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HANFORD 241-T FARM LEAK INVENTORY ASSESSMENT REPORT

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EXECUTIVE SUMMARY

Washington State Department of Ecology along with the Tank Farms Operating Contractor for the U.S. Department of Energy developed a process to reassess selected tank leak estimates (volumes and inventories), and to update single-shell tank leak and unplanned release volumes and inventory estimates as emergent field data is obtained (RPP-32681, *Process to Assess Tank Farm Leaks in Support of Retrieval and Closure Planning*). This process does not represent a formal tank leak assessment in accordance with procedure TFC-ENG-CHEM-D-42, "Tank Leak Assessment Process." This report documents a collaborative effort to reassess the inventory of past releases in the 241-T Tank Farm.

Tank waste loss events were initially reassessed for single-shell tanks currently classified as "assumed leakers" (the integrity classification of a waste storage tank for which surveillance data indicate a loss of liquid in the past attributed to a breach in the liner integrity, i.e., a tank leak) (HNF-EP-0182, *Waste Tank Summary Report for Month Ending February 28, 2013*). Table ES-1 summarizes the results of tank waste loss reassessments for these tanks and provides a comparison to the waste loss estimates contained in HNF-EP-0182. The estimated volumes of waste lost and the waste composition (types) were evaluated to update the estimated inventory of constituents in RPP-26744, *Hanford Soil Inventory Model, Rev. 1*. Appendix D of RPP-ENV-33418, *Hanford C-Farm Leak Assessments Report* provides a description of waste types and compositions and describes the rationale and logic used for assessments. In addition, tanks currently assumed as "sound" (the integrity classification of a waste storage tank for which the most recent surveillance data indicate no loss of liquid attributed to a breach of tank integrity) were reviewed to assess the potential for loss of waste containment. There was no indication of a tank liner failure and subsequent release of waste (leak) from any of the tanks classified as "sound" in the 241-T Tank Farm, except tank 241-T-102. The mechanism as to the release of detected waste measured in drywell 50-02-05 is unclear. A tank leak integrity assessment (i.e., the TFC-ENG-CHEM-D-42 process) was recommended for this tank.

DOE/RL-88-30, *Hanford Site Waste Management Units Report* contains the official listing of unplanned releases identified at the Hanford Site. The operational history for the 241-T Tank Farm was reviewed to determine if additional information exists for the unplanned releases within the 241-T Tank Farm that are not associated with tank waste loss events. Nothing significant was identified in any of the new or existing documented unplanned releases information. However, during the review of the operational histories for the 241-T Tank Farm it was determined that there is a potential of newly identified unplanned releases as a result of pipeline failures or releases from overfilled tanks as summarized in Section 5.0. Except for the waste quantity estimates presented, there was insufficient information to estimate a volume or inventory of tank waste released to the soil for the identified unplanned releases. A rough estimate of surface releases was developed based on the most recent drywell data measurements.

Table ES-1. Summary of Tank Waste Loss Events. (3 sheets)

Tank	Description	HNF-EP-0182 Waste Loss Estimate (gal)	Revised Estimate[1]
241-T-101	Classified an "assumed leaker" based on one 2.6- in. liquid level decrease. Drywell 50-01-04 shows ^{137}Cs activity between 20 and 120 ft below ground surface. Historical documentation indicates that CWR waste was released from the spare inlets. The volume and inventory of waste released was estimated based on ^{137}Cs distribution in drywells and the waste type in the tank (CWR2) when it was overfilled in 1969.	7,500	264,000 gal 1,300 Ci of ^{137}Cs Tank integrity assessment (TFC-ENG-CHEM-D-42, "Tank Leak Assessment Process") recommended.
241-T-102	Currently classified a sound tank. A narrow peak of gamma activity was first detected in drywell 50-02-05 in 1974; ~2,000 pCi/g of ^{137}Cs was detected using the spectral gamma logging system in 1998 and 50,000 pCi/g of ^{137}Cs was detected using the high rate logging system in 2009. The estimated volume and inventory of the release was based on drywell logging results and 1974 sample results.	0	50 to 500 gal Tank integrity assessment in progress per TFC-ENG-CHEM-D-42, additional characterization is recommended to determine the reason for the increased ^{137}Cs activity and source of the release.
241-T-103 (T-103)	Classified an "assumed leaker" based on 0.3-in. liquid level decrease. The liquid level decrease was determined to be suspect. High levels of gamma activity were detected in drywell 50-03-04. The activity was reported to be from a leak in a failed grout seal in the spare inlet line. The size of the leak and inventory of waste released was estimated based on drywell ^{137}Cs activity, 1974 sample data, and CSR waste concentration estimates.	<1,000 gal	1,300 gal 600 Ci of ^{137}Cs Tank integrity assessment (TFC-ENG-CHEM-D-42) recommended.
241-T-106 (T-106)	Classified an "assumed leaker" based on a 42-in. liquid level decrease in 1973 and elevated gamma activity in drywell 50-08-11. Based on in-tank liquid level measurements an estimated 115,000 gal of ion exchange (CSR) waste leaked from the bottom of the tank. RHO-ST-14, *High-Level Waste Leakage from the 241-T-106 Tank at Hanford* estimates the inventory of ^{137}Cs and other radionuclides released.	115,000	115,000 gal 20,000 Ci of ^{137}Cs

Table ES-1. Summary of Tank Waste Loss Events. (3 sheets)

Tank	Description	HNF-EP-0182 Waste Loss Estimate (gal)	Revised Estimate[1]
241-T-107	Classified an "assumed leaker" based on increased gamma activity in drywell 50-07-07. The release may be from a spare inlet overflow or a tank leak. Liquid level measurements are suspect and spectral gamma logging system measurements show less than 10 pCi/g in drywell 50-07-07.	—[2]	Release estimate TBD Recommend additional characterization near spare inlets followed by a tank integrity assessment (TFC-ENG-CHEM-D-42) if results indicate a spare inlet release.
241-T-108 (T-108)	Classified an "assumed leaker" based on a 0.3-in. liquid level decrease. Liquid level measurements were erratic and unreliable. Gamma activity in drywells near tank T-108 may be migration from the tank T-106 leak or may be from tank T-108. Releases near tank T-108 are currently included with tank T-106 leak estimates.	<1,000[3]	Releases near tank T-108 included in tank T-106 leak volume estimates. Additional characterization recommended to further assess tank T-108 liner integrity.
241-T-109 (T-109)	Classified an "assumed leaker" based on gamma activity in drywell 50-09-01. Gamma activity in drywells near tank T-109 is attributed to migration of the tank T-106 leak. No inventory estimate was determined for tank T-109.	<1,000[3]	Tank integrity assessment (TFC-ENG-CHEM-D-42) recommended.
241-T-111 (T-111)	Classified as an "assumed leaker" based on a 0.3-in liquid level decrease in 1974. Liquid level decreases were also observed starting in 1993and again starting December 2007. Drywell data have shown no indication of a release prior to 1998. There are insufficient data available since 1998 to support any statement regarding recent releases. The estimated size of the leak is based on liquid level decreases between 1995 and 2013 (RPP-RPT-54964, *Evaluation of Tank 241-T-111 Level Data and In-Tank Video Inspection*). The inventory of waste released was calculated from Best-Basis Inventory waste concentration estimates.	<1,000[3]	2,100 gal 0.9 Ci of ^{137}Cs RPP-RPT-54964
Other 241-T Farm (T Farm) Single-Shell Tanks	Single-shell tanks T-103, 241-T-104, 241-T-105, 241-T-110 and 241-T-112 show activity in nearby drywells that has previously been attributed to operational spills, overflows or line leaks or migration of subsurface contaminants attributed to other sources. No evidence of a liner failure was found for any of these tanks or the T-200-series tanks.	NA	NA

Table ES-1. Summary of Tank Waste Loss Events. (3 sheets)

Tank	Description	HNF-EP-0182 Waste Loss Estimate (gal)	Revised Estimate[1]
241-T-200	Tanks 241-T-202 and 241-T -203 are currently being evaluated for potential leaks. No drywells exist around the 200-series tanks for evaluation.	NA	NA
Near-surface Unplanned Releases in T Farm	The volume and inventory of near-surface releases in T Farm were estimated based on drywell data and volume and inventory estimates for designated UPRs and other release events.	NA	<28 Ci ^{137}Cs Volume released ranges from a few thousand gal to a few million gal depending on waste type.
Other Unplanned Releases	Documented releases and descriptions of releases are described in Tables 4-1 and 5-2. Volume and inventory estimates are not available for most of the releases.	NA	See Table 4-1 for unplanned releases with volume and inventory estimates.
Intentional Releases in and near T Farm	Waste was discharged from tanks to nearby cribs and trenches and to the 207-T retention basin and associated ponds and ditches. Operations and intentional releases to facilities near 241-TX Tank Farm are summarized in Section 6.0.	NA	~40 million gal to cribs and trenches ~2,200 Ci ^{137}Cs Over 11 billion gal of cooling water to 207-T and 216_T-4 ditches. ~10 Ci ^{137}Cs

[1] Except as noted, ^{137}Cs inventories are decayed to January 1, 2001 consistent with values in the Hanford Soil Inventory Model.

[2] The leak volume estimate in HNF-EP-0182 for this tank was based on an assumption that the cumulative leakage is approximately the same as for 18 of the 24 tanks where leak volumes were determined by liquid-level decreases. Single-shell tanks 241-SX-110 and T-106 were considered atypical and were not included. Single-shell tanks 241-B-201, 241-B-203, 241-B-204, and 241-C-203, also excluded, are 200-series small diameter tanks. The 18 tank leak estimates that were included in the estimate were single-shell tanks 241-A-103, 241-AX-102, 241-B-107, 241-B-110, 241-BY-107, 241-C-101, 241-C-111, 241-S-104, 241-SX-104, 241-SX-109, T-103, T-108, T-109, T-111, 241-TY-101, 241-TY-104, 241-U-110, and 241-U-112 (Letter 8901832B R1, "Single-Shell Tank Leak Volumes"). The total liquid-loss assumed for the 19 tanks was 150,000 gal, an average of ~8,000 gal/tank.

[3] According to HNF-EP-0182, the leak volume estimate is based solely on observed liquid level decreases in these tanks. This is considered to be the most accurate method for estimating leak volumes.

CSR = cesium recovery by ion exchange waste
CWR2 = Reduction-Oxidation (S Plant) cladding waste, aluminum clad fuel (1961-1966)
CWR = Reduction-Oxidation (S Plant) cladding waste, aluminum clad fuel

References:
HNF-EP-0182, *Waste Tank Summary Report for Month Ending February 28, 2013*, Rev. 299.

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LIST OF TERMS

Abbreviations and Acronyms

BBI	Best-Basis Inventory
bgs	below ground surface
c/s	counts per second
CY	calendar year
DOE	U.S. Department of Energy
DST	double-shell tank
Ecology	Washington State Department of Ecology
ERDF	Environmental Restoration Disposal Facility
FIC	Food Instrument Corporation
HDW	Hanford Defined Waste
HPGe	high-purity germanium
HRLS	high rate logging system
HRR	High Resolution Resistivity
ILL	interstitial liquid level
LLWMA	Low-Level Waste Management Area
LOW	liquid observation well
MT	manual tape
PUREX	Plutonium Uranium Extraction (Plant)
RAS	Radiation Assessment System
RCRA	*Resource Conservation and Recovery Act of 1976*
REDOX	Reduction-Oxidation (S Plant)
SALDS	State-Approved Land Disposal Site
SGE	surface geophysical exploration
SGLS	spectral gamma logging system
SIM	Hanford Soil Inventory Model
SST	single-shell tank

UPR	unplanned release
WIDS	Waste Information Data System
WMA	Waste Management Area

Units

c/s	counts per second
Ci	Curie

Waste Type Abbreviations

1C	Bismuth phosphate first cycle decontamination waste
1C1	Bismuth phosphate process first cycle decontamination waste and coating waste (1944-1949)
1C2	Bismuth phosphate process first cycle decontamination waste and coating waste (1950-1956)
224	224 Building lanthanum fluoride process waste
2C	Bismuth phosphate process second cycle decontamination waste
2C1	Bismuth phosphate process second cycle decontamination waste (1944-1949)
2C2	Bismuth phosphate process second cycle decontamination waste (1950-1956) and low activity cell 5-6 drainage waste (June 1951-1956)
CSR	cesium recovery by ion exchange waste
CW	cladding (coating) waste
CWP2	PUREX cladding waste, aluminum clad fuel (1961-1972)
CWR1	REDOX cladding waste, aluminum clad fuel (1952-1960)
CWR2	REDOX cladding waste, aluminum clad fuel (1961-1966)
MW	Bismuth phosphate metal waste
MW1	Bismuth phosphate process metal waste (1944-1949)
MW2	Bismuth phosphate process metal waste (1950-1956)
R	REDOX waste

1.0 INTRODUCTION

Waste releases to the Hanford tank farms vadose zone are from many different sources, including tank leaks (a breach in tank liner, loss of integrity), cascade and spare inlet losses due to plugging of lines and overfilling the tanks, spills resulting from tank farm operations, and leaks in transfer pipelines. Vadose zone inventories are estimated by multiplying the release volume by the contaminant concentration in the solution released to the soil. The concentration of the solution released is based on process knowledge of the waste composition in the tank at the time the release occurred. For some major releases, historical records confirm the waste loss event and provide a strong technical basis for leak volume and inventory estimates. However, for many releases little data are available and there are varying degrees of uncertainty or differences in the available data.

Numerous studies and investigations have estimated the inventory of contaminants in the tank farms vadose zone. Document HNF-EP-0182, *Waste Tank Status Summary Report for Month Ending February 28, 2013* provides the current official tank leak volume estimates for tanks classified as "assumed leakers," but it does not provide associated inventory estimates, and tank leak volume estimates reported in HNF-EP-0182 have not been updated for many years. The Waste Tank Status Summary Reports were originally prepared for operational decisions, not to estimate the inventory released. It was not until the 1990s that the Waste Tank Status Summary Reports took on new meaning as the "official records" of leaking tanks—thereby assigning them a role different than originally intended. Document RPP-23405, *Tank Farm Vadose Zone Contamination Volume Estimates* summarizes vadose zone tank leak characterization and investigations. The leak volume estimates presented in RPP-23405 are consistent with many of the estimates listed in HNF-EP-0182, but some estimates are much higher and others lower. RPP-23405 suggests that some releases attributed to tank leaks may have been from evaporation of waste, spare inlet overflows, line leaks or spills during process operations. RPP-23405 also provides volume estimates for other unplanned releases (UPRs) in the single-shell tank (SST) farms.

Washington State Department of Ecology (Ecology) along with the Tank Farm Operations Contractor for the U.S. Department of Energy (DOE) developed a process to reassess selected tank leak estimates (volumes and inventories), and to update tank leak and UPR volumes and inventory estimates as emergent field data is obtained (RPP-32681, *Process to Assess Tank Farm Leaks in Support of Retrieval and Closure Planning*). This report documents the results of applying the process described in RPP-32681 to reassess tank and UPR waste discharge (leak) estimates in the 241-T Tank Farm (T Farm). Current Hanford Soil Inventory Model (SIM) (RPP-26744, *Hanford Soil Inventory Model, Rev. 1*) estimates and leak volume estimates in the tank waste status report (HNF-EP-0182) should be updated to reflect revised estimates in this report.

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2.0 SCOPE AND CRITERIA

An assessment team comprised of representatives from Ecology, DOE's Office of River Protection and the Tank Farm Operations Contractor was assembled to review available information relating to waste loss events in T Farm. The assessment team membership is listed in Table 2-1. Minutes from team meetings are included in Appendix A.

Table 2-1. Waste Loss Event Assessment Team.

Name	Organization	Role
Jim Alzheimer	Washington State Department of Ecology	Regulatory oversight (primary focus: tank closure).
Mike Barnes	Washington State Department of Ecology	Lead regulatory oversight (primary focus: tank retrieval and closure).
Joe Caggiano	Washington State Department of Ecology	Regulatory oversight (primary focus: vadose zone and groundwater data).
Jim Field	Washington River Protection Solutions	Leak Assessment lead. Knowledge and experience with tank monitoring and vadose zone investigations.
Les Fort	Washington River Protection Solutions	Knowledge and experience in tank farm waste processing and operations and vadose zone characterization.
Paul Henwood	S. M. Stoller, Inc.	Knowledge and experience in gamma and spectral gamma logging and analyzing logging data.
Jeremy Johnson	U.S. Department of Energy Office of River Protection	Tank Farms Programs Division.
Beth Rochette	Washington State Department of Ecology	Regulatory oversight (primary focus: near-surface unplanned releases).

In accordance with RPP-32681, the following steps were conducted in reassessing waste losses within T Farm.

- Collect information and data regarding past tank leaks in T Farm (see RPP-32681).
- Collect information and data regarding UPRs, including pipeline leaks, spills, and near-surface contamination in T Farm.
- Compile information from previously reported waste tank leaks and UPRs to estimate the volume of tank waste which leaked to the vadose zone and the time at which these leaks occurred.
- Compile data regarding the waste composition at the time of a tank leak or UPR from the available sources, such as sample data, Tank Waste Information Network System, Best-Basis Inventory (BBI), Hanford Defined Waste (HDW) model, etc.

- Combine waste leak volume with waste composition to enable radionuclide and chemical inventory estimates for tank leaks and UPRs.

3.0 BACKGROUND

Approximately 57 million gal of radioactive waste from chemical processing and plutonium processing operations are stored in 177 underground storage tanks on the Hanford Site. Of these tanks, 149 are SSTs, which consist of a single steel liner inside a reinforced concrete tank. Nominal capacities range from 55,000 to 1,000,000 gal. For the immediate future, plans call for retrieval of waste from the SSTs and transfer to the 28 double-shell tanks (DSTs) with proven integrity, and eventual transfer for treatment in the Waste Treatment and Immobilization Plant.

3.1 241-T TANK FARM DESCRIPTION

The 241-T Tank Farm was constructed between 1943 and 1944 in the 200 West Area and consists of twelve 100-series SSTs, diversion boxes, pipelines, and other ancillary equipment. The 100-series tanks have a capacity of 530,000 gal, a diameter of 75 ft, and an operating depth of 23 ft. The 200-series tanks are 20 ft in diameter with an operating capacity of 55,000 gal. The base of the farm excavation is about 40 ft below the ground surface, allowing space for footings and other construction requirements. The T Farm tanks have a dished bottom with a 4-ft radius knuckle. The tanks were designed with a primary mild steel liner and a concrete dome with various risers (as described and displayed in Appendices B and C). The tanks were designed for waste with a maximum fluid temperature of 220 °F. They were set on a reinforced concrete foundation and covered with ~8 ft of backfill material. Figure 3-1 shows a simple schematic of a T Farm SST.

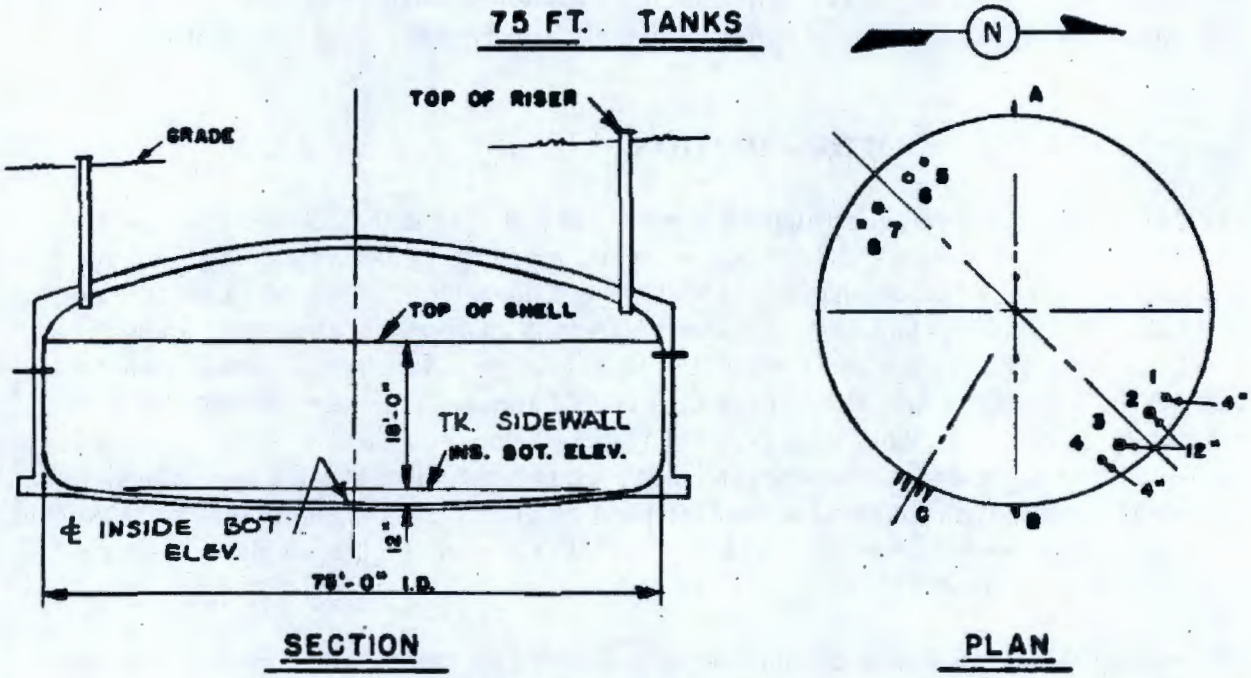
The twelve 100-series tanks were constructed at different elevations with connecting overflow lines that allowed waste to cascade from tank to tank. The tank farm has four cascades, three of three tanks and one of two tanks. A cascade overflow line 3 in. in diameter connects tank 241-T-101 (T-101) as the first in a cascade series of three tanks finishing with tanks 241-T-102 (T-102) and 241-T-103 (T-103). Each tank in the cascade series is set 1 ft lower in elevation from the preceding tank. The cascade outlet height is ~23.8 ft from the tank bottom. The height of the cascade line outlet from the bottom of each tank controls the maximum capacity of the tank. The cascade inlet and overflow connections are sleeved and welded to the tank steel liners about 2 ft below the top of the liner, which is about 21 ft below the ground surface. The cascade lines are set on reinforced concrete beams that bridge the distance between the tanks, and the beams are reinforced at the concrete tank shells. The spare inlet nozzles are ~4.5 in. higher in elevation than the cascade outlet.

Figures 3-1 and 3-2 show the cascade and spare inlet nozzle arrangements for the T Farm tanks.

The 241-T Tank Farm was built to store waste from the 221-T Plant (T Plant). The first cascade began receiving metal waste from T Plant bismuth phosphate process in December 1944. The other cascades received decontamination-cycle waste. The tanks were later emptied and used for ion exchange waste, T Plant wastes, and tri-butyl phosphate waste from the 244-CR vault. The primary additions to the tanks were bismuth phosphate process first-cycle decontamination waste (1C1 [1944-1949] and 1C2 [1950-1956]), second-cycle decontamination waste (2C1 [1944-1949] and 2C2 [1950-1956]), and metal waste (MW1 [1944-1949] and MW2

[1950-1956]); ferrocyanide supernate scavenging waste; saltcake waste from the 1951-1956 242-T Evaporator campaign; uranium recovery waste; decontamination water; Reduction-Oxidation (S Plant) (REDOX) coating (cladding) waste (CWR1 [1952-1960] and CWR2 [1961-1966]); 244-U waste (224), and water.

Figure 3-1. Schematic of 100-Series 241-T Farm Tanks.



Inside bottom elevation is 23.8 ft below Nozzle "A"

TANK NO.	"A" NOZZLE	"B" NOZZLE	"C" NOZZLES
101,104,107,110	INV. 651.96	NONE	INV. 652.33
102,105,108,111	INV. 650.96	INV. 651.21	INV. 651.33
103,106,109,112	NONE	INV. 650.21	INV. 650.33

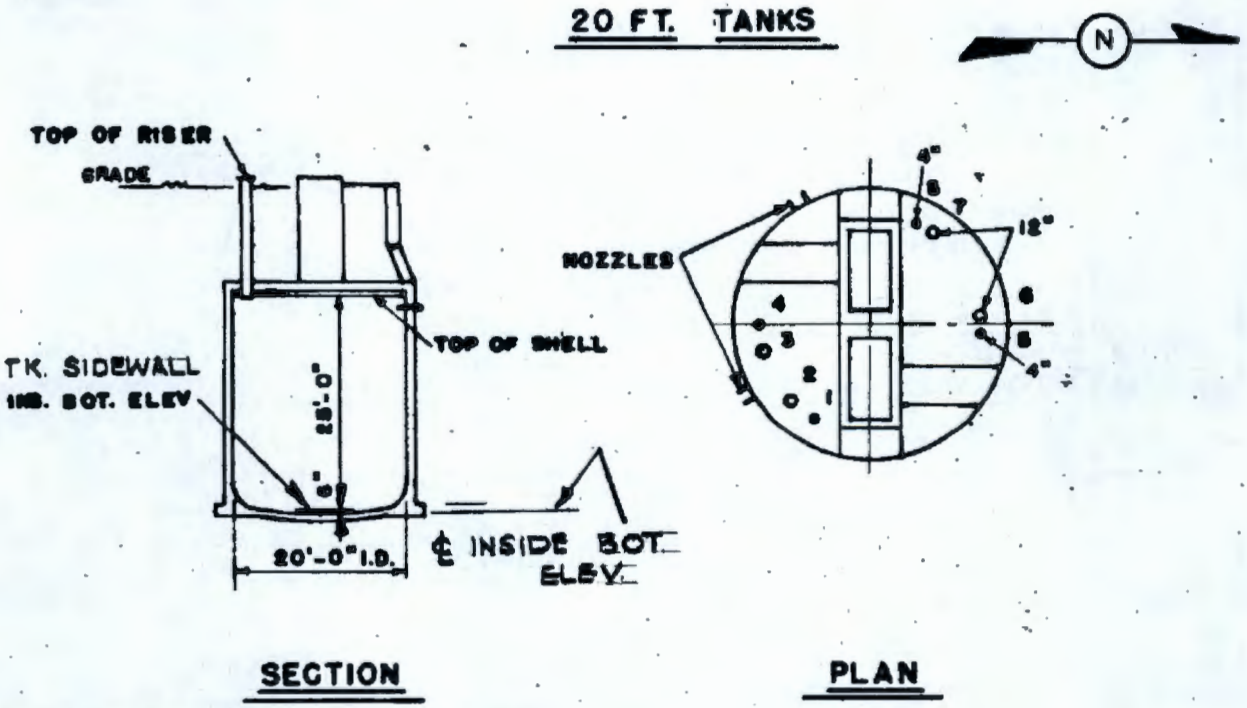
Reference: H-2-1741, *Tank Farm Riser & Nozzle Elev.*

Tanks T-101 through T-103 underwent metal waste removal during 1953 and were sluiced during 1956 and 1957. For additional detail see HNF-SD-WM-ER-320, *Supporting Document for the Historical Tank Content Estimate for T Tank Farm.*

The SSTs in T Farm have been interim stabilized and interim isolated, all raw water is cut off at the farm edge, and minimal air and electrical supplies remain. In 2007 and 2008 an interim barrier was constructed over a portion of the T Farm SSTs to mitigate migration of waste from the 241-T-106 (T-106) tank leak (see Section 4.3).

Table 3-1 shows the estimated waste types and volumes of waste remaining in the SSTs in T Farm as of May 1, 2013.

Figure 3-2. Schematic of 200-Series 241-T Farm Tanks.



Reference: H-2-1741, *Tank Farm Riser & Nozzle Elev.*

3.2 TANK LEAK DETECTION MONITORING

Historically, SSTs were monitored by two independent methods: in-tank and ex-tank monitoring. From the beginning of Hanford Site tank farm operations, the primary leak detection system was routine monitoring of static liquid-surface levels within each tank. Monitoring of gross gamma activity in drywells near the SSTs provided the second leak detection method. Six drywells were constructed in the T Farm in 1944 (the designated "00" wells not immediately adjacent to the tanks) and the rest were constructed in 1973 or later. After the SSTs were pumped and interim stabilized, gross gamma monitoring was no longer required except as specified in tank waste retrieval work plans (RPP-9937, *Single-Shell Tank System Leak Detection and Monitoring Functions and Requirements Document*). Figure 3-3 shows the location of drywells in T Farm and Table 3-2 shows T Farm drywell numbers, ID, names, dates the drywells were drilled, and depth of the drywells.

Table 3-1. Remaining Waste in 241-T Farm Tanks (top to bottom).[1]

Tank	Waste Type	Volume (gal)	Total (gal)
241-T-101	Saltcake from the 1965-1976 242-T Evaporator campaign	62,000	99,000
	REDOX cladding waste, aluminum clad fuel (1961-1966) sludge	37,000	
241-T-102	Supernate from cesium recovery by ion exchange	2,000	32,000
	PUREX cladding waste, aluminum clad fuel (1961-1972) sludge	17,000	
	Bismuth phosphate process metal waste (1950-1956) sludge	13,000	
241-T-103	Supernate from cesium recovery by ion exchange	4,000	26,000
	REDOX cladding waste, aluminum clad fuel (1952-1960) sludge	5,000	
	PUREX cladding waste, aluminum clad fuel (1961-1972) sludge	17,000	
	Bismuth phosphate process metal waste (1950-1956)	1,000	
241-T-104	1C sludge	317,000	317,000
241-T-105	REDOX cladding waste, aluminum clad fuel (1952-1960)	24,000	98,000
	1C	2,000	
	2C	72,000	
241-T-106	1C	10,000	22,000
	REDOX cladding waste, aluminum clad fuel (1952-1960)	9,000	
	REDOX cladding waste, aluminum clad fuel (1961-1966)	3,000	
241-T-107	PUREX cladding waste, aluminum clad fuel (1961-1972)	8,000	173,000
	Tri-butyl phosphate process waste (1952-1958)	17,000	
	1C	148,000	
241-T-108	Saltcake from the 1951-1955 242-T Evaporator campaign	11,000	16,000
	1C sludge	5,000	
241-T-109	Saltcake from the 1951-1955 242-T Evaporator campaign	62,000	
241-T-110	2C supernate	1,000	370,000
	224 sludge	10,000	
	2C sludge	359,000	
241-T-111	224 sludge	239,000	447,000
	2C sludge	208,000	
241-T-112	supernate	7,000	67,000
	224 sludge	24,000	
	2C	36,000	
241-T-201	224 supernate	2,000	30,000
	224 sludge	28,000	
241-T-202	224 sludge	20,000	20,000
241-T-203	224 sludge	36,000	36,000
241-T-204	224	36,000	36,000

[1] Best Basis Inventory estimates as of April 2013 (see Appendix B and C), see RPP-19822, *Hanford Defined Waste Model – Revision 5.0* for waste type composition estimates.

