgs.

In 1997, C farm drywells were logged using a high-resolution spectral gamma logging system. This effort was part of the baseline characterization for WMA C. Results are documented in DOE-GJO (1998c) and its associated addendum DOE-GJO (2000g).

The major gamma-emitting contaminants associated with WMA C are cesium-137 and cobalt-60 with lesser amounts of europium-154. These contaminants are located mostly in and around areas of confirmed or suspected tank and pipeline leaks. Although most of the drywells are deeper than the surrounding contamination, some zones of contamination extend deeper than nearby drywells. Consequently, the maximum depth of vadose zone contamination is not known in some areas of WMA C.

Figure 2-66. Vadose Zone Monitoring Network for Waste Management Area C



Limitations of estimates on the extent of contamination include the following:

- No data are available from directly under the tanks.
- No data are available below the bottoms of drywells. The deepest drywell in WMA C is 155 ft bgs (well 30-00-03), and the maximum logged depth is 143 ft bgs (well 30-04-08).

As part of the ongoing vadose zone characterization, a WMA C Phase I field investigation study is presently underway (Crumpler 2004). A FIR will document the results of the field characterization data. Additional information on manmade radionuclide distribution and movement with WMA C will be discussed in the FIR scheduled to be issued in fiscal year 2006.

2.10.5.2 Contamination

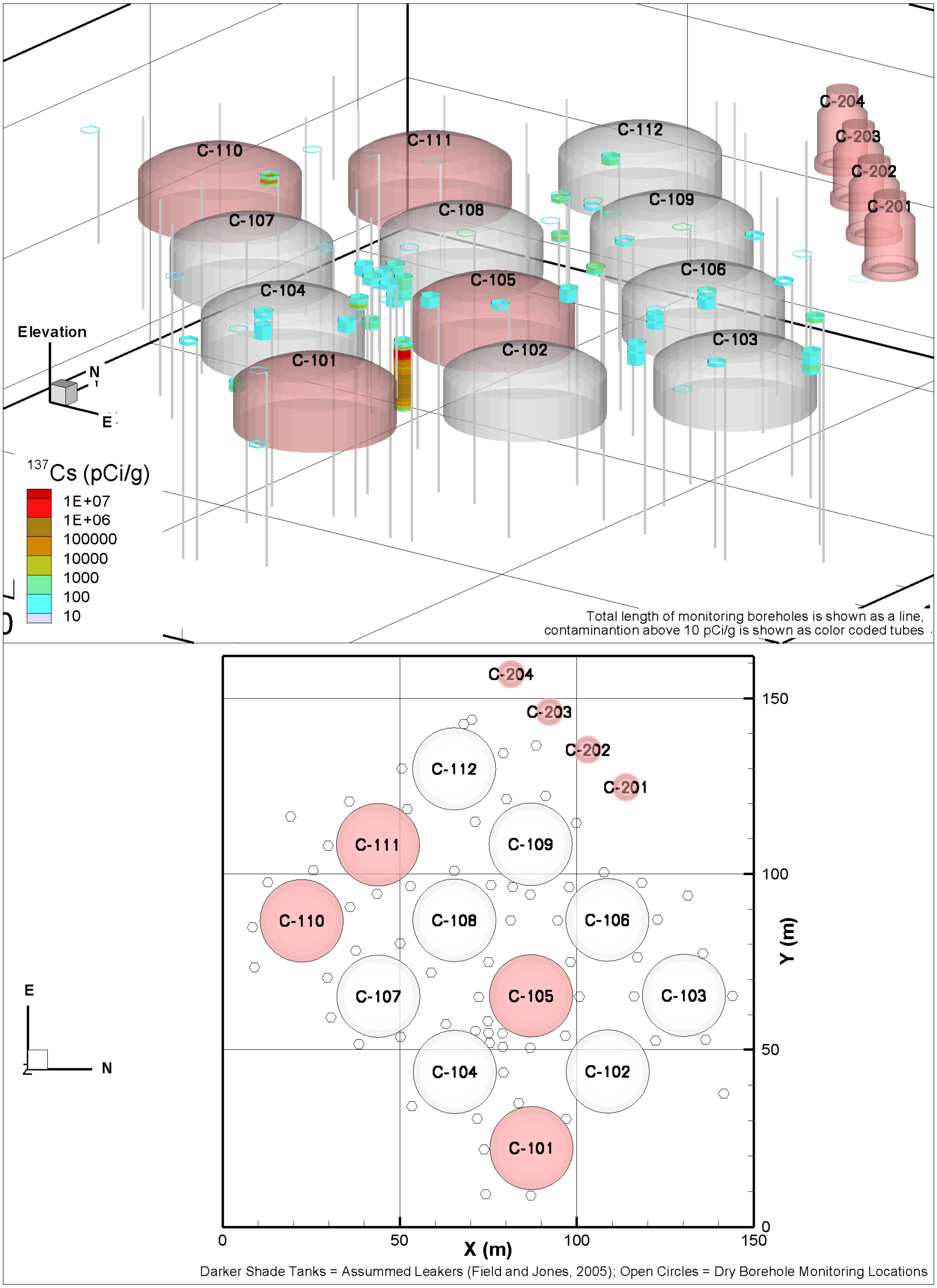
Figure 2-67 provides a visualization of the vadose zone contamination beneath WMA C as represented by cesium-137 data. This figure is a three-dimensional perspective of WMA C providing locations of tanks and associated drywells. Tanks considered to be assumed leakers based on information in Field and Jones (2005) are shown with darker shading. Each drywell is represented with a single vertical line. Shaded rings around the drywells indicate the level of vadose zone contamination based on spectral gamma logging results. Only the more significant soil contamination zones are shown. Zones with contamination levels less than 10 pCi/g are not shown.

An overall assessment of the spectral gamma logging data from C farm drywells indicates that, with the exception of contamination zones near tank C-105 and three unplanned pipeline releases, most vadose zone contamination originated from surface or near-surface contamination events that were not generally associated with particular recorded events and are not considered to be significant sources of vadose zone contamination (Wood et al. 2003).

Neither tank C-104 nor tank C-105 is listed as a confirmed or suspected leaker in Hanlon (2005). Spectral gamma logging data indicate the presence of contamination in the region between tanks C-104 and C-105. The most concentrated contamination occurs at drywell 30-05-07 on the southwest side of tank C-105 (Figures 2-66 and 2-67), where two high cesium-137 concentration zones occur at and below the tank bottom (Wood et al. 2003). The origin of the contamination has not been conclusively established and a leak from tank C-105 cannot be ruled out. A characterization borehole was drilled between tanks C-104 and C-105 during fiscal year 2004 (Crumpler 2004). Vadose zone sample data from that borehole will be incorporated into the analysis presented in the FIR for WMA C.

Evidence from the historical record indicates that three unplanned near-surface release events (UPR-200-E-81, UPR-200-E-82, UPR-20-E-86) occurred on the southwest side of the C tank farm (Figure 2-63). These events are known to have made relatively significant contributions to vadose zone contamination (Wood et al. 2003). The UPR-200-E-81 event occurred near the 241-CR-151 diversion box and involved the loss of approximately 36,000 gal of waste. The UPR-200-E-82 event occurred near the 241-C-152 diversion box and involved the loss of approximately 2,600 gal of waste. The UPR-200-E-86 event occurred in a pipeline break near the southwest corner of the C tank farm and involved the loss of approximately 17,400 gal of waste.

Figure 2-67. Three-Dimensional Perspective of Waste Management Area C Tanks and Drywells Showing Occurrence of Significant (>10 pCi/g) Cesium-137 Contamination in the Vadose Zone



Spectral gamma logging data also indicate the presence of generalized near-surface contamination across WMA C. About a dozen of the drywells have elevated cesium-137 gamma activity in the upper 15 ft of the vadose zone. Two of these higher concentration zones, between tanks C-104 and C-105 and between tanks C-108 and C-109, are apparently related to small transfer line leaks (Wood et al. 2003).

2.10.6 Unconfined Aquifer Conditions

This section summarizes WMA C groundwater monitoring and characterization activities and the current understanding of contamination in the unconfined aquifer.

2.10.6.1 Monitoring and Characterization

The initial background-monitoring program for WMA C is complete; monitoring is currently conducted under an interim status indicator evaluation program as described in Horton and Narbutovskih (2001). The WMA C monitoring network currently consists of nine RCRA groundwater monitoring wells located outside the C tank farm fenceline. To date, monitoring results have not indicated that sources within WMA C have affected groundwater quality. The contaminant indicator parameters and statistical evaluation methodology for the WMA C groundwater indicator evaluation program are described in Horton and Narbutovskih (2001).

Three modifications to the monitoring plan have been issued through interim change notices (Horton and Narbutovskih 2002, 2003a, 2003b). Results of the groundwater detection indicator evaluation program are published annually.

When the monitoring network for WMA C was designed, flow was believed to be due west. A general flow direction to the southwest has subsequently been established based on direct flow measurements with a colloidal boroscope (Hartman et al. 2004). Three new downgradient wells and one new upgradient well were installed in fiscal year 2003 to improve the capability of the detection network to monitor the site.

During fiscal year 2003, the site was monitored with the original configuration of wells (Figure 2-63). Sampling data from the four new monitoring wells are expected to be available for inclusion in future annual groundwater monitoring reports. Monitoring under the indicator evaluation program will continue until the entire WMA is closed, or at such time as there is a shift to assessment monitoring as a result of statistically significant changes in indicator parameter concentrations in groundwater.

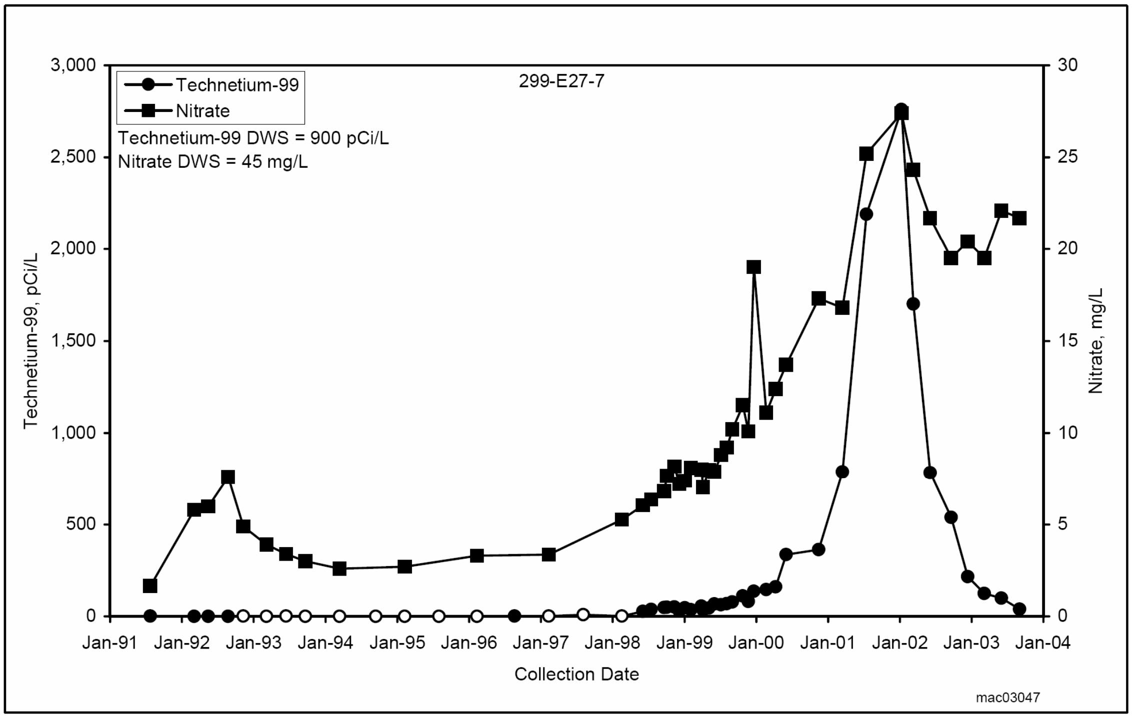
2.10.6.2 Contamination

Following is a summary of the fiscal year 2003 results adapted from Hartman et al. (2004). Additional detail on groundwater contamination and geochemistry at WMA C can be found in Hartman et al. (2004) and Reidel et al. (2006).

Wells were sampled quarterly during fiscal year 2003 at the request of Ecology due to rising trends in sulfate, nitrate, and calcium currently detected in both upgradient and downgradient wells. The critical mean values for the indicator parameters (i.e., pH, specific conductance, total organic carbon, and total organic halides) were not exceeded.

In 1999, technetium-99 began rising in upgradient well 299-E27-7, reaching a maximum in January 2002, then declining sharply to the current value of 39 pCi/L in September 2003 (Figure 2-68). Nitrate followed a similar trend to technetium-99 in this upgradient well. The current trend appears to be stable. Contamination sources both inside and outside of WMA C have been suggested but the origin of the concentration spike has not been conclusively established. Further insight into the source of the technetium-99 may be possible when data from the four new fiscal year 2003 wells are available.

Figure 2-68. Technetium-99 Concentrations Compared to Nitrate Concentrations for Upgradient Well 299-E27-7 at Waste Management Area C [a]



[a] *Hartman et al. (2004)*

2.10.7 Reference Case Source Terms

The reference case describes a set of assumed post-retrieval conditions that are based on current waste retrieval plans. The reference case analysis for WMA C includes three source terms consisting of past UPRs, residual SST waste, and residual ancillary equipment waste. Table 2-23 provides a listing of the reference case source terms for WMA C, and the inventory data source for that source term.

Source term inventories (reference case) for WMA C are provided in Table 2-24. To simplify the table, only the contaminants that dominate post-closure impacts are shown. All BBI contaminants are included in the reference case modeling analysis. Refer to Section 2.5 for a summary of source term inventory development methods. Complete source term inventory data are provided in Appendix C.

2.10.7.1 Past Unplanned Releases

The WMA C reference case includes eight past UPRs associated with SSTs (C-101, C105, C110, C-111, C-201, C-202, C-203, C-204) and four past UPRs associated with ancillary equipment (UPR-200-E-81, UPR-200-E-82, UPR-200-E-86, UPR-200-E-107). Volume estimates for those 12 waste loss events were developed by Field and Jones (2005) and vadose zone contaminant inventories were generated by Corbin et al. (2005) (Section 2.5.2).

2.10.7.2 Residual Single-Shell Tank Waste

The WMA C reference case includes residual waste in each of the 12 100-Series and four 200-Series SSTs in the C tank farm. Residual waste volume estimates for all tanks except C-106 were based on retrieving waste to the HFFACO Milestone M-45-00 goals (360 ft^3 for 100-Series tanks and 30 ft^3 for 200-Series tanks) (Ecology et al. 1989). Tank C-106 has been retrieved and is now undergoing an Appendix H exception request (Sams 2004b). Inventory estimates for tanks other than C-106 were generated with the use of the HTWOS model (Kirkbride et al. 2005), which accounts for the waste retrieval technology and tracks the fate of soluble and insoluble constituents in the waste (Section 2.5.3). Residual inventories for tank C-106 are based on post-retrieval sample analyses (Sams 2004a) rather than the HTWOS model.

2.10.7.3 Residual Ancillary Equipment Waste

The WMA C reference case includes the plugged and blocked piping in the C tank farm and the residual waste in five MUSTs consisting of one catch tank (241-C-301) and the four tanks in the 244-CR vault (244-CR-001, 244-CR-002, 244-CR-003, 244-CR-011) (Section 2.5.4). In the previous risk assessment for WMA C (Lee 2004), no information existed on the volume of plugged pipelines and a very conservative estimate was made. For that estimate, the length of all pipelines within WMA C was totaled (approximately 20,000 linear ft). It was assumed that 25% of those lines were blocked or plugged, which led to a volume of 250 ft^3 of blocked pipelines. Since that assumption was made, Lambert (2005) has developed a revised estimate (28 L) of the volume of plugged and blocked pipelines in WMA C. That estimate is much lower than the previous estimate but was based on information about the actual conditions of the pipeline systems in WMA C. The blocked pipeline, a cascade line, was designed to drain by gravity, as were most other pipelines. For this reason, most failed pipelines (i.e., failed pressure testing of the pipeline) are expected to have only a small inventory of residual waste.

Volume estimates for the residual waste in the WMA C MUSTs were calculated by assuming each tank would be retrieved to a residual volume proportional to that required under the HFFACO Milestone M-45-00 for 200-Series tanks (Ecology et al. 1989). Contaminant inventories associated with the residual ancillary equipment waste were estimated using the average chemical composition of the waste in the WMA C SSTs.

Table 2-23. Reference Case Analysis of Waste Management Area C (2 pages)

Inventory and Source Terms

Sources	Assumed Retrieval Method	Residual Volume	Volume Associated with Past Release [a] gal	Basis for Contaminant Inventory Estimate	
				Residual Waste [b]	**Past Release**
241-C-101	Mobile retrieval system	360 ft^3	1,000	HTWOS	Corbin et al. 2005
241-C-102	Sluicing	360 ft^3	None	HTWOS	None
241-C-103	Sluicing	360 ft^3	None	HTWOS	None
241-C-104	Sluicing	360 ft^3	None	HTWOS	None
241-C-105	Mobile retrieval system	360 ft^3	1,000	HTWOS	Corbin et al. 2005
241-C-106	Retrieved	360 ft^3	None	HTWOS	None
241-C-107	Sluicing	360 ft^3	None	HTWOS	None
241-C-108	Sluicing	360 ft^3	None	HTWOS	None
241-C-109	Sluicing	360 ft^3	None	HTWOS	None
241-C-110	Mobile retrieval system	360 ft^3	2,000	HTWOS	Corbin et al. 2005
241-C-111	Mobile retrieval system	360 ft^3	5,500	HTWOS	Corbin et al. 2005
241-C-112	Sluicing	360 ft^3	None	HTWOS	None
241-C-201	Vacuum	30 ft^3	550	HTWOS	Corbin et al. 2005
241-C-202	Vacuum	30 ft^3	450	HTWOS	Corbin et al. 2005
241-C-203	Vacuum	30 ft^3	400	HTWOS	Corbin et al. 2005
241-C-204	Vacuum	30 ft^3	350	HTWOS	Corbin et al. 2005
UPR-200-E-81	NA	NA	36,000	NA	Corbin et al. 2005
UPR-200-E-82	NA	NA	2,600	NA	Corbin et al. 2005
UPR-200-E-86	NA	NA	18,500	NA	Corbin et al. 2005
UPR-200-E-107	NA	NA	5	NA	Corbin et al. 2005
241-C-302 catch tank [c]	TBD [c]	19 ft^3	None	Average	None
244-CR-001 vault tank [c]	TBD [c]	27 ft^3	None	Average	None
244-CR-002 vault tank [c]	TBD [c]	8 ft^3	None	Average	None

Table 2-23. Reference Case Analysis of Waste Management Area C (2 pages)

Inventory and Source Terms					
Sources	**Assumed Retrieval Method**	**Residual Volume**	**Volume Associated with Past Release [a] gal**	**Basis for Contaminant Inventory Estimate**	
				Residual Waste [b]	**Past Release**
244-CR-003 vault tank [c]	TBD [c]	8 ft^3	None	HTWOS	None
244-CR-011 vault tank [c]	TBD [c]	27 ft^3	None	Average	None
241-C tank farm pipelines [d]	TBD	28 L	None	Lambert 2005	NA

[a] Past leak volumes listed in Field and Jones (2005).