1C = Bismuth phosphate process first cycle decontamination waste and coating waste
224 = Plutonium Lanthanum fluoride finishing waste from bismuth phosphate process and uranium recovery in the 224 Buildings
2C = Bismuth phosphate process second cycle decontamination waste
PUREX = Plutonium Uranium Extraction (Plant)
REDOX = Reduction-Oxidation (S Plant)

Figure 3-3. Location of Drywells in 241-T Tank Farm.

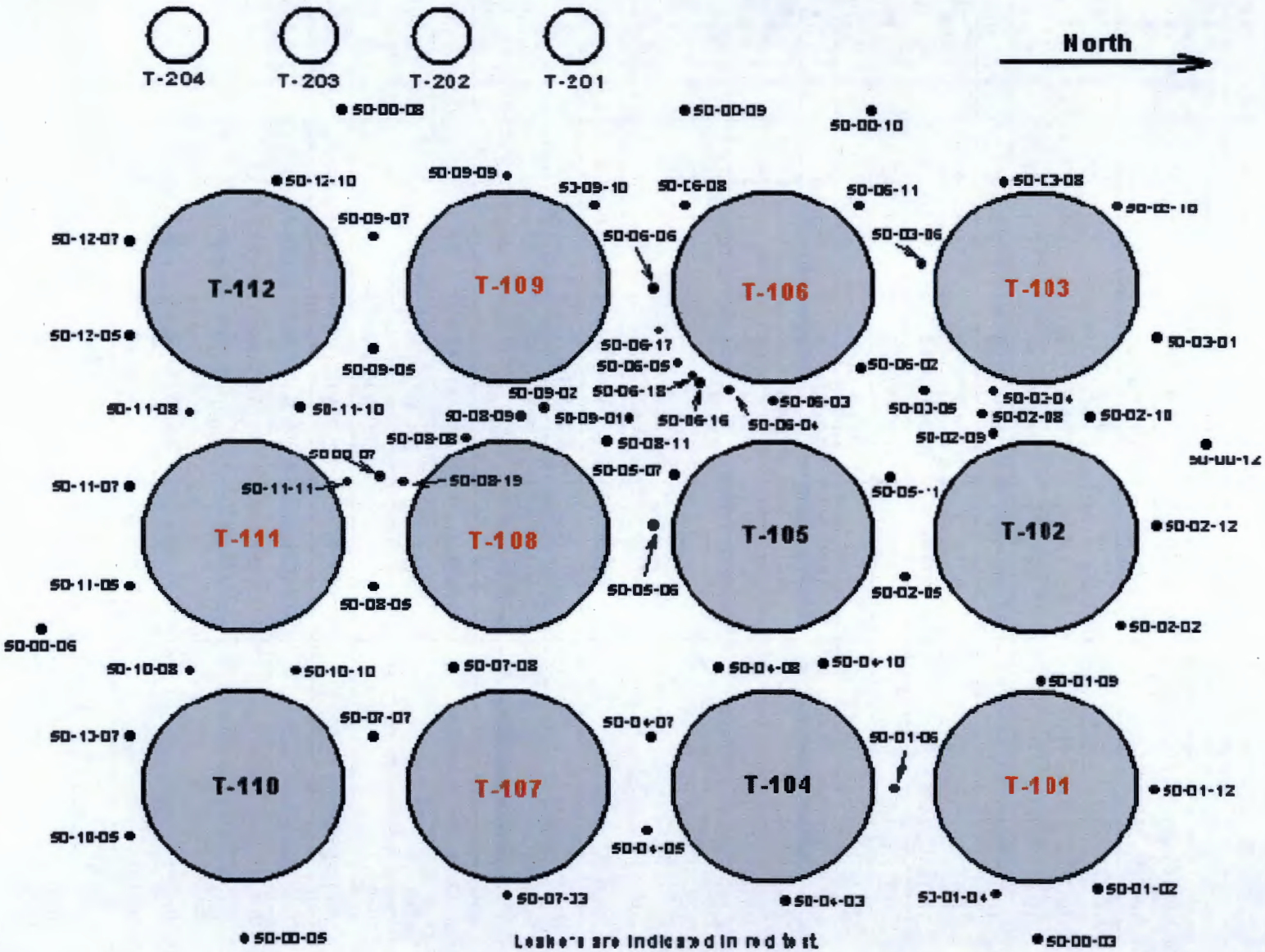


Table 3-2. 241-T Tank Farm Drywells.[a] (3 sheets)

Well Number	Well ID	Well Name	Drill Date	Drill Depth (ft)
50-00-05	A7294	299-W11-53	30-Sep-44	150[b]
50-00-03	A7291	299-W11-51	30-Sep-44	148
216-T-7, 224-T-9	A7170	299-W10-80	30-Sep-51	115
216-T-32, 224-T-7	A7165	299-W10-75	31-Oct-47	75
216-T-7, 221-T-1	A7164	299-W10-74	31-Oct-47	49
216-T-7, 221-T-9, 241-T-9	A7158	299-W10-68	31-Aug-47	150
216-T-7, 221-T-7	A7157	299-W10-67	31-Aug-47	150
216-T-7, 221-T-4	A7156	299-W10-66	30-Sep-47	125
216-T-32, 224-T-6	A7155	299-W10-65	31-Aug-47	75
216-T-32, 224-T-5	A7154	299-W10-64	31-Jul-47	75
216-T-7, 221-T-8	A7153	299-W10-63	31-Jul-47	150
216-T-7, 221-T-6	A7152	299-W10-62	31-Jul-47	150
216-T-7, 221-T-5	A7151	299-W10-61	31-Jul-47	150
216-T-7, 221-T-3	A7150	299-W10-60	31-Jul-47	150
216-T-7, 221-T-2	A7149	299-W10-59	31-Jul-47	150
216-T-32, 224-T-3	A7148	299-W10-58	31-Jul-47	150
216-T-32, 224-T-2	A7147	299-W10-57	30-Jun-47	150
216-T-32, 224-T-1	A7146	299-W10-56	30-Jun-47	150
50-00-06	A7145	299-W10-55	30-Sep-44	150[f]
50-00-10	A7144	299-W10-54	31-Oct-44	150
50-00-12	A7143	299-W10-53	31-Oct-44	151
50-00-08	A7142	299-W10-52	31-Oct-44	148
50-08-11	A7141	299-W10-51	31-Oct-44	148[d]
50-06-18	A7274	299-W10-196	4-Apr-93	180[c]
50-08-19	A7257	299-W10-178	31-Aug-79	95[d]
50-11-11	A7256	299-W10-177	31-Jul-79	95[d]
50-08-08	A7255	299-W10-176	30-Apr-78	100[d]
50-00-09	A7251	299-W10-168	28-Feb-77	122
50-06-16	A7250	299-W10-167	31-Jul-75	90[b]
50-09-02	A7249	299-W10-166	30-Jun-75	82[e]
50-05-07	A7248	299-W10-165	31-Aug-75	88[b]
50-09-01	A7247	299-W10-164	30-Sep-75	90[b]
50-06-17	A7246	299-W10-162	31-Jul-75	122
50-12-05	A7244	299-W10-154	31-Jan-75	100
50-11-10	A7243	299-W10-153	31-Jan-75	100

Table 3-2. 241-T Tank Farm Drywells.[a] (3 sheets)

Well Number	Well ID	Well Name	Drill Date	Drill Depth (ft)
50-11-07	A7242	299-W10-152	28-Feb-75	94
50-10-08	A7241	299-W10-151	31-Mar-75	93
50-07-08	A7240	299-W10-150	28-Feb-75	94
50-07-03	A7239	299-W10-149	31-Mar-75	92
50-04-08	A7238	299-W10-148	31-Jan-75	100
50-04-07	A7237	299-W10-147	28-Feb-75	100
50-04-03	A7236	299-W10-146	28-Feb-75	90
50-03-06	A7235	299-W10-145	31-Jan-75	99
50-09-07	A7234	299-W10-144	31-Mar-74	94
50-08-05	A7233	299-W10-143	31-Mar-74	93
50-07-07	A7232	299-W10-142	31-Mar-74	94
50-12-10	A7231	299-W10-141	31-Mar-74	94
50-12-07	A7230	299-W10-140	31-Mar-74	94
50-11-08	A7229	299-W10-139	28-Feb-74	94
50-11-05	A7228	299-W10-138	28-Feb-74	93
50-10-10	A7227	299-W10-137	28-Feb-74	94
50-10-07	A7226	299-W10-136	28-Feb-74	94
50-10-05	A7225	299-W10-135	28-Feb-74	94
50-09-05	A7224	299-W10-134	31-Mar-74	94
50-08-07	A7223	299-W10-133	28-Feb-74	94
50-04-10	A7220	299-W10-130	31-Mar-74	93
50-04-05	A7219	299-W10-129	31-Mar-74	94
50-03-10	A7218	299-W10-128	28-Feb-74	93
50-03-08	A7217	299-W10-127	28-Feb-74	91
50-03-01	A7216	299-W10-126	28-Feb-74	92
50-02-12	A7215	299-W10-125	28-Feb-74	92
50-02-10	A7214	299-W10-124	31-Mar-74	91
50-02-05	A7213	299-W10-123	31-Mar-74	91
50-02-02	A7212	299-W10-122	28-Feb-74	91
50-05-11	A7211	299-W10-121	31-Aug-73	92
50-09-09	A7210	299-W10-120	31-Aug-73	92
50-02-09	A7209	299-W10-119	31-Jul-73	91
50-03-04	A7208	299-W10-118	31-Aug-73	87
50-03-05	A7207	299-W10-117	09-Aug-73	91
50-02-08	A7206	299-W10-116	31-Jul-73	87
50-06-11	A7205	299-W10-115	31-Jul-73	87
50-09-10	A7204	299-W10-114	31-Jul-73	93

Table 3-2. 241-T Tank Farm Drywells.[a] (3 sheets)

Well Number	Well ID	Well Name	Drill Date	Drill Depth (ft)
50-05-06	A7203	299-W10-113	31-Jul-73	87
50-08-09	A7202	299-W10-112	31-Jul-73	87
50-06-05	A7201	299-W10-111	31-Aug-73	94
50-06-04	A7200	299-W10-110	31-Jul-73	93
50-06-08	A7199	299-W10-109	31-Jul-73	92
50-06-02	A7198	299-W10-108	31-Jul-73	92
50-06-03	A7197	299-W10-107	31-Jul-73	100
50-06-06	A7196	299-W10-106	31-Jul-73	100
50-01-12	A7195	299-W10-105	11-Aug-73	92
50-01-09	A7194	299-W10-104	31-Aug-73	96
50-01-06	A7193	299-W10-103	31-Aug-73	94
50-01-04	A7192	299-W10-102	31-Aug-73	87
50-01-02	A7191	299-W10-101	31-Jul-73	94

[a] Except as specified, the drywells have 6-in. and 4-in. diameter steel casings. The 6-in. casing was perforated in the upper ~20 ft and bottom ~2 ft, a 4-in. diameter casing was placed inside the 6-in. casing and grout was pumped into the annulus between the casings (referred to as a Webster Completion Well).

[b] Drywell with a triple casing, 10-in. upper portion of hole, and 8- and 6-in. casing to the bottom of the hole, inner casing retracted and hole below bottom of casing filled with grout.

[c] Drywell with a triple casing, 10-in. and 8-in. casings in upper half of hole, and 6-in. casing to the bottom of the hole. Bentonite seals placed at the bottom of the casing strings. Grouted in top 10 ft between temporary 12-in. casing and 10-in. casing.

[d] Drywell with a single 6-in. diameter casing. Annular space grouted and grout plug in bottom of drywell.

[e] Drywell with 8-in. and 6-in casings, grout between casings and grout plug in bottom 20 ft of perforated 6-in. casing.

[f] Drywell with 12-in. and 5-in. casings from ground surface to 103 ft and 6-in. and 5-in. casings from 103 to 150 ft with grout between casings and a grout plug at the bottom of the hole.

References:

Environmental Dashboard Application, Queried 06/20/2013, [Well Reports/Document Lookup, provides multiple report formats for groundwater well information from Hanford Environmental Information System, Hanford Well Information System, and Waste Information Data System], http://environet.hanford.gov/EDA/index.cfm?regid=%23%2EP%28%22%0A&fwnavid=%23%2D%20%24%2F%0A&navMode=%28%3FT%3D%3A%28Y%3EJ%3B1%5C%20%0A.
GJ-HAN-1, *Vadose Zone Characterization Project at the Hanford Tank Farms Tank Summary Data Report for Tank T-110.*
GJ-HAN-2, *Vadose Zone Characterization Project at the Hanford Tank Farms Tank Summary Data Report for Tank T-107.*
GJ-HAN-115, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank T-101.*
GJ-HAN-116, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank T-102.*
GJ-HAN-117, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank T-103.*
GJ-HAN-118, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank T-104.*
GJ-HAN-119, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank T-105.*
GJ-HAN-120, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank T-106.*
GJ-HAN-121, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank T-108.*
GJ-HAN-122, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank T-109.*
GJ-HAN-123, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank T-111.*
GJ-HAN-124, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank T-112.*

3.2.1 In-Tank Monitoring

Originally liquid levels were measured using pneumatic dip tubes (HW-10475 C-DEL, *Hanford Technical Manual Section C*, pp. 908). This practice was later replaced with a manual tape (MT) that had a conductivity electrode used to detect the liquid surface (H-2-2257, *Conductor Reel for Liquid Level Measurement*). The biggest limitations of the MT measurements were measurement precision, failures of the electrodes, and solids forming on the electrode and the surface of the waste within the tank. The statistical accuracy of the MT and electrode measurement technique was 0.75 in. (~2,060 gal), as determined in July 1955 (HW-51026, *Leak Detection -- Underground Storage Tanks*, pp. 4). Later, liquid-level determinations were automated in many of the SSTs to provide more accurate and reliable measurements. However, surface level measurements remain highly uncertain when supernate has been removed from tanks leaving solids or precipitated salts, or where solid crusts have formed on the waste surfaces. In addition to uncertainty in measurements of liquid level, liquid level decreases may be caused by a number of factors, including: a leak, evaporation, barometric pressure changes, or physical changes in waste surfaces (i.e., floating solids, surface collapse or gas release events). Liquid observation wells (LOW) were installed in many of the tanks to measure interstitial liquid levels (ILL) using gamma and neutron probe measurements.

All of the T Farm tanks were initially monitored using MT and or Food Instrument Corporation (FIC) gauge surface level measurements. Between 1994 FIC and MT gauges were removed and replaced by Enrafs[1] in the 100-Series T Farm SSTs. Enrafs replaced MT gauges in the 200-series SSTs in 2002. Liquid observation wells for neutron and gamma ILL measurements were installed in tanks 241-T-104 (T-104), 241-T-110 (T-110) and 241-T-111 (T-111) in 1995 and in tanks 241-T-109 (T-109) and T-101 in 2003 and 2004 respectively.

Following is a description of in-tank monitoring instrumentation summarized from RPP-9645, *Single-Shell Tank System Surveillance and Monitoring Program.*

Enraf. The Enraf gauge is the most accurate level gauge currently used in the tank farms. This gauge tracks level changes in tank waste by using a load cell to monitor the weight of a displacer. For the purposes of leak detection, the Enraf gauge needs a static free liquid surface (i.e., the top of the waste extending from the tank walls) below the displacer. The vendor quotes an Enraf precision of ± 0.004 in. and an accuracy of ± 0.04 inches. However, in-tank Enraf instruments are calibrated to an accuracy of ± 0.1 in. and the 2-decimal readout on the gauge provides a precision of ± 0.01 inch.

The condition providing the highest sensitivity to a potential leak is a smooth, pure liquid waste surface combined with the most accurate gauge (Enraf). These measurements are impacted very little by day-to-day variation from either the waste surface or gauge error. If the waste surface becomes more irregular or a gauge with lower resolution is used, the measurement data becomes more scattered (increases) during the normal day-to-day readings. For a heavy slurry waste with a highly irregular surface and a low-resolution instrument, the day-to-day readings exhibit a higher degree of nominal data scatter. Surface level gauges are not used for leak detection if the

[1] Honeywell Enraf is a product of Honeywell Process Solutions, Strahlenbergerstr. 110-112, 63067 Offenbach, Germany.

waste has a solid surface, since the level would not decrease in response to a leak. Liquid levels cannot be measured accurately during waste transfer operations or in self-boiling tanks with a dynamic surface.

Manual Tape. The MT is still used in a few tanks. It relies on a metal tape with a plummet contacting an electrically conductive waste surface. An MT in good working order on a highly conductive surface should be accurate and repeatable to ~0.25 inch. As the waste dries out, the device becomes less accurate, until ultimately no signal is received. Uncertainty for different tanks varied from 0.25 in. to 2 inches. The drying out of the waste surface is typically observed as increasing levels of data scatter during routine data reviews. Most DSTs use the MT as a backup to the Enraf.

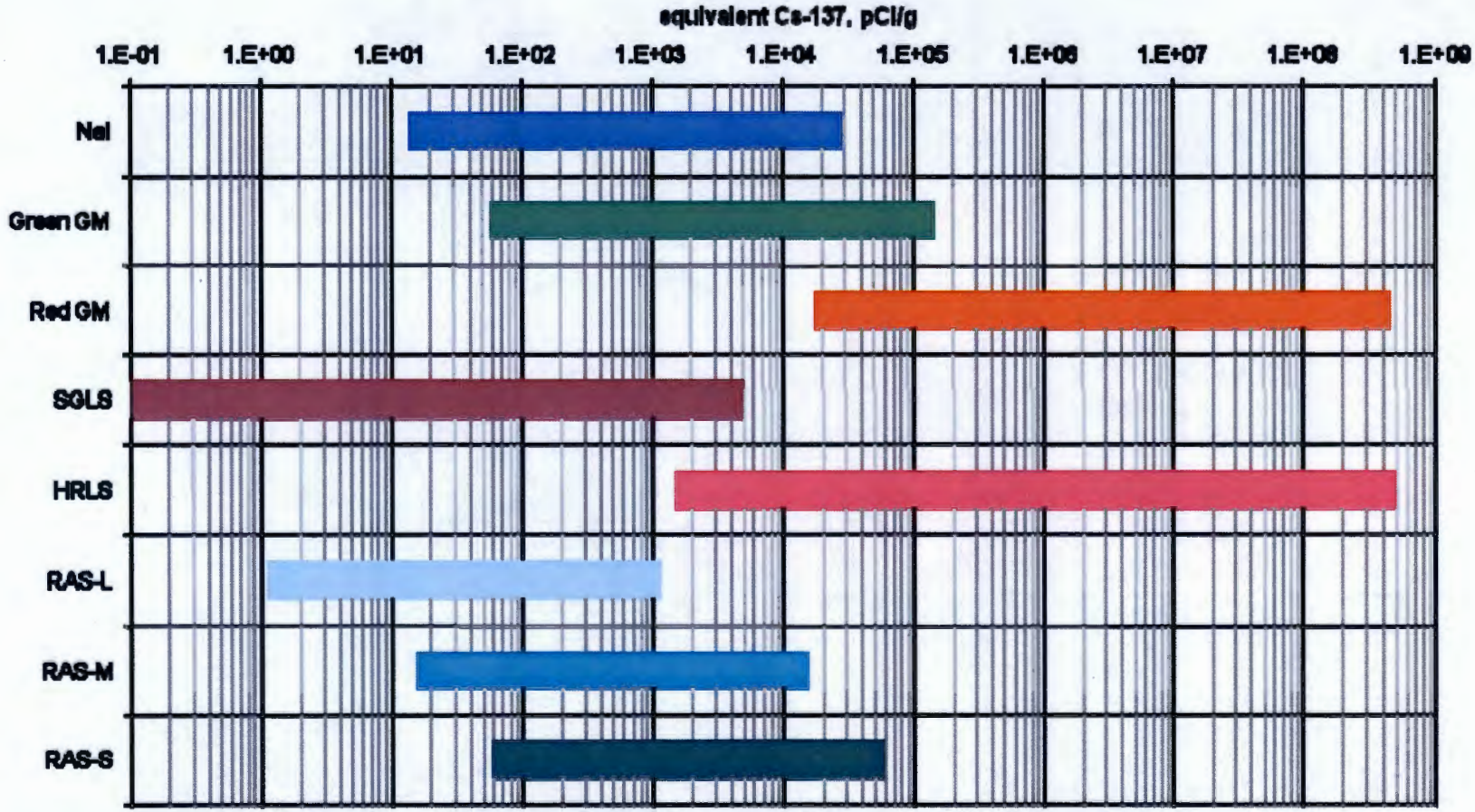
The FIC conductivity gauge is no longer used. The FIC was functionally equivalent to the MT, except that the tape and plummet were raised and lowered by a motor rather than manually. All FICs have now been replaced by Enraf gauges.

Interstitial Liquid Level. Levels of waste phases can be measured by using geophysical techniques deployed inside an LOW placed in a tank. The LOWs were installed in tanks containing permeable waste (i.e., tanks containing saltcake vs. sludge) and/or tanks with a solid waste surface. Originally the uncertainty of waste surface level measurements varied from 1 to 3 in. depending on the waste and barometric pressure changes. Interpreting LOW measurements is complicated, especially for a low permeability waste or when the liquid level is between two waste layers with different permeability (e.g., saltcake and sludge). Updated methods have improved the accuracy of current LOW measurements. Such actions include calibrating the waste depth measuring system daily before going to the field to ensure measurements are within ± 0.25 in. of its known value; verifying the neutron and gamma probes before each use; and comparing all of the measurement scans to a "reference scan" to identify any spikes, drifting, dead zones, or other anomalous problems (assuming a uniform waste porosity).

3.2.2 Ex-Tank Monitoring

Total gamma logging was initially performed in the drywells using NaI and Green and Red (Geiger Mueller detectors) total gamma monitoring detectors (Figure 3-4). Gross gamma logging detects only the cumulative sum of all radioactive isotopes and does not distinguish the isotopes creating the gamma energy. Gross gamma logs were used to detect relative changes in the drywell profile as an indicator of change—either decay or movement toward or away from a drywell. The total gamma logs were digitized starting in 1975; although some pre-1975 archive strip chart data has been located for drywells in other farms, to date, no data before 1975 has been located for T Farm tanks. However, there are some reports that discuss pre-1975 drywell logs, but no reliable logs have been located.

Figure 3-4. Measurement Ranges of Tank Farm Gamma Detectors.



Notes:

NaI:	Sodium iodide or scintillation detector used to measure total gamma in lower activity wells.
Green GM:	Geiger Mueller tube used to measure moderate gamma activity.
Red GM:	Geiger Mueller tube used to measure high gamma activity.
SGLS:	Spectral gamma logging system, uses a high purity germanium detector to measure gamma energy spectra for separate gamma radionuclides (i.e., ^{137}Cs, ^{60}Co, ^{154}Eu, ^{238}U).
HRLS:	High rate logging system, uses shielding to investigate gamma activity too intense for the spectral gamma logging system.
RAS-L:	Radionuclide Assessment System – large NaI detector.
RAS-M:	Radionuclide Assessment System – medium NaI detector.
RAS-S:	Radionuclide Assessment System – small NaI detector.

Between 1995 and 2000, all of the drywells in all of the farms were logged using a spectral gamma logging system (SGLS). The SGLS uses a high-purity germanium (HPGe) detector and provides isotope-specific gamma measurements (e.g., cesium, europium, cobalt and uranium isotopes). Detection and quantification of low specific activity radionuclides such as $^{238/235}U$, and other transuranics or radionuclides that have experienced significant decay such as ^{60}Co, generally require an SGLS. For areas of higher activity (> 2,000 pCi/g), a high rate logging system (HRLS) employing an HPGe is used to quantify activity levels as high as 1E8 pCi/g.

The Radiation Assessment System (RAS) truck was designed for routine gamma monitoring against the baseline established from the SGLS data in 1999. The RAS uses a series of three interchangeable NaI(Tl)-based scintillation detectors (RAS-L, RAS-M, and RAS-S) for measurement over the range from background levels to about 10^5 pCi/g ^{137}Cs. The size of a leak that can be detected by RAS depends on the radioactivity level of the waste leaked, the leak rate, proximity of a drywell (dry drywell) to the leak, and subsurface soil properties controlling flow rate and direction. Consequently, there is no single value that can be stated as the maximum leak that could go undetected by drywell monitoring for an SST. Figure 3-3 shows approximate measurement ranges of different types of gamma radiation detectors for man-made and naturally occurring radionuclides.

As with the in-tank measurements, there are uncertainties associated with the ex-tank geophysical logging. Three sources of uncertainty are as follows.

1. Number and location of wells/laterals/leak detection pits: There were rarely more than six drywells surrounding the 100-series SSTs (circumference ~235 ft) and often fewer. The 200-series tanks in T Farm have no associated drywells. These drywells are generally 6-in. diameter steel casings that extend vertically 75 to 125 ft below ground surface (bgs) (groundwater is between 245 and 300 ft bgs) and allow access of geophysical probes. Because the holes had to be steel cased to prevent collapse and loss of the drywell, only gamma-emitting radionuclides within about a 12-in. radius of a drywell are detected. Geologic conditions at the Hanford Site require that monitoring drywells (drywells) must be cased to prevent collapse. Alpha and beta radiation are blocked by the casing; only gammas (and neutrons) can penetrate to the detector. With HPGe detectors, it is possible to collect gamma energy spectra with sufficiently good energy resolution to identify characteristic decay gammas, and to calculate concentration based on net counts for specific photopeaks. Table 3-3 lists prominent gamma decay "lines" for various man-made and naturally occurring radionuclides. Typical minimum detection limits are provided for HPGe detectors; these detection limits will be significantly higher for detectors such as NaI or BGO, which have poorer energy resolution capability.

   The presence of steel drywell casing and the steel housing of the logging sonde restrict the minimum detectable gamma energy to about 180 keV. At lower energies, gamma attenuation becomes severe, but very high concentrations may still be detectable. "Pure" beta emitters such as ^{90}Sr can be qualitatively detected on the basis of bremsstrahlung radiation resulting from beta interactions in the casing. In other cases, radionuclides with few or no detectable gamma lines may be intimately associated with other, more detectable radionuclides. Examples include ^{237}Np (^{233}Pa), ^{240}Pu (^{239}Pu), ^{241}Pu (^{237}U), and ^{233}U

($^{232}U/^{208}Tl$). It is also possible that mobile, readily detectable radionuclides such as ^{60}Co and ^{237}Np may serve as surrogates or indicators for other less detectable radionuclides such as ^{99}Tc and plutonium, respectively.

Table 3-3. Radionuclides Detectable with High-Purity Germanium Equipment. (2 sheets)

Man-made Gamma-Emitting Radionuclides						
Radionuclide	Half-life (years)	Primary Gamma Rays		Secondary Gamma Rays		Typical MDL, pCi/g
		E, keV	Y	E, keV	Y	
Co-60	5.2714	**1,332.50**	**0.9998**	**1,173.24**	**0.9990**	0.15
Ru-106	1.0238	511.86	0.2040	621.93	0.0993	
Sb-125	2.7582	427.88	0.2960	600.60 635.95 463.37	0.1786 0.1131 0.1049	
Sn-126	2.07E+05	414.52	0.977	666.16 694.83	0.999 0.959	
Cs-137	30.07	**661.66**	**0.851**			0.2
Eu-152	13.542	1,408.01	0.2087	344.28 964.13 1,112.12 778.90	0.2658 0.1434 0.1354 0.1296	
Eu-154	8.593	**1,274.44**	**0.3519**	723.31 1,004.73 873.19	0.2022 0.1801 0.1227	0.2
U-235	7.04E+08	185.72	0.5720	205.31	0.0501	0.6
U-238 (Pa-234m)[a]	4.47E+09	**1,001.03**	**0.0084**	766.36	0.0029	10-15
(Pa-233)	2.14E+06	**311.90**	**0.385**	300.13 340.48 415.76	0.0662 0.0445 0.0173	1
Pu-239	24,110	**375.05** 413.71	**1.554E-5** 1.466E-5	203.55 345.01 332.85	5.69E-6 5.86E-6 5.48E-6	20,000
Pu-241 (U-237)	14.3	**208.005**	**5.19E-6**[b]	164.61 332.35	4.56E-7[b] 2.94E-7[b]	
Am-241[b]	432.2	208.01 335.37 **662.40** **722.01**	7.91E-6 4.96E-6 **3.64E-6** **1.96E-6**	368.05 376.65 322.52 332.35	2.17E-6 1.38E-6 1.52E-6 1.49E-6	50,000

Table 3-3. Radionuclides Detectable with High-Purity Germanium Equipment. (2 sheets)

Naturally Occurring Radionuclides						
	Primary Gamma Rays			Secondary Gamma Rays		
Radionuclide	**daughter**	**E, keV**	**Y**	**daughter**	**E, keV**	**Y**
K-40	Ar-40	**1,460.83**	**0.1067**			
Th-232[c]	**Tl-208**	**2,614.53**	**0.3534**	^{228}Ac	911.21	0.266
	Pb-212	238.63	0.433	^{228}Ac	968.97	0.1617
	Tl-208	**583.19**	**0.3011**	^{228}Ac	338.32	0.1125
U-238[d]	Pb-214	351.92	0.358	^{214}Pb	295.21	0.185
	Bi-214	**609.31**	**0.4479**	^{214}Bi	1,120.29	0.148
	Bi-214	**1,764.49**	**0.1536**	^{214}Pb	241.98	0.0750
				^{214}Bi	1,238.11	0.0586
				^{214}Bi	2,204.21	0.0486

E = Energy level
MDL = minimum detection limit, based on routine analysis with Spectral Gamma Logging System
Y = Yield; gammas per decay or fractional probability of a gamma ray emission

[a] Pa-234m is a short-term daughter of U-238. The yield is relatively low, and these gamma lines are generally not seen in "natural" uranium. Within the uranium decay series, secular equilibrium is achieved slowly, and gamma activity from Pb-214 or Bi-214 will not reach significant levels in less than several hundred thousand years. Hence, the presence of gamma activity originating from Pa-234m, without much higher levels of activity from Pb-214 and Bi-214 is an indication of the presence of anthropogenic U-238, which has been chemically separated from its decay products.

[b] Yield corrected for branching ratio of 0.0000245.

[c] Th-232 occurs naturally in geologic materials. At Hanford, "background" values are generally in the range of 0.5 to 1 pCi/g. Th-232 will establish secular equilibrium throughout the decay series relatively quickly. Hence, anomalous values may indicate the presence of anthropogenic Th-232. Concentrations above 2 pCi/g warrant further evaluation.

[d] U-238 occurs naturally in geologic materials. At Hanford, "background" values are generally in the range of 0.5 to 2.5 pCi/g. For anthropogenic U-238, the decay series will not be in secular equilibrium, and the peaks shown above will not be elevated. Elevated Bi-214 and Pb-214 concentrations may be an indication that Rn-222 may be present.

Laterals beneath the tanks provided a gamma monitoring system as a means to compare drywell readings; however, there are no laterals in T Farm. Consequently, the absence of gamma activity in a well does not necessarily indicate that a tank did not leak.

A few drywells were installed within the tank farms when they were constructed, but most were not installed until the 1970s. During the Hanford operational period, data collection technology evolved from manual records of detector readings to strip charts to digital data collection. Probe types, detectors and logging practices also changed. From 1974 to 1994, total gamma data are available in electronic format, and these detectors have been reasonably well characterized. Although most leaks and releases occurred prior to 1973, careful evaluation of available drywell data can be used to reconstruct contaminant distribution and migration patterns over a period of 20 years. Chemical contaminants as well as alpha- and beta-emitting isotopes are not detected during logging and can only be found through soil sampling and analyses. However, the existence of short-lived mobile gamma-emitting radionuclides deep in the vadose zone may be an indicator of pathways for mobile chemical contaminants such as nitrates.

2. Waste type: The overall effectiveness of gross gamma logging in drywells as a leak detection system depends on the waste type in the tank and other factors. It can be used to evaluate the approximate time period when tank waste may have entered the sediments. Early gross gamma logging can indicate the nature of waste streams by considering the decay rate of gamma activity. The gross gamma logging system is most effective with waste types containing high concentrations (activities) of gamma-emitting radionuclides (e.g., ^{137}Cs or ^{60}Co at the present time and short-lived radionuclides in the past) and large releases, and less effective with lower activity waste types such as aluminum cladding waste or waste that contains transuranics. In addition to limitations on the effectiveness of gamma measurements for different waste types, there were lags of months to years between release and detection where multiple waste transfers in the adjacent tank may have occurred. Consequently, the type of waste in the nearest tank when a leak was detected may not be the same as the waste that leaked. This contributes to uncertainty in inventory and leak volume estimates.

3. Other contamination sources: Gamma activity observed in drywells may also have originated from near-surface waste loss events, transfer line leaks or tank overfills, in which case there is no loss of integrity of the steel liner in the tank. However, all releases contribute to the soil inventory, regardless of whether the liner failed.

Geophysical techniques can also be used outside of a tank to measure increased moisture and gamma-emitting contaminants. Drywell neutron moisture and/or RAS total gamma leak detection monitoring is performed during retrieval in accordance with tank waste retrieval work plans. The accuracy of drywell logging count rates is roughly the square of the total number of counts (*Radiation Detection and Measurement* [Knoll 2000], pp. 94-96). The correlation between counts per second (c/s) and radioactivity or moisture measurements varies by detector.

Leak detection monitoring for retrieval is conducted by observing changes in neutron readings (c/s) compared to an established baseline for the detector being used. Therefore, for a given detector, accuracy of calibration is not a factor. The level of moisture change that triggers additional RAS monitoring is specified in tank waste retrieval work plans. Most of the drywells in T Farm are double or triple cased with grout between casings (see Table 3-2) and cannot be used to measure soil moisture.

Supplemental one-time readings are often obtained during the installation of wells and/or push holes as part of characterization efforts. Such data, when available, will be used as information as appropriate.

Ex-Tank High Resolution Resistivity. High Resolution Resistivity (HRR) leak detection monitoring is used during retrieval operations and measures changes in resistivity against baseline conditions as specified in tank waste retrieval work plans. Because tank waste is high in sodium and nitrate, changes in resistivity/conductivity are a potential indicator of a tank leak. In leak injection tests in 241-S Tank Farm, 13,000 gal of saline solution were injected to the soil near tank 241-S-102. It was determined that HRR could detect a leak of 2,100 gal or more with 95% accuracy. Initial tests showed responses after only a few hundred gallons of saline solution were injected (RPP-30121, *Tank 241-S-102 High-Resolution Resistivity Leak Detection and*

Monitoring Test Report). In comparison, drywell neutron moisture measurements showed negligible changes during leak injection tests. The HRR system does not quantify leak volume or rate, but provides a continuous measure of resistivity during retrieval as compared to weekly moisture measurements and provides three-dimensional spatial measurements compared to measurements indicating conditions within a radius of ~1 ft from a drywell. Furthermore, HRR senses a much larger volume than a drywell, including beneath a tank. However, HRR is affected by the presence of steel infrastructure and corrections must be made for such facilities. Retrieval has not started in T Farm and HRR has not been used for leak detection monitoring in T Farm.

3.3 RETAINED GAS

Many radioactive wastes generate and retain hydrogen, nitrogen, nitrous oxide, ammonia, methane, and other volatile organic compounds. Retained gas is defined as that gas held in the waste predominately by yield strength, producing particle-displacing bubbles. The generation rates of the major fuel (hydrogen, ammonia, methane) and diluent species (nitrogen) aid in assessing the long-term behavior of tank wastes (surface level measurements) and support analyses of potential changes in waste storage conditions (to assess postulated gas release events). The presence of such gases as ammonia, methane, and nitrous oxide can have a significant influence on the flammability characteristics of a gas mixture. Increases in retained gas may result in ILL rise or an increase in the measured surface level. Gas release events may result in the tank head space exceeding flammability limits and a sudden decrease in the ILL complicating interpretation of the ILL data. For some tanks containing retained gas, the ILLs may also increase and decrease with changes in barometric pressure.

Any original wastes that were discharged to the waste tanks from an evaporator were essentially free of retained gas. The gases retained in the wastes were generated during waste storage as a result of radiolytic degradation of organic products and water within the waste. Non-convective layers and crusts retain large quantities of the entrained and underlining gases. In contrast, convective layers do not retain significant amounts of such gases. The principal soluble gas, ammonia, is widely distributed throughout the liquid phases of the waste. Retained gas sampling observations and other findings show that the gases that have been retained in the waste for long intervals are enriched in hydrogen. An evaluation of the empirically measured rates of gas generation results from the slow decomposition of nitrogen and ammonia, and differences in transportation rates (RPP-6664, *The Chemistry of Flammable Gas Generation*).

Tanks T-101, T-104, 241-T-105 (T-105), 241-T-107 (T-107), T-111, 241-T-112 (T-112), and the T-200-series tanks were evaluated for flammable gas (WHC-SD-WM-ER-526, *Evaluation of Hanford Tanks for Trapped Gas*). Tank T-110 was on the flammable gas watchlist due to high retained gas hydrogen content (RPP-7771, *Flammable Gas Safety Issue Resolution*) and tank T-111 was on the organic watchlist due to high total organic carbon. Tank T-111 also showed high exotherms and was evaluated for the flammable gas watchlist as a result of liquid level decreases (WHC-SD-WM-ER-337, *Engineering Report Managing the Assumed Leak from Single-Shell Tank 241-T-111*). None of the T Farm tanks were sampled using a retained gas sampler.

Based on surface level increases and barometric pressure correlations, tanks T-101, T-105, T-107, T-111 and T-112 were estimated to contain between 0.5 and 11.5% by volume of flammable gas with estimated headspace gas concentrations from 6 to 32% of the lower explosive limit in the event of a gas release event. The T-200-series tanks were estimated to contain between 4 and 13% by volume of flammable gas with estimated headspace gas concentrations from 41 to 390% in the event of a gas release event (WHC-SD-WM-ER-526). Surface level changes in these tanks may be attributed, at least in part, to retained gas build-up and releases.

3.4 TANK LEAKS

Sixty-seven of 149 SSTs have been designated as "confirmed or assumed leakers" over the SST operational timeline (1945 to 1980) (HNF-EP-0182). HNF-EP-0182 defines "assumed leaker" as "The integrity classification of a waste storage tank for which surveillance data indicate a loss of liquid attributed to a breach of integrity" (i.e., a breach in the tank liner). By inference a "questionable integrity" tank is a tank for which the liner integrity is in question. Conversely, a sound tank is classified as "the integrity classification of a waste storage tank for which surveillance data indicate no loss of liquid attributed to a breach of integrity." Other types of releases from tanks or near tanks such as cascade and transfer line leaks or spare inlet releases are UPRs and should not be considered tank leaks.

During the active operation of the SST farms, either an anomalous liquid-level measurement of 0.5 to 2 in. (depending on the type of waste in a tank and the accuracy of measurement techniques) or a significant increase in gamma activity in a drywell, lateral or leak detection pit was generally a sufficient reason for the tank to be listed as "questionable integrity" or an "assumed leaker" (SD-WM-TI-356, *Waste Storage Tank Status and Leak Detection Criteria*). When a tank was designated as "questionable integrity" it was pumped to a "minimum heel" and taken out of service. In some cases the "questionable integrity" designation was followed up with additional investigations which concluded that a tank did not leak or identified an overflow or transfer line leak source and the tank was returned to operation. However, in many cases no additional investigations were performed. In the late 1980s, all SSTs that had been flagged as "questionable integrity," "assumed leakers" or "confirmed leakers" were combined into the list contained in the monthly waste tank summary report (HNF-EP-0182) and flagged as "confirmed or assumed leakers." Because of the uncertainty associated with the measurements, unexplained waste level decreases were generally considered an inadequate basis for designating a tank as a "confirmed leaker." The "confirmed leaker" designation required an observed waste level decrease combined with increasing gamma activity in a nearby drywell. The "assumed leaker" designation could be assigned based on either measurement (an observed waste level decrease or increasing gamma activity in a nearby drywell), without confirmation from the other measurement. As shown in this report, some gamma activity in drywells appears to be the result of UPRs rather than a breach in a tank liner and the tank may not have leaked. However, all waste releases add to the contaminant inventory in the soil.

3.5 INTERIM STABILIZATION

Uncertainties associated with both the primary and secondary leak detection systems for the SSTs led to a number of decisions. By the early 1960s, decisions were made to move from an SST design to a DST design for construction of new tanks. The double-shell design provided both secondary containment and reliable leak detection systems between the two liners. A decision was also made to pump liquids stored in the SSTs into the DSTs. This process was referred to as interim stabilization of the SSTs.

A consent decree (*Washington v. DOE*, Case No. CT-99-5076-EFS) was established that set a timetable and specified criteria to complete interim stabilization, and by 2003 all of the SSTs were interim stabilized except two that went directly to retrieval without undergoing interim stabilization (HNF-EP-0182). A tank was considered interim stabilized when it contained less than 50,000 gal of drainable interstitial liquid and less than 5,000 gal of supernate. If the tank was jet pumped to achieve interim stabilization, then the jet pump flow or saltwell screen inflow must have been at or below 0.05 gpm. Due to equipment failure some jet pump tanks were administratively stabilized before reaching the 0.05 gpm criteria (see HNF-EP-0182).

3.6 SURFACE GEOPHYSICAL EXPLORATION IN 241-T TANK FARM

A surface geophysical exploration survey was conducted in 2005 and 2006 to collect and analyze soil electrical resistivity data as a means to identify and locate low resistivity regions in and around the T Farm area. This was done to identify potential areas of high nitrate or sodium contamination. The results of this original effort were reported in RPP-RPT-28955, *Surface Geophysical Exploration of T Tank Farm*. The initial part of the survey effort integrated ground penetrating radar and electrical resistivity. High-resolution electrical resistivity data were collected in a well-to-well survey using existing groundwater and vadose zone wells in the T Farm area.

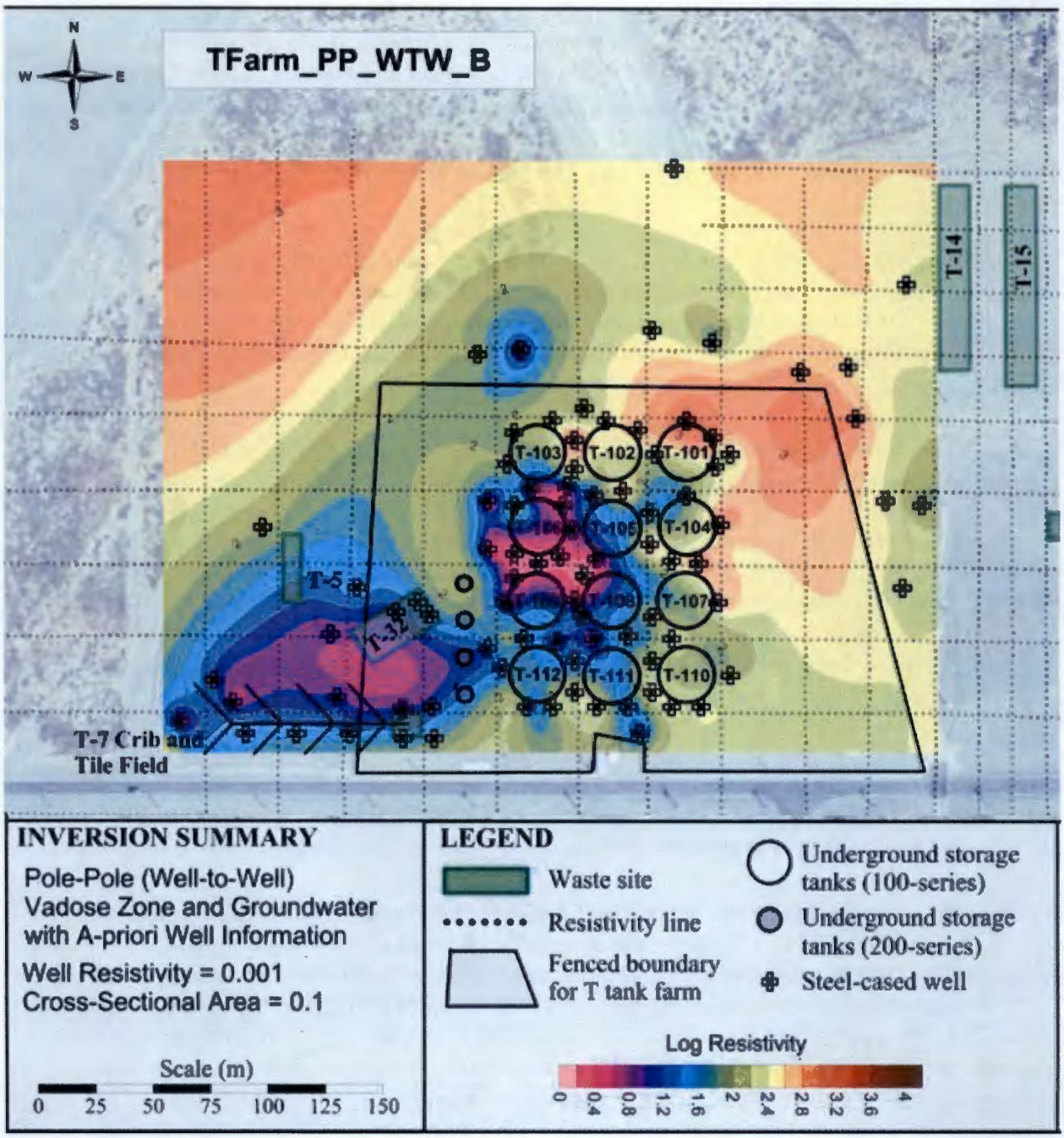
A reanalysis (including processing and inversion) of electrical resistivity data collected during the initial investigation of T Farm was conducted and reported in RPP-RPT-42844, *Reanalysis of Surface Geophysical Resistivity Data for the 241-T Tank Farm*. The reanalysis was performed to incorporate the significant advances that had been made in modeling resistivity data that encompass large tank farm domains in one single inversion model. The scope of reprocessing of the T Farm data included reprocessing the well-to-well, surface-to-surface, and well-to-surface data using these enhanced tools with an upgraded version of the software code[2].

Figure 3-5 displays reanalysis of the original survey results for the well-to-well inversion. In general, the well-to-well model shows several low resistivity targets around known disposal areas. The most significant target is found in the southwest corner of the grid around cribs T-5, T-7, and T-32. Given the large volume of disposal for these trenches, the target matches hydrogeologic expectations. The exact shape and position of the large target, however, is likely influenced by the distribution and density of the wells. Another significant target is found at the southeast corner of tank T-106, which matches the conceptual model discussed in RPP-23752,

[2] RES3DINV is a product of Geotomo Software Sdn. Bhd., Penang, Malaysia.

Field Investigation Report for Waste Management Areas T and TX-TY. This target is elongated from the northwest corner of tank T-106 (and directly south of tank T-103) to the northwest corner of tank T-111. The surface geophysical exploration results for T Farm provided only two-dimensional imagery; consequently, the depth of low resistivity regions is unknown. Future characterization direct push samples are recommended in these areas.

Figure 3-5. 241-T Tank Farm Well-to-Well Surface Geophysics Exploration Results.



Source: RPP-RPT-42844, *Reanalysis of Surface Geophysical Exploration Resistivity Data for the 241-T Tank Farm.*

3.7 INTERIM SURFACE BARRIER

In April 2008 an interim surface barrier and monitoring system (Figure 3-6) was constructed over a portion of the tanks in T Farm and began operations. The interim surface barrier was constructed by spraying a ~0.5-in. layer of polyurea over a geotextile fabric to minimize the infiltration of precipitation into the soil zones containing radioactive contaminants and minimize the movement of contaminants. In particular, the barrier was designed to slow releases to the soil from the 1973 tank T-106 leak. Vadose zone moisture is monitored to assess the effectiveness of the barrier in reducing soil moisture and mitigating contaminant movement. Solar-powered systems were installed to continuously monitor soil water conditions beneath the barrier and outside the barrier footprint. Nest TA was placed in the area outside the barrier footprint and serves as a control, providing information on subsurface conditions outside the influence of the surface barrier. Nest TB provides subsurface measurements to assess surface-barrier edge effects. Nests TC and TD are beneath the interim surface barrier (see Figure 3-6).

Each instrument nest is composed of a capacitance probe with multiple sensors, multiple heat-dissipation units, and a neutron probe access tube. The principal variables monitored for this purpose are soil-water content (θ) and soil-water pressure (ψ). Soil temperature, precipitation, and air temperature are also measured. Results of barrier monitoring are recorded and reported annually.

The 2012 annual monitoring report (RPP-RPT-55143, *T-TY Tank Farm Interim Surface Barrier Demonstration – Vadose Zone Monitoring FY12*) showed the following.

In the soil below the T Farm interim surface barrier (Nests TC and TD), the capacitance probe- and neutron probe-measured soil water content measurements showed small, if any, changes in moisture level. Soil-water models show that the soil water content will decrease gradually over many years. A more sensitive indirect measure of soil-water content is soil-water pressure. Figure 3-7 shows that since the T Farm interim surface barrier was constructed the heat-dissipation unit-measured soil-water pressure has decreased, indicating soil water drainage and gradual drying of the soil.

3.8 GROUNDWATER CONTAMINATION FROM RELEASES AT WASTE MANAGEMENT AREA T

Groundwater monitoring in the vicinity of T Farm is performed collectively with monitoring at nearby 241-TX and 241-TY Tank Farms as a part of *Resource Conservation and Recovery Act of 1976* (RCRA) monitoring of these waste management areas (WMAs) in accordance with the RCRA groundwater monitoring program. DOE/RL-2011-118, *Hanford Site Groundwater Monitoring Report for 2011* describes the Hanford Site groundwater monitoring program and reports current monitoring results. Figure 3-8 shows the location of wells used to monitor groundwater in WMA T. Currently the groundwater monitoring network consists of 2 up-gradient, 2 mid-field, and 11 down-gradient monitoring wells.

Figure 3-6. 241-T Tank Farm Interim Surface Barrier and Monitoring System.

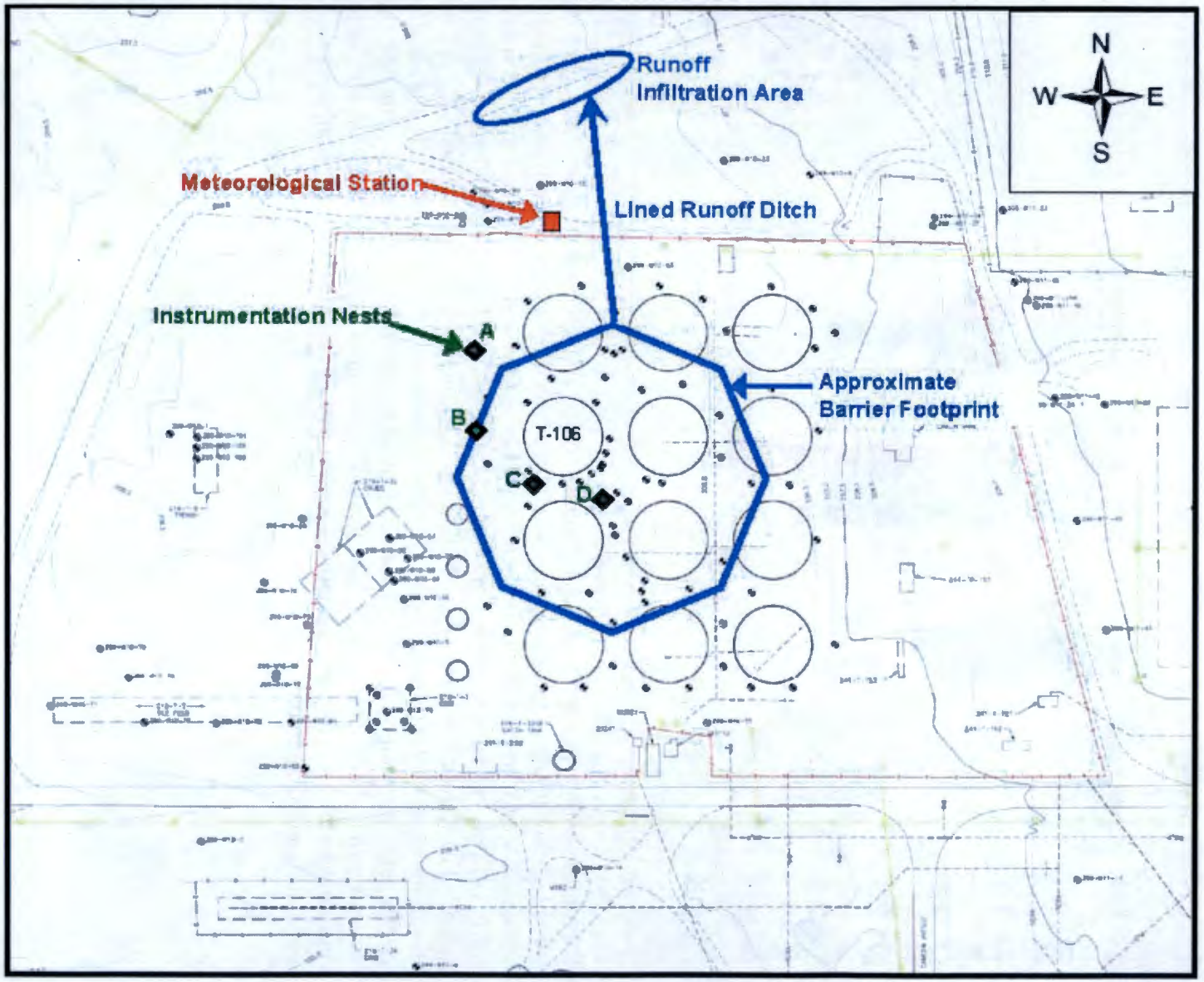
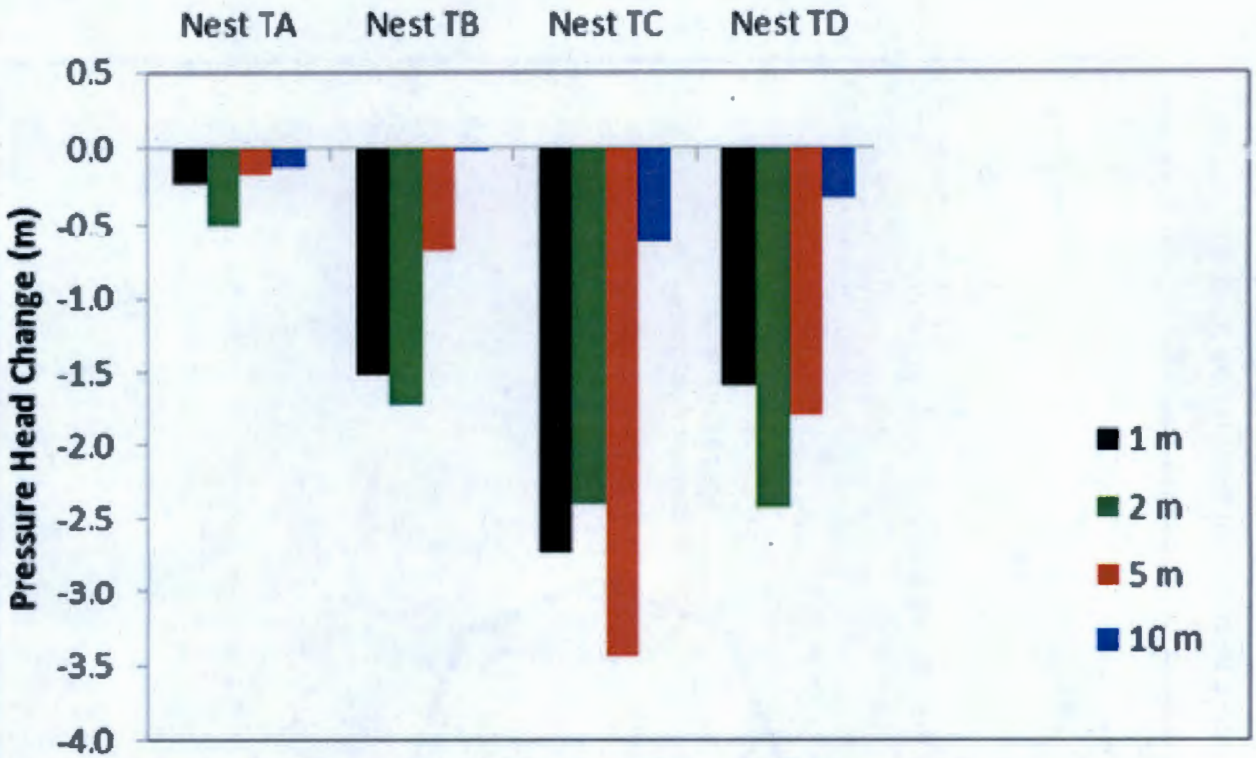
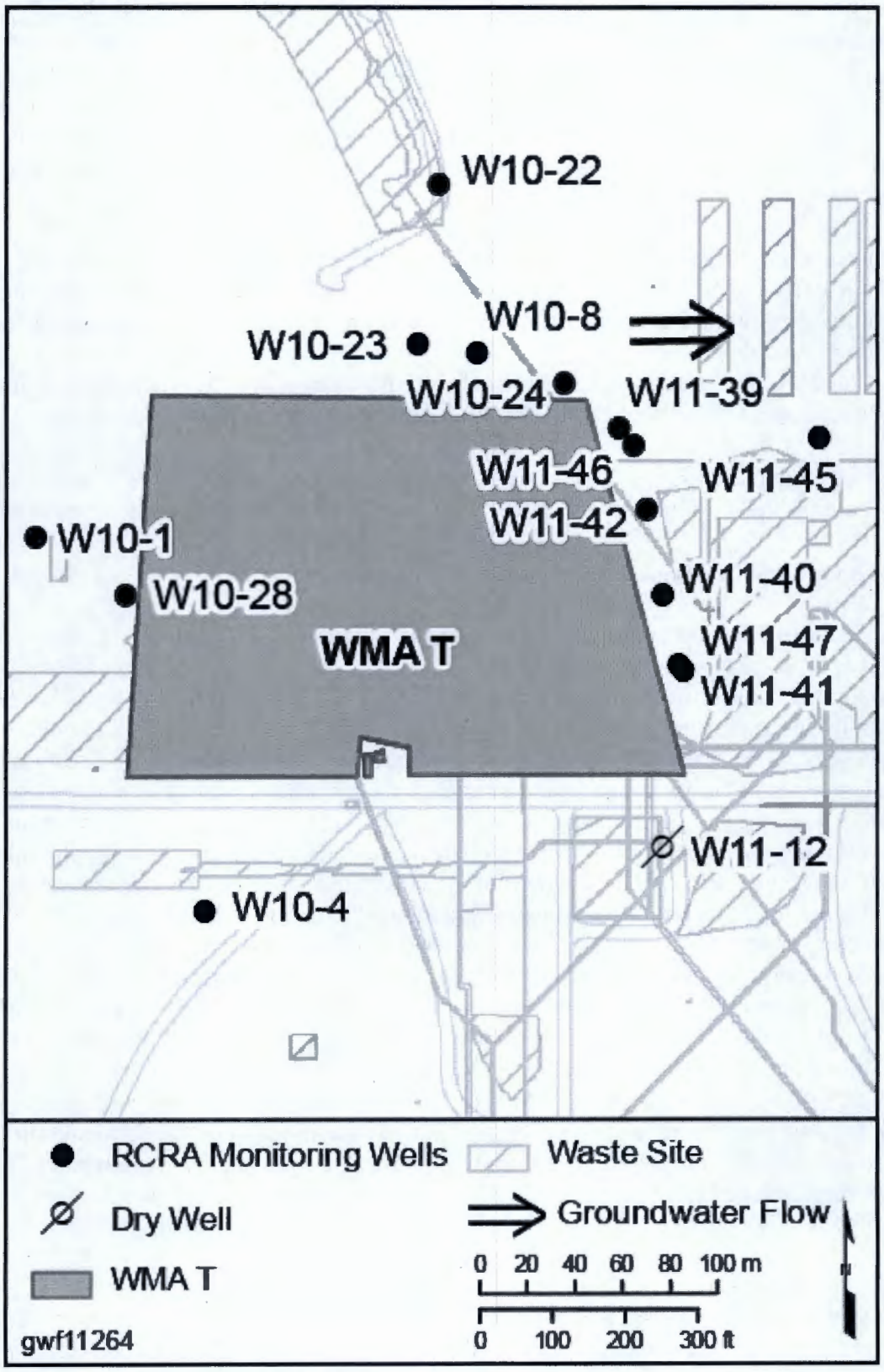


Figure 3-7. Heat-Dissipation Unit-Measured Soil-Water-Pressure-Head Changes Fiscal Year 2008 to Fiscal Year 2012.