[b] Residual inventories from HTWOS model output (Kirkbride et al. 2005).

[c] TBD = to be determined. Final disposition of MUSTs not yet determined; however, MUSTs were carried forward in the assessment assuming MUSTs will be retrieved to at least the HFFACO goal (Ecology et al. 1989, Milestone M-45-00) equivalent to the 200-Series tanks. The residual volume is calculated by ratio of the total volume of the MUST to the 200-Series tanks (e.g., the retrieval goal for the 55,000-gal 200-Series tanks is 30 ft^3; thus, a MUST that is ⅔ the size of the 200-Series tank would have a residual volume of 20 ft^3). Inventory was calculated based on average waste per ft^3 within the WMA calculated from the HTWOS model (Kirkbride et al. 2005).

[d] Final disposition of pipelines is not yet determined; however, pipelines were carried forward in the assessment. Pipeline residual volumes shown represent the volume of waste in plugged or blocked pipelines as determined by Lambert (2005).

NA = not applicable

Table 2-24. Reference Case Inventory Estimates for Waste Management Area C

Source Type	Dominant Contaminants for Groundwater Pathway Impacts [a]							Dominant Contaminants for Inadvertent Intruder Impacts [a]						
	C-14 Ci	Tc-99 Ci	I-129 Ci	Cr(VI) kg	NO_3 kg	NO_2 kg	U kg	Sr-90 Ci	Tc-99 Ci	Sn-126 Ci	Cs-137 Ci	Pu-239 Ci	Pu-240 Ci	Am-241 Ci
Past releases [b]	3.46E-01	6.93E+00	3.02E-02	1.11E+02	1.07E+04	4.35E+03	7.88E+00	1.76E+03	6.93E+00	9.13E-02	2.19E+04	1.28E+00	2.89E-01	5.63E+00
Tank residuals	6.24E-02	2.72E+00	1.29E-02	9.96E+01	2.60E+03	1.04E+03	2.43E+03	1.70E+05	2.72E+00	2.15E+00	2.01E+04	2.00E+02	4.29E+01	2.30E+02
Ancillary equipment residuals [c]	1.52E-03	5.86E-02	2.78E-04	2.15E+00	5.93E+01	2.24E+01	5.22E+01	NA	NA	NA	NA	NA	NA	NA

[a] The reference case analysis included all BBI contaminants. As described in Bowen (2004), the standard analyte list tracked in the BBI contains **25 chemicals** including:

- aluminum
- bismuth
- calcium
- chlorine
- chromium
- fluorine
- total inorganic carbon as carbonate
- iron
- mercury
- potassium
- lanthanum
- manganese
- sodium
- nickel
- nitrite
- nitrate
- oxalate
- lead
- phosphate
- silicon
- sulfate
- strontium
- uranium total
- zirconium
- total organic carbon

and **46 radionuclides** including:

- tritium
- carbon-14
- nickel-59
- cobalt-60
- nickel-63
- selenium-79
- strontium-90
- yttrium-90
- zirconium-93
- niobium-93m
- technetium-99
- ruthenium-106
- cadmium-113m
- antimony-125
- tin-126
- iodine-129
- cesium-134
- cesium-137
- barium 137m
- samarium-151
- europium-152
- europium-154
- europium-155
- radium-226
- actinium-227
- radium-228
- thorium-229
- protactinium-131
- thorium-232
- uranium-232
- uranium-233
- uranium-234
- uranium-235
- uranium-236
- neptunium-237
- plutonium-238
- uranium-238
- plutonium-239
- plutonium-240
- americium-241
- plutonium-241
- curium 242
- plutonium-242
- americium-243
- curium-243
- curium-244

[b] Inventories shown are the combined inventories from SST past releases and ancillary equipment past releases. Both release types were considered for the groundwater pathway analysis; however, only the SST past releases were included in the inadvertent intruder analysis (along with SST residuals).

[c] NA indicates insufficient information is available to make estimates of intruder impacts into ancillary equipment (e.g., pipelines, diversion boxes).

2.11 DESCRIPTION OF WASTE MANAGEMENT AREA B-BX-BY

This section provides site-specific information for WMA B-BX-BY. It is a summary from numerous documents that describe present conditions (Hanlon 2005), geology and hydrology (Reidel et al. 2006), subsurface contamination (Wood et al. 2000; Knepp 2002b), and source terms (Kirkbride et al. 2005; Field and Jones 2005; Lambert 2005; Corbin et al. 2005).

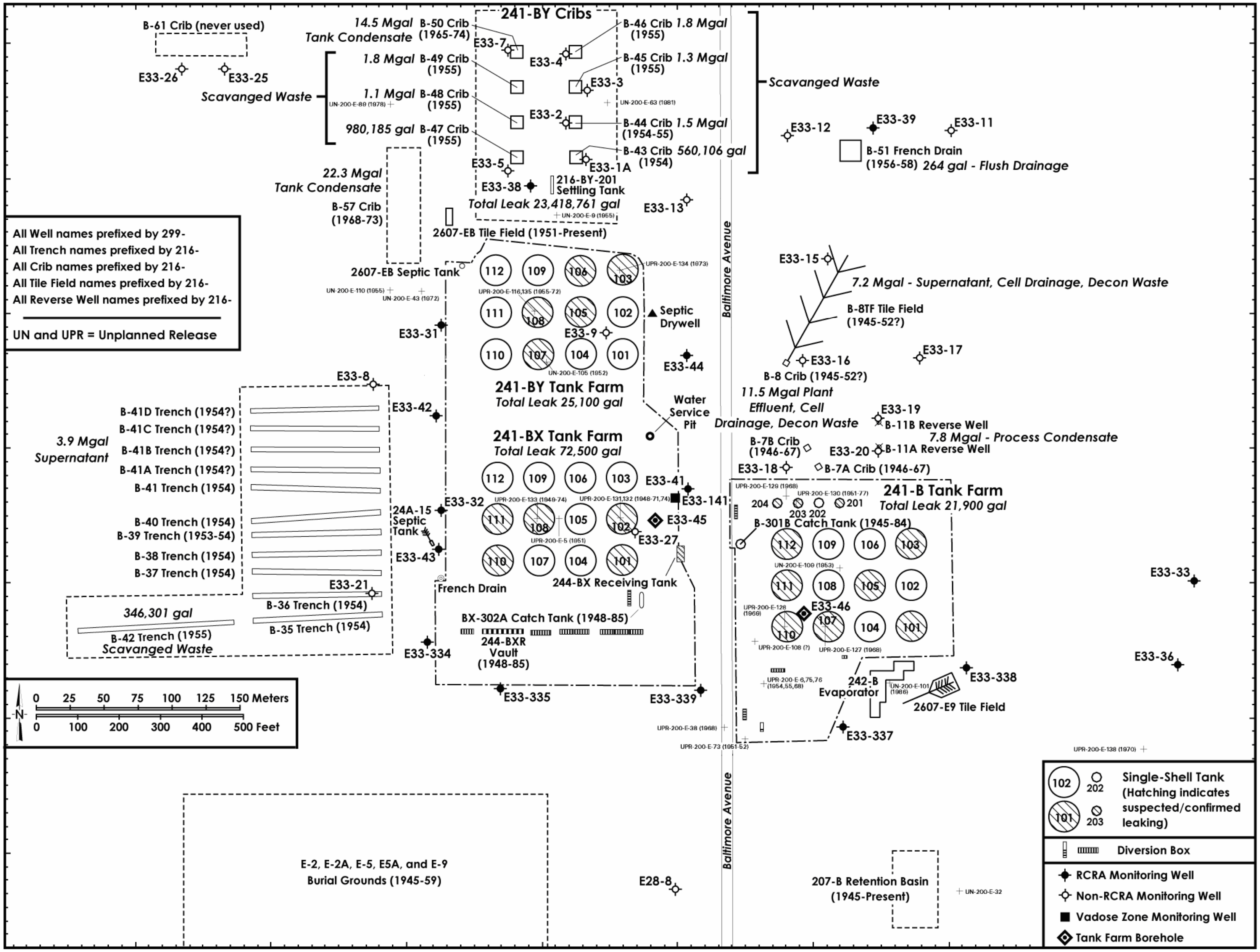
2.11.1 Background

WMA B-BX-BY is located in the north central portion of the 200 East Area (Figure 2-69) and contains the B, BX, and BY tank farms. In general, WMA B-BX-BY is an L-shaped area where, in the southern edge of the BY tank farm, it is adjacent to the northern boundary of the BX tank farm, while the western edge of the B farm is next to the eastern edge of the BX tank farm, separated by Baltimore Avenue. BX and BY tank farms share an enclosing fence, while B tank farm has its own enclosing fence.

The current understanding of contaminant occurrences and environmental conditions at WMA B-BX-BY is described in Wood et al. (2000). Further information on subsurface contamination with in the WMA was provided by vadose zone field characterization activities conducted during fiscal year 2001 and documented in Knepp (2002b). Metal waste was the initial waste stream produced in the plutonium extraction process and contained the highest concentrations of radionuclide constituents. Field and Jones (2005) estimate this leak volume to be 91,000 gal. Groundwater contamination caused by tank leaks within the WMA is further complicated by large discharges of process waste (>10,000,000 gal) to nearby cribs and ditches.

Detailed discussion of WMA B-BX-BY farm construction and operations along with historical information on soil surface and vadose zone contamination in WMA B-BX-BY is provided in Williams (1999). Table 2-25 lists the estimated volume of waste stored in the WMA B-BX-BY tanks as of November 30, 2004.

Figure 2-69. General Configuration of Waste Management Area B-BX-BY [a]



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[a] *Knepp (2002b)*

Table 2-25. Waste Volume Estimates as of November 30, 2004, in Waste Management Area B-BX-BY Single-Shell Tanks[a] (2 pages)

Tank	Total Waste Volume gal × 1,000	Supernate gal × 1,000	Saltcake gal × 1,000	Sludge gal × 1,000
241-B-101	109	0	81	28
241-B-102	32	4	28	0
241-B-103	56	0	55	1
241-B-104	374	0	65	309
241-B-105	290	0	262	28
241-B-106	123	1	0	122
241-B-107	161	0	75	86
241-B-108	92	0	65	27
241-B-109	125	0	75	50
241-B-110	245	1	0	244
241-B-111	242	1	0	241
241-B-112	35	3	17	15
241-B-201	29	0	0	29
241-B-202	28	0	0	28
241-B-203	50	1	0	49
241-B-204	49	1	0	48
241-BX-101	48	0	0	48
241-BX-102	79	0	0	79
241-BX-103	74	12	0	62
241-BX-104	100	3	0	97
241-BX-105	72	5	0	68
241-BX-106	38	0	0	38
241-BX-107	347	0	0	347
241-BX-108	31	0	0	31
241-BX-109	193	0	0	193
241-BX-110	205	1	139	65
241-BX-111	189	0	157	32
241-BX-112	164	1	0	163
241-BY-101	370	0	333	37
241-BY-102	279	0	279	0
241-BY-103	417	00	408	9
241-BY-104	358	0	313	45
241-BY-105	481	0	433	48
241-BY-106	462	—	430	32
241-BY-107	272	0	256	16
241-BY-108	222	0	182	40

Table 2-25. Waste Volume Estimates as of November 30, 2004, in Waste Management Area B-BX-BY Single-Shell Tanks [a] (2 pages)

Tank	Total Waste Volume gal × 1,000	Supernate gal × 1,000	Saltcake gal × 1,000	Sludge gal × 1,000
241-BY-109	287	0	263	24
241-BY-110	366	0	323	43
241-BY-111	301	0	301	0
241-BY-112	286	0	284	2

[a] Hanlon (2005).

2.11.2 Infrastructure

This section describes the WMA B-BX-BY infrastructure components that were included in the SST PA and listed in Table 2-26. Reference case inventory development for those components is described in Section 2.11.7. Refer to Section 2.4 for generic infrastructure component descriptions and Section 2.5 for a summary of infrastructure inventory development methods.

2.11.2.1 Single-Shell Tanks

Two types of tanks (100-Series and 200-Series) are found in WMA B-BX-BY. The 100-Series tanks are 75 ft in diameter and 32 ft tall. The 200-Series tanks are 20 ft in diameter and 25 ft tall. The 100-Series tanks in B farm and all tanks in BX farm have a 16-ft operating depth, and an operating capacity of 530,000 gal each. All BY tanks have a 23-ft operating depth and an operating capacity of 758,000 gal each. The 200-Series tanks in B farm have a 24-ft operating depth, and an operating capacity of 55,000 gal each. Typical tank configuration and dimensions are shown in Figure 2-70. The tanks sit belowgrade with at least 7 ft of soil cover to provide shielding from radiation exposure to operating personnel. Tank pits are located on top of the tanks and provide access to the tank, pumps, and monitoring equipment. Additional details about tank construction can be found in Section 2.3.

The 100-Series tanks were constructed with cascade overflow lines in a 3-tank series that allowed gravity flow of liquid between tanks. The end of each cascade in BX tank farm is connected to the start of a cascade in the BY tank farm; therefore, a total of six tanks were connected. The current residual waste quantities in each tank farm are listed in Table 2-21.

The B tank farm contains twelve 100-Series SSTs and four 200-Series SSTs. These tanks were constructed between 1943 and 1944. The 100-Series tanks are arranged in four rows of three tanks each with cascade lines providing overflow. The 200-Series tanks are arranged in a straight line near the northern fenceline of the B tank farm. The B tank farm was built to provide storage for bismuth phosphate process waste (Wood et al. 2000). The B tank farm first received waste in April 1945 (Williams 1999).

The BX tank farm contains twelve 100-Series SSTs constructed between 1947 and 1949. The tanks are arranged in four rows of three tanks each with cascade lines providing overflow. The BX tank farm was built to provide storage capacity in addition to that of B tank farm for bismuth phosphate process waste (Wood et al. 2000). The BX tank farm first received waste in January 1948 (Williams 1999).

The BY tank farm contains twelve 100-Series SSTs constructed between 1947 and 1949. The tanks are arranged in four rows of three tanks each with cascade lines providing overflow. The BY tank farm was built to provide storage capacity in addition to that of B and BX tank farms for bismuth phosphate process waste (Wood et al. 2000). Each of the overflow cascades lines for each set of BY farm tanks are connected to the final cascade overflow from each set of BX tank cascades. The farm first received waste in March 1950 (Williams 1999).

Table 2-26. Operating Period and Capacities for Waste Management Area B-BX-BY Facilities Included in the Performance Assessment [a] (2 pages)

Facility	Removed From Service	Constructed	Operating Capacity gal
Single-Shell Tanks			
241-B-101	1974	1943 to 1944	530,000
241-B-102	1978		
241-B-103	1977		
241-B-104	1972		
241-B-105	1972		
241-B-106	1977		
241-B-107	1969		
241-B-108	1977		
241-B-109	1977		
241-B-110	1971		
241-B-111	1976		
241-B-112	1977		
241-B-201	1971	1943 to 1944	55,000
241-B-202	1977		
241-B-203	1977		
241-B-204	1977		
241-BX-101	1972	1946 to 1947	530,000
241-BX-102	1971		
241-BX-103	1977		
241-BX-104	1980		
241-BX-105	1980		
241-BX-106	1971		
241-BX-107	1977		
241-BX-108	1974		
241-BX-109	1974		
241-BX-110	1977		
241-BX-111	1977		
241-BX-112	1977		

Table 2-26. Operating Period and Capacities for Waste Management Area B-BX-BY Facilities Included in the Performance Assessment [a] (2 pages)

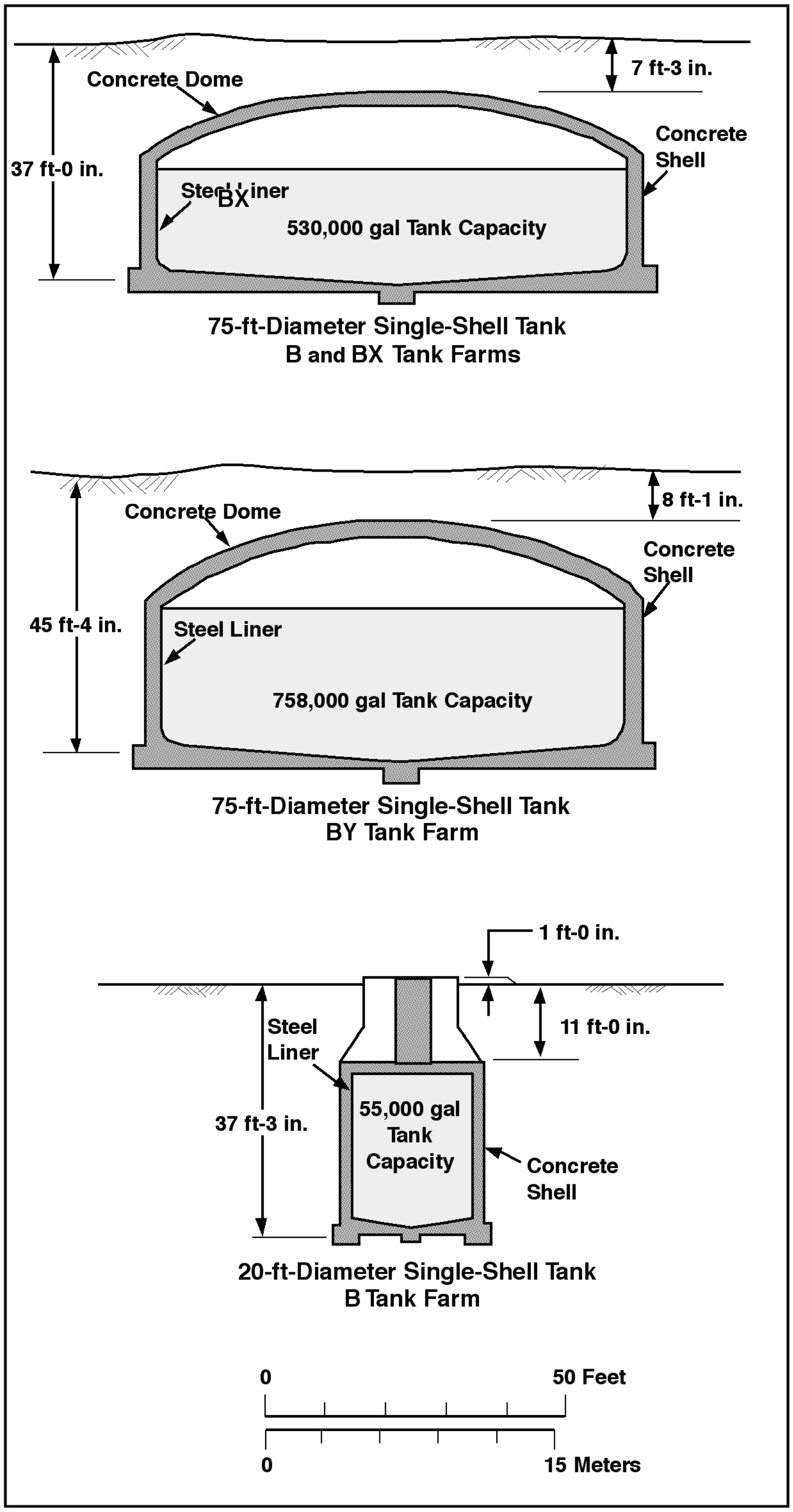
Facility	Removed From Service	Constructed	Operating Capacity gal
241-BY-101	1971	1948 to 1949	758,000
241-BY-102	1977		
241-BY-103	1973		
241-BY-104	1977		
241-BY-105	1974		
241-BY-106	1977		
241-BY-107	1974		
241-BY-108	1972		
241-BY-109	1979		
241-BY-110	1979		
241-BY-111	1977		
241-BY-112	1978		
Miscellaneous Underground Storage Tanks			
241-B-301B catch tank	1984	1945	36,400
241-BX-302A catch tank	1985	1948	11,389
244-BX-DCRT	Active	1983	31,000
244-BXR-001 vault tank	1951 (244-BXR vault)	1957	50,000
244-BXR-002 vault tank		1957	15,000
244-BXR-003 vault tank		1957	15,000
244-BXR-011 vault tank		1956	50,000
Underground Waste Transfer Lines			
241-B tank farm pipelines	NA	1943 to 1944	13,100 (+/-4,600)
241-BX tank farm pipelines	NA	1946 to 1947	15,000 (+/-4,600)
241-BY tank farm pipelines	NA	1948 to 1949	19,800 (+/-4,400)

[a] Data on the facilities is from DOE-RL (2005) and Field (2003a).