The vadose zone beneath WMA T is between ~66 and 70 meters thick. The sediments from ground surface to top of the underlying basalt, in descending sequence, consist of the Hanford formation, the Cold Creek Unit, the member of Taylor Flat of the Ringold Formation (lower portion of unit 4), and the member of Wooded Island of the Ringold Formation (upper portion of unit 5). The water table is between ~132.5 and 133.5 meters in elevation based on water table elevations measured in calendar year (CY) 2011. Based on current water levels and the depth of the Ringold lower mud unit, the unconfined aquifer beneath WMA TX-TY is estimated to be between ~48 and ~56 meters thick. The Ringold lower mud unit serves as a confining or semi-confining layer separating the unconfined aquifer from a confined (or partly confined) aquifer in the underlying Ringold unit 9.

Figure 3-8. Groundwater Wells near 241-T Tank Farm.



RCRA = *Resource Conservation and Recovery Act of 1976* WMA T = Waste Management Area T

Elevated concentrations of selected contaminants that include ^{99}Tc, ^{129}I, chromium and nitrate are found in the upper part of the unconfined aquifer underlying WMA T and are an indication that groundwater has been impacted by past releases of tank waste from WMA T. Contamination within groundwater has likely been caused by past releases to the vadose zone that may include a combination of tank waste releases for SSTs or related ancillary facilities and equipment and waste that has been discharged to cribs and trenches located adjacent to the T Farm. However, elevated concentrations of tank-waste related contaminants in groundwater have not been attributable to any specific releases or sources within the WMA because of a number of factors. These would include:

- Uncertainty in the number, timing, and volumes of possible source releases (e.g., leaks or release from SSTs for tank failures or overfilling; leaks or losses from waste transfer lines, diversion boxes or cascade lines) within the WMA during its operational history,

- Complex history of changes in groundwater flow directions in response to historical management of wastewater in 200 West Area during the period of operations,

- Recent impacts to groundwater from pump and treat operations to the west and south of the area and a limited groundwater monitoring history (since the early to mid-1990s),

- Unique, indicator constituents found only in a specific tank.

3.8.1 Past and Current Directions of Groundwater Flow

General groundwater flow directions under the WMA TX-TY (and WMA T) areas have changed substantially in the past because of Hanford operations (RPP-7123, *Subsurface Conditions Description of the T and TX-TY Waste Management Areas*). The general flow direction within the local unconfined aquifer was from west to east prior to when Hanford Site operations began. The water table changed significantly during early tank farm operations. During that time, when active waste disposal occurred in the late 1940s and the 1950s in nearby T Pond, groundwater flowed to the south and southeast away from mounds that developed in the discharge area. The shift in discharge of large volumes of wastewater from T Pond to U Pond in the early 1950s raised the local water table near WMAs T and TX-TY as much as 19 m (62 ft) above pre-Hanford operation levels (PNNL-12086, *Hanford Site Groundwater Monitoring for Fiscal Year 1998*). In the early 1950s, effluent discharges to U Pond, located about 450 m southwest of WMA U and 1.5 km (~1 mi) southwest of WMA TX-TY, created a broad, flat 26-m (85-ft) mound on the existing water table that quickly shifted groundwater flow to a dominantly northeasterly flow pattern across the WMA T, TX-TY and U areas (RHO-ST-42, *Hydrology of the Separations Area*). This northeasterly flow pattern continued to be the dominant direction of flow during the 1960s through the 1980s and through most of the 1990s. As a result of U Pond being decommissioned in 1984, water level elevations began declining to pre-Hanford levels and currently have dropped about 12 m (~39 ft) below levels observed in the mid-1980s.

Water levels are expected to continue to decline, but at a decreasing rate compared to pre-Hanford conditions. In the WMA T area, a number of new wells have been constructed with longer screened intervals to replace older wells that have gone dry. Along with the water level

decline in the area of WMA T has been a decrease in the hydraulic gradient. The previous mound caused by past discharges to the U Pond, though relatively flat, continues to have some influence on groundwater flow conditions today. Since about 1996, local groundwater levels continue to decline at a rate of ~1.0 meter per year due to cessation of artificial recharge from liquid waste disposal operations in the area (see Figure 3-9).

Groundwater flow directions are becoming more easterly on a regional basis. However, water levels are locally influenced by recent pump and treat operations associated with the containment and removal of carbon tetrachloride and other constituents of concern which have been ongoing, primarily to the south of T Farm, since the mid-1990s. The process of groundwater extraction has altered the local direction and rates of groundwater flow and thus the transport of contaminants in affected portions of the aquifer. Two extraction wells (299-W11-45 and 299-W11-46) (Figure 3-8) located on the east boundary of T Farm have been in use as extraction wells since July 2010 and the pumping at these locations has clearly influenced local groundwater flow and movement of contaminants. Figure 3-10 illustrates the effects of these extraction wells based on measurements made in the March 2011 time frame and the radial pattern of flow that has developed around the local cone of depression caused by the pumping in the regional east-to-northeast flow field.

3.8.2 Summary of Groundwater Contamination

Since the beginning of extensive groundwater monitoring that has been conducted around WMA T in the early 1990s, high concentration levels of ^{99}Tc, chromium, and nitrate have been consistently observed in a number of wells immediately down gradient of WMA T (see Figures 3-11 and 3-12). These include observations in groundwater wells 299-W10-24, 299-W11-39, 299-E11-42, 299-W11-40, and 299-E11-41 located along the northeast corner and east side of T Farm.

3.8.2.1 Technetium-99. Technetium-99 concentration levels have consistently exceeded the drinking water standard (DWS) of 900 pCi/L in several wells since extensive groundwater monitoring has been conducted in 1992. In 2011, ^{99}Tc exceeded the 900-pCi/L DWS at 14 groundwater wells used for monitoring groundwater in the ZP-1 operable unit area (located around the Plutonium Finishing Plant). Sources of ^{99}Tc contamination in 200-ZP-1 were releases from past leaks in SSTs and pipelines in WMAs T and TX-TY, and liquid waste disposal from plutonium processing operations to cribs and trenches adjacent to the WMAs.

Figure 3-13 shows three distinct ^{99}Tc plumes above the 900-pCi/L DWS, centered at (1) the south end of WMA TX-TY, (2) the north end of WMA TX-TY, and (3) beneath WMA T. The highest concentration was 7,600 pCi/L in monitoring well 299-W11-41, located east (down gradient) of WMA T.

Figure 3-9. Time History of Hydraulic Head Changes at Selected Wells to the Northwest, Southwest, Southeast, and East of Waste Management Area TX-TY. (sheet 1 of 2)

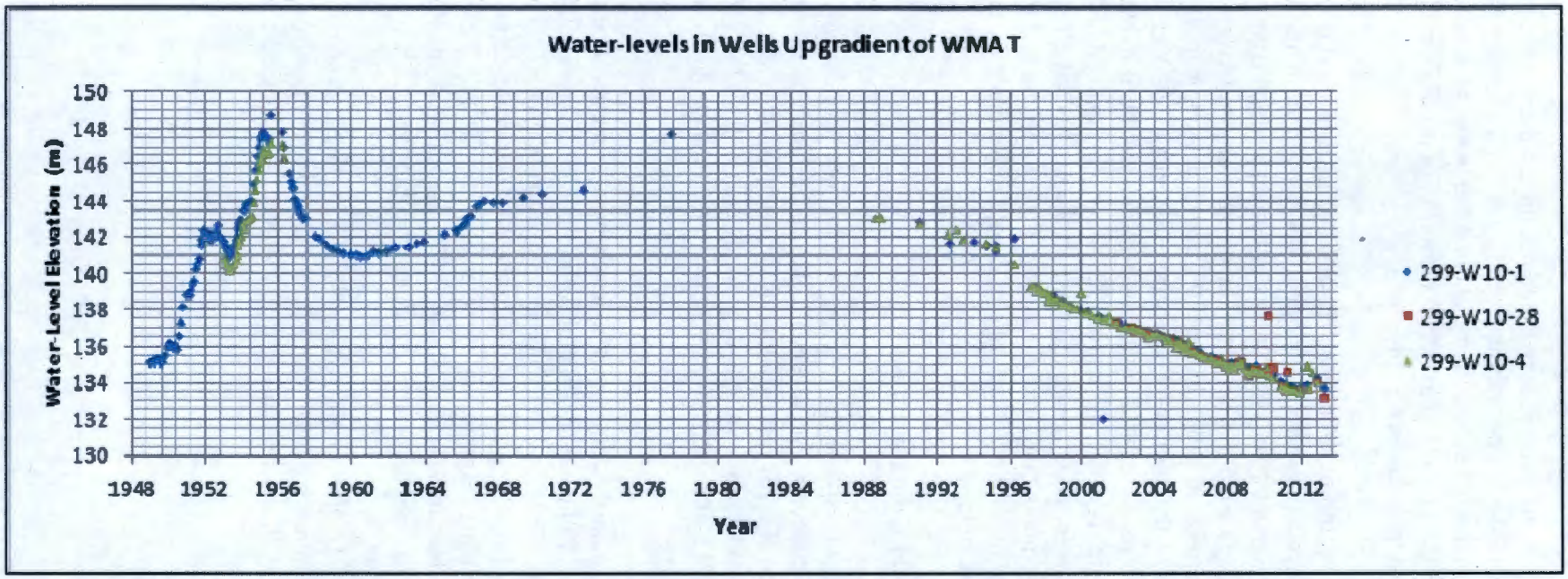
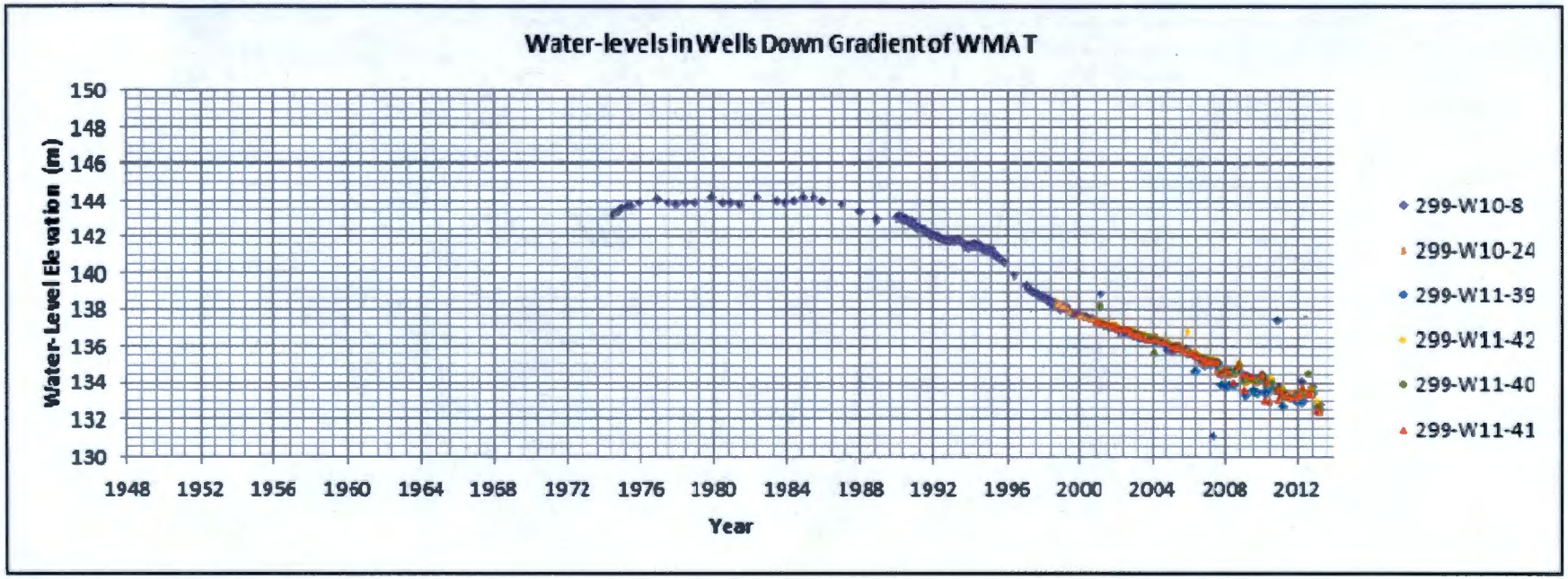
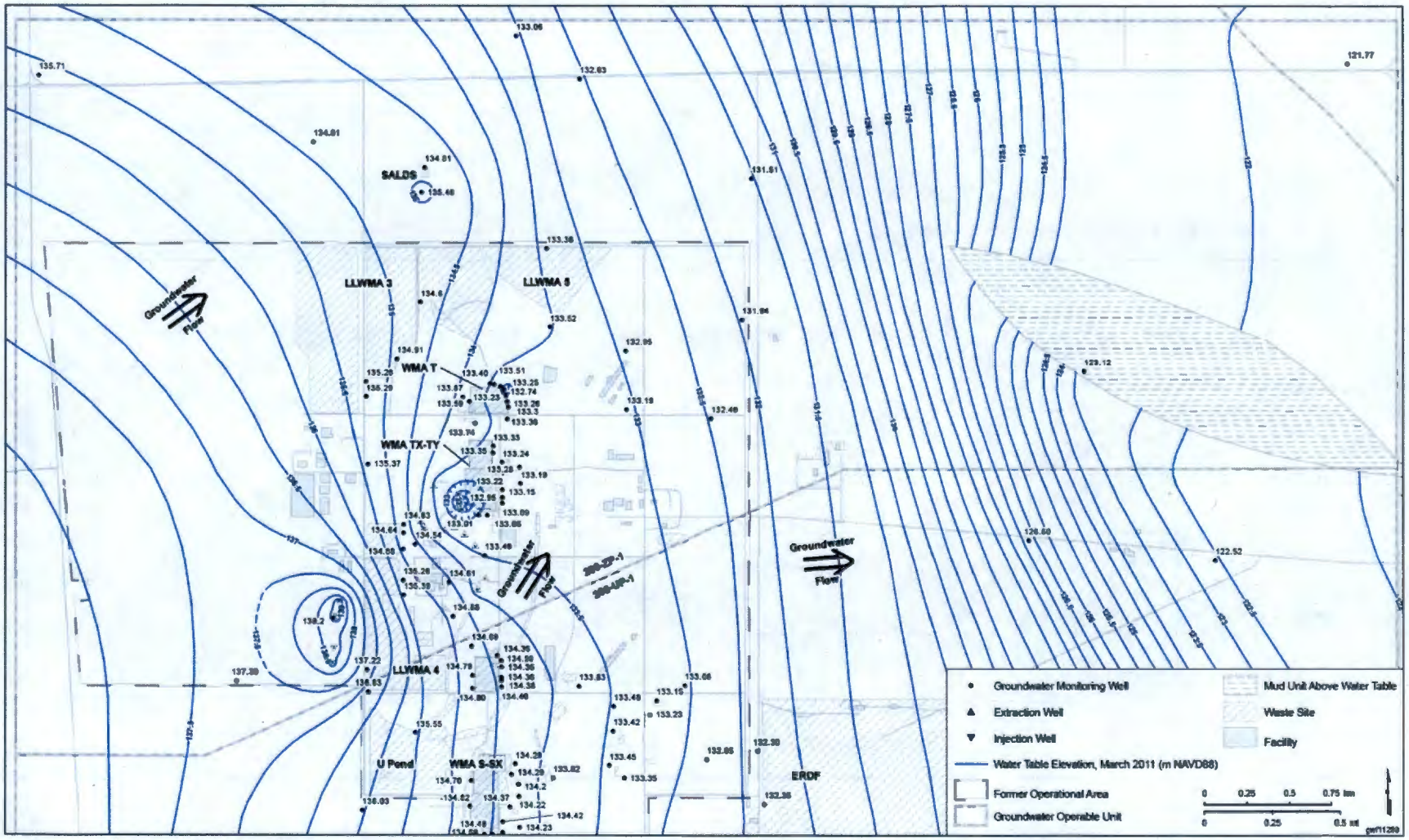


Figure 3-9. Time History of Hydraulic Head Changes at Selected Wells to the Northwest, Southwest, Southeast, and East of Waste Management Area TX-TY. (sheet 2 of 2)



WMA T = Waste Management Area T

Figure 3-10. Water-Table Elevation in Vicinity of Waste Management Areas within the 200-ZPI Operable Unit in the Northern Half of 200 West Area, Hanford Site.



ERDF = Environmental Restoration Disposal Facility
LLWMA = Low-Level Waste Management Area
SALDS = State-Approved Land Disposal Site
WMA = Waste Management Area

Source: DOE/RL-2011-118, *Hanford Site Groundwater Monitoring Report for 2011.*

Figure 3-11. Time History of Technetium-99, Iodine-129, Chromium, and Nitrate Concentrations at Up-gradient Wells 299-W10-4 and Down-gradient Monitoring Wells 299-W10-24, 299-W11-39, 299-W11-42, and 299-W11-40.

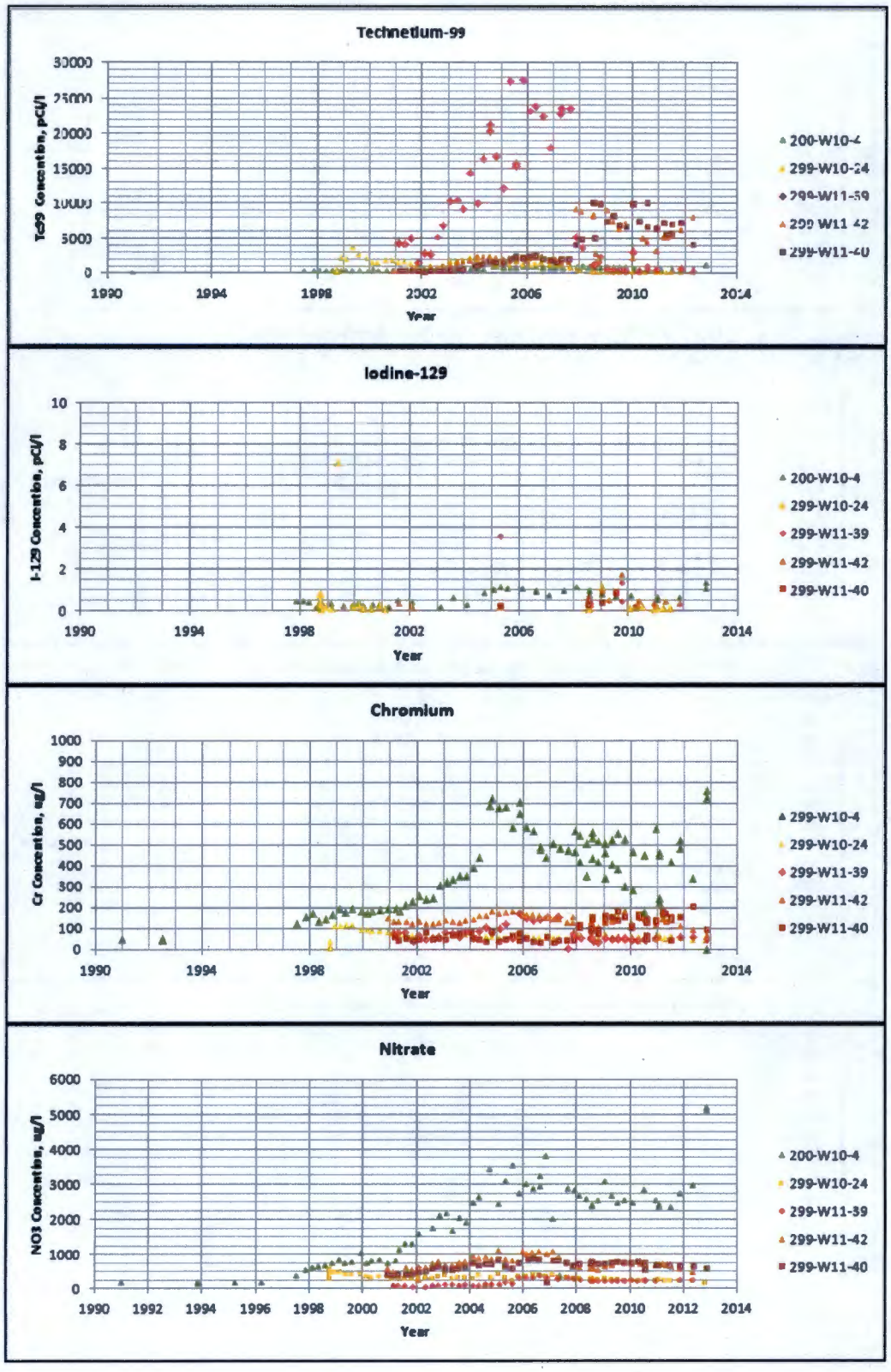
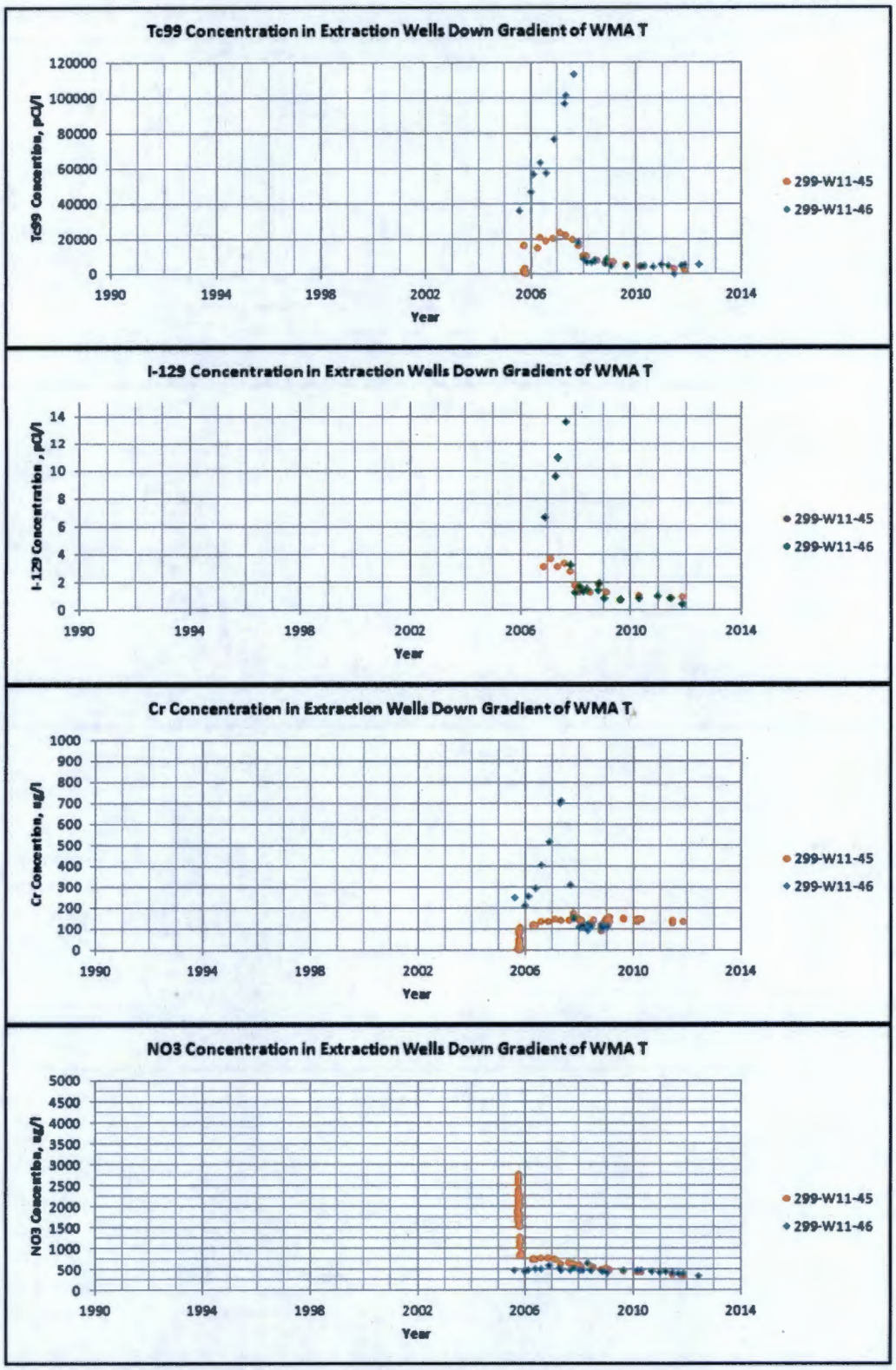
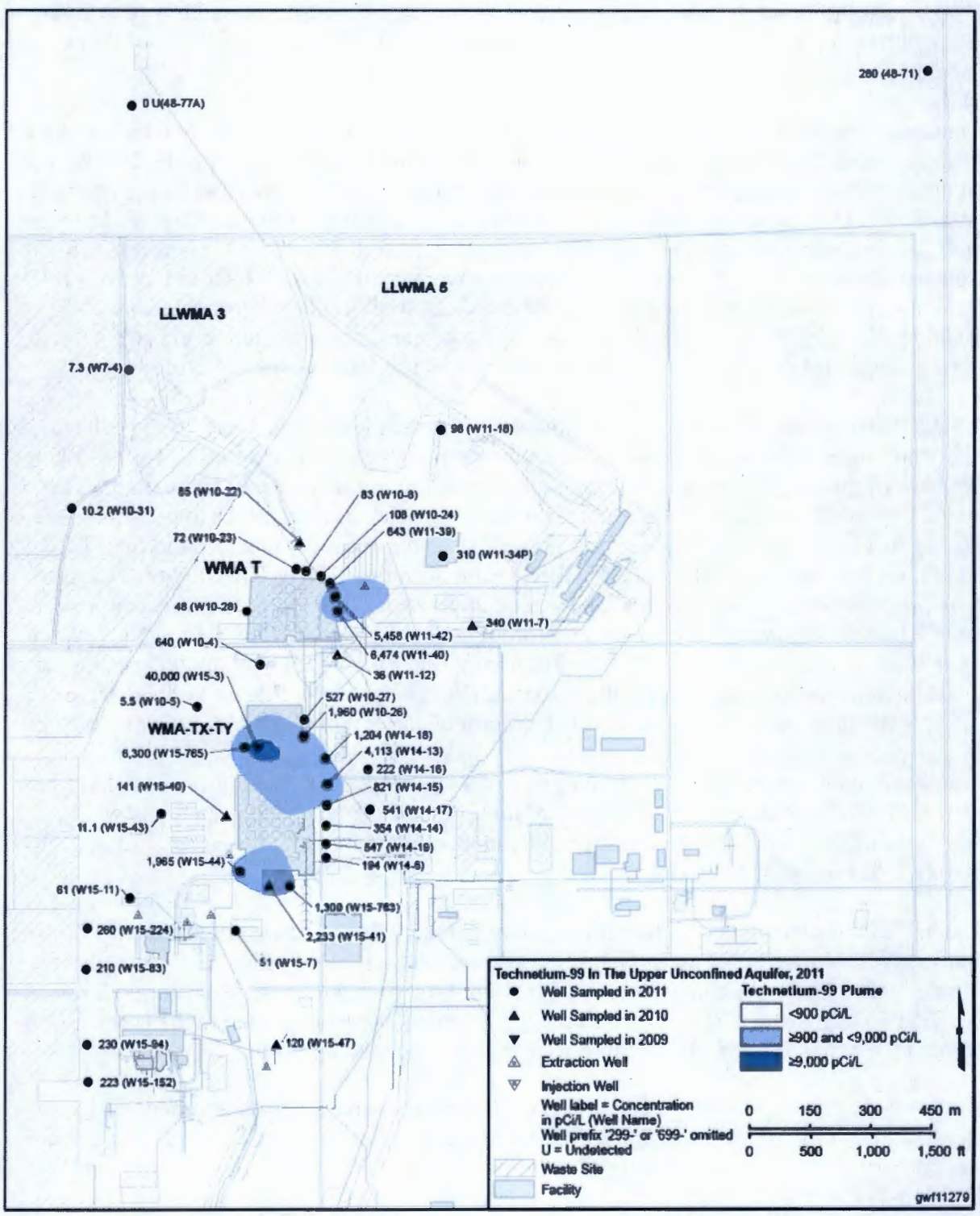


Figure 3-12. Time History of Technetium-99, Iodine-129, Chromium, and Nitrate Concentrations at Extraction Wells 299-W11-45 and 299-W11-46.