DCRT = double-contained receiver tank

NA = not applicable

Figure 2-70. Typical Configuration and Dimensions of Single-Shell Tanks in Waste Management Area B-BX-BY



2.11.2.2 Ancillary Equipment

A complete listing of the WMA B-BX-BY ancillary equipment currently identified for inclusion in the SST system closure is provided in Lee (2004). As discussed in Section 2.5.4, the ancillary components included in the SST PA consist of the underground waste transfer lines and MUSTs located inside each WMA boundary. For WMA B-BX-BY, the ancillary components analyzed consist of the B, BX, and BY tank farms waste transfer piping and seven MUSTs. The MUSTs consist of two catch tanks (241-B-301B, 241-BX-302A), one double-contained receiver tank (244-BX DCRT), and the 244-BXR vault, which contains four tanks (244-BXR-001, 244-BXR-002, 244-BXR-003, 244-BXR-011).

Multiple levels of piping were installed over time in WMA B-BX-BY. A time line of piping installations is described in Williams (1999). It is estimated that there are approximately 6.7 mi (+/-2.4 mi) of waste transfer piping in the B tank farm, 7.7 mi (+/-2.4 mi) in the BX tank farm, and 10.2 mi (+/-2.3 mi) in the BY tank farm (Field 2003a).

2.11.3 Geology

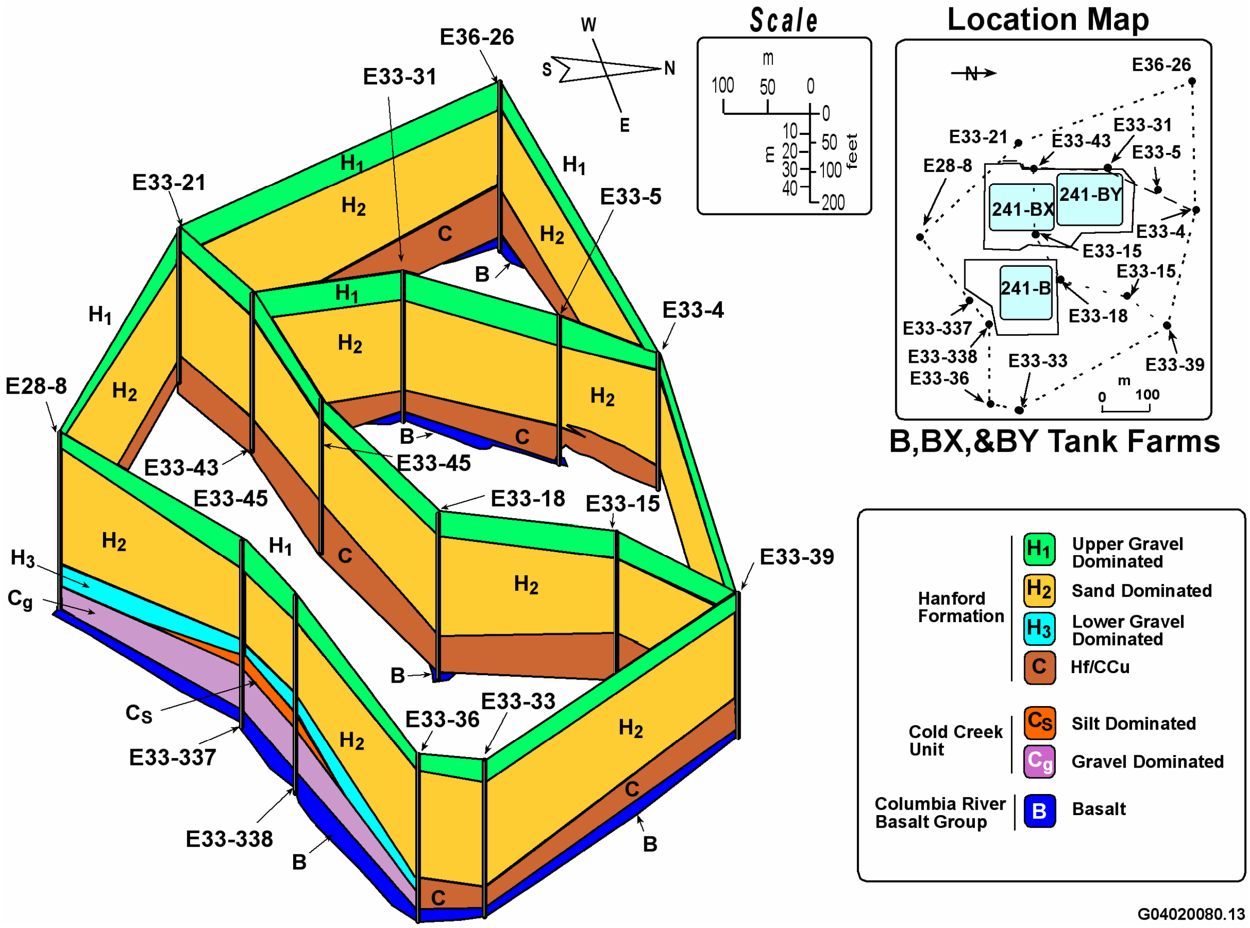
Following is an overview of the geology of WMA B-BX-BY summarized from the information provided in Reidel et al. (2006). The generalized stratigraphy and thicknesses in the 200 East Area are shown in Section 2.3. A generalized cross-section through WMA B-BX-BY is shown in Figure 2-71. Maps and cross-sections presented in Reidel et al. (2006) illustrate the distribution and thicknesses of these units in additional detail.

Seven stratigraphic units lie within WMA B-BX-BY. From oldest to youngest, the primary geologic units are:

- Columbia River Basalt Group
- Undifferentiated Cold Creek unit fine unit and/or Ringold Formation
- Undifferentiated Cold Creek unit gravel and/or Ringold Formation Unit A?
- Hanford formation – lower gravelly sequence (H3 unit)
- Hanford formation – sand sequence (H2 unit)
- Hanford formation – upper gravelly sequence (H1 unit)
- Recent deposits (wind deposited material and backfill material placed during construction).

The general characteristics of these units are described in Section 2.3 and in more detail in Reidel et al. (2006). The SSTs at WMA B-BX-BY were emplaced within the Hanford formation sediments of the upper, gravel-dominated (H1) unit. The water table or potentiometric surface lies approximately 60 m (200 ft) below the bottom of the tank farms excavations within the Ringold Formation Unit E.

Figure 2-71. Fence Diagram Showing Cross-Sections through Waste Management Area B-BX-BY [a]



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[a] *Reidel et al. (2006)*

2.11.4 Hydrology

Following is an overview of the hydrology of the uppermost, unconfined aquifer beneath WMA B-BX-BY. More detailed information supporting this section can be found in Reidel et al. (2006), Wood et al. (2000), and Hartman et al. (2004). Currently, the general groundwater flow direction in the unconfined aquifer beneath WMA B-BX-BY ranges from south-southwest to west-southwest (Wood et al. 2000). This is based on observations of contaminant movement because the water table is very flat overall, with an estimated hydraulic gradient of only 0.00017. This extremely small gradient makes it difficult to define the direction of groundwater flow. The estimated groundwater flow velocity is approximately 0.9 m/day (Wood et al. 2000).

Water levels stopped declining across the site during fiscal year 2003 (Hartman et al. 2004). However, some sampling wells in the area began showing an increase in water levels. This phenomenon is under further investigation. Currently, the water table beneath WMA B-BX-BY lies 122 m (400 ft) amsl with about 77 m (255 ft) of vadose zone. The aquifer thickness, based on the top of basalt at 108 m (355 ft), is approximately 13.4 m (44 ft). The aquifer materials consist dominantly of unconsolidated gravels. Hydraulic conductivity values reported for the aquifer in this area is approximately 1,600 m/day (5,300 ft/day). Additional hydraulic property data from aquifer testing at wells near WMA B-BX-BY are provided in Wood et al. (2000), Reidel et al. (2006), and Hartman et al. (2004).

2.11.5 Vadose Zone Conditions

This section summarizes WMA B-BX-BY vadose zone monitoring and characterization activities and the current understanding of contamination in the vadose zone.

2.11.5.1 Monitoring and Characterization

The B tank farm has 52 leak detection wells (Figure 2-72) available for leak detection monitoring and to provide access for limited vadose zone characterization (e.g., geophysical logging). These drywells were drilled from 1944 to 1974. The depth ranges for most of these drywells is between 18.6 m (61 ft) and 45.7 m (150 ft) bgs.

The BX tank farm has 76 leak detection wells (Figure 2-73) available for leak detection monitoring and to provide access for limited vadose zone characterization (e.g., geophysical logging). These drywells were drilled from 1947 to 1977. The depth ranges for most of these drywells is between 22.9 m (75 ft) and 45.7 m (150 ft) bgs.

The BY tank farm has 70 leak detection wells (Figure 2-74) available for leak detection monitoring and to provide access for limited vadose zone characterization (e.g., geophysical logging). These drywells were drilled from 1949 to 1974. The depth ranges for most of these drywells is between 30.5 m (100 ft) and 45.7 m (150 ft) bgs.

Gamma logging took place in WMA B-BX-BY over two decades allowing evaluation of the time-dependent behavior of the gamma-emitting radionuclides. Between 1997 and 1999, spectral gamma logging was used to evaluate WMA B-BX-B-BY. This effort was part of the baseline characterization for WMA B-BX-BY. Results are documented in DOE-GJO (1997c, 1998d, 2000h). The baseline reports are further supplemented by their associated addenda reports (DOE-GJO 2000i, 2000j, 2000k).

The major gamma-emitting contaminants associated with WMA B-BX-BY are cesium-137, cobalt-60, ruthenium-106, antimony-125, and strontium-90. These contaminants are located mostly in and around areas of confirmed or suspected tank and pipeline leaks. However, the evaluation of time-dependent behavior indicates that the more mobile radionuclides have migrated away from their locations of emplacement (Wood et al. 2000). Although most of the drywells are deeper than the surrounding contamination, some zones of contamination extend deeper than nearby drywells. Consequently, the maximum depth of vadose zone contamination is not known in some areas of WMA B-BX-BY.

During fiscal year 2001, field characterization efforts were conducted at WMA B-BX-BY in support of RCRA Corrective Action process requirements. The investigative approach for this work is described in Rogers and Knepp (2000b). A detailed discussion of these investigations and an analysis of the results are included in the WMA B-BX-BY FIR (Knepp 2002b).

Figure 2-72. Vadose Zone Monitoring System for the B Tank Farm within Waste Management Area B-BX-BY

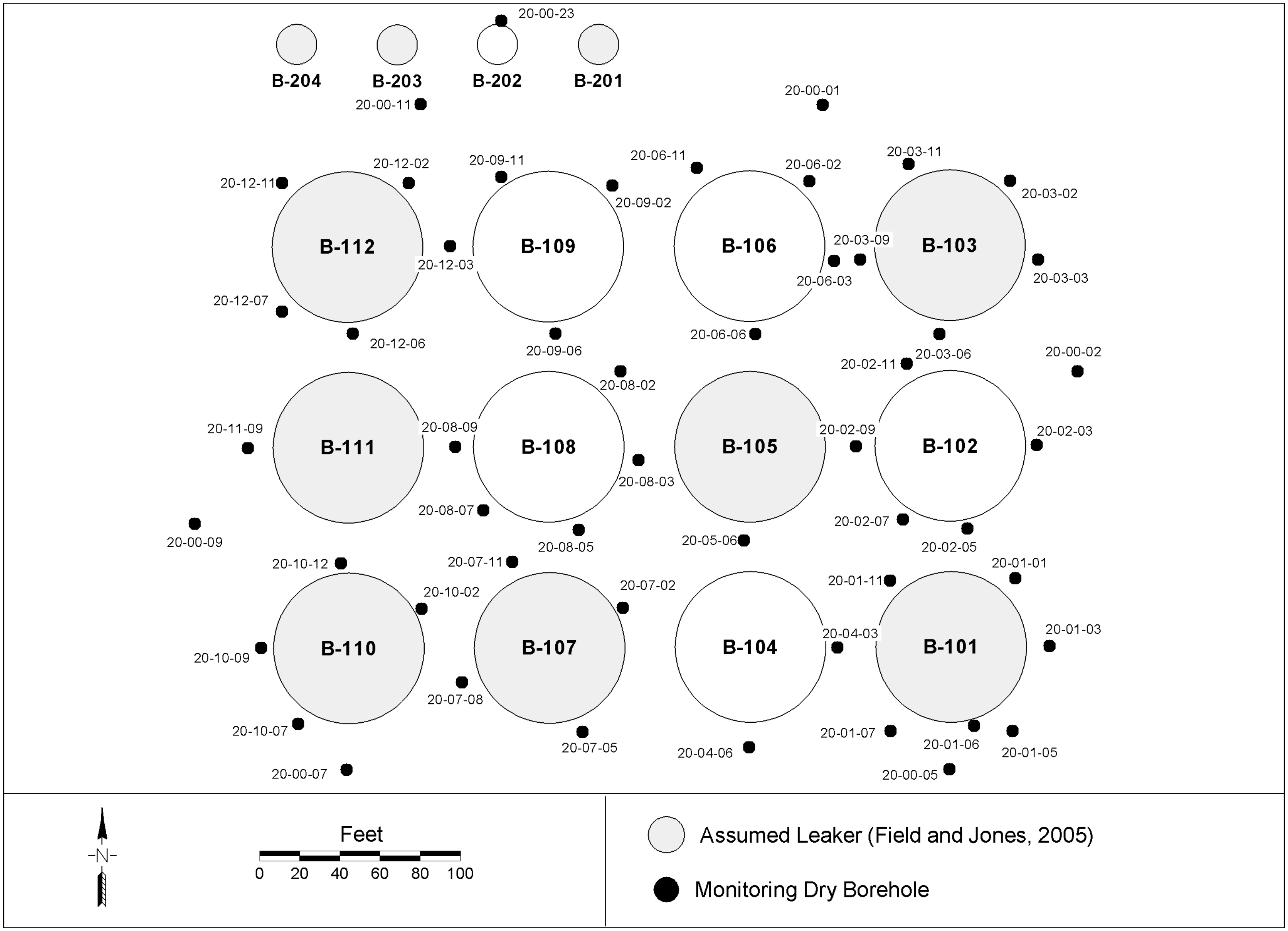


Figure 2-73. Vadose Zone Monitoring System for the BX Tank Farm within Waste Management Area B-BX-BY

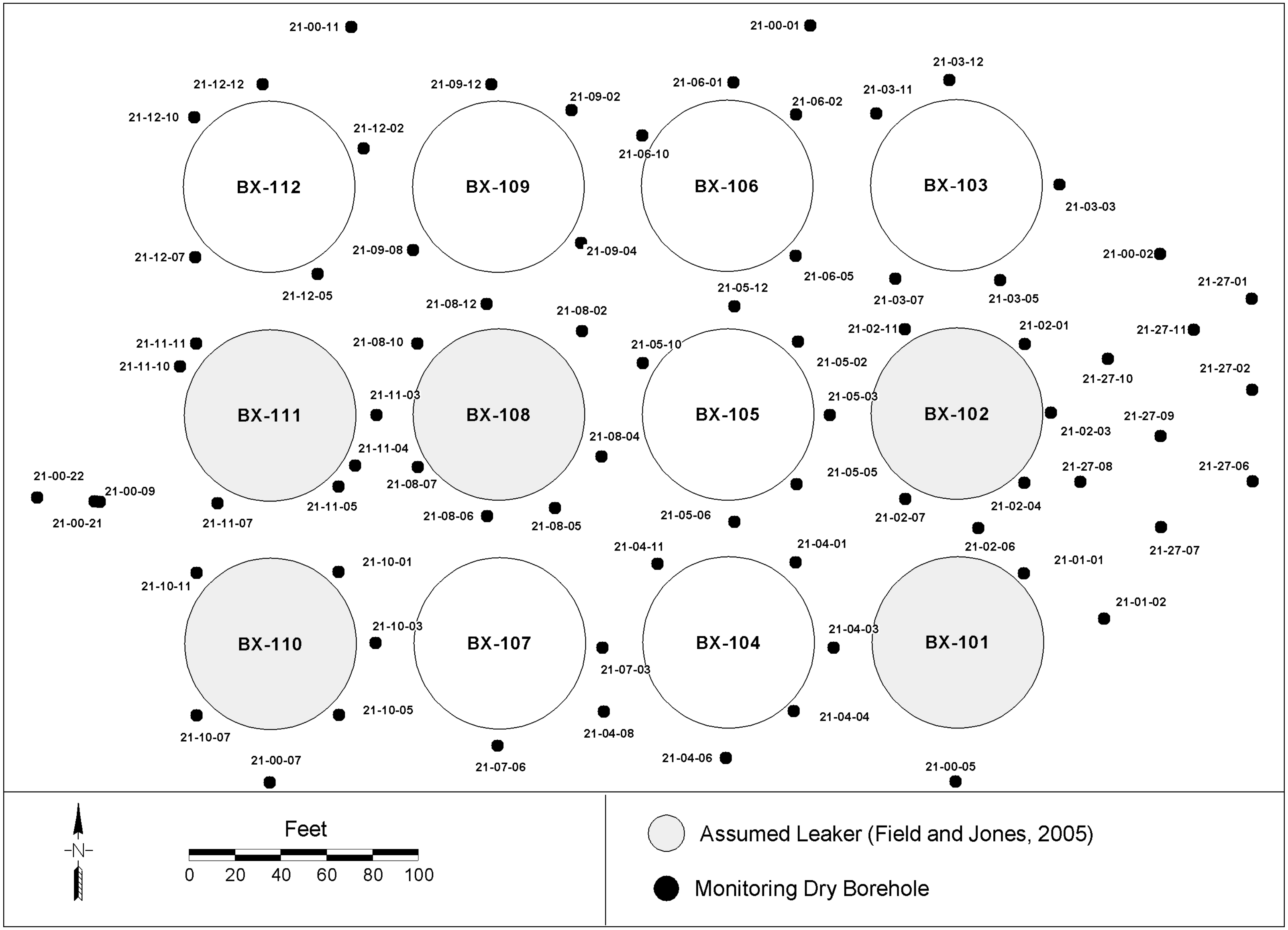
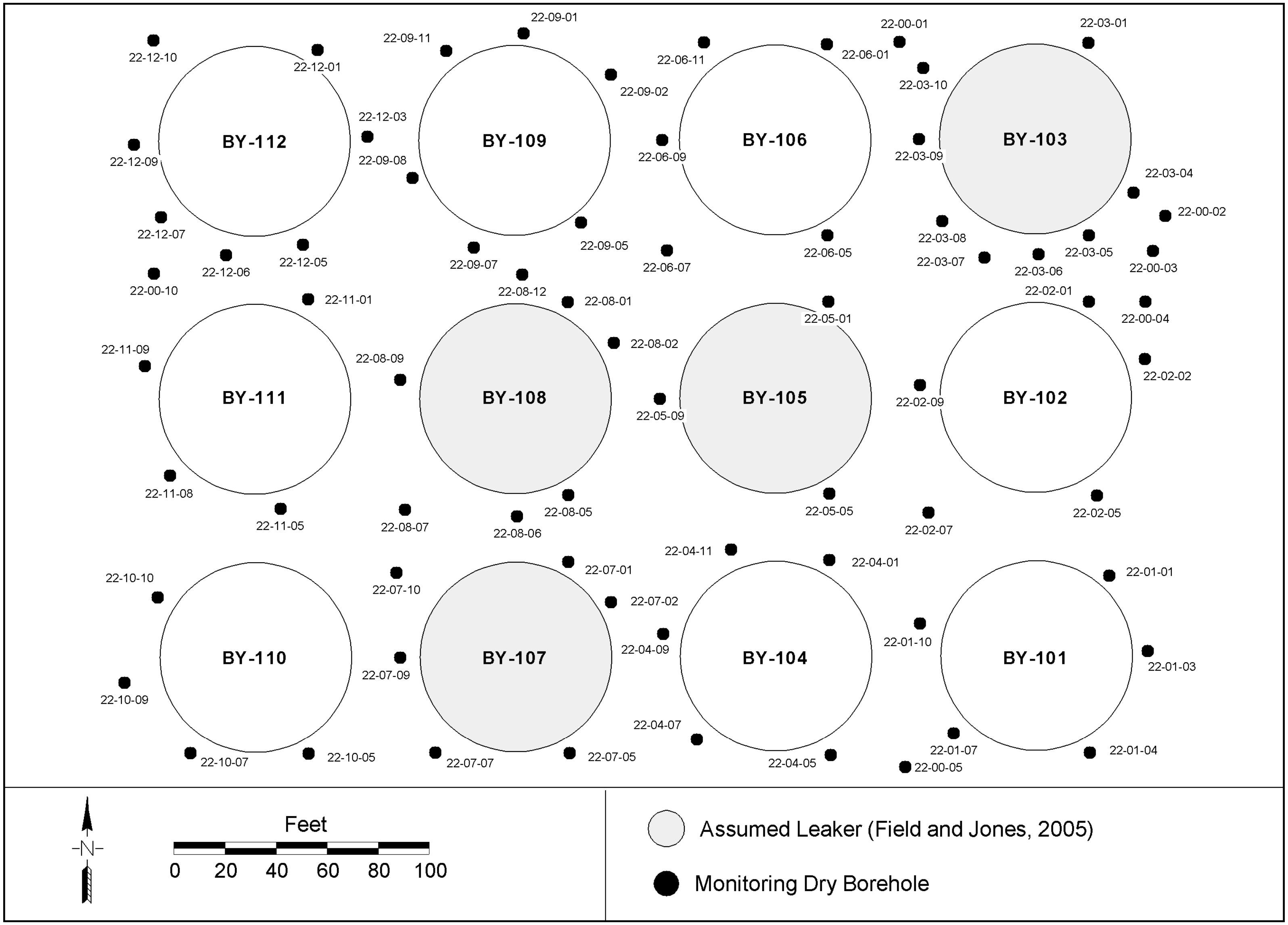