WMA T = Waste Management Area T

Figure 3-13. Distribution of Technetium-99 Concentrations in Upper Part of Unconfined Aquifer in Vicinity of Waste Management Areas TX-TY and T within 200 West Area – Calendar Year 2011.



LLWMA = Low-Level Waste Management Area WMA = Waste Management Area

Source: DOE/RL-2011-118, *Hanford Site Groundwater Monitoring Report for 2011*.

Concentration levels of ^{99}Tc in up-gradient well 299-W10-4 (see Figure 3-11) have been just below and just above DWS of 900 pCi/ L since September of 2004 and have risen to 1,100 pCi/L in the most recent sampling. Of the all the down-gradient wells, the highest concentrations have been observed in well 299-W11-39 where ^{99}Tc levels have reached as high as 27,600 pCi/L in 2005. Concentrations in these wells have been decreasing since November 2007 in response to extraction well pumping at wells 299-W11-46 and 299-W11-45 to current levels of between 360 and 640 pCi/L.

Concentrations of ^{99}Tc observed at the extraction wells increased significantly after the initiation of extraction in 2005 to levels reaching 113,000 pCi/L and 23,500 pCi/L in wells 299-W11-46 and 299-W11-45, respectively (see Figure 3-12). Technetium-99 in these wells has declined since 2007 to levels still above the DWS of 900 pCi/L (between 4,400 and 5,100 pC/L in well 299-W11-46 and between 2,100 and 2,500 pCi/L in well 299-W11-45) in recent sampling. Concentrations of ^{99}Tc observed in other down-gradient wells 299-W11-40 and 299-W11-42 have also increased since September of 2004, reaching peak levels between 9,000 and 10,000 pCi/L (see Figure 3-11). For the past several years, concentration levels of ^{99}Tc have been on a general downward trend but currently remain well above the DWS of 900 pCi/L.

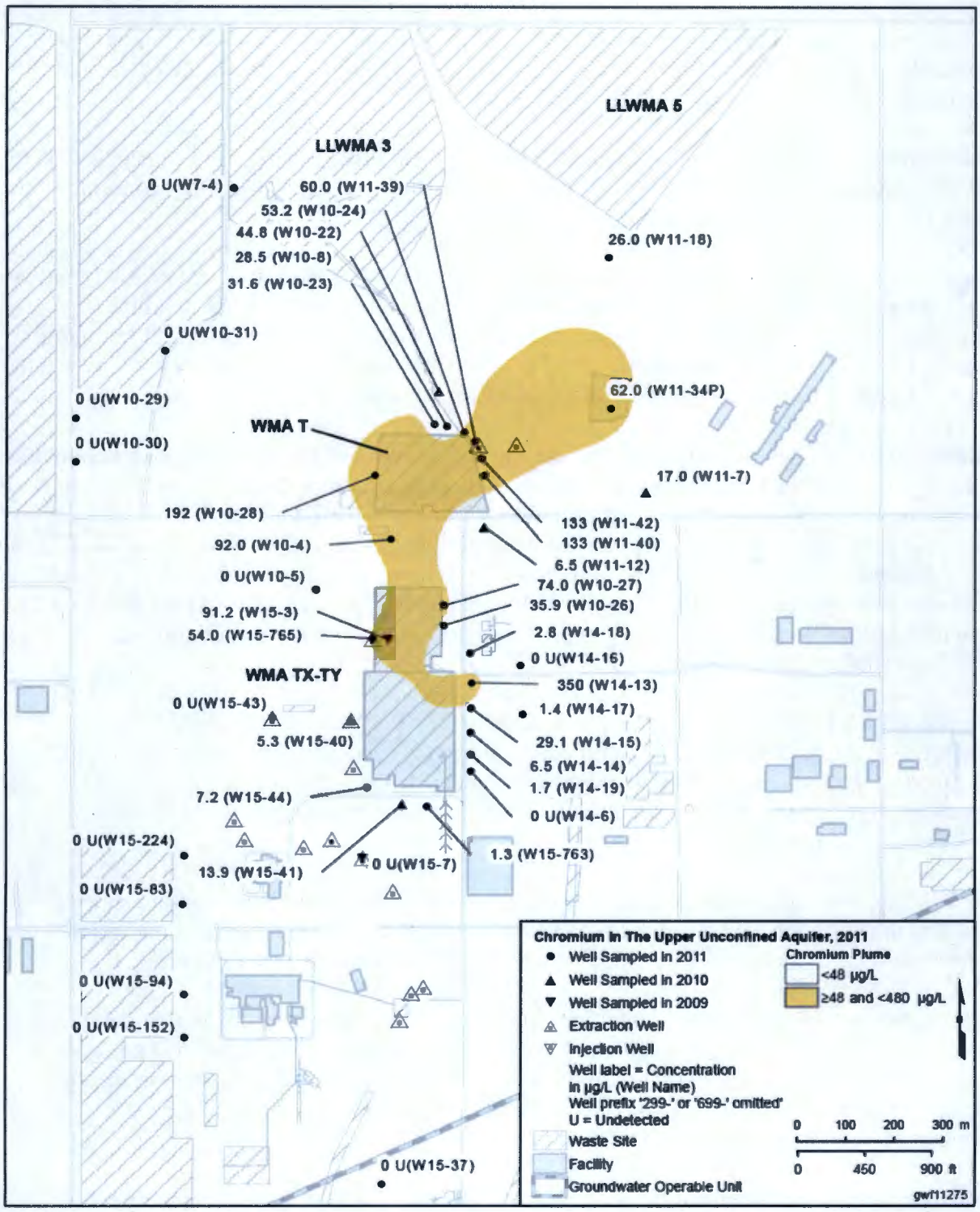
3.8.2.2 Chromium. Chromium contamination is found at levels above the DWS (100 µg/L for total chromium and 48 µg/L for hexavalent chromium) beneath the SSTs at WMA TX-TY and at WMA T (Figure 3-14). Sources of chromium contamination include past leaks from SSTs containing metal and liquid waste from chemical processing of uranium-bearing, irradiated reactor fuel rods; the bismuth phosphate process; uranium-recovery process; and from REDOX and Plutonium Uranium Extraction (PUREX) plant operations (DOE/RL-2009-66, *Interim Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area T*; DOE/RL-2009-67, *Interim Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area TX-TY*). For groundwater plume analysis, total chromium is used to characterize concentrations and plume extent; total chromium in filtered samples represents hexavalent chromium because the hexavalent form of chromium is soluble and mobile in water.

Concentration levels of chromium in up-gradient well 299-W10-4 (see Figure 3-11) have been above the DWS of total and hexavalent chromium since 1998 and have risen to just over 700 µg/L in 2004 and 2005. In 2011, the maximum chromium concentration of 522 µg/L for 200-ZP1 was found at this well.

The highest concentrations of chromium reported at the WMA T extraction wells 299-W11-45 and 299-W11-46 were 172 µg/L (October 2007) and 708 µg/L (May 2007), respectively (see Figure 3-12). The highest concentration of chromium reported in these wells during 2011 declined 137 µg/L and 120 µg/L, respectively. Chromium contamination in the northeastern corner of WMA T is within the capture zone of the two extraction wells.

Of the all the down-gradient wells, the highest current concentrations observed in 2011 were measured in wells 299-W11-40 and 299-W11-41 along the east side of WMA T where levels were observed to be between 144 µg/L and 172 µg/L and between 158 and 167, respectively (see Figure 3-11).

Figure 3-14. Distribution of Chromium Concentrations in Upper Part of Unconfined Aquifer in Vicinity of Waste Management Areas TX-TY and T within 200 West Area – Calendar Year 2011.



LLWMA = Low-Level Waste Management Area WMA = Waste Management Area

Source: DOE/RL-2011-118, *Hanford Site Groundwater Monitoring Report for 2011.*

For the past several years, concentration levels of chromium have been on a general downward trend but currently remain well above the DWS of 48 μg/L.

3.8.2.3 Iodine-129. Iodine-129 concentrations exceed the 1 pCi/L DWS in wells east of WMAs T and TX-TY. Sources of ^{129}I include past leaks from SSTs containing metal and liquid waste from chemical processing and plant operations to liquid waste disposal facilities (for example, cribs and trenches) adjacent to the tank farms. Figure 3-15 shows the extent and geometry of the ^{129}I plume at the DWS of 1 pCi/L.

Concentration levels of ^{129}I in up-gradient well 299-W10-4 (see Figure 3-11) were observed to be detectable and just below the DWS of 1 pCi/L. In the most recent sampling, concentrations have reached and slightly exceeded the DWS.

In 2011, the maximum reported ^{129}I concentration level of 13.5 pCi/L (August of 2007) was at extraction well 299-W11-46, northeast of WMA T (see Figure 3-12). Since that time, concentrations of ^{129}I in this well appear to be on a downward trend and, in recent sampling, reached ~0.4 pCi/L. Concentrations of ^{129}I in other down-gradient wells of WMA T were either non-detected or just below the DWS of 1.0 pCi/L (see Figure 3-11).

3.8.2.4 Nitrate. Nitrate concentrations are above the DWS (45 mg/L, as nitrate) beneath much of 200-ZP-1 (Figure 3-16). Sources of nitrate include liquid waste disposal from Plutonium Finishing Plant processes to the cribs near WMA T and the 216-Z Cribs and Trenches. Two discrete, high concentration plumes are discernible: 1) beneath WMAs T and TX-TY, and 2) a diminishing plume observed at well 299-W18-16 (near the 216-Z Cribs and Trenches). These plumes merge above the 45 mg/L contour extending from the 216-Z Cribs and Trenches to beyond the 200 West Area boundary to the northeast. The size and concentration of contours in 2011 are similar to those reported in 2010.

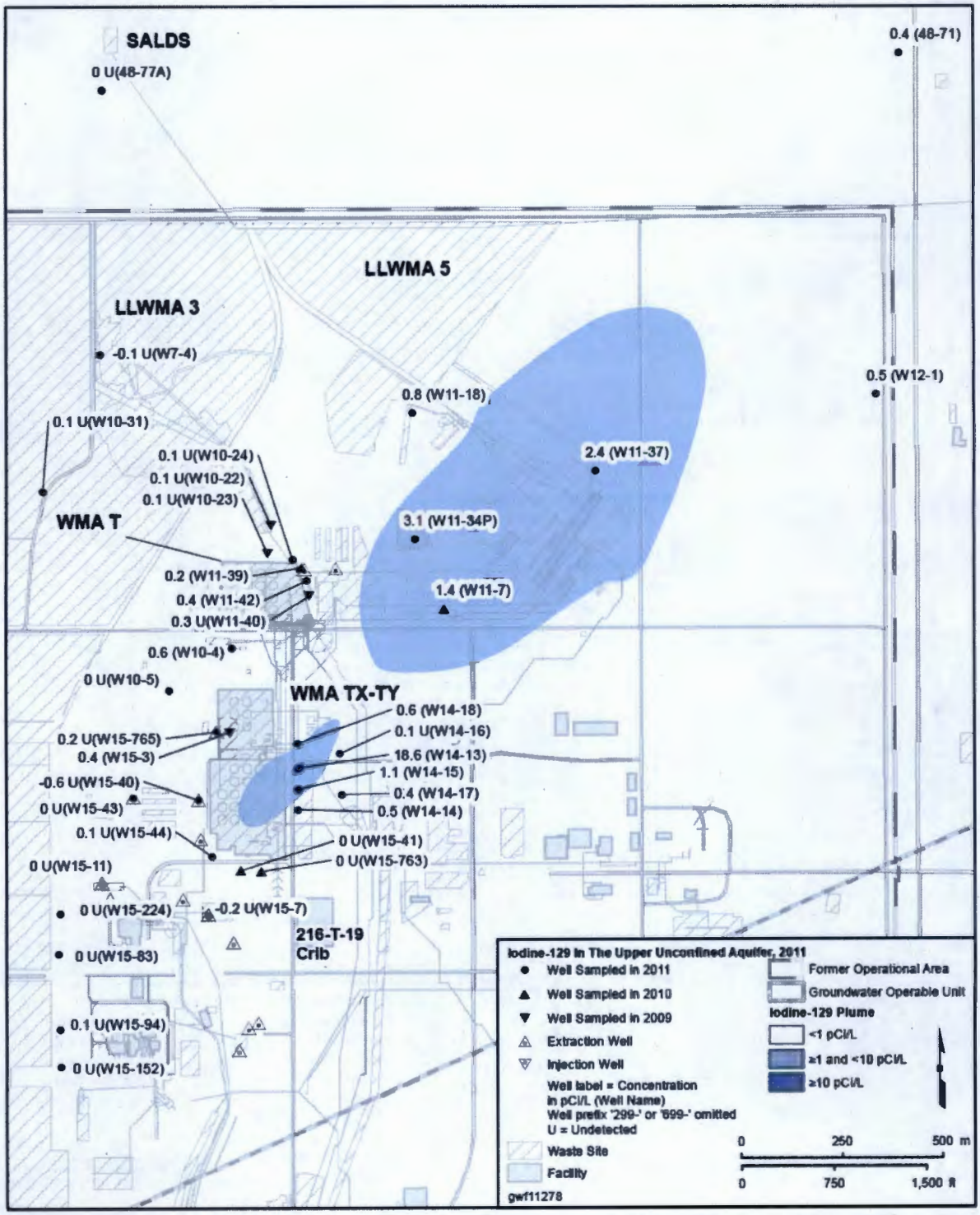
Concentration levels of nitrate in up-gradient wells 299-W10-28 and 299-W10-4 (see Figure 3-11) were observed to be significantly above the secondary DWS of 45 mg/L. In 2011, average concentrations of nitrate in these wells have reached 1,208 and 2,740 mg/L, respectively. In the most recent sampling, concentration in these wells were observed at 2,140 and 5,180 mg/L, respectively.

In 2011, the highest concentration plume at WMA T was found within the capture zone of extraction wells 299-W11-46 and 299-W11-45, northeast of WMA T. In 2011, average nitrate concentrations in these wells were 365 and 371 mg/L, respectively (see Figure 3-12).

The highest average nitrate concentrations in CY 2011 in other nearby down-gradient wells, 299-W11-42 and 299-W11-40, south of the extraction wells were at 572 and 662 mg/L respectively (see Figure 3-11). Average nitrate concentrations in CY 2011 in other nearby down-gradient wells, 299-W10-24 and 299-W11-39, northwest and north of the extraction wells were at 217 and 244 mg/L, respectively.

Most of the nitrate contamination is attributed to Plutonium Finishing Plant operations, as well as past-practice disposal to cribs and trenches in the area.

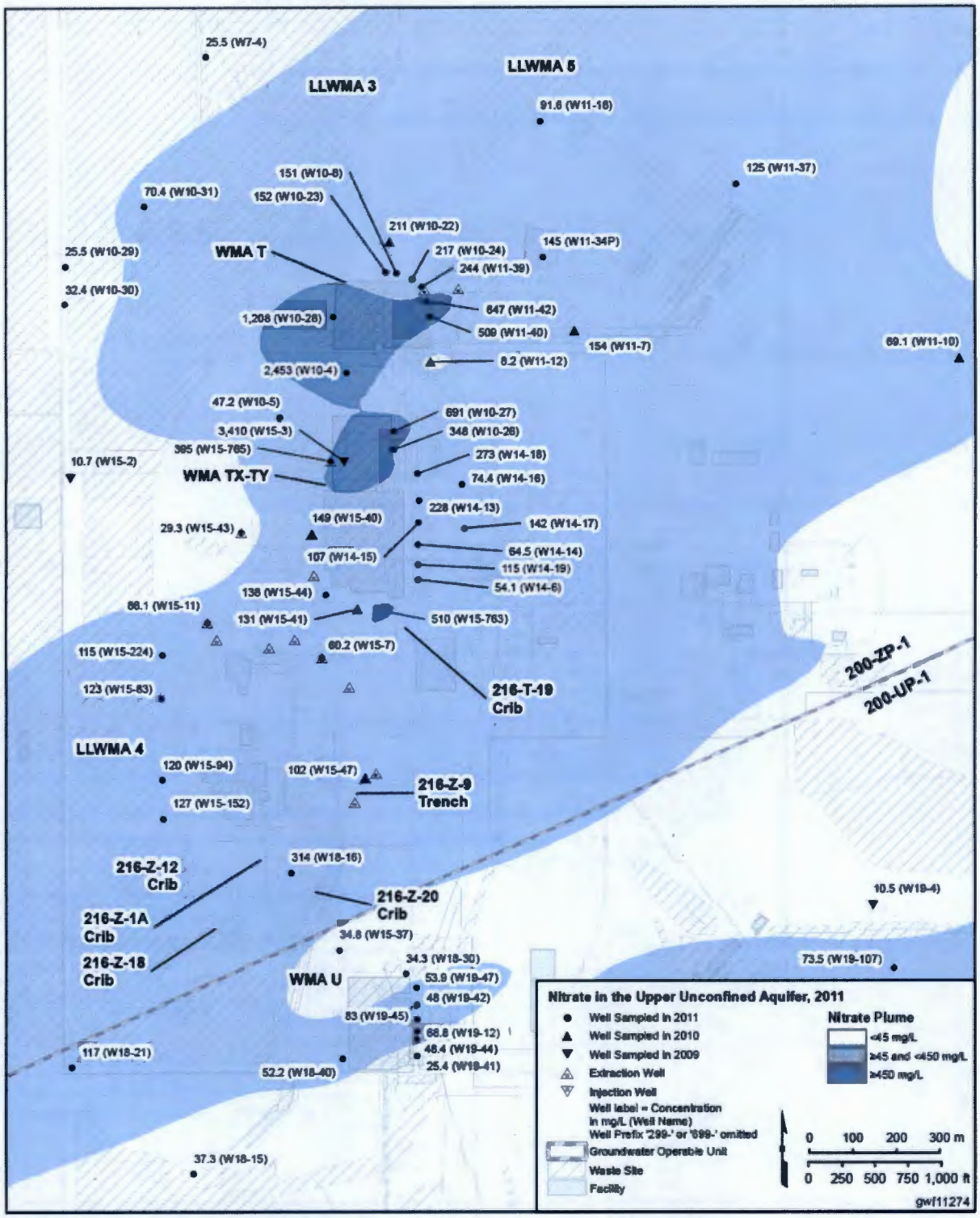
Figure 3-15. Distribution of Iodine-129 Concentrations in Upper Part of Unconfined Aquifer in Vicinity of Waste Management Areas TX-TY and T within 200 West Area – Calendar Year 2011.



LLWMA = Low-Level Waste Management Area
SALDS = State-Approved Land Disposal Site
WMA = Waste Management Area

Source: DOE/RL-2011-118, *Hanford Site Groundwater Monitoring Report for 2011.*

Figure 3-16. Distribution of Nitrate Concentrations in Upper Part of Unconfined Aquifer in Vicinity of Waste Management Area TX-TY and T within 200 West Area – Calendar Year 2011.



LLWMA = Low-Level Waste Management Area WMA = Waste Management Area

Source: DOE/RL-2011-118, *Hanford Site Groundwater Monitoring Report for 2011*.

3.8.2.5 Tritium. Tritium concentrations exceeded the DWS of 20,000 pCi/L within 200-ZP-1 at two locations: (1) adjacent to WMAs T and TX-TY and (2) adjacent to the State-Approved Land Disposal Site. Active permitted discharges at the State-Approved Land Disposal Site are an ongoing source of tritium to groundwater in 200-ZP-1. Other sources of contamination are the liquid wastes from plutonium processing to disposal facilities, including 216-T-25 Trench, and past leaks from tanks and pipelines adjacent to WMA TX-TY.

Figure 3-17 shows the geometry and extent of the tritium plumes, with contaminant levels greater than 20,000 pCi/L in wells southeast and east of WMA T to contaminant levels greater than 400,000 pCi/L east of WMA TX-TY. In 2011, the highest tritium concentration found in 200-ZP-1 operable unit area measured 420,000 pCi/L at well 299-W14-13 located east of WMA TX-TY in July of 2011.

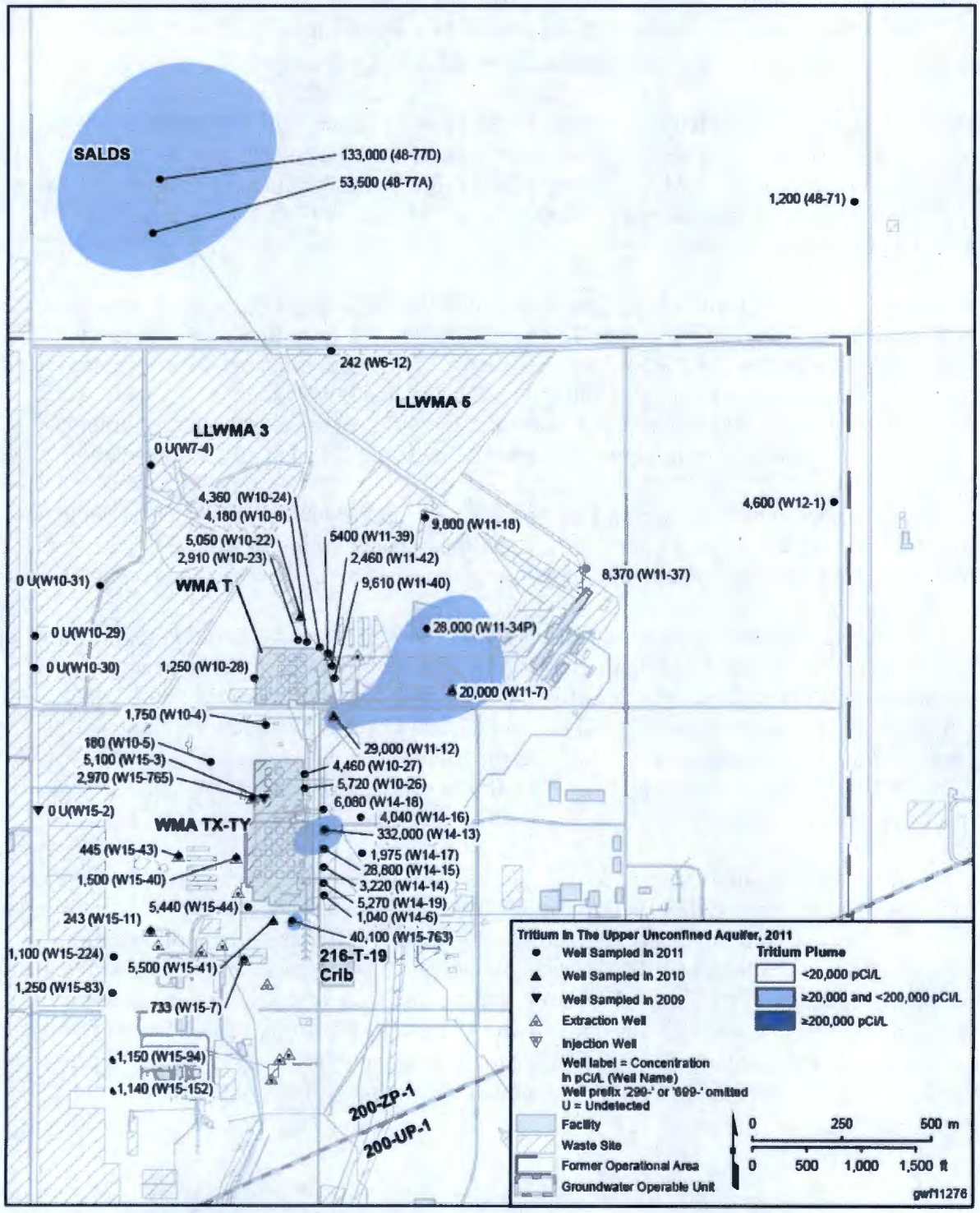
Concentration levels of tritium in up-gradient well 299-W10-4 (see Figure 3-17) were observed to be significantly above the secondary DWS of 20,000 pCi/L from the late 1980s through the 1990s, reaching highs of 111,000 in January of 1987. Since that time, tritium concentrations in this well have had a downward trend and dropped below the DWS in 1999. In 2011, average concentrations of tritium in this well reached ~1,750 pCi/L. In the most recent sampling, concentrations in this well were observed between 2,600 and 2,700 pCi/L, respectively.

In 2011, the highest concentration part of the tritium plume near WMA T is located southeast and east of the tank farm (see Figure 3-17). Declining concentration in wells down gradient of WMA T indicates that the overall area of tritium plume east of T Farm has been reducing.

In 2011, average concentrations in extraction wells 299-W11-46 and 299-W11-45, northeast of WMA T, were ~5,400 and 13,900 pCi/L, respectively (see Figure 3-18). The average concentrations in CY 2011 in other nearby down-gradient wells, 299-W11-42 and 299-W11-40, south of the extraction wells were at ~2,430 and ~9,600 pCi/L respectively (see Figure 3-18). Average tritium concentrations in CY 2011 in other nearby down-gradient wells, 299-W10-24 and 299-W11-39, northwest and north of the extraction wells were at ~4,350 and 5,400 pCi/L, respectively (see Figure 3-16).

The groundwater data summarized above suggests that two primary contamination plumes are affecting the unconfined aquifer underlying WMA T. The first plume includes ^{99}Tc, chromium and nitrate as major contaminants. High concentrations of ^{99}Tc in the plume of contaminated groundwater down gradient of WMA T strongly indicate a potential source from past releases of tank waste originating for T Farm. However, the specific tank waste release or releases responsible for this contamination is not known. Because the historical groundwater flow paths have been northerly since the mid-1950s, the plume appears to have originated in T Farm where several releases from the tank farm infrastructure (transfer pipelines) are known to have occurred.

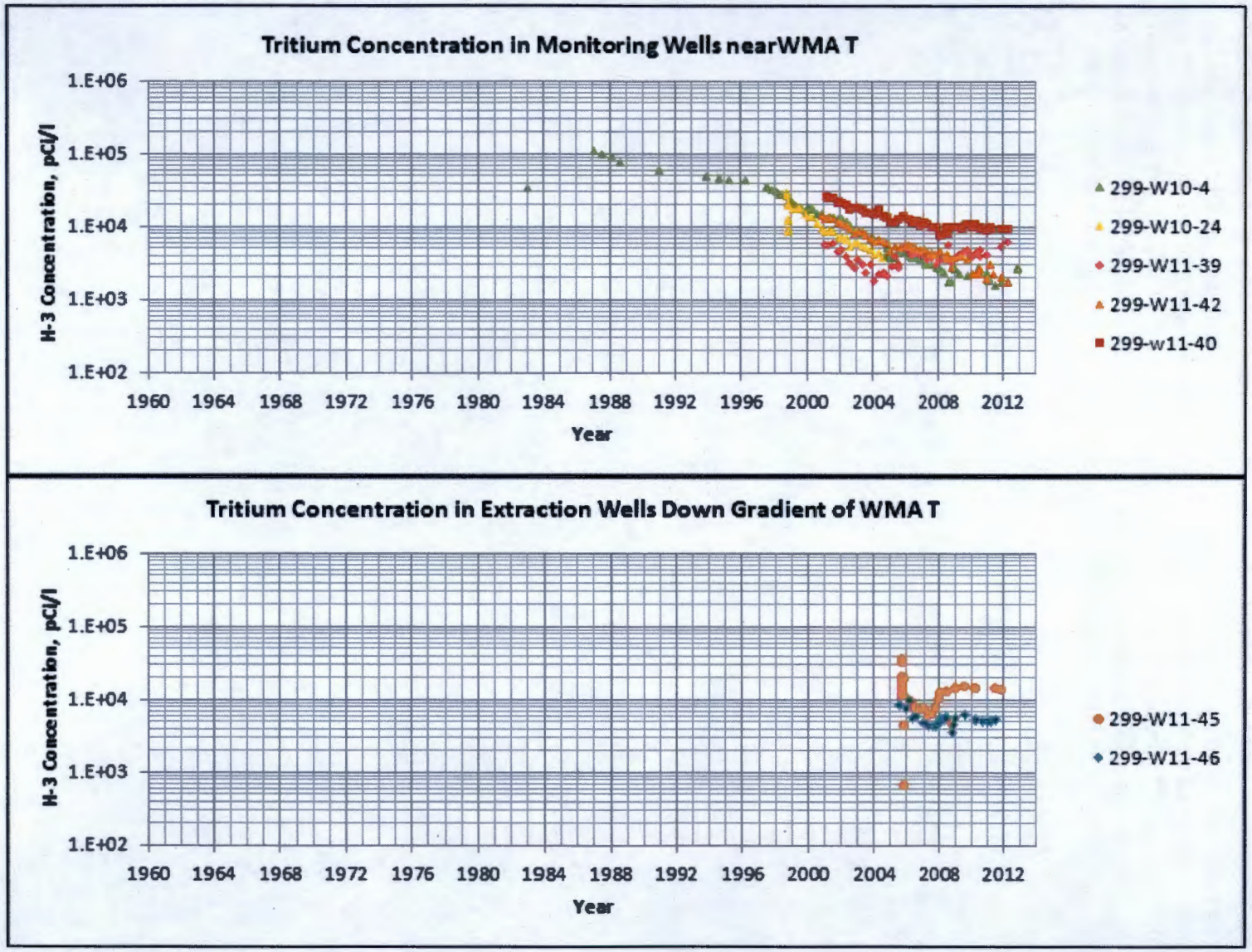
Figure 3-17. Distribution of Tritium Concentrations in Upper Part of Unconfined Aquifer in Vicinity of Waste Management Area TX-TY and T within 200 West Area – Calendar Year 2011.



LLWMA = Low-Level Waste Management Area
SALDS = State-Approved Land Disposal Site
WMA = Waste Management Area

Source: DOE/RL-2011-118, *Hanford Site Groundwater Monitoring Report for 2011.*

Figure 3-18. Time History of Iodine-129 and Tritium Concentrations at Wells 299-W14-2 and 299-W14-13.