Figure 2-74. Vadose Zone Monitoring System for the BY Tank Farm within Waste Management Area B-BX-BY



2.11.5.2 Contamination

Figures 2-75 through 2-77 provide a visualization of the vadose zone contamination beneath WMA B-BX-BY. These figures show a three-dimensional perspective of radioactive contamination levels observed in the boreholes in WMA B-BX-BY. Tanks considered to be assumed leakers based on information in Field and Jones (2005) are shown with darker shading. Each drywell is represented with a single vertical line. Shaded rings around the drywells indicated the level of vadose zone contamination based on spectral gamma logging results. Only the more significant soil contamination zones (>10 pCi/g) are shown. Zones with contamination levels less than 5 pCi/g are not shown for B and BX tank farms, and for BY tank farm, levels less than 10 pCi/g are not shown.

The primary areas of elevated gamma readings for WMA B-BX-BY occur in the drywells located around tanks (B-101, B-103, B-105, B-107, B-110, B-111, B-112, BX-101, BX-102, BX-108, BX-110, BX-111, BY-103, BY-105, BY-106, BY-107, BY-108). The presence of contamination in these areas has provided or supported the determinations of postulated leaks based on the WMA B-BX-BY historical record (Wood et al. 2000). The major gamma-emitting contaminants associated with WMA B-BX-BY are cesium-137, cobalt-60, ruthenium-106, antimony-125, and strontium-90.

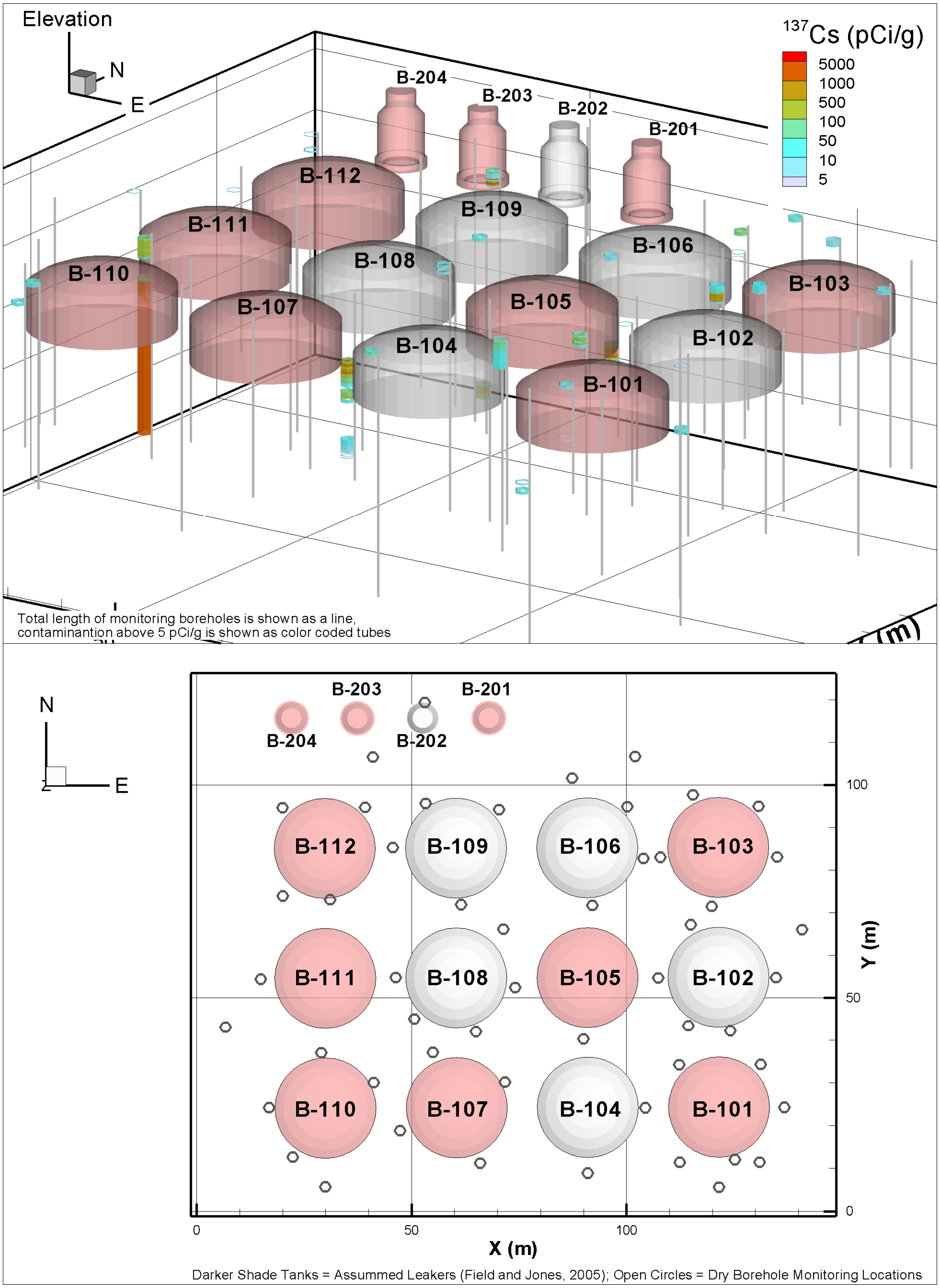
As there are two decades of temporal distribution of gamma activity data available, it is possible to evaluate any changes in estimated distributions. Six BX tank farm drywells and 26 drywells in BY tank farm show “instability,” changes over the duration of the monitoring activity (Wood et al. 2000). The evaluation for B tank farm is ongoing. It is believed that the areas of instability in WMA B-BX-BY are associated with the postulated leaks from tanks B-110, BX-102, BX-108, BX-110, and BX-111 (Wood et al. 2000).

Logging data in the drywells surrounding B-110 are unique in that they show the presence of significant quantities of strontium-90. Drywell 20-10-12 shows a large strontium-90 contamination zone from 8 to 30 m (25 to 100 ft) bgs, with the region from 18 to 30 m (60 to100 ft) bgs believed to contain a large inventory of strontium-90. The 8 to 30 m (25 to 100 ft) bgs zone also contains cesium-137 at concentrations that saturate the detector. The cesium-137 concentrations then decrease from 5,000 pCi/l to 100 pCi/L. Drywell 20-10-02 also shows a zone of strontium-90 contamination from 23 to 24 m (75 to 80 ft) bgs (Wood et al. 2000).

The most extensive region of contaminated vadose zone is found adjacent to and to the east of tank BX-102. The drywell logging data indicate the primary contaminants are cesium-137, uranium-235, and uranium-238, with smaller amount of cobalt-60 and antimony-125. Drywell 20-02-04 shows cesium-137 contamination starting at 8 m (25 ft) bgs and continuing to the bottom of the drywell at 70 m (230 ft) (Wood et al. 2000).

Several drywells associated with tanks BX-108 and BX-111 support the identification of these tanks as leakers. Numerous drywells show elevated cesium-137 contamination in a zone from 11 to 14 m (35 to 45 ft) bgs. Drywells 21-11-03 and 21-11-04 show gamma activity that is above the saturation level of the logging tool. The concentration in drywell 21-08-07 goes from a maximum of 80 pCi/g at a depth of 11 m (35 ft) below the surface to 1 pCi/g at a depth of 12 m (40 ft). Drywell 21-10-05 has cesium-137 concentrations above the gamma logging tool saturation point from 12 to 15 m (40 to 48 ft).

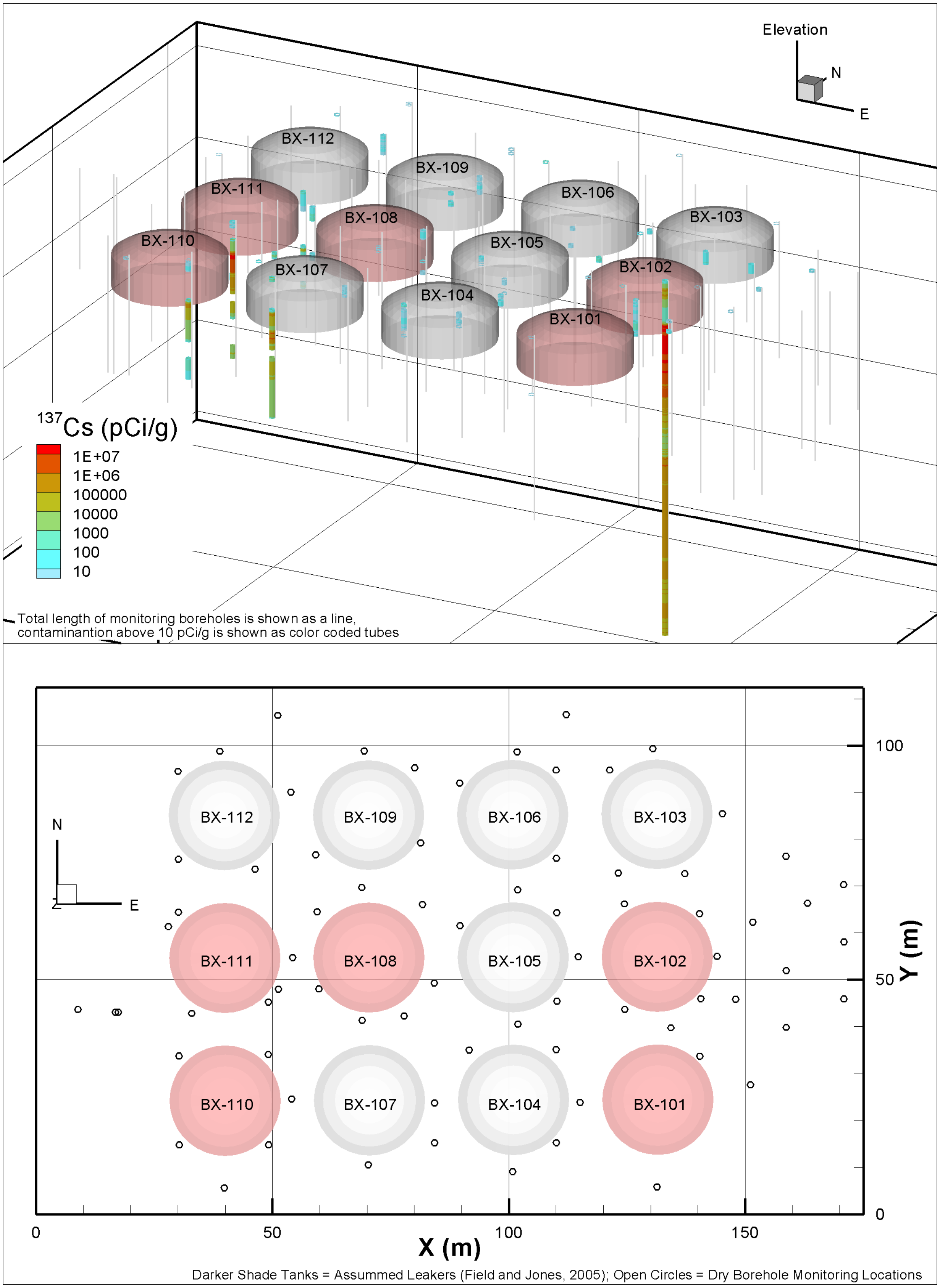
Figure 2-75. Three-Dimensional Perspective of B Tank Farm Tanks and Drywells Showing Occurrence of Significant (>5 pCi/g) Cesium-137 Contamination in the Vadose Zone



Total length of monitoring boreholes is shown as a line, contaminantion above 5 pCi/g is shown as color coded tubes

Darker Shade Tanks = Assummed Leakers (Field and Jones, 2005); Open Circles = Dry Borehole Monitoring Locations

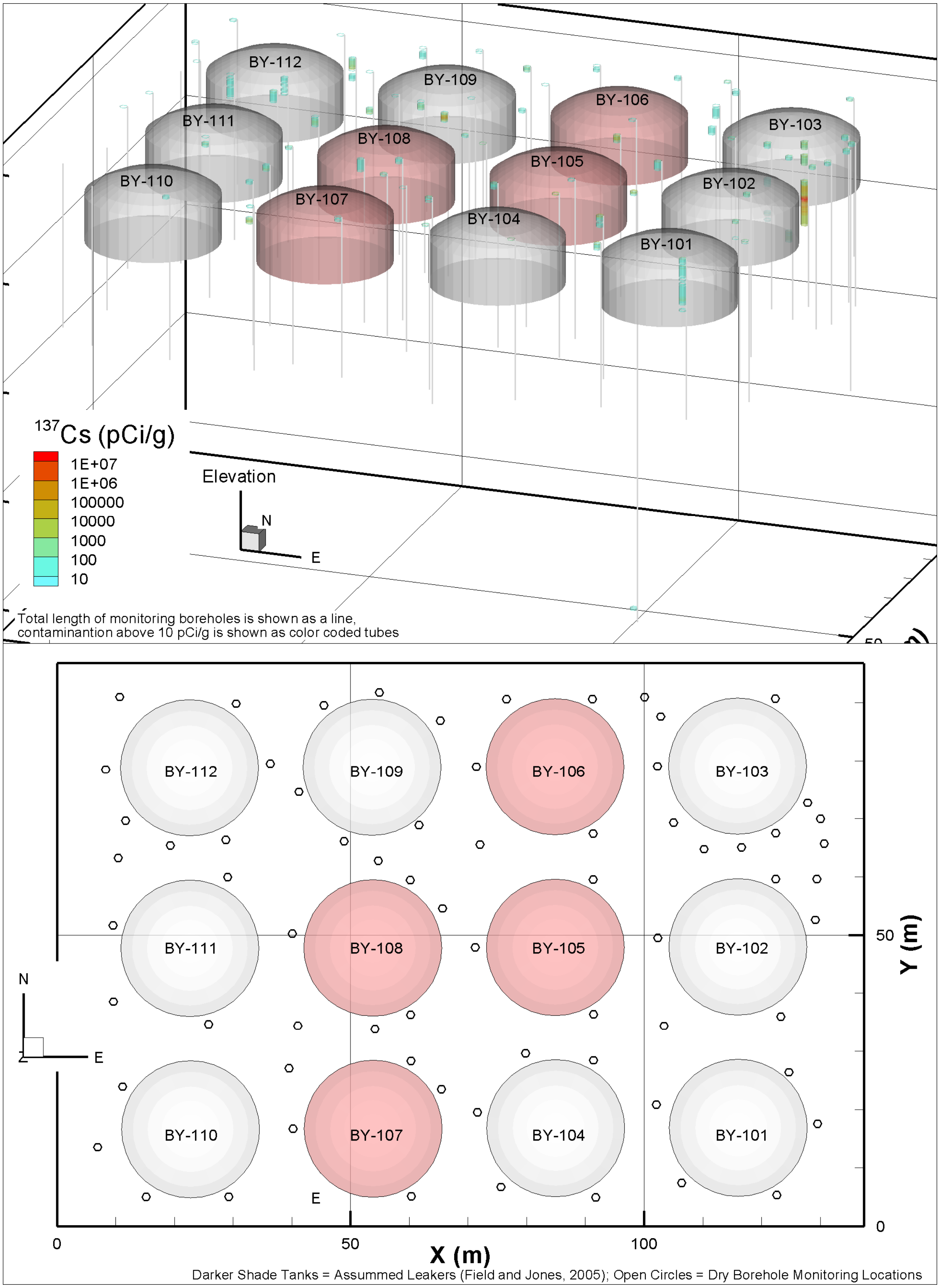
Figure 2-76. Three-Dimensional Perspective of BX Tank Farm Tanks and Drywells Showing Occurrence of Significant (>5 pCi/g) Cesium-137 Contamination in the Vadose Zone



Total length of monitoring boreholes is shown as a line, contaminantion above 10 pCi/g is shown as color coded tubes

Darker Shade Tanks = Assummed Leakers (Field and Jones, 2005); Open Circles = Dry Borehole Monitoring Locations

Figure 2-77. Three-Dimensional Perspective of BY Tank Farm Tanks and Drywells Showing Occurrence of Significant (>10 pCi/g) Cesium-137 Contamination in the Vadose Zone



Total length of monitoring boreholes is shown as a line, contaminantion above 10 pCi/g is shown as color coded tubes

Darker Shade Tanks = Assummed Leakers (Field and Jones, 2005); Open Circles = Dry Borehole Monitoring Locations

Drywells 20-10-03 and 20-10-05 show evidence of tank leaks from tank BX-110. Cesium-137 concentrations in drywell 20-10-03 are above the logging tool saturation point in three zones, 3 to 12 m (10 to 40 ft), 14 to 15 m (45 to 50 ft), and 24 to 25 m (80 to 82 ft) bgs. Uranium-235 was identified in drywell 21-10-05 with a concentration of approximately 100 pCi/L at a depth between 15 and 18 m (50 and 60 ft).

Although it is believed that five tanks in the BY tank farm leaked, the gamma logging records along with waste transfer records do not support this position. Spectral gamma logging data also indicate the presence of generalized surface contamination across the BY tank farm in the range of 100 pCi/g of cesium-137 (Wood et al. 2000), in most cases decreasing with depth. Cobalt-60 is often found from 12 m (40 ft) to the bottom of the drywells. High levels of cesium-137 are reported in the first 1.2 m (6 ft) for drywells 22-00-01, 22-05-04, 22-08-02, and 22-12-03. Appreciable cesium-137 is reported because depths greater than 1.2 m (6 ft) are reported for three drywells. Drywell 22-03-05 shows gamma activity high enough to saturate the detector between 7 and 14 m (24 and 47 ft) and drywells 22-02-01 and 22-03-06 show levels of approximately 100 pCi/g at a depth between 14 and 15 m (45 and 50 ft). No uranium isotopes were reported in any BY tank farm drywell. The significance of the gamma activity within the drywells with respect to actual tank leak volumes is discussed further in Section 2.12.7.1. Detailed discussions on this topic are found in Wood et al. (2000) and Field and Jones (2005).

2.11.6 Unconfined Aquifer Conditions

This section summarizes WMA B-BX-BY groundwater monitoring and characterization activities and the current understanding of contamination in the unconfined aquifer.

2.11.6.1 Monitoring and Characterization

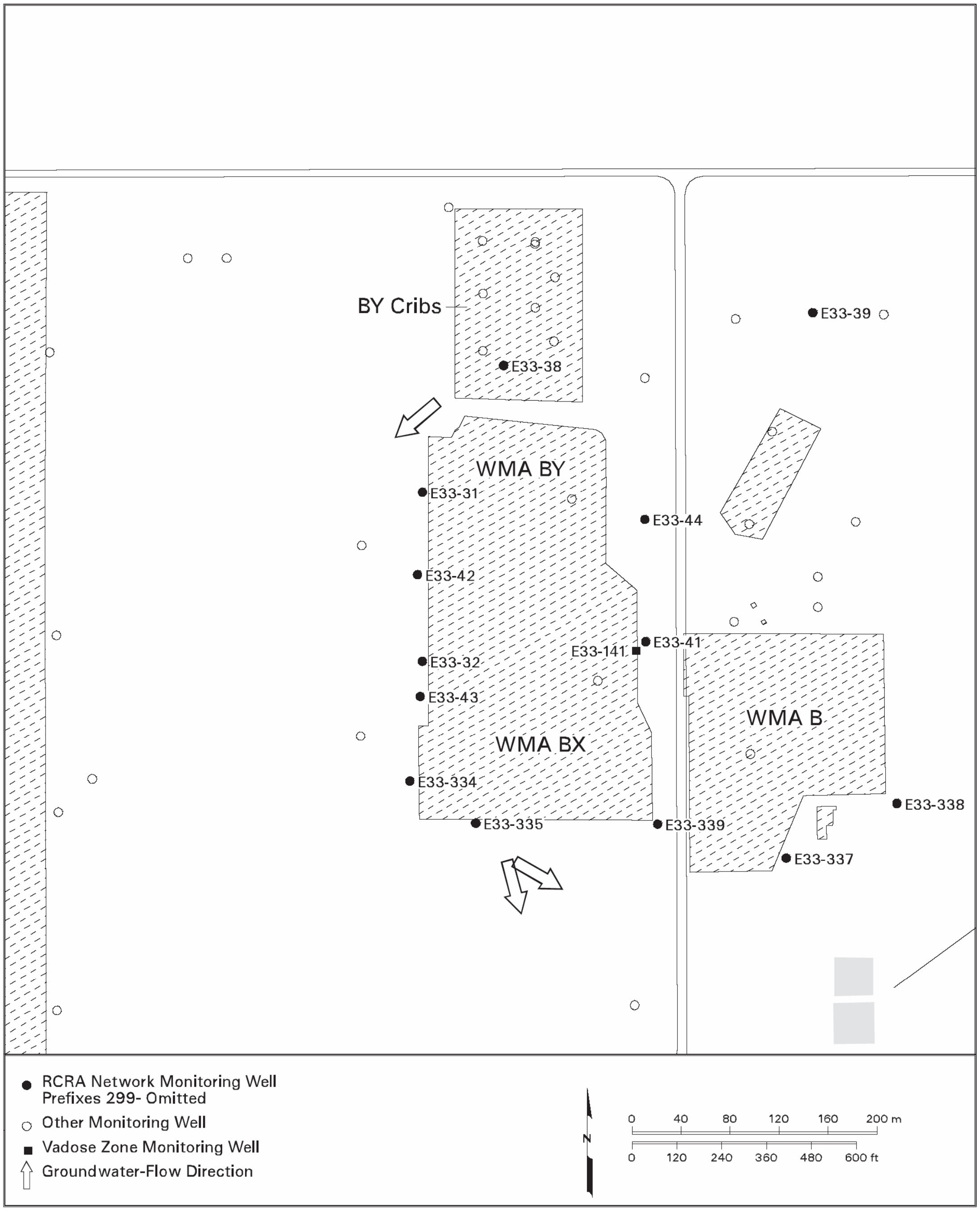
Thirteen RCRA groundwater monitoring wells associated with WMA B-BX-BY are shown in Figure 2-78. Twelve wells are located outside the tank farm fencelines. The wells are intended to monitor groundwater contamination attributable to the entire WMA rather than individual components. The initial background-monitoring program for WMA B-BX-BY is complete and monitoring is currently conducted under an interim status assessment monitoring program.

The parameters and the statistical evaluation methodology for the WMA B-BX-BY groundwater assessment program are described in Narbutovskih (2000). Two modifications to the monitoring plan have been issued to document changes in the monitoring program status (Narbutovskih 2002, 2003). Results of the groundwater detection indicator evaluation program are published annually. The most recently published data are for fiscal year 2003 (Hartman et al. 2004).

When the monitoring network for WMA B-BX-BY was designed, flow was believed to be toward the east. A general flow direction to the southwest has subsequently been established. Three new downgradient wells and one new upgradient well were installed in fiscal year 2003 to improve the capability of the detection network to monitor the site.

During fiscal year 2003, the site was monitored with the original configuration of wells (Figure 2-78). Sampling data from the four new monitoring wells are included in the groundwater monitoring report for fiscal year 2004 (Hartman et al. 2005). Monitoring under the groundwater assessment program will continue until the entire WMA is closed.

Figure 2-78. Ground Water Monitoring Network for Waste Management Area B-BX-BY[a]



can_gwf03_597 March 08, 2004 3:44 PM

[a] *Appendix B of Hartman et al. (2004)*

2.11.6.2 Contamination

The most recently published groundwater monitoring results for WMA B-BX-BY are for fiscal year 2003 (Hartman et al. 2004). Following is a summary of the fiscal year 2003 results adapted from Hartman et al. (2004). Additional detail on groundwater contamination and geochemistry at WMA B-BX-BY can be found in Hartman et al. (2004) and Reidel et al. (2006).

Wells were sampled quarterly during fiscal year 2003. A number of contaminants were detected at or above their respective DWS levels. A summary of these contaminants follows. Details regarding the measurements, levels found, and the wells showing contamination can be found in Hartman et al. (2004).

- Tritium contamination is widespread throughout the northwest part of the 200 East Area. Tritium values have increased recently at the south end of WMA B-BX-BY. The tritium is believed to have originated in the southern portion of the 200 East Area (Figure 2-20).
- One lobe of the nitrate plume beneath the 200 East Area originates in the vicinity of the BY and 216-B-8 cribs. This lobe joins the other lobe of nitrate contamination in moving northwest (Figure 2-20).
- A band of elevated iodine-129 concentrations extends through WMA B-BX-BY to the northeast corner of Low-Level Waste Management Area 1 (Figure 2-20).
- A plume of technetium-99 extends from the area of the BY cribs and WMA B-BX-BY to beyond the 200 East Area north boundary to the northwest. This plume is believed to have originated from early releases of technetium-99 to the BY cribs. Monitoring data indicates the plume is continuing to move northward (Figure 2-20).
- Cobalt-60 and cyanide are found to the north of WMA B-BX-BY in the monitoring wells associated with the BY cribs.
- There is a uranium plume found within the BY tank farm and on the east side of the tank farm. This plume is moving southward and is believed to have originated from a release at tank BX-102 (Figure 2-20).
- There is some localized cesium-137 and strontium-90 near their source as these contaminants are fairly immobile. These contaminants are believed to be from the 216-B-5 injection well (Figure 2-20).

2.11.7 Reference Case Source Terms

The reference case describes a set of assumed post-retrieval conditions that are based on current waste retrieval plans. The reference case analysis for WMA B-BX-BY includes three source terms consisting of past UPRs, residual SST waste, and residual ancillary equipment waste. Table 2-27 provides a listing of the reference case source terms for WMA B-BX-BY, and the inventory data source for that source term.

Source term inventories (reference case) for WMA B-BX-BY are provided in Table 2-28. To simplify the table, only the contaminants that dominate post-closure impacts are shown. All BBI contaminants are included in the reference case modeling analysis. Refer to Section 2.5 for a summary of source term inventory development methods. Complete inventory data are provided in Appendix C.

2.11.7.1 Past Unplanned Releases

The WMA B-BX-BY reference case include 12 past UPRs associated with SSTs (B-107, B-110, B-112, B-201, B-203, B-204, BX-101, BX-102, BX-108, BY-103, BY-107, BY-108) and nine past UPRs associated with ancillary equipment (UPR-200-E-6, UPR-200-E-38, UPR-200-E-73, UPR-200-E-74, UPR-200-E-75, UPR-200-E-105, UPR-200-E-108, UPR-200-E-109, UPR-200-E-110). Volume estimates for those 21 waste loss events were developed by Field and Jones (2005) and vadose zone contaminant inventories were generated by Corbin et al. (2005) (Section 2.5.2). No volume or inventory estimates were assigned to the waste loss events associated with tanks B-101, B-103, B-105, B-111, BX-110, BX-111, BY-105, and BY-106 because of insufficient information to quantify or verify the releases (Field and Jones 2005). If new information becomes available to quantify the waste loss events from those tanks, the data will be evaluated under the integrated regulatory closure process described in Chapter 1.0.

2.11.7.2 Residual Single-Shell Tank Waste

The WMA B-BX-BY reference case includes residual waste in each of the 36 100-Series and four 200-Series SSTs in the B, BX, and BY tank farms. The HFFACO Milestone M-45-00 goal allows up to 360 ft^3 of waste to remain in the 100-Series tanks after retrieval in the event that retrieval beyond that level becomes impracticable (Ecology et al. 1989). Thus, the analysis includes a 360 ft^3 source term associated with residual waste remaining in each of the tanks after retrieval. The inventory estimates were generated with the use of the HTWOS model (Kirkbride et al. 2005), which accounts for the waste retrieval technology and tracks the fate of soluble and insoluble constituents in the waste (Section 2.5.3).

2.11.7.3 Residual Ancillary Equipment Waste

The WMA B-BX-BY reference case includes the plugged and blocked piping in the B, BX, and BY tank farms and the residual waste in seven MUSTs consisting of two catch tanks (241-B-301, 241-BX-302A), one double-contained receiver tank (244-BX DCRT), and the four tanks in the 244-BXR vault (244-BXR-001, 244-BXR-002, 244-BXR-003, 244-BXR-011) (Section 2.5.4). Volume and inventory estimates for the waste in the plugged and blocked piping (none in B tank farm, 28 L in BX tank farm, none in BY tank farm) were developed by Lambert (2005). Volume estimates for the residual waste in the MUSTs were calculated by assuming each tank would be retrieved to a residual volume proportional to that required under the HFFACO Milestone M-45-00 for 200-Series tanks (Ecology et al. 1989). Contaminant inventories associated with the residual ancillary equipment waste were estimated using the average chemical composition of the waste in the WMA B-BX-BY SSTs.

Table 2-27. Reference Case Analysis of Waste Management Area B-BX-BY (3 pages)

Inventory and Source Terms					
Sources	**Assumed Retrieval Method**	**Residual Volume**	**Volume Associated with Past Release [a] gal**	**Basis for Contaminant Inventory Estimate**	
				Residual Waste [b]	**Past Release**
241-B-101 [c]	Mobile retrieval system	360 ft^3	NSI [c]	HTWOS	None
241-B-102	Sluicing	360 ft^3	None	HTWOS	None
241-B-103 [c]	Mobile retrieval system	360 ft^3	NSI [c]	HTWOS	None
241-B-104	Sluicing	360 ft^3	None	HTWOS	None
241-B-105 [c]	Mobile retrieval system	360 ft^3	NSI [c]	HTWOS	None
241-B-106	Sluicing	360 ft^3	None	HTWOS	None
241-B-107	Mobile retrieval system	360 ft^3	14,000	HTWOS	Corbin et al. 2005
241-B-108	Sluicing	360 ft^3	None	HTWOS	None
241-B-109	Sluicing	360 ft^3	None	HTWOS	None
241-B-110	Mobile retrieval system	360 ft^3	10,000	HTWOS	Corbin et al. 2005
241-B-111 [c]	Mobile retrieval system	360 ft^3	NSI [c]	HTWOS	None
241-B-112	Mobile retrieval system	360 ft^3	2,000	HTWOS	Corbin et al. 2005
241-B-201	Vacuum	30 ft^3	1,200	HTWOS	Corbin et al. 2005
241-B-202	Vacuum	30 ft^3	None	HTWOS	None
241-B-203	Vacuum	30 ft^3	300	HTWOS	Corbin et al. 2005
241-B-204	Vacuum	30 ft^3	400	HTWOS	Corbin et al. 2005
241-BX-101	Mobile retrieval system	360 ft^3	4,000	HTWOS	Corbin et al. 2005
241-BX-102	Mobile retrieval system	360 ft^3	91,600	HTWOS	Corbin et al. 2005
241-BX-103	Sluicing	360 ft^3	None	HTWOS	None
241-BX-104	Sluicing	360 ft^3	None	HTWOS	None
241-BX-105	Sluicing	360 ft^3	None	HTWOS	None
241-BX-106	Sluicing	360 ft^3	None	HTWOS	None
241-BX-107	Sluicing	360 ft^3	None	HTWOS	None
241-BX-108	Mobile retrieval system	360 ft^3	2,500	HTWOS	Corbin et al. 2005
241-BX-109	Sluicing	360 ft^3	None	HTWOS	None
241-BX-110 [c]	Mobile retrieval system	360 ft^3	NSI [c]	HTWOS	None

Table 2-27. Reference Case Analysis of Waste Management Area B-BX-BY (3 pages)

Inventory and Source Terms					
Sources	**Assumed Retrieval Method**	**Residual Volume**	**Volume Associated with Past Release [a] gal**	**Basis for Contaminant Inventory Estimate**	
				Residual Waste [b]	**Past Release**
241-BX-111 [c]	Mobile retrieval system	360 ft^3	NSI [c]	HTWOS	None
241-BX-112	Sluicing	360 ft^3	None	HTWOS	None
241-BY-101	Sluicing	360 ft^3	None	HTWOS	None
241-BY-102	Sluicing	360 ft^3	None	HTWOS	None
241-BY-103	Mobile retrieval system	360 ft^3	400	HTWOS	None
241-BY-104	Sluicing	360 ft^3	None	HTWOS	None
241-BY-105 [c]	Mobile retrieval system	360 ft^3	NSI [c]	HTWOS	None
241-BY-106 [c]	Mobile retrieval system	360 ft^3	NSI [c]	HTWOS	None
241-BY-107	Mobile retrieval system	360 ft^3	1,200	HTWOS	None
241-BY-108	Mobile retrieval system	360 ft^3	400	HTWOS	None
241-BY-109	Sluicing	360 ft^3	None	HTWOS	None
241-BY-110	Sluicing	360 ft^3	None	HTWOS	None
241-BY-111	Sluicing	360 ft^3	None	HTWOS	None
241-BY-112	Sluicing	360 ft^3	None	HTWOS	None
UPR-200-E-6	NA	NA	1,017	NA	Corbin et al. 2005
UPR-200-E-38	NA	NA	5,400	NA	Corbin et al. 2005
UPR-200-E-73	NA	NA	92.5	NA	Corbin et al. 2005
UPR-200-E-74	NA	NA	10	NA	Corbin et al. 2005
UPR-200-E-75	NA	NA	1,017	NA	Corbin et al. 2005
UPR-200-E-105	NA	NA	23,000	NA	Corbin et al. 2005
UPR-200-E-108	NA	NA	196	NA	Corbin et al. 2005
UPR-200-E-109	NA	NA	150	NA	Corbin et al. 2005
UPR-200-E-110	NA	NA	5,085	NA	Corbin et al. 2005
241-B-301 catch tank [d]	TBD [d]	20 ft^3	None	Average	None
241-BX-302A catch tank [d]	TBD [d]	6.4 ft^3	None	Average	None
244-BX DCRT [d]	TBD [d]	17 ft^3	None	Average	None

Table 2-27. Reference Case Analysis of Waste Management Area B-BX-BY (3 pages)

Inventory and Source Terms					
Sources	**Assumed Retrieval Method**	**Residual Volume**	**Volume Associated with Past Release [a] gal**	**Basis for Contaminant Inventory Estimate**	
				Residual Waste [b]	**Past Release**
244-BXR-001 vault tank [d]	TBD [d]	27 ft^3	None	Average	None
244-BXR-002 vault tank [d]	TBD [d]	8 ft^3	None	Average	None
244-BXR-003 vault tank [d]	TBD [d]	8 ft^3	None	Average	None
244-BXR-011 vault tank [d]	TBD [d]	17 ft^3	None	Average	None
241-B tank farm pipelines [e]	TBD	None	None	Lambert 2005	NA
241-BX tank farm pipelines [e]	TBD	28.0 L	None	Lambert 2005	NA
241-BY tank farm pipelines [e]	TBD	None	None	Lambert 2005	NA

[a] Past leak volumes listed in Field and Jones (2005).

[b] Residual inventories from HTWOS model output (Kirkbride et al. 2005).

[c] NSI = not sufficient information. Tanks B-101, B-103, B-105, B-111, BX-110, BX-111, BY-105, and BY-106 are identified as a "confirmed or suspected" leaker in Hanlon (2005) but Field and Jones (2005) state there is insufficient information for developing a leak volume at this time. As information becomes available, a leak volume will be developed.