WMA T = Waste Management Area T

A second plume includes tritium, a contaminant that is not commonly associated with tank waste releases, but is present in several crib discharges. In this case, trench 216-T-28 is a plausible source. The centers of mass of both ^{129}I and tritium are both near trench 216 T-28 (e.g., well 299-W14-2 was drilled through crib T-28) and discharge volumes through trench T-28 in the mid-1960s were sufficient to break through to the unconfined aquifer within the time frame of observed increases of tritium. For example, peak discharges of more than 15 million L (4 million gals) occurred in 1965 and a tritium spike in well 299-W14-2 was also measured that year. The discharged waste stream that may have contained ^{129}I is ambiguous but could have been a contaminant in laboratory waste whose contents were not quantified in historical documents.

4.0 TANK LEAK INVENTORY ASSESSMENT RESULTS

The following sections describe the T Farm leak assessments and results summarized in Table 4-1. Additional data and information reviewed for tanks classified as "assumed leakers" are presented in Appendix B. Appendix C shows data and information reviewed for tanks classified as "sound." Appendix D of RPP-ENV-33418, *Hanford C Farm Leak Assessments Report* describes the rationale and logic used for the assessment.

For each release event, the sections include a description of release, release type (point or non-point source), estimated depth of release, estimated time of release, and estimated magnitude of release (volume and inventory). Uncertainties associated with release parameters are also summarized.

Given the limited information available, a conservative approach was used to estimate leak volumes and inventories. Sample data was used when available near the time of release to estimate leak compositions. However, a limited number of constituents were analyzed and composition estimates were largely based on waste types characteristic of the data obtained, total and spectral gamma geophysical logging measurements, and SIM historical process waste estimates.

The HDW and SIM model estimates are described in RPP-19822, *Hanford Defined Waste Model – Revision 5.0* and RPP-26744. These models used Hanford Plant initial radionuclide inventory estimates from the Oak Ridge Isotope Generation and Depletion Code (RPP-13489, *Activity of Fuel Batches Processed Through Hanford Separations Plants, 1944 Through 1989*), tank waste transfer records, and release timing information to estimate waste composition in the SSTs and releases to the vadose zone.

It was noted that direct push logging and sampling is planned and further investigations will be made about the tanks after the data becomes available.

4.1 TANK 241-T-101

Tank T-101 is the first tank in the cascade series with tanks T-102 and T-103. In December 1944, metal waste from T Plant was sent to tank T-101, and by September 1945, the tank was full (528,000 gal) and cascading waste into tank T-102. Waste process history for this tank is presented in Appendix B.1.

4.1.1 Leak Status of Tank 241-T-101

Tank T-101 was removed from service in 1979 and was declared an "assumed leaker" on October 4, 1992 with a leak volume of 7,500 gal based on a liquid level decrease of 2.6 in. (Occurrence Report RL-WHC-TANKFARM-1992-0073, *Apparent Decrease in Liquid Level in Single Shell Underground Storage Tank 241-T-101; Leak Suspected; Investigation Continuing*).

Table 4-1. Estimated Waste Release Inventories in 241-T Tank Farm.[1]

Tank/UPR	Waste Release Volume, gal	^{60}Co, Ci	^{137}Cs, Ci	^{99}Tc, Ci	Basis
241-T-101	264,000	24	1,300	0.4	^{137}Cs distribution in drywells and CWR2 waste type concentration estimate.
241-T-102 (T-102)	50 to 500	<0.04	20 to 200	<4E-4	^{137}Cs in drywell 52-02-05, 1974 sample from tank T-102 and CWP2 waste type concentration estimates.
241-T-103	1,300	0.1	600	0.7	ARH-2874, *241-T-106 Tank Leak Investigation* volume estimate, 1974 sample from tank T-102, and CSR waste type concentration estimates.
241-T-106 (T-106)	115,000	10	20,000	63	Ru-106 data, samples (RHO-ST-14, *High-Level Waste Leakage from the 241-T-106 Tank at Hanford*) and CSR waste type concentration estimates and drywells.
241-T-107 (T-107)					Drywell activity near tank T-107 included in tank T-106 leak estimates.
241-T-108 (T-108)					Drywell activity near tank T-108 included in tank T-106 leak estimates.
241-T-109 (T-109)					Drywell activity near tank T-109 included in tank T-106 leak estimates.
241-T-111 (T-111)	2,100	7E-7	0.9	0.08	Leak volume estimated in RPP-RPT-54964, *Evaluation of Tank 241-T-111 Level Data and In-Tank Video Inspection* constituents from the tank T-111 Best-Basis Inventory. Drywells not logged since 1998 (except for two in 2008 for interim surface barrier baseline).
Near-Surface UPRs in 241-T Tank Farm	Thousands to millions	Not detected	<28 Ci	Not detected	Drywell ^{137}Cs detected in spectral gamma logging system measurements from 0 to 10 ft bgs. Volume and inventories vary depending on waste type released.
Other UPRs	Estimate not available. <2,000 gal for UPRs 200-W-29 and 200-W-97	0.006	1.9	0.001	RPP-26744, *Hanford Soil Inventory Model, Rev. 1* includes estimates for UPR-200-W-29 and 200-W-97 only. See Table 5-2. These and other significant releases identified in this table should be included as source terms in 241-T Tank Farm performance assessments.
Intentional Releases to Cribs and Trenches near 241-T Tank Farm	~40 million gal to cribs and trenches Over 10 billion gal cooling water to 207-T and 216-T-4 ponds and ditches	< 2	2,200	<1	Inventories provided are mean values from RPP-26744 for cribs and trenches in 241-T Tank Farm (see Section 6.0). No inventory for 207-T and 216-T-4 ponds and ditches. Significant releases identified in this Section should be included as source terms for 241-T Tank Farm performance assessments.

[1]Cesium-137, ^{60}Co, and ^{99}Tc values are approximations decayed to January 1, 2001.

CSR = supernate from which the cesium has been removed by ion exchange (1967-1976)
CWP2 = Plutonium Uranium Extraction (Plant) cladding waste, aluminum clad fuel (1961-1972)
CWR2 = Reduction-Oxidation (S Plant) cladding waste, aluminum clad fuel (1961-1966)
UPR = unplanned release

4.1.2 Leak Assessment Considerations

Tank T-101 was filled with coating waste (535,000 gal) in 1963 that was stored until early 1969. Process data (see Appendix B.1) shows that tank T-101 was filled above the cascade/spare inlet level in tank T-101 between 1964 and 1969. An UPR occurred in early 1969 when the tank was overfilled (539,000 gal) and tank waste overflowed to the soil column through the spare fill line. Following the overflow most of the REDOX coating waste was transferred. The tank did not receive additional waste until 1972 when the tank received waste from the 241-SX and 241-BX Tank Farms.

An engineering evaluation determined that the 2.6-in. liquid level decrease in 1992 was likely due to instrument error. The evaluation notes "false readings can occur because of instrument failures, floating salt cake and salt encrustation. Gages frequently self-correct and show no leak." The engineering evaluation goes on to state "the gage in Tank 241-T-101 has largely corrected itself since the mid-year 1992 reading. As a result, doubt exists that a leak has occurred or that the magnitude of the leak poses any environmental threat" (WHC-EP-0873, *Engineering Evaluation of Alternatives: Managing the Assumed Leak from Single-Shell Tank 241-T-101*).

Spectral gamma logging of the drywells surrounding tank T-101 shows a large contamination plume near drywell 50-01-04 that corresponds to the location of and starts at the depth of the spare inlet lines, ~20 ft bgs (see Appendix B). Historical data shows the plume was present before 1975 (RPP-6088, *Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-T Tank Farm – 200 West*). SD-WM-TI-356 states that "the contamination in wells 50-01-04, 50-10-06 and 50-00-03 originated from a leak through a spare fill line (i.e. spare inlet) and was a result of the tank being overfilled in an attempt to utilize the cascade line to 102-T."

As discussed in Section 5.1, some of the spare inlets were poorly sealed and waste may have been lost to the ground in T Farm if SSTs were filled above the height of the spare inlet nozzles, recognizing that the quantity of waste released was dependent on the height (head) and quality of the pipe seal.

4.1.3 Conclusions and Recommendations

The leak assessment team concluded that a spare inlet overflow appears to be the likely source of ^{137}Cs in drywell 50-01-04 and other nearby drywells. Given that the in-tank liquid-level observations made in 1992 (the primary basis for classifying tank T-101 as an "assumed leaker") were determined to be incorrect, the assessment team concluded that there was little or no evidence to indicate that there was a leak in the liner for tank T-101. Re-evaluation of the current tank integrity classification was recommended per the TFC-ENG-CHEM-D-42, "Tank Leak Assessment Process" process.

4.1.3.1 Release Type. A release from the spare inlet nozzles was reported to have occurred in 1969 as a result of overfilling the tank. In 1969 the tank contained CWR2 (REDOX cladding waste) precipitated from supernate transfers from 1963 to 1969. No samples representative of

the 1969 waste were available. As a result, HDW model composition estimates for CWR2 are recommended (RPP-19822).

4.1.3.2 Depth of Release. Drywell 50-01-04 shows subsurface ^{137}Cs activity beginning at ~20 ft bgs. Drywell 50-01-04 is near the spare inlet nozzles and the nozzles are located at ~20 ft bgs.

4.1.3.3 Magnitude of Release. The primary basis for the inventory estimate is the SGLS data for ^{137}Cs in drywell 50-01-04 documented in GJO-99-101-TARA/GJO-HAN-27, *Hanford Tank Farms Vadose Zone: Addendum to the T Tank Farm Report.* The report shows that ^{137}Cs was detected between 20 ft and 122 ft. However, the concentration of the ^{137}Cs is lower by an order of magnitude or more below ~60 ft bgs and is largely insignificant in the calculated estimate. A plume size was estimated by assuming a plume shape between 20 and 60 ft bgs with a radius of 6 ft (the distance from the drywell to the tank [Figure 4-1]), and assuming the entire concentration of cesium within the plume is $2(10)^7$ pCi/g (cesium saturation level in soils). See Appendix D of RPP-ENV-33418, for a discussion of ^{137}Cs saturation levels and migration of ^{137}Cs. Based on the 1997 drywell measurements at about ^{137}Cs capacity, the ^{137}Cs plume extends from the tank to the drywell between 25 and 30 ft bgs and attenuated radiation was detected from 20 to 25 ft bgs and from 30 to 60 ft bgs. Given these assumptions, it was estimated that 1,300 Ci of ^{137}Cs may have been released.

The HDW model estimates a ^{137}Cs concentration for REDOX coating waste (CWR2) supernate of ~$1.3\ (10)^{-3}$ Ci/L decayed to January 1, 2000. Dividing 1,300 Ci by this concentration equates to about 264,000 gal of CWR2. The waste stream released may have been more diluted and could be larger. Revision 6 of DOE/RL-88-30, *Hanford Site Waste Management Units Report* estimates a potential release of 400,000 gal of waste. Inventory estimates for other constituents released should use the HDW Rev. 5 (RPP-19822) CWR2 constituent concentrations multiplied by 264,000 gal.

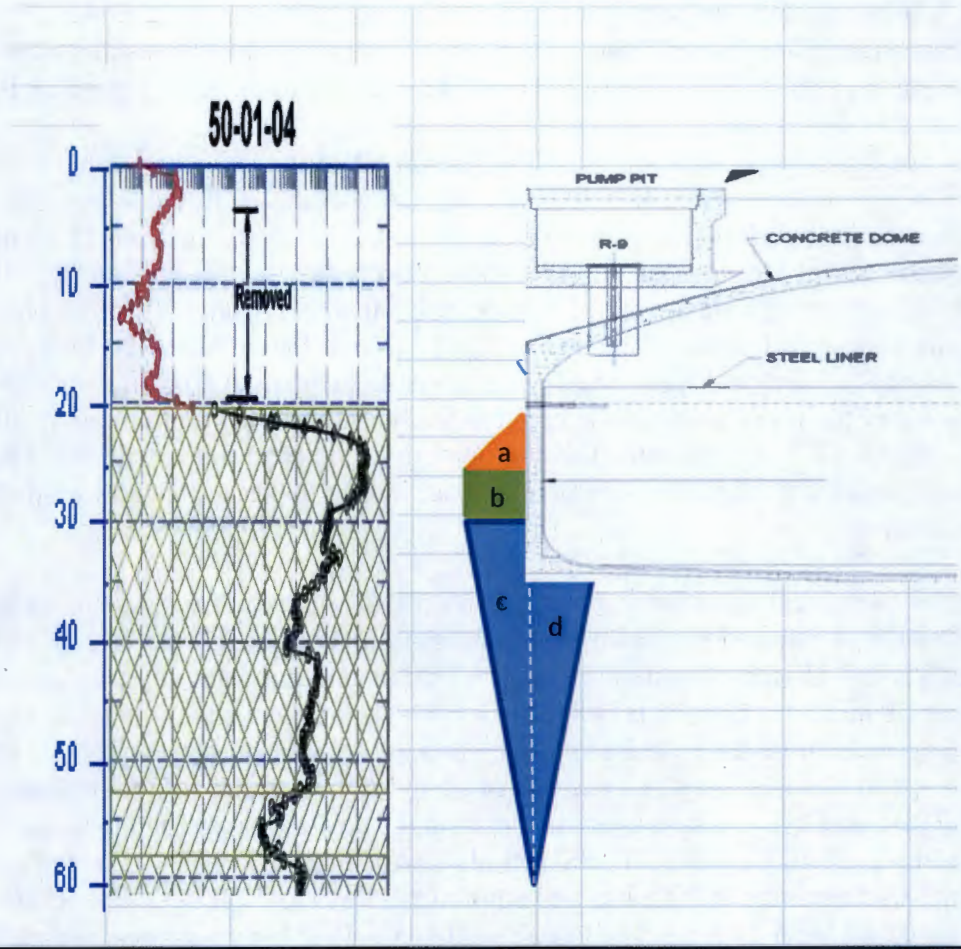
4.2 TANK 241-T-103

Tank T-103 is the third tank in a three-tank cascade that includes tanks T-101 and T-102. The tank began receiving metal waste from the cascade overflow line connected to tank T-102 in November 1945 and was full in February 1946. Waste process history for this tank is presented in Appendix B.2.

4.2.1 Leak Status of Tank 241-T-103

Single-shell tank T-103 was classified in March 1974 as having "questionable integrity" based on a 0.3-in. liquid level decrease, which took place from November 1973 to February 1974 (Internal letter LET-051480, "Review of Classification of Four Hanford Single-Shell "Questionable Integrity (QI)" Tanks"). Initial classification of "questionable integrity" is documented as an inlet line overflow (SD-WM-TI-356). No occurrence report was generated.

Figure 4-1. Estimated Size of 1973 Release from Tank 241-T-101.



Plume Calculation							
Soil Density	5.11E+04	g/ft^3					
Waste Cs Conc.	1.30E-03	Ci/L					
Waste Cs Conc	4.92E+09	pCi/gal					
Cs Sat Conc	2.00E+07	pCi/g		1.02E+12	pCi/ft^3		
Radius	6	ft					
Radius @ tank base	5	ft		Radius = sin angle times height			
Length Zone "a"	5	ft					
Length Zone "b"	5	ft					
Length Zone "c"	25	ft					
Length Zone "d"	30	ft					
Tank Depth	35	ft		Depth of			Depth ft
Zone "a"	9.43E+01	ft^3		20-25	ft		5
Zone "b"	2.83E+02	ft^3		25-30	ft		5
Zone "c"	5.66E+02	ft^3		30-60	ft	Base of tank	30
Zone "d"	3.27E+02	ft^3		35-60	ft	Under the tank	25
Total Cs Volume	1.27E+03	ft^3					
Cs Waste Activity	1.30E+15	pCi	=	1.30E+03	Ci		
Total Est. Release Vol.	2.64E+05	gal					

4.2.2 Leak Assessment Considerations

A previous leak assessment and report for Tank T-103 was reviewed (RPP-20820, *Waste Retrieval Leak Evaluation Report: Single-Shell Tanks*). The following considerations and discussion from the report were reviewed. Data discussed is presented in Appendix B.2.

Liquid level graphs show the cascade overflow level at 191.5 inches. From June of 1973 through March of 1974, the tank consistently held more than the operational liquid level of 184.4 in. and exceeded the cascade overflow level of 191.5 in. with a peak measurement of 197.5 in. in June of 1973. The waste surface level measurements show a declining trend from June 13, 1973 through August 5, 1973 indicating a waste loss of ~ 3,030 gal. However, March 29, 1974 photographs show irregularly shaped floating solids on the liquid surface (Letter 72730-80-097, "Review of Classification of Six Hanford Single-Shell "Questionable Integrity (QI)" Tanks"). Given the erratic behavior of the liquid level that is noted in the liquid level log from February 1974 through November 1974, it is possible that the floating solids are a foam material. Floating solids could cause erratic liquid level readings, which would make it difficult to estimate a true liquid level decrease.

Drywell 50-03-04 is located on the east side of SST T-103, near the spare inlet lines to the tank. Gamma activity was detected beginning at ~20 ft bgs, which is consistent with the elevation of the spare inlet lines. Historical gamma logs show that total gamma activity was present before 1975 between 20 and 50 ft bgs (RPP-6088). SD-WM-TI-356 shows that the total gamma readings for drywell 50-03-04 increased from 53 to 9,300 c/s between measurements on April 17, 1974 and October 2, 1974. The rate of decay of the gamma activity indicates the presence of ^{106}Ru and ^{137}Cs, which is consistent with the cesium ion exchange waste (CSR) that was present in SST T-103 in 1973. The SGLS plots (Appendix B) show ^{154}Eu is present in drywell 50-03-04 beginning at 20 ft bgs and continuing down to 71 ft bgs. Cobalt-60 is detected in drywell 50-03-04 from 24 ft bgs to 71 ft bgs (GJ-HAN-117, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank T-103*). Europium-152, ^{94}Nb, and ^{126}Sn are also detected predominantly between 20 and 42 ft.

An assessment of "questionable integrity" tanks concluded that "the distribution of the leak in the soil sediments relative to the depth and location of radioactivity detected in the drywell 50-03-04 indicates a grout seal failure on the tank fill/spare inlet lines" (Letter REI/80-003, "Classification of Questionable Integrity Tanks"). ARH-2874, *241-T-106 Tank Leak Investigation* states "several wells drilled North and East of the T-106 leak encountered radioactivity near the 241-T-103 tank. Subsequent investigations revealed that a leak resulted from a failed grout seal in a fill entry line. The volume of the liquid lost has been determined to be on the order of 5 cubic meters."

4.2.3 Conclusions and Recommendations

Liquid level measurements and drywell data show that a release occurred from the tank inlet lines ~ 20 ft bgs (~17 ft above the tank bottom center) or from a side wall liner leak near the spare inlet line. The assessment team recommended that the current integrity classification for tank T-103 be re-assessed per TFC-ENG-CHEM-D-42.

4.2.3.1 Release Type. Based on statements in ARH-2874 and SD-WM-TI-356, the release was assumed to be an overflow through the spare inlet lines in 1973. The waste type released was CSR supernate. The supernate present in tank T-103 about the time of the leak was sampled and analyzed in 1974 (WHC-EP-0424, *Vapor Space Sampling Criteria for Single-Shell Tanks Containing Ferrocyanide Waste*). Table 4-2 shows analytical results for the sample. The measured ^{137}Cs concentration about the time of the release was $8.44(10)^5$ µCi/gal.

Table 4-2. Single-Shell Tank 241-T-103 Supernate Analyses (March 13, 1974).

Visual Observation of Sample	Clear, yellow, no solids. 250-mrads/hr
pH	12.8
Specific Gravity	1.2482
OH	0.459 M
Al	0.165 M
Na	3.93 M
NO_2	1.09 M
NO_3	1.31 M
Pu	1.07 E-05 gm/L
Differential Thermal Analysis	No exotherm
SO_4	0.189 M
PO_4	0.0157 M
F	0.0456 M
CO_3	0.246 M
Gamma energy analysis	Cs-134: 7.34E+03 µCi/gal Cs-137: 8.44E+05 µCi/gal
Water	74.56 wt%

4.2.3.2 Depth of Release. Gamma activity was detected starting at about 20 ft bgs. This is about the level of the spare inlet lines. A small peak of cesium activity was observed between 20 and 25 ft bgs. Cobalt-60 and europium activity were detected in SGLS measurements down to 100 bgs with most activity between 20 and 50 ft bgs. Based on ^{106}Ru measurements, ARH-2874 states that "the greatest depth to which the T-103 fill line penetrated is about 25 meters *(~80 ft)* below the ground service, or about 37 meters *(120 ft)* above the water table." (Note: italics added.)

4.2.3.3 Magnitude of Release. ARH-2874 states "the volume of liquid lost has been determined to be on the order of five cubic meters *(~1,300 gal)*... The one microcurie per liter ruthenium isopleth was also used to delineate the contaminated zone associated with this leak. The volume of sediments was determined to be about 1,700 cubic meters *(60,000 ft^3)*." (Note: italics added.)

The measured 1974 concentration of ^{137}Cs in tank T-103 supernate was $8.44(10)^5$ μCi/gal (decayed to January 1, 2000 equals 0.47 Ci/gal). Multiplying 1,300 gal by 0.47 Ci/gal, an estimated 611 Ci of ^{137}Cs were released.

The ^{137}Cs concentration for CSR waste in HDW Rev. 5 (RPP-19822) is 0.057 Ci/gal (decayed to January 1, 2000). This is a factor of 8 smaller than the measured sample concentration of 0.47 Ci/gal. As a result, inventory estimates for other constituents released should use the HDW Rev. 5 CSR constituent concentrations multiplied by 8 and multiplied by 1,300 gal. The estimated inventory of ^{60}Co released is 0.25 Ci ([$2.4(10)^{-5}$ * 8] Ci/gal * 1,300 gal).

4.3 TANK 241-T-106

Tank T-106 is the third of the three-tank cascade that included tanks T-104 and T-105. Tank T-106 was placed into service in June 1947. Waste process history for this tank is presented in Appendix B.3.

4.3.1 Leak Status of Tank 241-T-106

Tank T-106 recorded level decreases of 42 in. over a period of 49 days between April and June 1973 for a total estimated leak volume of 115,000 gal. The tank was pumped to a minimum heel in June 1973 and further pumped down to a residual layer of less than 6 in. by July 1974. All of the drywells located adjacent to the tank show significant levels of activity. The leak event was documented and underwent significant analysis and investigation (ARH-2874, RHO-ST-1, *Status of Liquid Waste Leaked From the 241-T-106 Tank*; and RHO-ST-14, *High-Level Waste Leakage from the 241-T-106 Tank at Hanford*).

Tank T-106 was primary stabilized in January 1979. The tank was interim stabilized and intrusion prevention was completed in August 1981. The tank remains categorized as an "assumed leaker."

4.3.2 Leak Assessment Considerations

The available historical gross gamma log data collected from 1975 to 1994 and summaries of this data from 1973 to 1987 presented in SD-WM-TI-356 suggest that the majority of the radionuclides that constitute the contaminant plume have remained stable and have not migrated through the formation sediments since 1974. However, some movement of radionuclide contamination within the contaminant plume was detected around drywells 50-06-02 and 50-06-03. In drywell 50-06-02, the data suggest that ^{60}Co contamination migrated downward within the contaminant plume from 1973 to 1992. In drywell 50-06-03, the data suggest that continued lateral migration of deep ^{60}Co contamination occurred between 1973 and 1994.

The distinct zone of elevated ^{137}Cs contamination detected from 11 to 14 ft around drywell 50-06-18 could be the result of a pipeline leak or may represent contamination that has migrated into this region of the backfill material. It is also possible that the contamination was carried down to this depth by the installation and subsequent removal of the 12-in. surface casing used to facilitate the drilling of this drywell.

Small ^{137}Cs peaks detected between 20 and 21 ft in drywells 50-06-03, 50-06-04, 50-06-18, and 50-06-05 may be the result of a transfer line leak near the southeast side of tank T-106. A broad plume of contamination was detected below 33 ft in all of the monitoring drywells surrounding the east, west, and south sides of tank T-106.

4.3.3 Conclusions and Recommendations

Liquid level measurements show clear evidence of a tank leak in April to June 1973. Drywell data show that an extensive subsurface contaminant plume exists around and below the base of tank T-106. The leak source is located on the southeast side of the tank, nearest to drywells 50-06-05 and 50-06-17. The plume extends radially outward as much as 100 ft from the leak source. Except for some movement of deep ^{60}Co contamination around drywells 50-06-02 and 50-06-03, the majority of the radionuclides that constitute the contaminant plume appear to have remained stable and have not migrated through the formation sediments since 1974.

The assessment team concluded that documentation clearly shows that the liner for tank T-106 failed near the bottom of the tank and waste leaked to the ground.

4.3.3.1 Release Type. At the end of March 1973, tank T-106 contained ~78,000 gal of liquid and sludge, consisting primarily of REDOX coating waste with smaller amounts of 221-B Plant low-level waste and ion exchange waste. On April 4, 1973, transfers of CSR waste from tank T-107 to tank T-106 via the cascade through tank T-105 began. Tank T-106 was declared a "confirmed leaker" on June 8, 1973 on the basis of a 41-in. decrease in the liquid level inside tank T-106 and elevated radiation counts in drywell 50-08-11 in May and June 1973. The tank was removed from service and pumped to a minimum heel in June 1973.

4.3.3.2 Depth of Release. The history, status, fate and impact of the 115,000-gal radioactive waste leak from tank T-106 have been studied since 1973 (RHO-ST-14). As of May 1978, the maximum detected depth of the 1-microcurie per liter (μCi/L) concentration of ^{106}Ru penetration was 33 meters (108 ft) below the ground surface or 29 meters (95 ft) above the regional water table. This maximum depth of penetration was detected in two of the dry wells in T Farm. In no other well has radioactivity greater than 1.0 pCi/g been found deeper than 29 meters (95 ft). This is ~43% of the distance from the bottom of the tank to the water table.

Although drywell data indicates the T-106 plume may not have reached groundwater, groundwater monitoring data shows clear evidence of contaminants from T Farm waste (see Section 3.8).

4.3.3.3 Magnitude of Release. As stated in Section 4.3.1 above, there was an observed 42-in. decrease in the waste level (ARH-2874); at 2,750 gal/in this equates to a leak volume of 115,000 gal. RHO-ST-14 states "the volume of the leak was determined to be approximately 4.35×10^5 liters (115,000 gallons) containing approximately 14,000 Ci of strontium-90, 40,000 Ci of ^{137}Cs, and 4 Ci of plutonium (^{239}Pu and ^{240}Pu). In addition, the leak contained ~270,000 Ci of radionuclides with half-lives of less than 3 years (99% of which were 1 year half-life ^{106}Ru)." Decayed to January 1, 2000, inventory of ^{137}Cs released was ~20,000 Ci or 0.17 Ci/gal.

RPP-19822 estimates a composition of 0.057 Ci/gal for CSR waste. This is 3 times lower than the estimated concentration of 0.17 Ci/gal in RHO-ST-14. Inventory estimates for other constituents should be estimated by multiplying 115,000 gal by the CSR concentration for that constituent and a factor of 3.

4.4 TANK 241-T-107

Tank T-107 is the first tank in a three-tank cascade that included tanks 241-T-108 (T-108) and T-109. Tank T-107 first entered service receiving 1C waste from T Plant in February 1945. Waste process history for this tank is presented in Appendix B.4.

4.4.1 Leak Status of Tank 241-T-107

Tank T-107 was designated "questionable integrity" in 1976 based on measured increases in gamma activity in drywell 50-07-07 showing radionuclide activity at 44 ft, which has slowly been declining since first monitored in 1974. Tank T-107 is one of 19 tanks grouped together to estimate a cumulative leak volume based on the assumption that their mean tank volume was approximately the same as the mean leak volume for 18 tanks which were considered to be "typical leakers." The 18 "typical leakers" were determined to have a mean estimated leak volume of 7,782 gal. After some rounding, the group of 19 tanks were assessed a cumulative leak volume estimate of 150,000 gal with individual leak volume estimates of 8,000 gal each (Letter 8901832B R1, "Single-Shell Tank Leak Volumes").

No leak volume is provided in HNF-EP-0182 for this tank other than assigning an 8,000-gal leak based on the average leak volume estimate for 19 tanks (Letter 8901832B R1).

4.4.2 Leak Assessment Considerations

Historical tank volume records show that tank T-107 was filled above the cascade outlet on at least two occasions, in 1953 and around 1966. Drywell 50-07-03, located on the east side of tank T-107, showed increased radiation monitoring readings from 300 to 1,100 c/s between July 1975 and March 1977, then slowly decreased. Drywell 50-07-07 radiation readings have decreased since 1974 (RPP-6088). Although the radiation was detected at depths near the tank base, Occurrence Report 76-60, *Monitoring Dry Well Has Shown Increase in Radiation Approaching the Action Criteria* concluded that the slow increase in radiation indicates the radioactivity was ruthenium and "suggests a contamination source other than a tank leak." Although some of the radioactivity in 1976 was likely ruthenium, the evaluation of historical gamma measurements from 1975 to 1995 (RPP-6088) and SGLS data indicates that ^{60}Co and ^{137}Cs are also present. Subsequent measured activity levels have decreased over time so that gross gamma logs now show near-background levels (i.e., 50 c/s). The spectral gamma drywell log data indicate low concentrations of ^{137}Cs at 44 ft in drywell 50-07-07 and low concentrations of ^{60}Co in drywell 50-07-03.

A previous assessment concluded "that there is sufficient evidence to indicate that the activity observed in drywells 50-07-03 and 50-07-07 were likely from a leak near the base of

SST T-107" (RPP-20820). However, the location and nature of the plume and in-tank photos indicating the tank may have been overfilled also suggest the possibility of a spare inlet overflow. Characterization near the spare inlets is recommended to further assess the source of ^{137}Cs and ^{60}Co in drywells 50-07-03 and 50-07-07, the inventory of waste released to the soil and tank T-107 integrity.