[d] TBD = to be determined. Final disposition of MUSTs not yet determined; however, MUSTs were carried forward in the assessment assuming MUSTs will be retrieved to at least the HFFACO goal (Ecology et al. 1989, Milestone M-45-00) equivalent to the 200-Series tanks. The residual volume is calculated by ratio of the total volume of the MUST to the 200-Series tanks (e.g., the retrieval goal for the 55,000-gal 200-Series tanks is 30 ft^3; thus, a MUST that is ⅔ the size of the 200-Series tank would have a residual volume of 20 ft^3). Inventory was calculated based on average waste per ft^3 within the WMA calculated from the HTWOS model (Kirkbride et al. 2005).

[e] Final disposition of pipelines is not yet determined; however, pipelines were carried forward in the assessment. Pipeline residual volumes shown represent the volume of waste in plugged or blocked pipelines as determined by Lambert (2005).

NA = not applicable

Table 2-28. Reference Case Inventory Estimates for Waste Management Area B-BX-BY

Source Type	Dominant Contaminants for Groundwater Pathway Impacts [a]							Dominant Contaminants for Inadvertent Intruder Impacts [a]						
	C-14 Ci	Tc-99 Ci	I-129 Ci	Cr(VI) kg	NO_3 kg	NO_2 kg	U kg	Sr-90 Ci	Tc-99 Ci	Sn-126 Ci	Cs-137 Ci	Pu-239 Ci	Pu-240 Ci	Am-241 Ci
Past releases [b]	3.98E-01	1.00E+01	1.53E-02	1.99E+02	2.44E+04	3.98E+03	1.01E+04	3.53E+03	1.00E+01	1.19E-01	9.30E+03	1.91E+00	2.23E-01	1.98E+00
Tank residuals	6.00E-01	3.92E+01	9.98E-02	1.80E+03	2.09E+04	2.33E+03	6.54E+03	8.71E+04	3.92E+01	7.14E-01	2.84E+04	1.45E+02	2.27E+01	5.14E+01
Ancillary equipment residuals [c]	2.27E-03	1.05E-01	2.47E-04	9.62E+00	1.33E+02	1.52E+01	5.51E+01	NA	NA	NA	NA	NA	NA	NA

[a] The reference case analysis included all BBI contaminants. As described in Bowen (2004), the standard analyte list tracked in the BBI contains **25 chemicals** including:

- aluminum
- bismuth
- calcium
- chlorine
- chromium
- fluorine
- total inorganic carbon as carbonate
- iron
- mercury
- potassium
- lanthanum
- manganese
- sodium
- nickel
- nitrite
- nitrate
- oxalate
- lead
- phosphate
- silicon
- sulfate
- strontium
- uranium total
- zirconium
- total organic carbon

and **46 radionuclides** including:

- tritium
- carbon-14
- nickel-59
- cobalt-60
- nickel-63
- selenium-79
- strontium-90
- yttrium-90
- zirconium-93
- niobium-93m
- technetium-99
- ruthenium-106
- cadmium-113m
- antimony-125
- tin-126
- iodine-129
- cesium-134
- cesium-137
- barium 137m
- samarium-151
- europium-152
- europium-154
- europium-155
- radium-226
- actinium-227
- radium-228
- thorium-229
- protactinium-131
- thorium-232
- uranium-232
- uranium-233
- uranium-234
- uranium-235
- uranium-236
- neptunium-237
- plutonium-238
- uranium-238
- plutonium-239
- plutonium-240
- americium-241
- plutonium-241
- curium 242
- plutonium-242
- americium-243
- curium-243
- curium-244

[b] Inventories shown are the combined inventories from SST past releases and ancillary equipment past releases. Both release types were considered for the groundwater pathway analysis; however, only the SST past releases were included in the inadvertent intruder analysis (along with SST residuals).

[c] NA indicates insufficient information is available to make estimates of intruder impacts into ancillary equipment (e.g., pipelines, diversion boxes).

2.12 DESCRIPTION OF WASTE MANAGEMENT AREA A-AX

This section provides site-specific information for WMA A-AX. It is a summary from numerous documents that describe present conditions (Hanlon 2005), geology and hydrology (Reidel et al. 2006), subsurface contamination (Wood et al. 2003), and source terms (Kirkbride et al. 2005; Field and Jones 2005; Lambert 2005; and Corbin et al. 2005).

2.12.1 Background

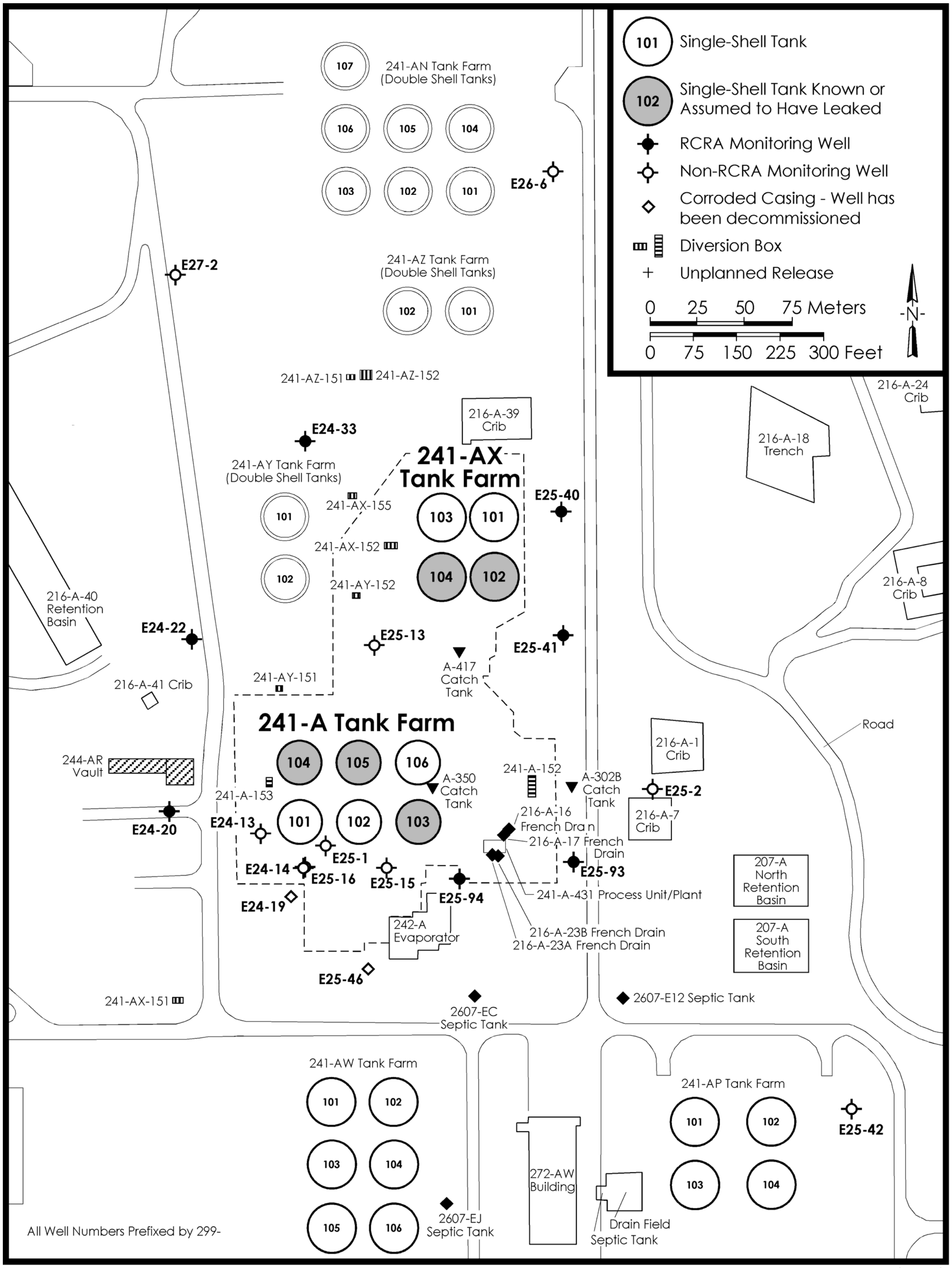
WMA A-AX is located in the south central portion of 200 East Area (Figure 2-79). WMA A-AX contains the A tank farm and AX tank farm. The A tank farm contains six SSTs that were constructed in 1954, put into service in 1955, and used to store and transfer waste until 1980. The AX tank farm contains four tanks that were constructed in 1963, put into service in 1964, and used to store and transfer waste until 1980. The A and AX tank farms received waste generated by PUREX Plant operations. The PUREX process produced three major waste streams: PUREX coating waste, PUREX acid waste which contained about 99% of the fission products, and organic wash waste.

During its operational history, there were a number of confirmed or suspected waste loss events in WMA A-AX. These included suspected tank leaks and known waste losses from piping systems. Currently, the pumpable liquid wastes have been removed from the WMA A-AX tanks and all tanks have been interim stabilized (Hanlon 2005). Table 2-29 lists the estimated volume of waste stored in the WMA A-AX tanks as of November 30, 2004.

The current understanding of contaminant occurrences and environmental conditions at WMA A-AX is described in Wood et al. (2003). Historical information on soil surface and vadose zone contamination in WMA A-AX is provided in Williams (2001c). The primary contamination zones currently identified in WMA A-AX are a localized cesium-137 activity zone near the bottom of tanks A-104 and A-105 and three UPRs near pipelines and diversion boxes.

A FIR for WMA A-AX is scheduled to be issued in fiscal year 2006. Field characterization data to support the FIR is scheduled to be collected in fiscal year 2005 as outlined in Crumpler (2004). Planned WMA A-AX closure and post-closure actions identified at the present time are described in Lee (2004).

Figure 2-79. Location Map of Waste Management Area A-AX and Surrounding Facilities[a]



2005/DCL/A-AX/003 (05/27)

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[a] *Crumpler (2004)*

Table 2-29. Waste Volume Estimates as of November 30, 2004, in Waste Management Area A-AX Single-Shell Tanks [a]

Tank	Total Waste Volume kgal	Supernate kgal	Saltcake kgal	Sludge kgal
241-A-101	320	0	317	3
241-A-102	40	3	37	0
241-A-103	370	4	364	2
241-A-104	28	0	0	28
241-A-105	37	0	0	37
241-A-106	79	0	29	50
241-AX-101	358	0	355	3
241-AX-102	30	0	24	6
241-AX-103	107	0	99	8
241-AX-104	7	0	0	7

[a] Hanlon (2005).

2.12.2 Infrastructure

This section describes the WMA A-AX infrastructure components that were included in the SST PA and are listed in Table 2-30. Reference case inventory development for those components is described in Section 2.12.7. Refer to Section 2.4 for generic infrastructure component descriptions and Section 2.5 for a summary of infrastructure inventory development methods.

2.12.2.1 Single-Shell Tanks

The A and AX series tanks are 75 ft in diameter and 44 ft tall from base to dome. The A tank farm contains six SSTs with a capacity of 1,000,000 gal each, and the AX tank farm contains four SSTs with a capacity of 1,000,000 gal each. Typical tank configuration and dimensions are shown in Figure 2-80. The tanks sit belowgrade with a 6.0 ft soil cover to provide shielding from radiation exposure to operating personnel. Tank pits are located on top of the tanks and provide access to the tank, pumps, and monitoring equipment.

The SSTs were constructed in place with carbon steel (ASTM 2005) lining the bottom and sides of a reinforced concrete shell. The tanks in the A and AX tank farms have a flat bottom. In addition, the A tank farm was underlain by laterals connected to caissons as a leak detection system because the tank farm was designed to store boiling waste. The AX farm tanks included a grid of drain slots beneath the steel liner bottom and a leak detection well that could collect potential leakage. The tanks in WMA A-AX were connected by overflow lines but did not cascade.

Table 2-30. Operating Period and Capacities for Waste Management Area A-AX Facilities Included in Performance Assessment [a]

Facility	Removed From Service	Constructed	Operating Capacity gal
Single-Shell Tanks			
241-A-101	1980	1954 to 1955	1,000,000
241-A-102	1980	1954 to 1955	
241-A-103	1980	1954 to 1955	
241-A-104	1975	1954 to 1955	
241-A-105	1963	1954 to 1955	
241-A-106	1980	1954 to 1955	
241-AX-101	1980	1963 to 1964	
241-AX-102	1980	1963 to 1964	
241-AX-103	1980	1963 to 1964	
241-AX-104	1978	1963 to 1964	
Miscellaneous Underground Storage Tanks			
241-A-350 catch tank	1985	1956	800
241-A-417 catch tank	1985	1956	44,2000
241-AX-152 catch tank [b]	1985	1965	NA
244-AR vault [c]	1985	1976	NA
Underground Waste Transfer Lines			
241-A tank farm pipelines	NA	1954 to 1955	17,600 (+/-5,800)
241-AX tank farm pipelines	NA	1963 to 1964	15,300 (+/-4,400)

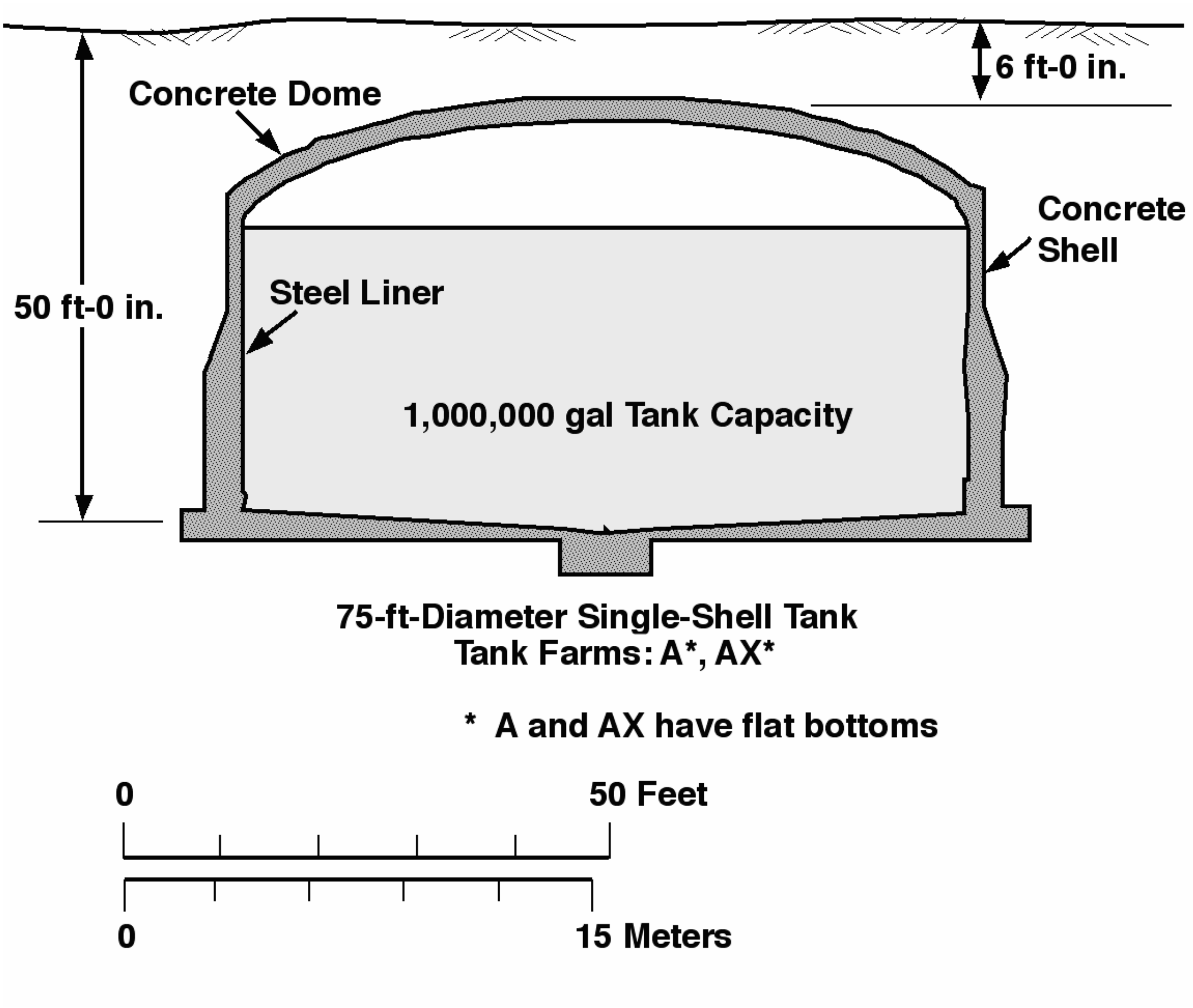
[a] Data on the facilities is from DOE-RL (2005).

[b] Catch tank 241-AX-152 was stabilized and isolated in 2002 (Allen 2002) and has a reported waste level of 0 in.

[c] The 244-AR vault is located outside the WMA A-AX boundary and was not included in the analysis.

NA = not applicable

Figure 2-80. Typical Configuration and Dimensions of Single-Shell Tanks in Waste Management Area A-AX



2.12.2.2 Ancillary Equipment

A complete listing of the WMA A-AX ancillary equipment currently identified for inclusion in the SST system closure is provided in Lee (2004). As discussed in Section 2.5.4, the ancillary components included in the SST PA consist of the underground waste transfer lines and MUSTs located inside each WMA boundary. For WMA A-AX, the ancillary components analyzed consist of the A and AX tank farms waste transfer piping and two MUSTs (241-A-350 and 241-A-417 catch tanks).

The 241-AX-152 catch tank is located inside the WMA A-AX boundary and is not included in the analysis because it was stabilized and isolated in 2002 (Allen 2002) and has a reported waste level of 0 in. The 244-AR vault is located outside the WMA A-AX boundary (Figure 2-79) and is not included in the analysis. That facility will be evaluated in the future under the integrated regulatory closure process described in Chapter 1.0.

Multiple levels of piping were installed over time in WMA A-AX. A time line of piping installations is described in Williams (2001c). It is estimated that there are approximately 9.1 mi (+/-3.0 mi) of waste transfer piping in the A tank farm and 7.9 mi (+/-2.3 mi) in the AX tank farm (Field 2003a).

Four intentional discharge facilities (216-A-16, 216-A-17, 216-A-23A, 216-A-23B French drains) are located inside the WMA A-AX boundary (Figure 2-79). As discussed in Section 2.5.2, intentional discharge facilities are not included in the SST PA. Those facilities will be evaluated in the future under the integrated regulatory closure process described in Chapter 1.0.