The implication of the data is that the drywells may have been compromised by downward migration of surface contaminants along the outside of the drywell casings. Surface contaminants may have followed this preferential pathway and accumulated in finer-grained material further down the drywell. Surface contamination may also have migrated from the surface along the tank sides and collected in the formation at the heel of the tank, or there could be subsurface leaks from a tank. Contamination may exist from a combination of these sources. The top 20 ft of the drywells in the tank T-107 vicinity were sealed with grout in 1981 and it is unlikely additional logging will be able to definitively determine the source of the contamination (i.e., if the tank is leaking or surface contamination migrated down the outside of the drywell or tank).

4.4.3 Conclusions and Recommendations

Direct push logging and sample analysis near the spare inlets is recommended to further assess the source of ^{137}Cs and ^{60}Co in drywells 50-07-03 and 50-07-07. The assessment team determined that a review of available information according to the TFC-ENG-CHEM-D-42 procedure was advisable. However, a tank leak cannot be ruled out at this time and additional characterization is needed before an assessment is performed.

4.4.3.1 Release Type. Based on existing drywell data, there is not enough information to determine a source or type of waste released. Occurrence Report 76-60 and drywell data together confirm suspicions that waste loss was observed at the 140 in. waste level and indicate the possibility of a tank waste release. The waste-level measurement was providing erratic waste-level measurements from June 13, 1973 (141.7 in.) through March 5, 1976 (SD-WM-TI-356). The tank waste level slowly decreased from 140.9 in. on September 16, 1975 to 140.5 in. on January 12, 1976 (RPP-20820).

4.4.3.2 Depth of Release. The radiation readings in drywell 50-07-03 appear to follow (with some lag) the changes in waste level in SST T-107. No previously known tank waste leaks are located in the vicinity of drywell 50-07-03, which was installed in 1975. The peak radioactivity measured in drywell 50-07-07 occurred at ~40-ft depth, which corresponds to the base of the tank. The spectral gamma drywell log data indicate low concentrations of ^{137}Cs (10 pCi/g) at 44 ft in drywell 50-07-07 and low concentrations of ^{60}Co in drywell 50-07-03.

4.4.3.3 Magnitude of Release. As stated in Section 4.4.3.1 above, there was an observed 0.4-in. decrease in waste level in the September 16, 1975 to January 12, 1976 time frame that corresponds to a loss of ~1,100 gal (RPP-20820). However, this estimate is suspect. Consequently, no estimated leak volume or inventory was made for tank T-107 pending direct push logging and analysis near the spare inlet.

4.5 TANKS 241-T-108

Tank T-108 is the second tank in a three-tank cascade that included tanks T-107 and T-109. Waste was first added to tank T-108 in September 1945 with the cascade of 1C1 waste from tank T-107, which continued until the first quarter of 1946. Waste process history for this tank is presented in Appendix B.5.

4.5.1 Leak Status of Tank 241-T-108

Tank T-108 was removed from service and classified as "questionable integrity" in 1974 based on an unexplained decrease in liquid level of 0.3-in. between June 1973 and April 1974 (RHO-CD-896, *Review of Classification of Nine Hanford Single-Shell "Questionable Integrity" Tanks*). Occurrence Report 75-02, *Increasing Dry Well Radiation Levels Adjacent to Waste Tanks 105-T and 108-T* (January 6, 1975) documented an observed increase in radiation measurements in drywell 50-05-06, which is located between tanks T-105 and T-108. The increase in measured radiation was attributed to the migration of waste from tank T-106. Occurrence Reports 76-56, *Dry Well Radiation Increase Exceeding Action Criteria* (April 9, 1976) and 78-60, *Dry Well Radiation Increase Exceeding Criterion* (June 9, 1978) addressed the increase in radiation measured in drywells 50-08-09 and 50-08-07, respectively, attributed to migration of waste released from tank T-106.

4.5.2 Leak Assessment Considerations

Tank T-108 liquid level measurements during the period between July 1973 and April 1974 indicate a general decline of ~0.2 in. in the liquid level. However, the liquid level measurements are erratic and comments noted by operating personnel making these measurements indicate possible instrument malfunction (e.g., recalibration of unit and flushing of tape). The supernate was transferred from tank T-108 to tank 241-S-110 during the latter part of April 1974. The liquid level data is inconclusive.

Drywells located near tank T-108 show highest contamination at 60 to 80 ft below grade. Assuming that the highest contamination is closest to the source, these plots imply that a contamination plume flowed from drywells 50-09-01 to 50-08-11; the contamination plume appears to migrate from tank T-106. Assuming the tank T-106 leak plume is the only source of contamination, the radioactivity measured in drywells should decrease with distance away from tank T-106.

4.5.3 Conclusions and Recommendations

The drywell data near tank T-108 is complicated by the tank T-106 leak plume, which occurred in May 1973. The leak plume(s) near tank T-108 are also complicated and the drywell data is inconclusive. No conclusions could be reached concerning the integrity of tank T-108.

Because drywell data shows low activity attributed to migration from another source and there is no occurrence report or indication of a viable liquid level decrease, no inventory for a release was estimated for this tank.

From previous evaluations of drywell gross gamma activity there were concerns that either tank T-108 or tank T-111 had experienced a leak, but the source could not be conclusively identified.

For purposes of inventory estimates, the inventory of drywell activity near tank T-108 should be included with tank T-106 estimates. Given the probability of migration from tank T-106 and/or a tank overflow, a tank integrity assessment for tank T-108 should be considered. However, a tank leak cannot be ruled out at this time and additional characterization may be needed before an assessment is performed.

4.6 TANK 241-T-109

Tank T-109 is the third of the three-tank cascade that included SSTs T-107 and T-108. Waste was initially added to tank T-109 in the fourth quarter of 1945 with the cascade of 1C waste from tank T-108. Waste process history for this tank is presented in Appendix B.6.

4.6.1 Leak Status of Tank 241-T-109

Tank T-109 was identified as being of "questionable integrity" in June 1974 (RHO-CD-896) based on observed increases in drywell 50-09-10 radiation readings between February 1974 and June 1974. Occurrence Report 74-108, *Symptoms of Leakage from Liquid Level Drop and Dry Well Activity in Waste Tank 109-T* documented the increase in radiation readings measured in drywell 50-09-10 at a depth of 36 to 39 ft and drywell 50-06-06 at a depth of 39 ft. Adjacent drywells 50-09-05, 50-09-07, and 50-09-09 did not indicate an increase in measured radioactivity. The activity measured in drywell 50-09-10 steadily decreased since 1976.

4.6.2 Leak Assessment Considerations

Drywell 50-09-10 was installed in 1973. This drywell is located on the northwest side of tank T-109 and is southwest of tank T-106. The data indicates that plumes of ^{137}Cs, ^{60}Co, ^{154}Eu, ^{152}Eu, ^{125}Sb, and ^{126}Sn are present below a depth of ~32 ft near tank T-109. The source of this contamination is probably a leak from tank T-106. Surface spills may have also occurred near the tank.

4.6.3 Conclusions and Recommendations

The contour plots of radioactivity in T Farm show general ^{137}Cs contamination from the surface to 10 ft bgs near tank T-109. There is no contamination detected in drywell 50-09-10 until ~39 ft bgs, with ^{60}Co and ^{154}Eu and no ^{137}Cs being detected at this elevation. The ^{60}Co and ^{154}Eu contamination detected in drywell 50-09-10 extends downward to 71 ft bgs.

Both ^{60}Co and ^{154}Eu are highly mobile in the Hanford soils, whereas ^{137}Cs is not very mobile. The absence of ^{137}Cs detected in drywell 50-09-10 suggests the contamination source is not located near this drywell. The radioactivity contour plots indicate the source of contamination detected in drywell 50-09-10 likely originated from the tank T-106 leak that occurred in May 1973. Therefore, it is unlikely that a leak developed in tank T-109.

This tank was removed from service because of questionable integrity as a result of increasing activity found in dry wells. Since 1976, activity in all dry wells has steadily decreased, although this tank is still considered to be an "assumed leaker." Drywells are the only means of leak detection because the FIC plummet is contacting solids.

The waste level data does not indicate a liquid loss from tank T-109; however, report HNF-SD-WM-ER-351, *Historical Tank Content Estimate for the Northwest Quadrant of the Hanford 200 West Area* shows that the tank was overfilled to near the spare inlet ports between 1965 and 1970. In 1973 the reported waste level was 5.1 in. below the spare inlets. Photographs show solids in the spare inlet ports, indicating that supernate may have been released from the spare inlet ports to the soil. Given the probability of migration from tank T-106 and a tank overflow, a tank integrity assessment (TFC-ENG-CHEM-D-42) is recommended for tank T-109.

4.7 TANK 241-T-111

Tank T-111 is the second tank in a three-tank cascade that included tanks T-110 and T-112. Tank T-111 was brought into service during the fourth quarter of 1945 with a cascade from tank T-110 of second cycle decontamination (2C) waste. Waste process history for this tank is presented in Appendix B.7. It was noted that tank T-111 has 10 times the total organic carbon in the waste compared to other T Farm tanks. High organic carbon has been linked to the formation of gas.

4.7.1 Leak Status of Tank 241-T-111

Tank T-111 was categorized as having questionable integrity after an unexplained liquid level decrease of 0.30 in. in 1974 (HNF-4872, *Single-Shell Tank Leak History Compilation*). In 1994, tank T-111 was classified as an "assumed re-leaker" after additional unexplained liquid-level decreases were observed. An action plan to jet pump tank T-111 was developed in May 1994 (WHC-SD-WM-ER-337).

Tank T-111 interstitial liquid and surface levels peaked in late 2006 and have decreased since December 2007. The conditions in tank T-111, as of April 1, 2013, were evaluated (RPP-RPT-54964, *Evaluation of Tank 241-T-111 Level Data and In Tank Video Inspection*) and it was determined that the interstitial liquid level drop in tank T-111 is likely due to the tank leaking.

4.7.2 Leak Assessment Considerations

Observations of in-tank liquid-level decreases provide the primary evidence that tank T-111 may have leaked. Several occurrence reports were reviewed for liquid level increases and decreases in tank T-111. A gradual increase in the interstitial liquid level of 1.5 in. was observed between 1980 and 1992. The increase was followed by an abrupt 1.6-in. decrease in the interstitial liquid level in 1993. The Enraf and LOW levels again gradually increased between about 1995 and 2007 and have continued to decrease from 2007 to present. Of interest is that the rate of increase and rate of decrease of the waste surface and interstitial liquid levels are nearly parallel. The

panel noted that for a tank leak, the solids surface level (measured by the Enraf) would be expected to decrease at a slower rate than the interstitial liquid level, measured by the LOW. Also discussed was the general uncertainty associated with ILL measurements in sludge that is as high in moisture content as that in tank T-111.

In-tank photographs and historical surface level measurements show that the tank was filled above the cascade level, indicating the possibility of a spare inlet or cascade line release. If this occurred, it would have been between 1957 and 1973. In-tank photos and video also show a fairly flat sludge surface with a dished depression in the sludge surface and a liquid pool around the central saltwell screen. The waste surface appears moist with cracks throughout. No active intrusion drips were observed during the 2013 videos, but there is considerable evidence of past intrusion into the tank (RPP-RPT-54964).

Baseline spectral gamma scans of drywells around tank T-111 were obtained in 1998 along with other T Farm drywells and should be re-done. The contour plots of radioactivity in T Farm show general ^{137}Cs contamination was detected near the ground surface and the shallow subsurface in the vicinity of all the drywells. Cobalt-60 contamination was detected on the north side of the tank in drywells 50-11-10, 50-11-11, and 50-08-07 at depths that indicate the contamination originated from tank T-106 or another subsurface source. It is unlikely that the contamination in this plume originated from tank T-111.

Several assessments have been conducted to determine whether tank T-111 was leaking or is currently leaking, as follows.

A 1979 review noted that, "other incidents of 1.00 inch liquid level decreases which occurred in April 1977 and August 1978 are considered to be due to collapsing/shifting of in-tank sludge/solids which has been known to occur following saltwell pumping." The chief scientist for the evaluation stated "there is a very strong probability that the 0.3 inch liquid level decrease recorded for Tank 111-T is well within measurement system error limits." The report concluded that there was insufficient evidence to declare tank T-111 a leaker and the tank should remain classified as "Questionable Integrity" (RHO-CD-896).

An Integrity Investigation of tank T-111 done in February 1994 reviewed riser levels, evaporation losses, FIC and LOW equipment, and potential gas build-up and releases and drywell data and concluded,

> "Review of the above information shows:
>
> 1. SL and ILL are both showing a decrease
> 2. The decrease cannot be accounted for
> 3. Riser elevations are within reasonable range, and
> 4. Drywell data is inconclusive"

The report also concluded that, "it cannot be stated that the tank is not leaking. ...the tank should be re-classified as an assumed re-leaker. Emergency pumping preparations should commence immediately." (TFC60-74-016, *Waste Tank 111-T Integrity Investigation*).

In May 1994 a report was prepared providing investigation findings and recommended actions for safe management of the tank T-111 waste (WHC-SD-WM-ER-337). The report states "The tank appears to have emitted built-up gases (i.e. burped) or leaked liquids. Presently, there is no way to distinguish between the two activities." The report notes that "the gradual increase in the waste level (1.5 in. between 1980 and 1992) followed by a rapid decrease (1.6 in. in 1993) is similar in pattern to the waste behavior observed in tanks on the hydrogen watch list. However, it is much longer." An evaluation concluded that if the level decrease was due to gas release it would not have exceeded 25% of the lower explosive limit and the tank was not recommended to be added to the flammable gas watch list. As a result, "the safest and most prudent management action is to classify tank T-111 as an assumed leaker and prepare the tank for pumping on an emergency basis."

Selected drywells were re-logged with the spectral gamma system in 2008 and 2009 following installation of the T Farm barrier (RPP-RPT-44202, *Hanford Geophysical Logging Project Spectral Gamma Re-Baseline Logging for the T-Farm Interim Surface Barrier*). This re-logging showed minor movement of ^{60}Co below 83 ft in drywell 50-08-07 when compared to the 1998 scans. No change was detected in ^{137}Cs movement compared to the 1998 scans. It was noted that only 2 of the 10 drywells around tank T-111 have been monitored since liquid level decreases started in 2007. These two drywells (50-08-19 and 50-08-07) were monitored only below 70 ft in depth in 2008. Therefore, no monitoring of the soil at depths near the tank bottom where a tank leak may be indicated has been performed since the leak began. Additional logging and/or undertaking additional push probes was recommended to update the soil contamination profile.

In November 2012, PER-2012-1977 was submitted for liquid level decreases greater than 3 standard deviations and recommending additional assessments. PER-2013-0056 was submitted January 13, 2013 to track assessments; this PER is in progress. On February 15, 2013, tank T-111 was reported by the Governor's office and in the media as a possible re-leaker. On February 16, 2013 a shift operations emergency notification was submitted (PER-2013-0262) and required notifications to DOE and offsite agencies were initiated for liquid level decreases in tank T-111. Additional investigations of tank T-111 were performed and a report documenting investigations was prepared (RPP-RPT-54964).

4.7.3 Conclusions and Recommendations

RPP-RPT-54964 presents the following conclusions.

1. Tank T-111 began to leak somewhere between 2002 and 2009, most likely around 2002.

2. The tank T-111 leak rate as of April 1, 2013 is between 2.0 and 3.1 gal/day, with the most likely rate ~2.8 gal/day.

3. The post-1994 tank T-111 leak volume is probably between 1,000 and 3,900 gal, with the most likely volume ~2,100 gal.

4. The intrusion rate into tank T-111 either did not decrease following the grading in T Farm in 2007 or decreased at a moderate rate to near zero over a five- to six-year period.

5. The calculated intrusion rate is dependent upon the assumed evaporation rate. If there was no decrease in the intrusion rate from 1995 to 2013, evaporation has no impact on the estimated leak volume. If the intrusion rate decreased, then evaporation has an impact on the estimated leak volume; higher evaporation rates result in a decreased estimated leak volume.

6. Drywell logging around tank T-111, while desirable from an information standpoint, is not required.[3]

The recommendations are as follows.

1. Monitoring Frequency – Continue with obtaining monthly LOW data for tank T-111 until the level decrease rate slows down, then return to quarterly monitoring. The additional data may not alter any decisions to be made on actions to be taken, but it is prudent that up-to-date data be available on what is going on in a tank that is leaking so that new information and/or trends become readily apparent. The daily Enraf gauge monitoring should continue.

2. In-Tank Video – Obtain a tank T-111 video from Riser 2 to permit viewing of the anomaly on the southeast side of the tank above the dome/stiffener ring interface from a different angle, and to observe the tank liner better on the opposite side of the tank from the video taken through Riser 6.

4.7.3.1 Release Type. Liquid level decreases indicate tank T-106 may have leaked between 1995 and 2013 and possibly earlier. The supernate released is classified in the BBI as interstitial liquid from 224 and 2C sludge. Drywell data shows no evidence of a leak from this tank prior to 1998. However, only limited data have been acquired since 1998 in boreholes around the tank near the depth of the tank bottom. Anomalous measurements at that depth would be direct evidence of a leak. Therefore, the location of a leak or corroboration of a leak since 1998 cannot be determined from currently available information.

4.7.3.2 Depth of Release. The location and depth of the release could not be determined from current information.

4.7.3.3 Magnitude of Release. Based on liquid level decreases, the post-1994 tank T-111 leak volume was estimated to range between 1,000 and 3,900 gal, with the most likely volume about 2,100 gal (RPP-RPT-54964). The inventory of waste released was estimated by multiplying the leak volume by BBI concentration estimates for applicable chemicals or radionuclides.

[3] The leak assessment team concluded logging of drywells around tank T-111 would be useful to provide direct evidence of a leak, determine the nature and extent of contamination, and provide baseline conditions in 2013 of an ongoing leak. Absent any direct evidence of a leak, the team recommends push hole characterization to provide evidence of leak location and contaminant inventory.

4.8 241-T FARM SOUND TANKS

In addition to tanks assumed to have leaked in the past, tanks currently classified as "sound" (HNF-EP-0182) were reviewed. These include tanks T-102, T-104, T-105, T-110, T-112 and the T-200-series tanks. Summary information for these tanks is included in Appendix C. Many of the tanks were overfilled and some tanks show activity in nearby drywells that have been attributed to operations spills, line leaks or leaks from another tank. The assessment team concluded that there was no conclusive evidence of a liner failure for any of these tanks (see Appendix A). Only tank T-102 showed evidence of releases near the tank. Discussion of tank T-102 and an estimated inventory for the near-by release is included in section 4.9.

4.9 TANK 241-T-102

4.9.1 Leak Status of Tank 241-T-102

Tank T-102 is currently classified as sound (HNF-EP-0182). However, on June 18, 2009 Washington River Protection Solutions was notified that a pre-existing gamma ray peak in drywell 50-02-05, located between tanks T-102 and T-105, had risen from 2,000 pCi/g to ~50,000 pCi/g, a greater than tenfold increase. A team was formed and a formal leak assessment (TFC-ENG-CHEM-D-42) was started for tank T-102 in June 2009. During these meetings a plan was developed to obtain additional data (Interoffice memorandum WRPS-0901156, "Drywell 50-02-05 Investigation Plan"). As part of the plan, total gamma measurements were performed to monitor drywell 50-02-05 and selected surrounding drywells through 2010. An assessment meeting was convened on August 16, 2012 to continue the formal tank T-102 leak assessment. It was determined in that meeting that the information available did not conclusively point to a source of the contamination and that tanks T-102 and T-105 should remain classified as "Sound" tanks until further information is obtained from direct pushes in the area surrounding the 50-02-05 drywell. Process information and vadose zone data for tank T-102 are presented in Appendix C.1.

4.9.2 Leak Assessment Considerations

Tank T-102 has a liquid surface level which provides accurate measurements. The Enraf measurements show little or no change in the liquid level. The possibility exists that intrusions into the tank could have masked a liquid level decrease. A small release (< 100 gal) may not be detected by surface level measurements.

Gamma radioactivity measured in drywells 50-01-09, 50-02-08, and 50-02-09 was attributed to migration from tanks T-101 and T-103, respectively and possibly T-106. However, the source of a narrow peak of ^{137}Cs activity at ~40 ft bgs (near the base of the tank) in drywell 50-02-05 has not been explained. Total gamma plots show that gamma activity increased between 1990 and 1994, then gradually decreased. Spectral gamma logging system baseline measurements at the 40 ft level in 1998 reported a concentration of 1,850 pCi/g. However, dead time was high and it was acknowledged that the concentration may be higher than measured. The well was not re-logged using an HRLS at that time because the detector did not appear to be saturated. Four RAS gamma measurements were obtained between July 2001 and 2003. In

September 2008 SGLS measurements showed higher dead time and indicated the detector was saturated. High rate logging system measurements obtained in 2009 showed that the ^{137}Cs concentration in drywell 50-02-05 increased from ~2,000 pCi/g to ~50,000 pCi/g.

Monthly gamma logging followed by quarterly logging using the RAS was conducted in drywell 50-02-05 and several surrounding drywells in 2009 and 2010. The RAS data indicated that gamma activity has stabilized and monitoring was discontinued. It has been about three years since the drywell has been logged.

The logging report states that the increase in ^{137}Cs in drywell 50-02-05 is a clear indication that there has been a contamination event or that existing contamination has been remobilized. Radiation Assessment System data collected between 2008 and 2010 indicate that gamma activity has stabilized (HGLP-OTH-007, *Discussion of Cs-137 Increase at 38 to 41 feet in Drywell 50-02-05* [Appendix B of RPP-RPT-44202]). It has been about three years since the drywell has been measured.

The possibility that the surface barrier completed in April 2008 was creating latent vadose zone effects, including the ^{137}Cs increase in drywell 50-02-05, was reviewed. The barrier discharge ditch is located between tanks T-101 and T-102. It was determined that the runoff from the barrier is unlikely to be affecting the drywell 50-02-05 plume because of channeling through disturbed soil. When the T Farm excavation was prepared in 1943, the excavation slope was probably 2:1 or less – it would have extended outward a maximum of ~80 ft beyond the base of 40 ft deep excavation. The pond is well beyond this distance. Based on percolation behavior, it is likely that the runoff is moving down through the vadose zone rather than laterally to the barrier and affecting existing plumes in the excavation. It was also observed that none of the nearby drywells showed an increase in activity or any indication of moisture movement as would be expected if the changes in drywell 50-02-05 were due to barrier affects.

There is an area of low resistivity on the southeast quadrant of the tank, but the source is near drywell 52-02-05 and unknown. The low resistivity measurements could be the result of a NO_3 plume, interference from underground piping, or soil moisture. For purposes of the leak assessment, the soil resistivity measurements are inconclusive regarding the increased activity in drywell 50-02-05.

4.9.3 Conclusions and Recommendations

The assessment team concluded that surface level measurements do not indicate the presence of a leak in tank T-102 and except for drywell 50-02-05, gamma activity measured in drywells can be attributed to other sources than tank T-102. The ^{137}Cs, ^{60}Co, and ^{154}Eu gamma activity measured in drywell 50-02-05 may be the result of a spare inlet overflow or tank liner leak.

The team recommended completing the tank integrity assessment (TFC-ENG-CHEM-D-42) in process for tank T-102 after additional data is obtained. Direct pushes are recommended to further investigate contamination in the vicinity of drywell 50-02-05. Total gamma and moisture logs in the direct push casings will help determine the extent of the contamination and whether moisture is a contributing factor in the migration of contaminants. If possible, the direct push

casings should remain in place for periodic monitoring of gamma activity levels and vadose zone moisture content. Geochemical and radiological analyses of direct push samples may provide clues as to mechanisms enabling ^{137}Cs migration and help determine the true concentration and extent of the contamination.

4.9.3.1 Release Type. Because gamma activity was not reported when drywell 50-02-05 was drilled in 1974 and reported in 1977, 1974 tank waste sample results (Figure 4-2) are assumed to be representative of the waste leaked. The ^{137}Cs concentration of the waste was 0.76 Ci/gal in March 1974. Given the ^{60}Co concentrations the waste appears to be PUREX cladding waste or a combination of cladding waste and CSR waste.

4.9.3.2 Depth of Release. The release may have been from the spare inlets, ~20 ft bgs or may have been a tank leak. Drywell 50-02-05 shows a narrow peak of ^{137}Cs at 38 to 41 ft bgs, near the base of the tank. This depth is assumed to estimate the magnitude of release.

Figure 4-2. March 1974 Sample Results for Tank 241-T-102 Supernate.

Date: March 13, 1974

To: R. L. Walser

From: W. H. Sant by R E Wheeler

Subject: ANALYSIS OF TANK FARM SAMPLES
SAMPLE: T-2287 TANK 102-T

VIS-OTR: Clear, Yellow, No solids 150 mrads/hr.

pH: 12.25

SpG: 1.2382

OH: 0.474 M

Al: 0.214 M

Na: 4.12 M

NO_2: 0.722 M

NO_3: 2.18 M

Pu: 3.99×10^{-6} g/l

D.T.A.: No Exotherm

SO_4: 0.102 M

PO_4: 1.18×10^{-2} M

F: 4.58×10^{-2} M

CO_3: 0.176 M

GEA: ^{134}Cs - 5.60×10^{3} µCi/gal
^{137}Cs - 7.64×10^{5} µCi/gal

Water: 73.67%

Cooling Curve: No solids at room temperature
10°C for 45 min. No solids.
5°C for 90 min. No solids.

cc: LG Johnson (2)
WH Sant

Reference: WHC-EP-0424, *Vapor Space Sampling Criteria for Single-Shell Tanks Containing Ferrocyanide Waste.*

4.9.3.3 Magnitude of the Release. Based on a maximum 10 ft peak width at drywell 52-02-05 and a 1974 sample from tank T-102, a leak volume range of 50 to 500 gal was estimated via calculation. A leak volume range was estimated as follows.

Drywell 50-02-05 Plume Size Estimate

Assumptions and Inputs:

(T) Thickness of plume is minimum 10 ft (based on SGLS 10 ft thickness btwn 10 pCi/g and 50,000 pCi/g measurements)

(A) Peak activity logged in drywell = 50,000 pCi/g

(r) Plume Radius:

r_{15} = 15 ft (based on distance between well and tanks T-102 and T-105, assumes leak from edge of tank.

-or-

r_{50} = 50 ft (based on distance to closest drywells with no Cs-137 activity at 40 ft depth and low activity (<10 pCi/g anywhere in the well).

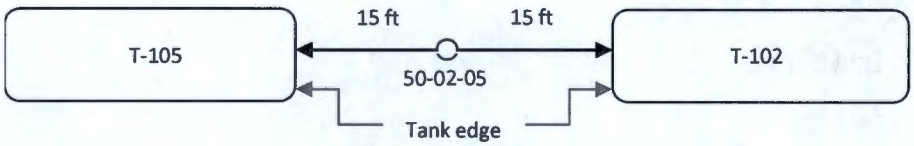
(C) Concentration of Waste Leaked

0.76 Ci/gal grab sample (T-2287) supernate measurement on 3/1974

Assumed date of increased leak around 1/1/2000

Concentration decayed to 1/1/2000 = 0.42 Ci/gal

Assume plume is a cylinder with drywell 50-02-05 as center of radius.



Calculations:

(P) Plume size = $\pi r^2(T)$

$P_{15} = \pi(15)^2(10) = 7{,}000\ ft^3$

$P_{50} = \pi(50)^2(10) = 79{,}000\ ft^3$

(I) Cs-137 Inventory in soil = (P)(A)(d)* unit conversions

d = density

$I_{15} = 7{,}000\ ft^3 \times 50{,}000\ pCi/g \times 1.7 g/cc \times 28{,}320\ cc/ft^3 \times Ci/10^{12}\ pCi = 16.9\ Ci$

$I_{50} = 79{,}000\ ft^3 \times 50{,}000\ pCi/g \times 1.7 g/cc \times 28{,}320\ cc/ft^3 \times Ci/10^{12}\ pCi = 190.7\ Ci$

(V) Plume Volume Estimate = I/C

Vol_{15} = 16.9 Ci/0.42 Ci/gal = 40.2 gal or ≈ 50 gal

Vol_{50} = 190.7 Ci/0.42 Ci/gal = 454 gal or ≈ 500 gal

5.0 OTHER POTENTIAL RELEASES

Information on potential spare inlet or cascade line releases, pipeline failures and other UPRs in WMA T was collected from the following sources:

- DOE/RL-88-30, *Hanford Site Waste Management Units Report*, Rev. 22
- RPP-RPT-29191, *Supplemental Information Hanford Tank Waste Leaks*
- RHO-CD-673, *Handbook 200 Area Waste Sites*
- Waste status summary reports for the SSTs from January 1945 through December 1980 (various reports)
- Review of radiation incident reports and T Farm occurrence reports.