2.12.3 Geology

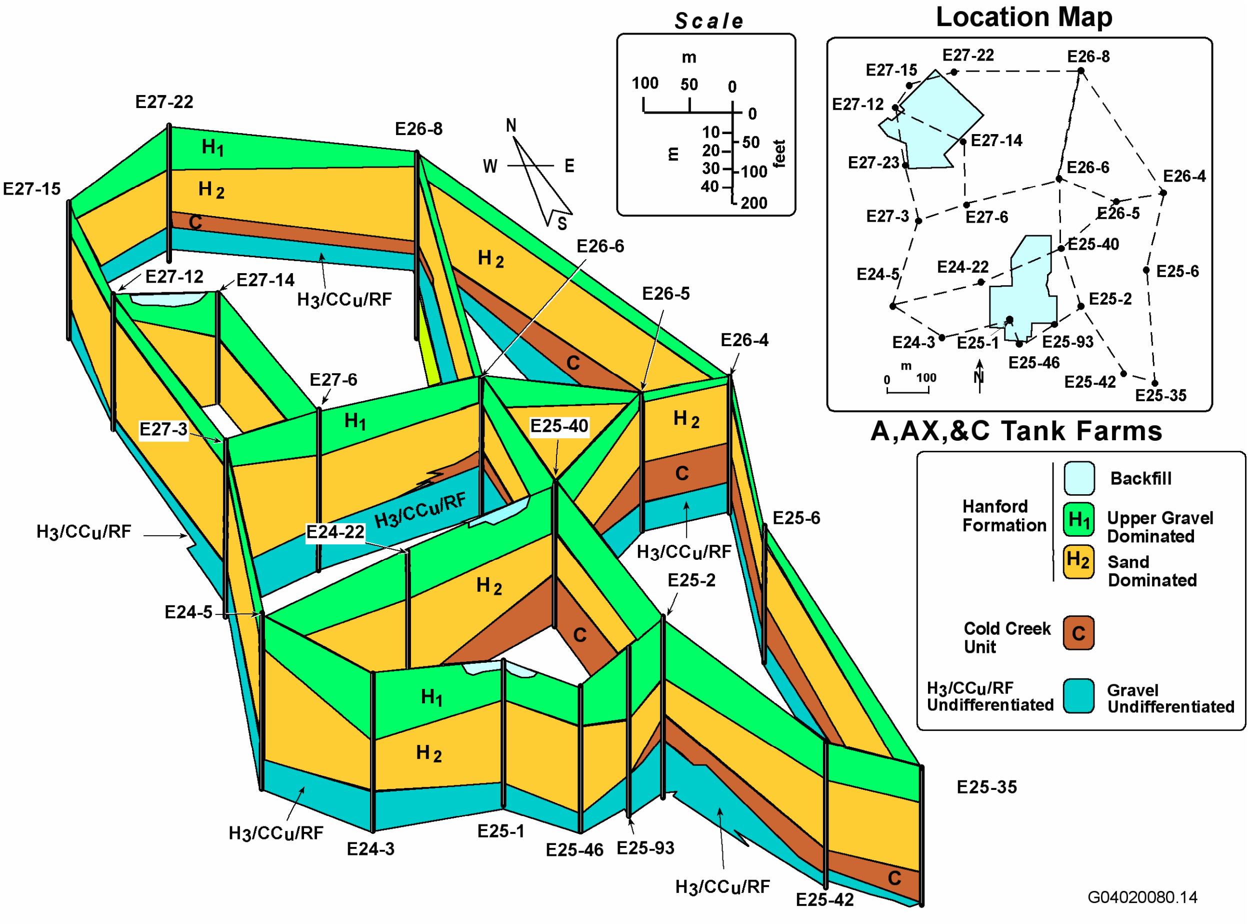
Following is an overview of the geology of WMA A-AX summarized from the information provided in Reidel et al. (2006). Because WMA A-AX and WMA C are in close proximity and have similar geologic conditions, they are discussed together in Reidel et al. (2006) and will be discussed together here. The generalized stratigraphy and thicknesses in the 200 East Area are shown in Section 2.3. A generalized cross-section through WMAs A-AX and C is shown in Figure 2-81. Maps and cross-sections presented in Reidel et al. (2006) illustrate the distribution and thicknesses of these units in additional detail.

Seven stratigraphic units lie within WMAs A-AX and C. From oldest to youngest, the primary geologic units are:

- Columbia River Basalt Group
- Undifferentiated Cold Creek unit fine unit and/or Ringold Formation
- Undifferentiated Cold Creek unit gravel and/or Ringold Formation Unit A?
- Hanford formation – lower gravelly sequence (H3 unit)
- Hanford formation – sand sequence (H2 unit)
- Hanford formation – upper gravelly sequence (H1 unit)
- Recent deposits.

The general characteristics of these units are described in Section 2.3 and in more detail in Reidel et al. (2006). The SSTs at WMAs A-AX and C were emplaced within the Hanford formation sediments of the upper, gravel-dominated (H1) unit, and may locally intercept the upper portions of the sand-dominated Hanford (H2) unit. The water table or potentiometric surface lies approximately 200 ft below the bottom of the tank farms excavations at the basal portion of the Hanford formation (i.e., lower sand/silt dominated) H3 unit, or within the uppermost portions of the Cold Creek unit or Ringold Formation.

Figure 2-81. Fence Diagram Showing Cross-Sections through Waste Management Areas A-AX and C [a]



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[a] *Reidel et al. (2006)*

2.12.4 Hydrology

Following is an overview of the hydrology of the uppermost, unconfined aquifer beneath WMA A-AX. More detailed information supporting this section can be found in Reidel et al. (2006), Wood et al. (2003), and Hartman et al. (2004). Currently, the general groundwater flow direction in the unconfined aquifer beneath WMA A-AX is to the southeast.

The shift in discharge of large volumes of wastewater in the early 1950s to B Pond raised the water table in the vicinity of WMAs C and A-AX as much as 16 ft above the pre-Hanford Site operations level (Hartman et al. 2004). Water levels began to decline in the late 1980s when wastewater discharges were reduced. The decline has become even more pronounced since other effluent discharges throughout the 200 Areas ceased in 1995. Water levels are expected to continue declining within the region surrounding WMAs A-AX and C.

The vadose zone extends to a depth of 295 ft around WMA A-AX (Narbutovskih and Horton 2001). The unconfined aquifer is relatively thin (60 to 90 ft) and resides mostly within the undifferentiated Cold Creek unit gravels and/or Ringold Formation Unit A? sequence.

2.12.5 Vadose Zone Conditions

This section summarizes WMA A-AX vadose zone monitoring and characterization activities, and the current understanding of contamination in the vadose zone.

2.12.5.1 Monitoring and Characterization

The A tank farm has 53 leak detection drywells available for leak detection monitoring (Figure 2-82). These drywells were drilled from 1955 to 1981. The depth ranges for most of these drywells are between 80 and 150 ft bgs, except for drywell 10-06-18, which is 180 ft bgs. Gamma logging data from the drywells from 1974 through 1993 were used to ascertain the integrity of the associated tanks.

The AX tank farm has 33 leak detection drywells available for leak detection monitoring and that provide access for limited vadose zone characterization (e.g., geophysical logging) (Figure 2-83). These drywells were drilled from 1974 to 1981. The depth ranges for most of these drywells are between 75 and 150 ft bgs.

A high-resolution spectral gamma logging system was used in 1997 to log AX tank farm drywells and in 1998 and 1999, to log A tank farm drywells. This effort was part of the baseline characterization for WMA A-AX. Results are documented in DOE-GJO (1997d, 1999b). The addendum report for A tank farm is DOE-GJO (2000L); the addendum report for AX tank farm is DOE-GJO (2000m).

The major gamma-emitting contaminant associated with WMA A-AX is cesium-137. Historical gross gamma evaluations also indicated the presence of ruthenium-106 in the 1970s, which has since decayed to negligible quantities. Contaminants are located mostly in and around areas of confirmed or suspected tank and pipeline leaks.

Additional information on manmade radionuclide distribution and movement will be discussed in the FIR resulting from the WMA A-AX Phase I field investigation. Collection of field characterization data to support the FIR is scheduled to begin in fiscal year 2005 (Crumpler 2004). The draft FIR for WMA A-AX is scheduled to be issued in fiscal year 2006.

Figure 2-82. Vadose Zone Monitoring Network for the A Tank Farm

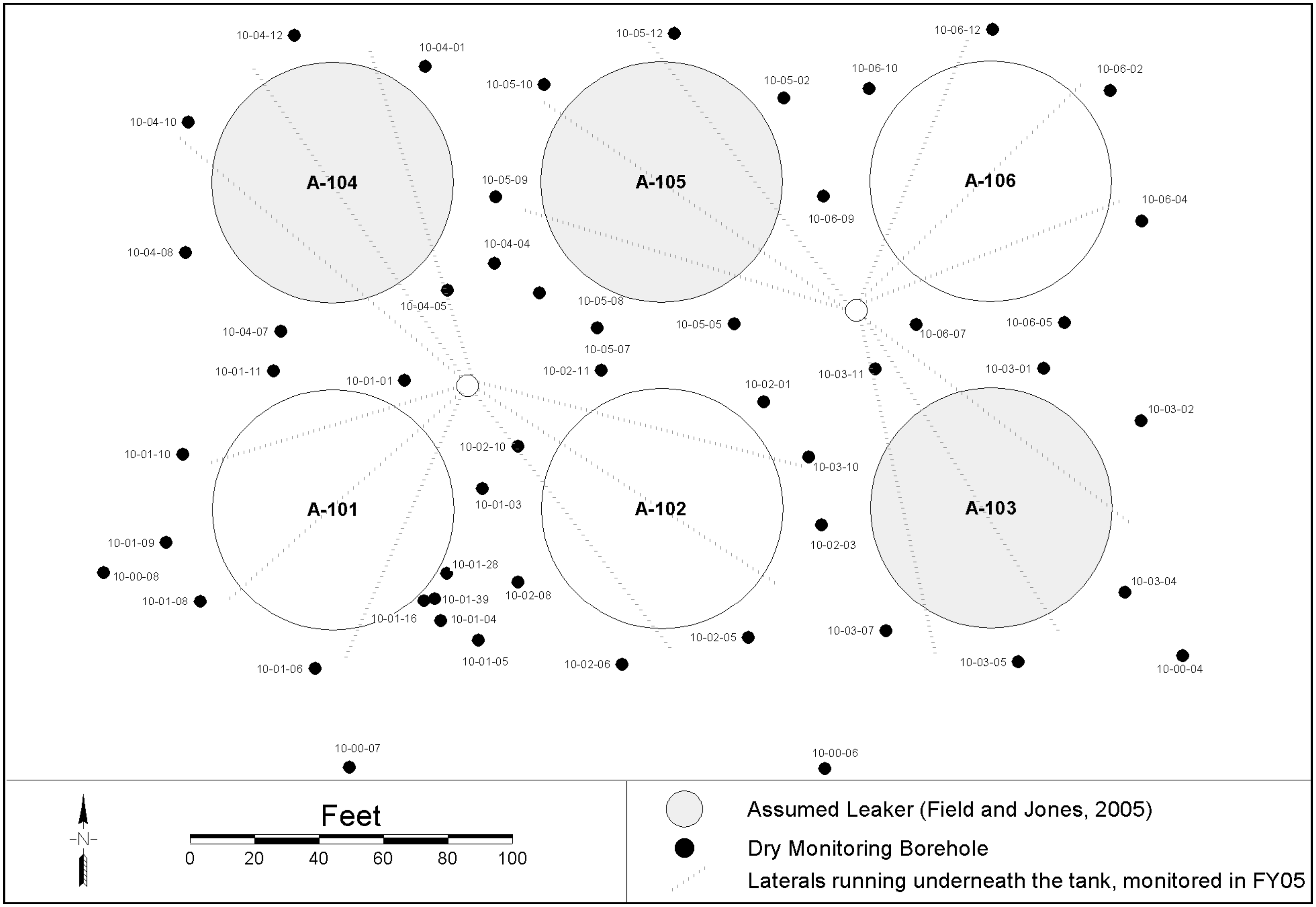
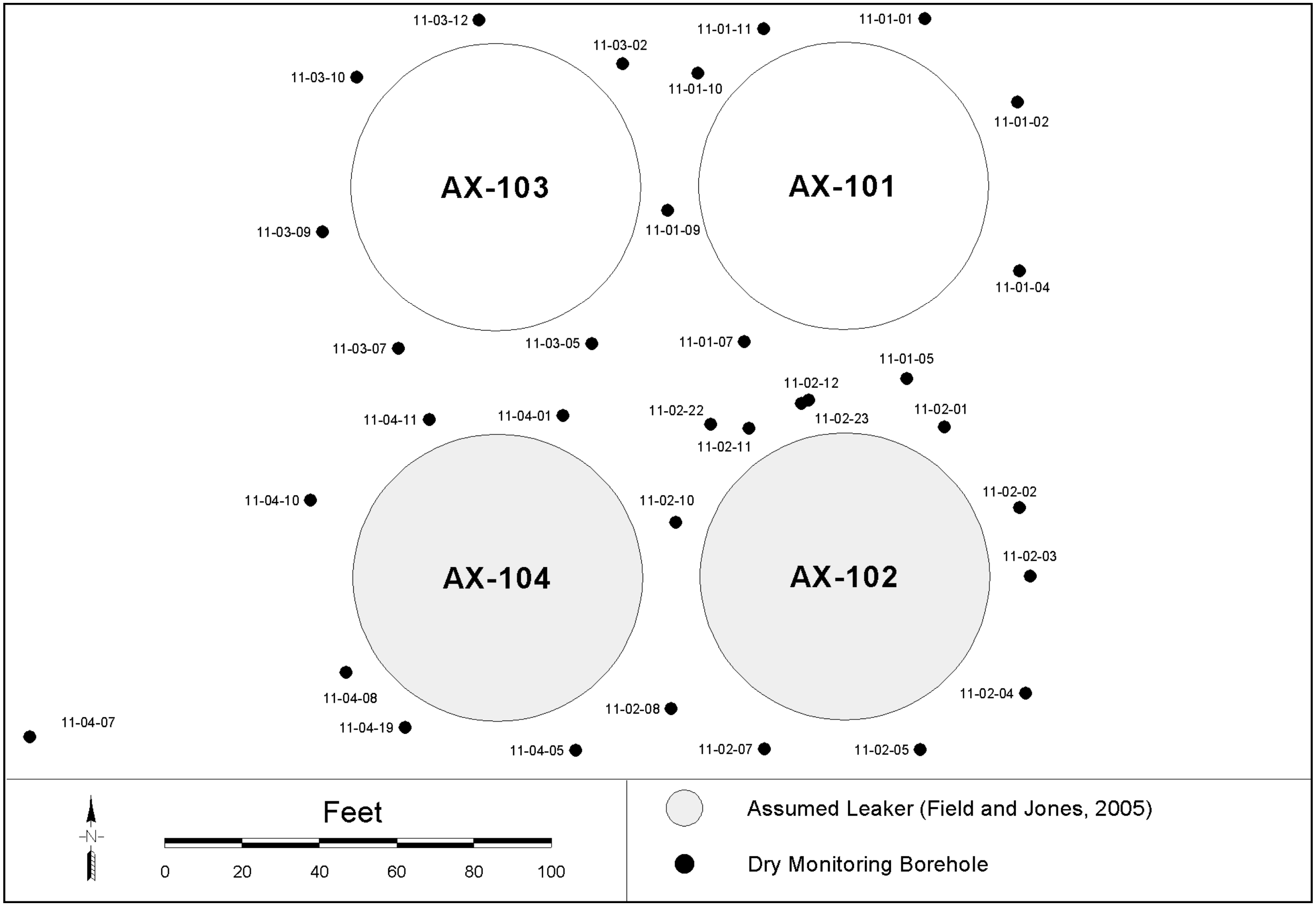


Figure 2-83. Vadose Zone Monitoring Network for the AX Tank Farm



2.12.5.2 Contamination

An overall assessment of the spectral gamma logging data from WMA A-AX drywells indicates minimal tank waste contamination in the vadose zone (Wood et al. 2003). Figures 2-84 and 2-85 are three-dimensional perspectives of A and AX tank farms providing locations of tanks and associated drywells. Tanks considered to be leakers based on information in Field and Jones (2005) are shown with darker shading. Each drywell is represented with a single vertical line. Shaded rings around the drywells indicate the level of vadose zone contamination based on spectral gamma logging results. Only the more significant soil contamination zones are shown. Zones with contamination levels less than 10 pCi/g are not shown.

Cesium-137 concentrations have been measured at several drywells (10-05-02, 10-05-05, 10-05-07, 10-05-09, 10-06-09, 10-05-12) at the tank bottom and lower depths. However, many of these drywells were constructed in two stages and drag-down contamination is likely in most of them. One drywell (10-05-10) may contain cesium-137 contamination from the tank A-105 leak (between 23 and 26 m [75 and 86 ft] bgs) but the complicated drilling process may have shifted the cesium-137 from its original location. The historical gross gamma log shows a shift in cesium-137 contamination levels around 1978; this is probably related to the second-stage drilling that occurred then.

2.12.6 Unconfined Aquifer Conditions

This section summarizes WMA A-AX groundwater monitoring and characterization activities and the current understanding of contamination in the unconfined aquifer.

2.12.6.1 Monitoring and Characterization

Seven RCRA groundwater monitoring wells are associated with WMA A-AX. The wells are intended to monitor groundwater contamination attributable to the entire WMA rather than individual components. There are four downgradient wells (299-E24-19, 299-E24-20, 299-E25-46, 299-E25-93) and three upgradient wells (299-E24-22, 299-E25-40, 299-E25-41). Wells 299-E24-22 and 299-E25-93 were both installed in fiscal year 2003 (Hartman et al. 2004). The initial background-monitoring program for WMA A-AX is complete and monitoring is currently conducted under an interim status indicator evaluation program.

The contaminant indicator parameters and the statistical evaluation methodology for the WMA A-AX groundwater indicator evaluation program are described in Narbutovskih and Horton (2001). Results of the groundwater detection indicator evaluation program are published annually. The most recently published data are for fiscal year 2003 (Hartman et al. 2004).

2.12.6.2 Contamination

The most recently published groundwater monitoring results for WMA A-AX are for fiscal year 2003 (Hartman et al. 2004). Following is a summary of the fiscal year 2003 results adapted from Hartman et al. (2004). Additional detail on groundwater contamination and geochemistry at WMA A-AX can be found in Hartman et al. (2004) and Reidel et al. (2006).

Technetium-99 levels have increased slightly across WMA A-AX, with the highest value of 234 pCi/L (in fiscal year 2003) found to the northeast in well 299-E25-41. The technetium-99 concentration in this well was 220 pCi/L in fiscal year 2002. Well 299-E25-41 is downgradient from the AX tank farm, which currently has no upgradient coverage. This slight rise means technetium-99 is probably moving into the area from farther north.

Figure 2-84. Three-Dimensional Perspective of A Tank Farm Tanks and Drywells Showing Occurrence of Significant (>10 pCi/g) Cesium-137 Contamination in the Vadose Zone

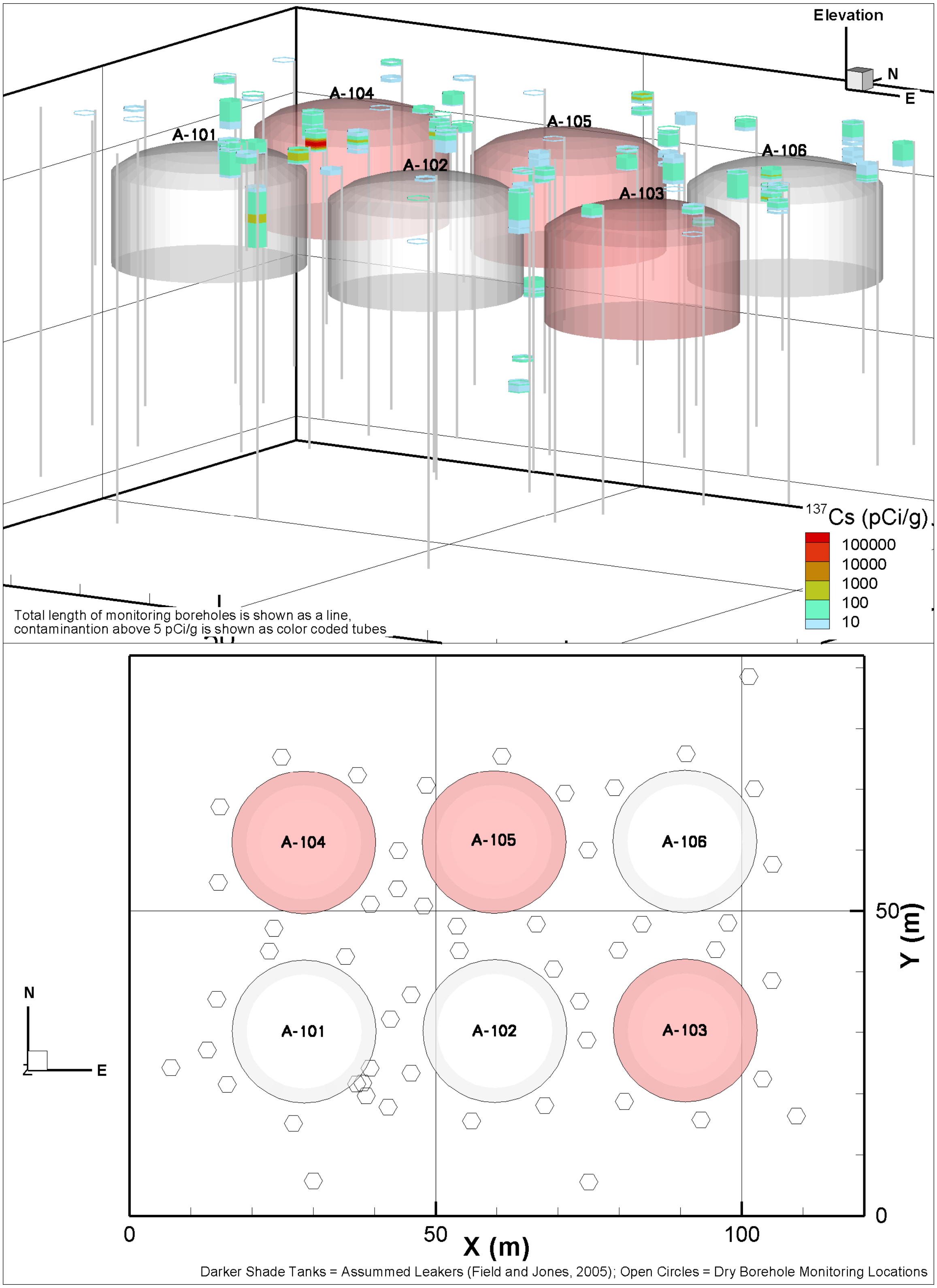
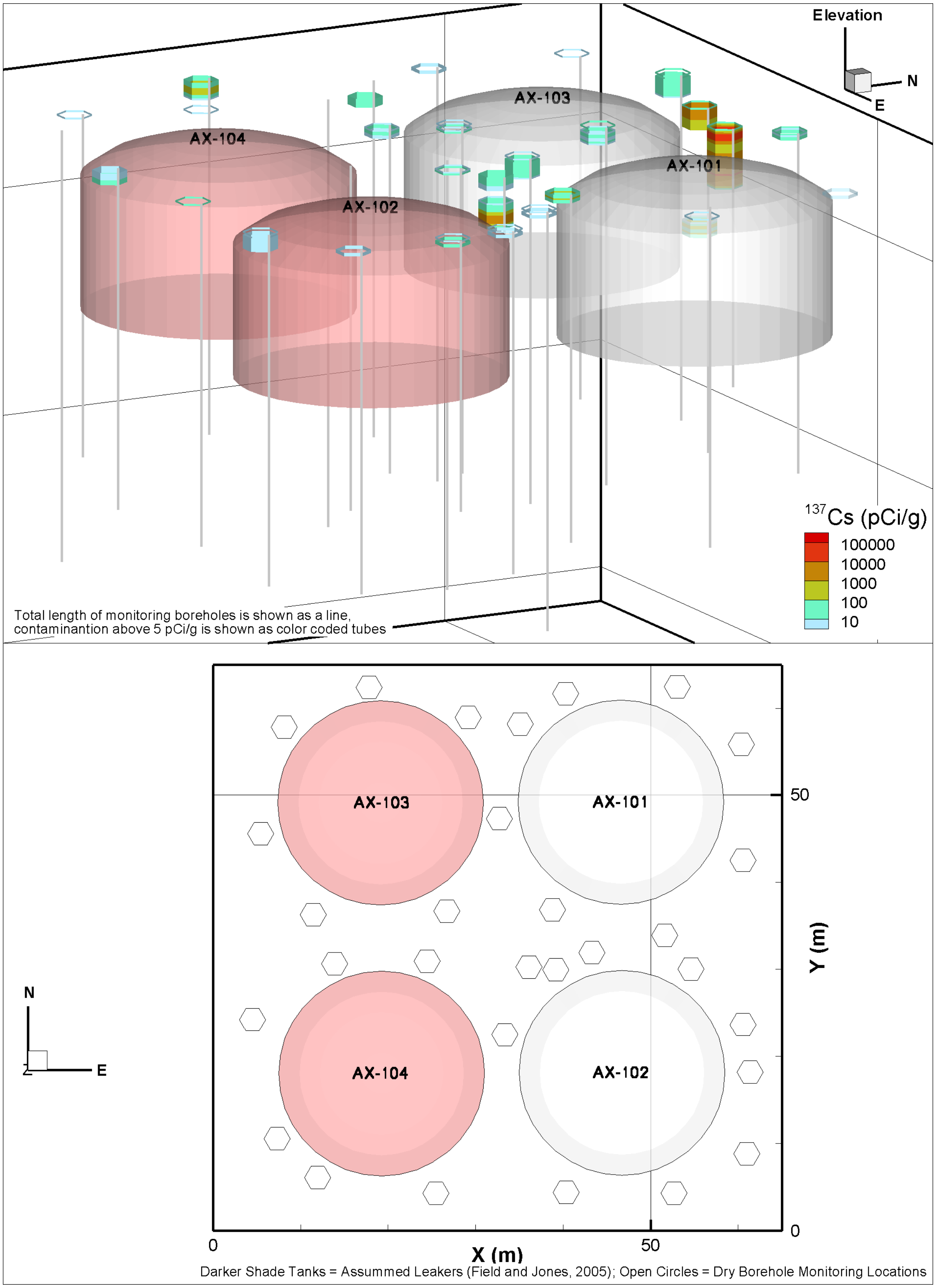


Figure 2-85. Three-Dimensional Perspective of AX Tank Farm Tanks and Drywells Showing Occurrence of Significant (>10 pCi/g) Cesium-137 Contamination in the Vadose Zone



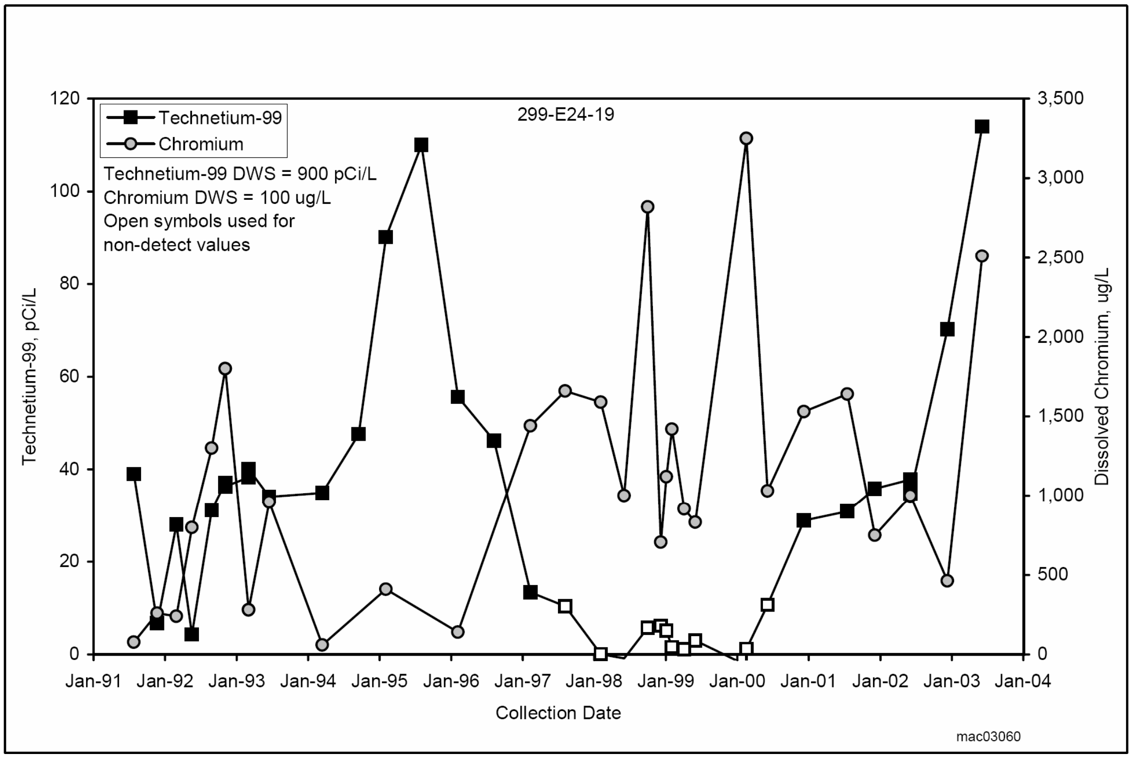
Total length of monitoring boreholes is shown as a line, contaminantion above 5 pCi/g is shown as color coded tubes

Darker Shade Tanks = Assummed Leakers (Field and Jones, 2005); Open Circles = Dry Borehole Monitoring Locations

Tritium values across WMA A-AX have increased from a range of 4,150 to 8,750 pCi/L reported for June 2002 to a range of 5,060 to 12,200 pCi/L in fiscal year 2003. The drinking water standard for tritium is 20,000 pCi/L. The highest value of 12,200 pCi/L is seen upgradient of the site. This local region had higher values of tritium (over 200,000 pCi/L) in the late 1960s when the PUREX Plant was operating. The rising tritium does not appear to be related to WMA A-AX and is, most likely, part of a regional trend.

In filtered samples from well 299-E24-19, chromium continued to be detected at values above the drinking water standard of 100 µg/L, ranging from 462 to 2,510 µg/L in fiscal year 2003. Historically, manganese and nickel also exceed the DWS levels when chromium concentrations are high (manganese, 50 µg/L; nickel, 100 µg/L). The elevated concentrations of metals are associated with the corrosion of stainless steel and not with any tank-associated waste as shown by comparing chromium concentrations to technetium-99 levels in this well (Figure 2-86). Sampling results from purge testing showed that the chromium is from a source close to the well and is not moving through the aquifer. Furthermore, the inverse relationship between chromium concentrations and pH observed during extended purge tests supports a chromium source based on a reduction-oxidation reaction of stainless steel.

Figure 2-86. Chromium and Technetium-99 Trends at Well 299-E24-19



2.12.7 Reference Case Source Terms

The reference case describes a set of assumed post-retrieval conditions that are based on current waste retrieval plans. The reference case analysis for WMA A-AX includes three source terms consisting of past UPRs, residual SST waste, and residual ancillary equipment waste. Table 2-31 provides a listing of the reference case source terms for WMA A-AX, and the inventory data source for those source terms.

Source term inventories (reference case) for WMA A-AX are provided in Table 2-32. To simplify the table, only the contaminants that dominate post-closure impacts are shown. All BBI contaminants are included in the reference case modeling analysis. Refer to Section 2.5 for a summary of source term inventory development methods. Source data are provided in Appendix C.

2.12.7.1 Past Unplanned Releases

The WMA A-AX reference case includes past UPRs associated with four SSTs (A-103, A-104, A-105, AX-102). Volume estimates for those four waste loss events were developed by Field and Jones (2005) and vadose zone contaminant inventories were generated by Corbin et al. (2005) (Section 2.5.2). No volume or inventory estimates were assigned to the waste loss event associated with tank AX-104 because of insufficient information to quantify or verify the releases (Field and Jones 2005). If new information becomes available to quantify the waste loss events from those tanks, the data will be evaluated under the integrated regulatory closure process described in Chapter 1.0.

2.12.7.2 Residual Single-Shell Tank Waste

The WMA A-AX reference case includes residual waste in each of the ten 100-Series SSTs in the A and AX tank farms. The HFFACO Milestone M-45-00 goal allows up to 360 ft^3 of waste to remain in the 100-Series tanks after retrieval in the event that retrieval beyond that level becomes impracticable (Ecology et al. 1989). Thus, the analysis includes a 360 ft^3 source term associated with residual waste remaining in each of the tanks after retrieval. The inventory estimates were generated with the use of the HTWOS model (Kirkbride et al. 2005), which accounts for the waste retrieval technology and tracks the fate of soluble and insoluble constituents in the waste (Section 2.5.3).

2.12.7.3 Residual Ancillary Equipment Waste

Lambert (2005) identified no plugged and blocked piping in the A and AX tank farms. Therefore, the reference case ancillary equipment source term for WMA A-AX includes only two ancillary components, the 241-A-350 and 241-A-417 catch tanks (Section 2.5.4). The estimated volume of residual waste in those tanks was calculated by assuming the tanks would be retrieved to a residual volume proportional to that required under the HFFACO Milestone M-45-00 for 200-Series tanks (Ecology et al. 1989). Contaminant inventories for the tanks were estimated using the average chemical composition of the waste in WMA T SSTs.

Table 2-31. Reference Case Analysis of Waste Management Area A-AX

Inventory and Source Terms					
Sources	**Assumed Retrieval Method**	**Residual Volume**	**Volume Associated with Past Release [a] gal**	**Basis for Contaminant Inventory Estimate**	
				Residual Waste [b]	**Past Release**
241-A-101	Sluicing	360 ft^3	None	HTWOS	None
241-A-102	Sluicing	360 ft^3	None	HTWOS	None
241-A-103	Mobile retrieval system	360 ft^3	5,500	HTWOS	Corbin et al. 2005
241-A-104	Mobile retrieval system	360 ft^3	2,000	HTWOS	Corbin et al. 2005
241-A-105	Mobile retrieval system	360 ft^3	1,000	HTWOS	Corbin et al. 2005
241-A-106	Sluicing	360 ft^3	None	HTWOS	None
241-AX-101	Sluicing	360 ft^3	None	HTWOS	None
241-AX-102	Mobile retrieval system	360 ft^3	3,000	HTWOS	Corbin et al. 2005
241-AX-103	Sluicing	360 ft^3	None	HTWOS	None
241-AX-104 [c]	Mobile retrieval system	360 ft^3	NSI [c]	HTWOS	None
241-A-350 catch tank [d]	TBD [d]	0.5 ft^3	NA	Average	None
241-A-417 catch tank [d]	TBD [d]	24.1 ft^3	NA	Average	None
241-A tank farm pipelines [e]	TBD	0	None	Lambert 2005	NA
241-AX tank farm pipelines [e]	TBD	0	None	Lambert 2005	NA

[a] Past leak volumes listed in Field and Jones (2005).

[b] HTWOS = Hanford Tank Waste Operation Simulator. Residual inventories from HTWOS model output (Kirkbride et al. 2005).

[c] NSI = not sufficient information. Tank AX-104-114 is identified as a “confirmed or suspected” leaker in Hanlon (2005) but both Hanlon (2005) and Field and Jones (2005) state there is insufficient information for developing a leak volume at this time. As information becomes available, a leak volume will be developed.

[d] TBD = to be determined. Final disposition of MUSTs not yet determined; however, MUSTs were carried forward in the assessment assuming MUSTs will be retrieved to at least the HFFACO goal (Ecology et al. 1989, Milestone M-45-00) equivalent to the 200-Series tanks. The residual volume is calculated by ratio of the total volume of the MUST to the 200-Series tanks (e.g., the retrieval goal for the 55,000-gal 200-Series tanks is 30 ft^3; thus, a MUST that is ⅔ the size of the 200-Series tank would have a residual volume of 20 ft^3). Inventory was calculated based on average waste per ft^3 within the WMA calculated from the HTWOS model (Kirkbride et al. 2005).

[e] Final disposition of pipelines is not yet determined; however, pipelines were carried forward in the assessment. Pipeline residual volumes shown represent the volume of waste in plugged or blocked pipelines as determined by Lambert (2005).

NA = not applicable

Table 2-32. Reference Case Inventory Estimates for Waste Management Area A-AX

Source Type	Dominant Contaminants for Groundwater Pathway Impacts [a]							Dominant Contaminants for Inadvertent Intruder Impacts [a]						
	C-14 Ci	Tc-99 Ci	I-129 Ci	Cr(VI) kg	NO_3 kg	NO_2 kg	U kg	Sr-90 Ci	Tc-99 Ci	Sn-126 Ci	Cs-137 Ci	Pu-239 Ci	Pu-240 Ci	Am-241 Ci
Past releases [b]	2.13E-01	6.98E+00	5.71E-03	6.97E+01	4.89E+03	2.86E+03	1.39E+00	1.06E+02	6.98E+00	9.09E-02	1.13E+04	2.17E-01	5.59E-02	2.88E-01
Tank residuals	7.81E-02	7.25E+00	2.41E-03	2.06E+03	2.54E+03	1.36E+03	1.88E+03	6.78E+05	7.25E+00	1.05E+00	6.13E+03	2.50E+02	6.19E+01	1.18E+03
Ancillary equipment residuals [c]	5.18E-04	6.18E-02	1.58E-05	1.31E+01	1.42E+01	9.15E+00	1.74E+01	3.31E+03	6.18E-02	4.48E-03	4.53E+01	1.77E+00	4.10E-01	4.61E+00

[a] The reference case analysis included all BBI contaminants. As described in Bowen (2004), the standard analyte list tracked in the BBI contains **25 chemicals** including:

- aluminum
- bismuth
- calcium
- chlorine
- chromium
- fluorine
- total inorganic carbon as carbonate
- iron
- mercury
- potassium
- lanthanum
- manganese
- sodium
- nickel
- nitrite
- nitrate
- oxalate
- lead
- phosphate
- silicon
- sulfate
- strontium
- uranium total
- zirconium
- total organic carbon

and **46 radionuclides** including:

- tritium
- carbon-14
- nickel-59
- cobalt-60
- nickel-63
- selenium-79
- strontium-90
- yttrium-90
- zirconium-93
- niobium-93m
- technetium-99
- ruthenium-106
- cadmium-113m
- antimony-125
- tin-126
- iodine-129
- cesium-134
- cesium-137
- barium 137m
- samarium-151
- europium-152
- europium-154
- europium-155
- radium-226
- actinium-227
- radium-228
- thorium-229
- protactinium-131
- thorium-232
- uranium-232
- uranium-233
- uranium-234
- uranium-235
- uranium-236
- neptunium-237
- plutonium-238
- uranium-238
- plutonium-239
- plutonium-240
- americium-241
- plutonium-241
- curium 242
- plutonium-242
- americium-243
- curium-243
- curium-244

[b] Inventories shown are the combined inventories from SST past releases and ancillary equipment past releases. Both release types were considered for the groundwater pathway analysis; however, only the SST past releases were included in the inadvertent intruder analysis (along with SST residuals).

[c] NA indicates insufficient information is available to make estimates of intruder impacts into ancillary equipment (e.g., pipelines, diversion boxes).

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