5.1 POTENTIAL WASTE LOSSES FROM SPARE INLET NOZZLES

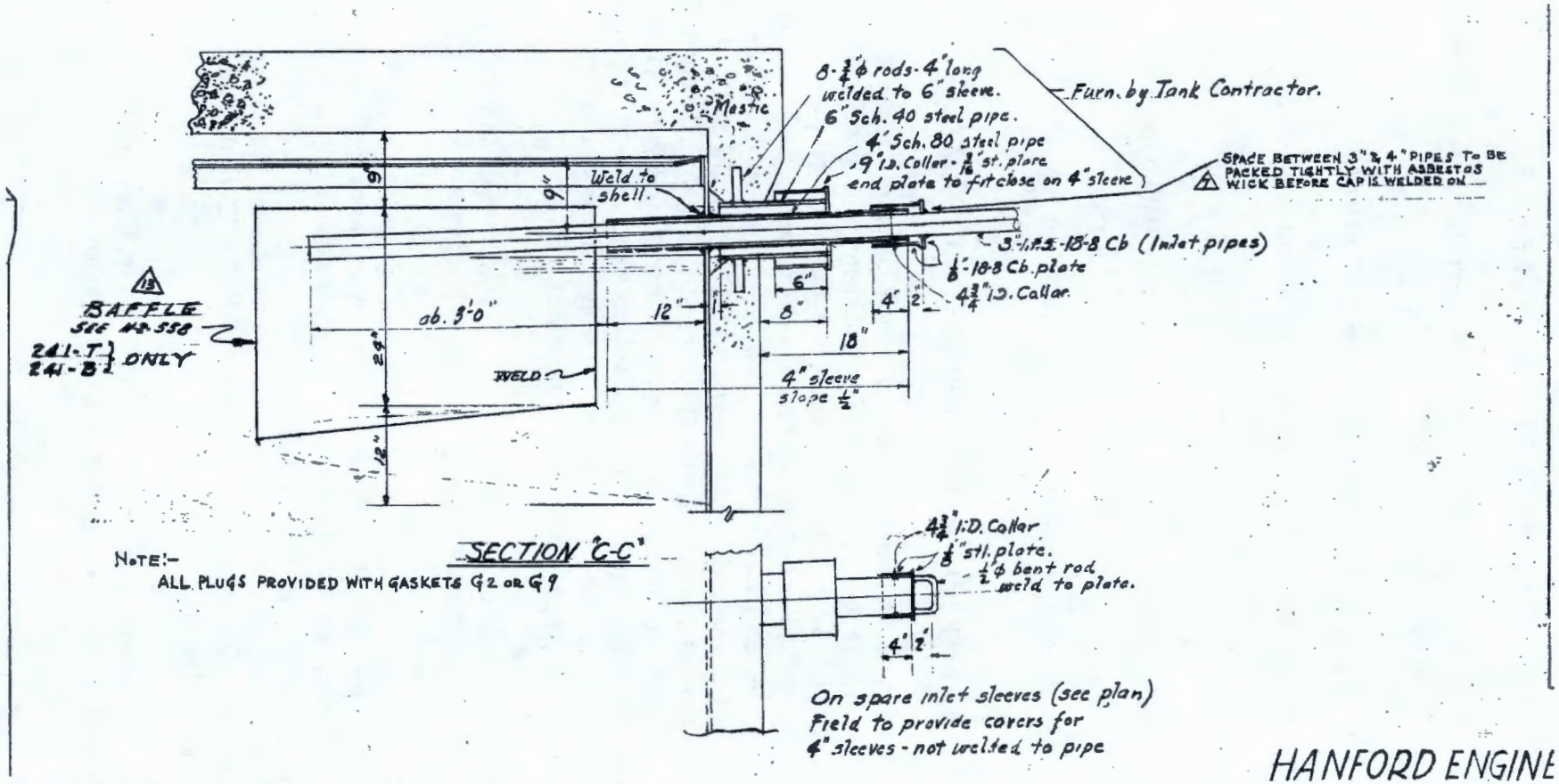
The SSTs in T Farm are each equipped with horizontal spare inlet nozzles, as shown in Figures 3-1 and 5-1. A nozzle consists of an inner 4-in. diameter schedule 80 steel pipe with an outer 6-in. diameter schedule 40 steel pipe. The outer 6-in. diameter steel pipe is imbedded in the concrete sidewall of the SST, attached to the exterior of the carbon steel sidewall using mastic and protrudes ~8 in. from the exterior of the tank wall. The 4-in. diameter steel pipe is inserted through the 6-in. diameter steel pipe, protrudes ~12 in. inside the SST and ~18 in. beyond the exterior of the concrete sidewall of the SST. The 4-in. diameter steel pipe is welded to the sidewall of the carbon steel tank. An 8-in. diameter steel collar is tightly fitted around the 6-in. diameter steel pipe where the 4-in. diameter steel pipe exits this outer pipe. Process waste lines, which are 3-in. inner diameter, 11 gauge (stainless steel) tubing, are inserted through the 4-in. diameter steel pipe and extend ~4 ft inside the SST.

The elevation of the spare inlet nozzles is ~24 ft from the center of the tank bottom. Inlet nozzles in T Farm are located at approximately the 4 o'clock position relative to north being 12 o'clock.

The design for the SSTs identified that a 4.5-in. diameter cover was to be placed over the 4-in. diameter spare inlet nozzles (see Figure 5-1). Some of the spare inlet nozzles were poorly sealed, some have blanks which are welded tight, some have wooden plugs driven into the spare nozzle covered by a cap and sealed with waterproofing, and some have caps covered with waterproofing membrane and then sealed in cement (see HW-20742, *Loss of Depleted Metal Waste Supernatant to Soil*, pp. 5).

Waste may have been lost to the ground in T Farm if SSTs were filled above the height of the spare inlet nozzles (~24 ft from tank center bottom, ~770,000 gal).

Figure 5-1. Inlet Nozzle Detail.



Source: W-72742, *Hanford Engineer Works 20'-0" Dia. Storage Tanks Arrangement Bldg# 241-T, 241-U, 241-B, 241-C.*

The waste volumes in all SSTs were reported in waste status summaries monthly from January 1945 through December 1960, semi-annually from January 1961 through June 1965, quarterly from September 1965 through September 1976, and monthly thereafter. The T Farm SSTs were all removed from service and interim isolated by January 1981 and no waste additions were allowed after this date. Potential losses from spare inlet lines based on operations data are summarized in Table 5-1. The volume and inventory of waste losses from spare inlet nozzles is unknown other than estimates based on drywell gamma activity. Table 5-1 shows estimates based on drywell activity that may be attributed to spare inlet overflows for T Farm tanks.

Table 5-1. Potential Waste Losses through Nozzles on Waste Management Area T Single-Shell Tanks.*

Tank	Year	Waste Type and Maximum Volume in Tank	
241-T-101	January 1969 – March 1969	CW	539,000 gal
241-T-102	January 1969 – March 1969	CW	538,000 gal
241-T-103	April 1973 – June 1974	BL-IX-EB-RIX-R-CW	556,000 gal
241-T-104	January 1954 – June 1954 January 1957 – March 1957 April 1957 – December 1961	1C 1C 1C	546,000 gal 541,000 gal 538,000 gal
241-T-105	January 1957 – March 1957	1C	540,000 gal
241-T-106 241-T-107 241-T-108	N/A	N/A	
241-T-109	January 1954 – December 1956 January 1957 – December 1964 April 1965 – September 1969	1C-TBP-EB EB EB	543,000 gal 541,000 gal 552,000 gal
241-T-110	N/A	N/A	
241-T-111	N/A	N/A	
241-T-112	January 1957 – March 1958 October 1965 – March 1966	224 & 2C 224 & 2C	560,000 gal 546,000 gal
241-T-201 241-T-202 241-T-203 241-T-204	N/A	N/A	

* Height/Volume levels for cascade lines and spare inlets were as follows:
Cascade Inlet – 194.5 in. above knuckle, 206.5 in. above bottom center, 547,400 gal
Cascade Outlet – 191.5 in. above knuckle, 203.5 in. above bottom center, 539,000 gal
Spare Inlets – 196.0 in. above knuckle, 208.0 in. above bottom center, 551,500 gal
Based on Vol (gal) = 2,750(in.) +12,500

Note: Although process records indicate the liquid level only exceeded the spare inlet level for tanks 241-T-109 and 241-T-112, in-tank photos show liquid levels above the spare inlets and waste in the cascade lines and spare inlet ports for many of the tanks and tank 241-T-112 was designed to overflow from a spare inlet to a crib.

Waste Types:
1C = Bismuth phosphate first cycle decontamination
224 = 224 Building lanthanum fluoride process
2C = Bismuth phosphate process second cycle decontamination
BL = 221-B Plant low-level
CW = cladding (coating)
EB = Evaporator bottoms
IX = Ion exchange
R = Reduction-Oxidation (S Plant) high-level
RIX = Reduction-Oxidation (S Plant) ion exchange
TBP = Tri-butyl phosphate process

5.2 UNPLANNED RELEASES

Information on UPRs in WMA T was collected from the following sources:

- DOE/RL-88-30, *Hanford Site Waste Management Units Report*, Rev. 22
- RPP-RPT-29191, *Supplemental Information Hanford Tank Waste Leaks*
- RHO-CD-673, *Handbook 200 Area Waste Sites*
- RPP-26744, *Hanford Soil Inventory Model, Rev. 1*
- RPP-PLAN-25942, *Waste Management Area Integration Study Waste Management Area T*
- Waste status summary reports for the SSTs from January 1945 through December 1980 (various reports)
- Review of radiation incident reports and T Farm occurrence reports.

The information provided on each UPR consists of the date when the waste loss event occurred, the waste type and estimate of the volume of waste discharged, if known.

5.2.1 Documented Unplanned Releases

Table 5-2 identifies documented known or suspected UPRs in T Farm. The date the release was detected, the waste type and the volume of waste that leaked to the soil (if known) are listed in Table 5-2. Some, but not all of these releases are designated UPRs in the Waste Information Data System (WIDS) database. Consolidated UPR-200-W-93 encompasses all of the individual tank farm soil UPRs inside and adjacent to the T Farm fence. Unplanned releases 200-W-147 and 200-W-148 were associated with the tank T-103 and tank T-106 leaks respectively and are described in Sections 4.2 and 4.3. Inventory estimates are provided in RPP-26744 for UPRs 200-W-29 and 200-W-97. Releases not currently included in WIDS will be submitted to the WIDS coordinator. Figure 5-2 shows pipelines in T Farm. Some of these lines are near areas of elevated gamma activity that could be accounted for by waste in pipelines or pipeline leaks.

Table 5-2. Unplanned Releases in or near 241-T Tank Farm. (5 sheets)

Date	Type of Event / Facility	Event as Described in Reference	Reference	Comments
01/01/1950	241-T-151 and 241-T-152 Diversion Boxes	Contamination spread from the 241-T-151 and 241-T-152 Diversion Boxes; UN-200-W-7. The 241-T-151 and 152 Diversion Boxes are located in the southeast corner of the 241-T Tank Farm - inside the tank farm fence. The release occurred inside the 241-T Tank Farm. The Tank Farm is surrounded with a chain link fence and posted with radiological warning signs. The diversion boxes have been covered with a protective foam layer. The unplanned release is not separately marked or posted.	UPR-200-W-7	In 1950, a portion of the contamination was removed and the balance covered with about a foot of clean soil. The area was delimited with rope and posted with radiation zone signs.
10/1952	Pipeline Leak at 242-T Evaporator	In October 1952, a steam coil in the 242-T waste evaporator tank caused ground contamination along the surface above the leaking cast iron pipe which carries cooling water and steam condensate from the waste evaporator building to the 207-T Retention Basin. Water was observed on the surface, east of the 241-TY Tank Farm.	UPR-200-W-14 HW-60807, *Unconfined Underground Radioactive Waste and Contamination in the 200 Areas–1959*	The leak in the line was repaired in 1952 and the contaminated areas were covered with about a foot of clean soil and gravel.

Table 5-2. Unplanned Releases in or near 241-T Tank Farm. (5 sheets)

Date	Type of Event / Facility	Event as Described in Reference	Reference	Comments
11/15/1954	Pipeline leak tank 241-T-105 to tank 241-TX-118	The incident involved failure of an unencased underground process line transporting first cycle waste supernate with subsequent cave-in and gross ground contamination near the corner of 23rd and Camden Streets. An area about 75 × 100 feet was affected, with dose rates up to 11.5-rads/hr at two inches including 3.5-r/hr being measured over the liquid. This line had been out of service for almost eight months, but had not been pressure-tested before use. The process waste leakage was hosed down to prevent wind borne contamination spread and the leak area was backfilled shortly after the leak was discovered. In 1978, contaminated soil adjacent to the zone was removed on the south side to a depth of 4 ft and on the west side to a depth of 3 ft. The entire zone area was excavated to depth of 1 ft, the new surface was then treated with a heavy coating of fiberfilm to seal against moisture penetration. It was covered with 4 in. of sand and was treated with ureabore herbicide. All surfaces were covered with 4 in. of crushed rock to stabilize against wind dispersal. The area was backfilled with earth and later covered with gravel.	HW-34001, *Separations Section Radiation Monitoring Monthly Report November, 1954*, pp. 7 HW-33979, *Manufacturing Department Radiation Incident Investigation Incident Number: 393*, pp. 2	HW-33979, pp. 2 describes transfer of first cycle waste from tank T-105 to tank TX-118 being the source of this leak. The waste leak was estimated as 3,450 gallons based on inventory readings at tanks 105-T and 118-TX. The 302-B catch tank was reported to retain 3,300 gallons of the leaked waste and rain water intrusion. The estimated volume of waste discharged to the ground was less than 1,000 gallons. UPR-200-W-29 The area was hosed down to prevent wind-borne spread of contamination. Within 6 hours of discovery, the cave-in was backfilled and the area was covered with gravel. A second release occurred at the same location in May 1966 (UPR-200-W-97). The same broken transfer line was mistakenly used again. The area was backfilled to grade with clean dirt. The new surface was treated with a heavy coating of fiberfilm. The area was then covered with 10 centimeters (4 inches) of sand and treated with ureabore herbicide. Ten centimeters (4 inches) of gravel was applied to the surface to prevent wind erosion.

Table 5-2. Unplanned Releases in or near 241-T Tank Farm. (5 sheets)

Date	Type of Event / Facility	Event as Described in Reference	Reference	Comments
02/20/1963	151-T Diversion Box	Contamination to 3 R/hr at 2 inches spread to 10 sq ft area west of the 151-T Diversion Box while removing the cover blocks. Source was flush water collected in the lifting bail recesses of the lower set of cover blocks. SWP clothing contaminated to 800 mrads/hr.		Contaminated dirt shoveled up and area surveyed and released.
05/1966	Transfer Line Leak	UPR-200-W-97 is associated with the underground pipeline connecting 241-T-152 Diversion Box and the 241-TX-153 Diversion Box. It occurred at the same location as UPR-200-W-29 and adjacent to UPR-200-W-64. The site is associated with UPR-200-W-29 because a repeat release from the same broken transfer line (documented in UPR-200-W-29 in 1954) occurred again in 1966.	UPR-200-W-97	See UPR-200-W-29
10/1966	Pipeline plug 242-T to waste storage tanks	During most of the month dilute feed from the 104-TY and 107-T underground storage tanks was processed at 242-T. This has greatly improved performance. However, pumping of evaporator bottoms through overground lines continues to be a problem because of plugging. A definite schedule of alternate pumping and steaming through these lines has helped some to keep them open.	ISO-563, *Chemical Processing Division Monthly Report for October, 1966*, pp. I-2	
02/07/1967	241-T Tank Farm	Drain hose blew from pipe nipple during attempted water flush of truck unloading line in 241-T Farm contaminating about 60 sq ft with dose rates generally 2 rads/hr at contact.		Contaminated dirt removed to depth of 8 inches. Remaining contamination (about 50 mrads/hr) was covered with a foot of gravel.

Table 5-2. Unplanned Releases in or near 241-T Tank Farm. (5 sheets)

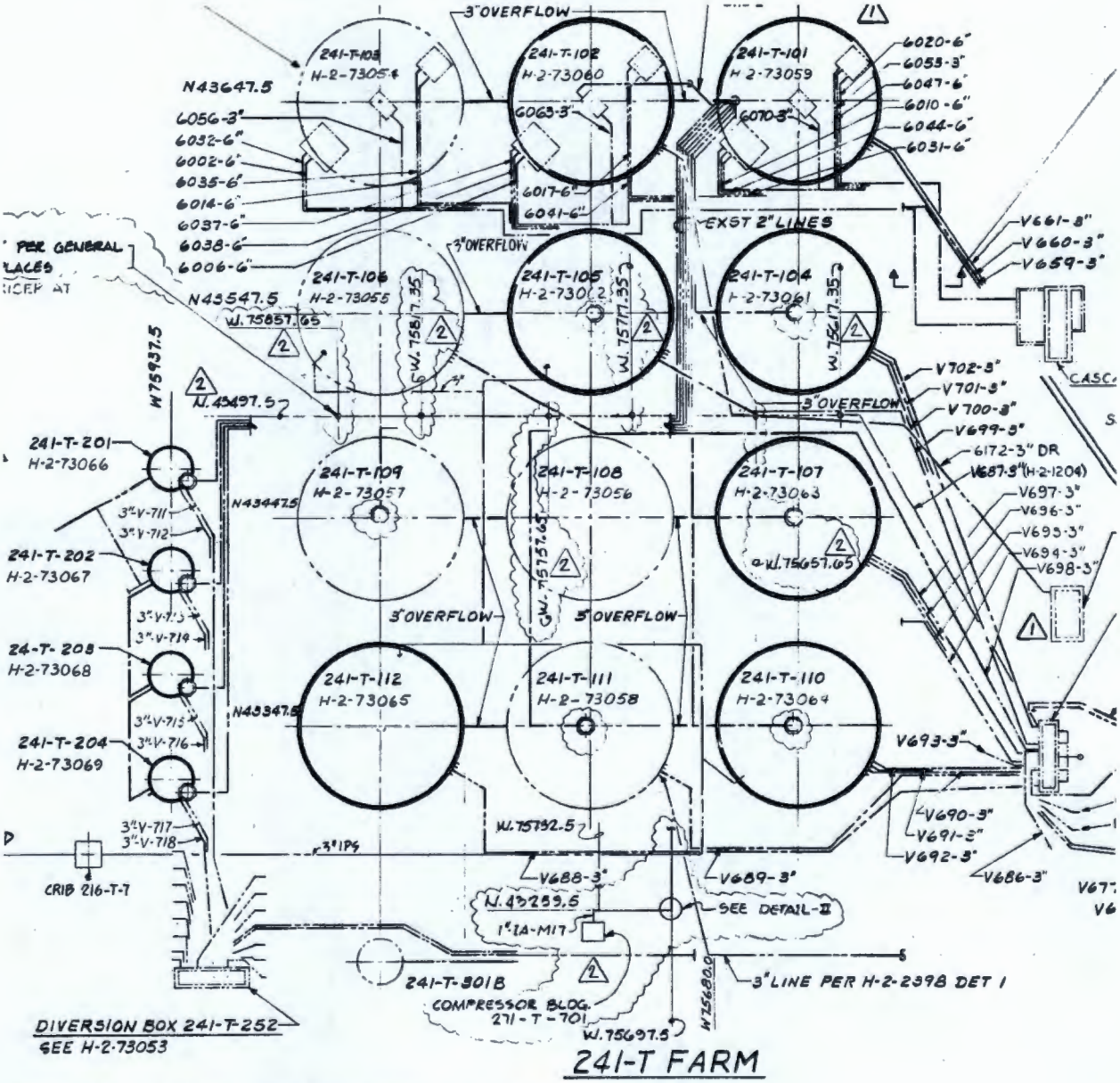
Date	Type of Event / Facility	Event as Described in Reference	Reference	Comments
03/25/1967	241-T Tank Farm	Leaking hose connector on tanker spread up to 300 mrad/hr contamination on ground in 241-T Farm during transfer. Subsequent washdown of spill spread contamination to about 450 square yards of ground reading generally 100,000 DPM.		Contaminated area covered with plastic for weekend then grossly contaminated soil taken to burial ground. Remaining was covered with gravel.
02/13/1969	Road Contamination at 23rd and Camden	Contamination was found along a 15.2-meter (50-foot) strip of ground bordering Camden Avenue at its intersection with 23rd Street in 1969. Radiation surveys of the adjacent radiation zone had found dose rates up to 500 millirem per hour only a few inches below the surface. The area was blocked temporarily, allowing traffic to flow but preventing access to the east shoulder.	UPR-200-W-64	It is believed that the contamination source was the adjacent radiation zone (UPR-200-W-29 and UPR-200-W-97) where two previous underground radioactive waste line leaks that occurred. Runoff from heavy snow may have caused the contamination movement. Dirt samples from the radiation zone to the east and roadway shoulder. The radiation zone adjacent to the corner of 23rd and Camden was surface stabilized in 1978. The contaminated soil adjacent to the zone on the south side was removed to a depth of 1.2 meters (4 feet) and on the west side to a depth of 0.9 meters (3 feet). The area was backfilled to grade with clean dirt.
04/20/1973	Tank 241-T-106 Leak	This release occurred while waste was being transferred from tank T-107 to tank T-106.	UPR-200-W-148 ARH-2874, *241-T-106 Tank Leak Investigation*	The tank was labeled a confirmed leaker and removed from service in 1973, as a result of this release.

Table 5-2. Unplanned Releases in or near 241-T Tank Farm. (5 sheets)

Date	Type of Event / Facility	Event as Described in Reference	Reference	Comments
07/05/1973	241-T Tank Farm	While backfilling a waste drum storage pit, the back hoe ran over a pipe flange located slightly below grade level. The radiation survey indicated 35 rads/hr; ~75 gallons of entrapped flush water seeped from the line. The damaged flange is at the end of the 241-T transfer header used to transfer waste from tank T-106. Clean sand was placed over the spill area. Plastic sheeting was then laid down and covered with dirt to reduce radiation to 10 mR/hr.	Occurrence Report 73-45, *Contamination Spread, 241-T Tank Farm*	The damaged header was abandoned and its connecting nozzle blanked in Diversion Box 241-T-153.
01/01/1974	241-T-103 Leak	The 241-T-103 tank was labeled an assumed leaker and removed from service in 1974. The waste penetrated to a maximum depth of 82 feet (25 meters) below ground surface or 121 feet (37 meters) above the water table.	UPR-200-W-147 ARH-2874	In 1973, while monitoring wells were being drilled to assess the 241-T-106 tank leak, contamination was identified between monitoring wells 299-W10-116 and 299-W10-118. This contamination plume was determined to be from the T-103 Tank. Subsequent investigations revealed that the leak resulted from a failed grout seal in a spare entry line to T-103.
11/26/1991	241-T Tank Farm	During the unloading and spreading gravel a thermocouple riser was inadvertently bumped and broke off at grade level.	UPR-200-W-166 RL-WHC-TANKFARM-1991-1067, *241-T Tank Farm Thermocouple Riser Broken off by Front-End Loader While Spreading Gravel*	The riser was disposed. The damage was repaired.
05/17/2006	241-T Tank Farm	Contamination discovered outside radiological area during a routine survey; of 600,000 dpm/ 100 cm^2 total beta/gamma; attributed to contaminated vegetation.	EM-RP-CHG-TANKFARM-2006-0018, *Contamination Discovered Outside Radiological Area During Routine Survey*	The contamination was removed and disposed.

DPM = disintegrations per minute SWP = Special work permit (protective clothing)

Figure 5-2. Pipeline Schematic for 241-T Farm Tanks.



Source: H-2-73112, *Piping Waste Tank Isolation 241-T & 241-TY Tank Farm Plot Plans.*

Except as noted in Table 5-2, information available was insufficient to estimate a leak volume or inventory for specific pipeline failures and surface releases. In some cases, failed pipelines were contained within a concrete diversion box, vault, or pipeline encasement. The surfaces of these concrete structures were coated with a chemically resistant paint. However, the integrity of the coatings and concrete structures are unknown and it is not known whether waste leaked from these concrete structures. In addition to the suspect pipeline failures and waste loss events documented in this report, other pipe line failures or liquid losses likely occurred. A 1985 BWIP water balance study (Internal letter 65633-128, "Status of the BWIP Water Balance Study") showed that between 1977 and 1984, between 15% and 41% (24% average) of the $8(10)^9$ L of water discharged to East Area general raw water lines was unaccounted for, suggesting either

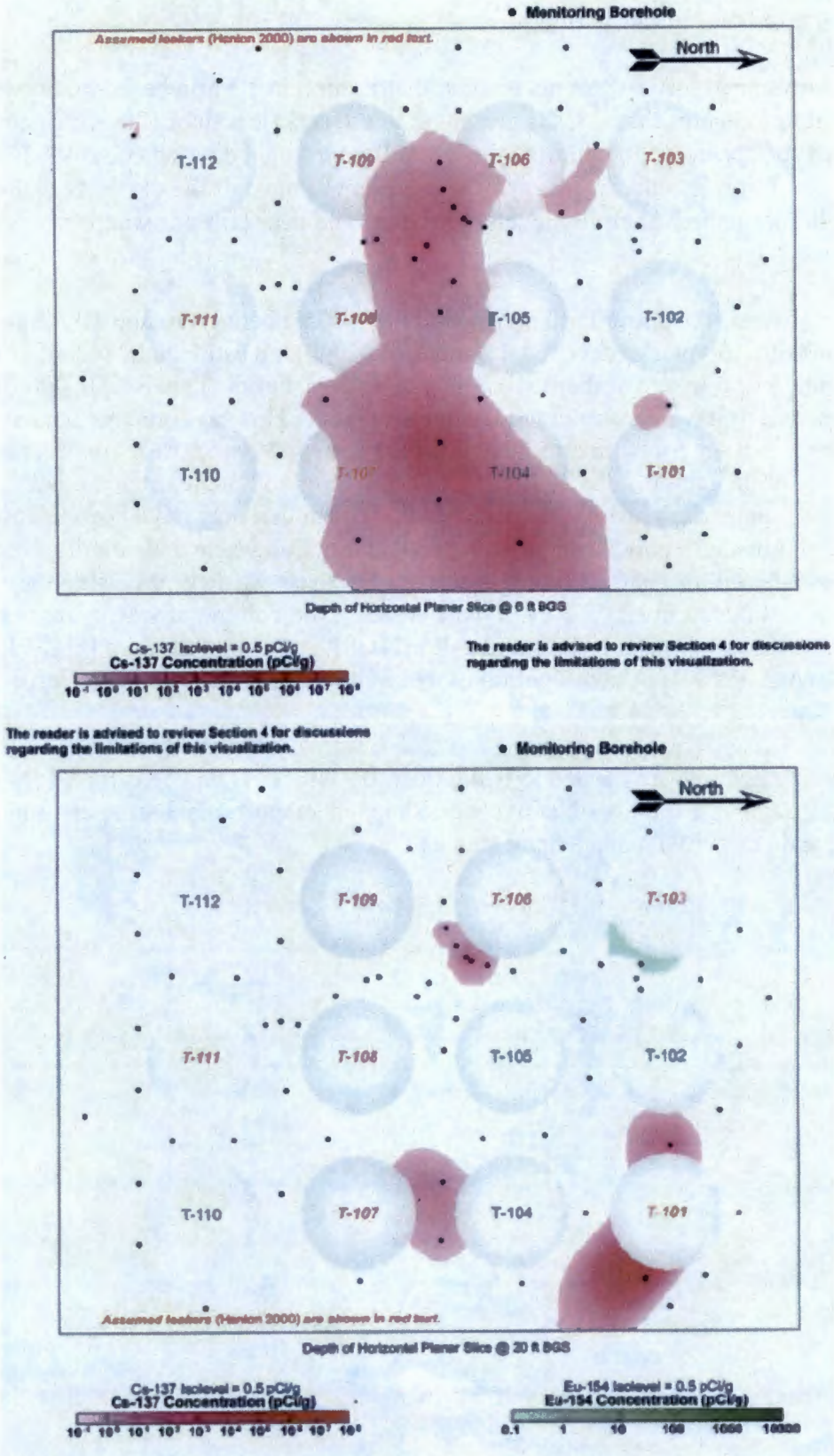
error in process measurements or significant losses in the water lines. Also, Table 5-2 shows about an eight-year gap in reported UPRs between 1954 and 1963. Other unreported releases may have occurred during this period.

Figure 5-3 shows near-surface gamma activity distribution in T Farm based on drywell logging data. The figure indicates that ^{137}Cs is present at low levels (less than 100 pCi/g) over ~⅓ to ¼ of the T Farm surface area. In addition, the drywell interpreted data set (GJO-99-101-TARA/ GJO-HAN-27) shows less than 1 pCi/g ^{137}Cs is present in most of the drywells in the farm. In general, the highest gamma activity levels were observed near tanks or where an inventory has been estimated.

Even if ^{137}Cs covered the entire farm area (~500 ft × 600 ft) between 0 and 10 ft bgs, for ^{137}Cs concentrations of <100 pCi/g (decayed to January 1, 2000), an estimated 28 Ci of ^{137}Cs would have been spilled or released at the surface near tanks in T Farm. This is ~1/1,000 of the amount of ^{137}Cs estimated to have been released from tank T-106. This suggests that near-surface UPRs may have been smaller, contaminants have been flushed, and/or the waste lost contained lower levels of non-mobile gamma activity (i.e., ^{137}Cs) compared to tank leaks and other documented releases. Based on process history, waste types in T Farm that may have been released include CSR, CWR, and bismuth phosphate process decontamination waste and coating waste from 1944 to 1949 (C1) and 1950 to 1956 (C2) or 224 waste. For these waste types, using the concentrations estimated in HDW Rev. 5 (RPP-19822), the volume of waste represented by 28 Ci of ^{137}Cs ranges from a few thousand gallons (CSR) to tens of thousands (CWR) to millions of gallons (C1/C2 or 224). A combination of these and other waste types may have been released.

Additional investigations are needed to better quantify UPRs. Data needs for UPRs will be determined through data quality objective workshops in support of T Farm performance assessments and corrective management studies.

Figure 5-3. Spectral Gamma Logging Visuals.



6.0 FACILITIES IN OR NEAR 241-T TANK FARM

The following sections describe facilities in or near T Farm that were utilized during waste transfer operations. Potential impacts of past releases or potential future releases to the ground from these facilities should be considered in performance assessments. These facilities are described in more detail in:

- DOE/RL-91-61, *T Plant Source Aggregate Area Management Study Report*,
- BHI-00177, *T Plant Aggregate Area Management Study Technical Baseline Report*,
- DOE/RL-88-30, *Hanford Site Waste Management Units Report*,
- RPP-PLAN-25942, *Waste Management Area Integration Study Waste Management Area T*,
- SGW-49498, *Geophysical Logging Report for 200-DV-1 Operable Unit Waste Sites in the T Complex Area*,
- RPP-26744, *Hanford Soil Inventory Model, Rev. 1*,
- PNL-6456, *Hazard Ranking System Evaluation of CERCLA Inactive Waste Sites at Hanford*, and
- RHO-CD-673, *Handbook 200 Area Waste Sites (Volumes 1, 2 and 3)*.

Figure 6-1 shows the location of the facilities presented.

6.1 241-T DIVERSION BOXES

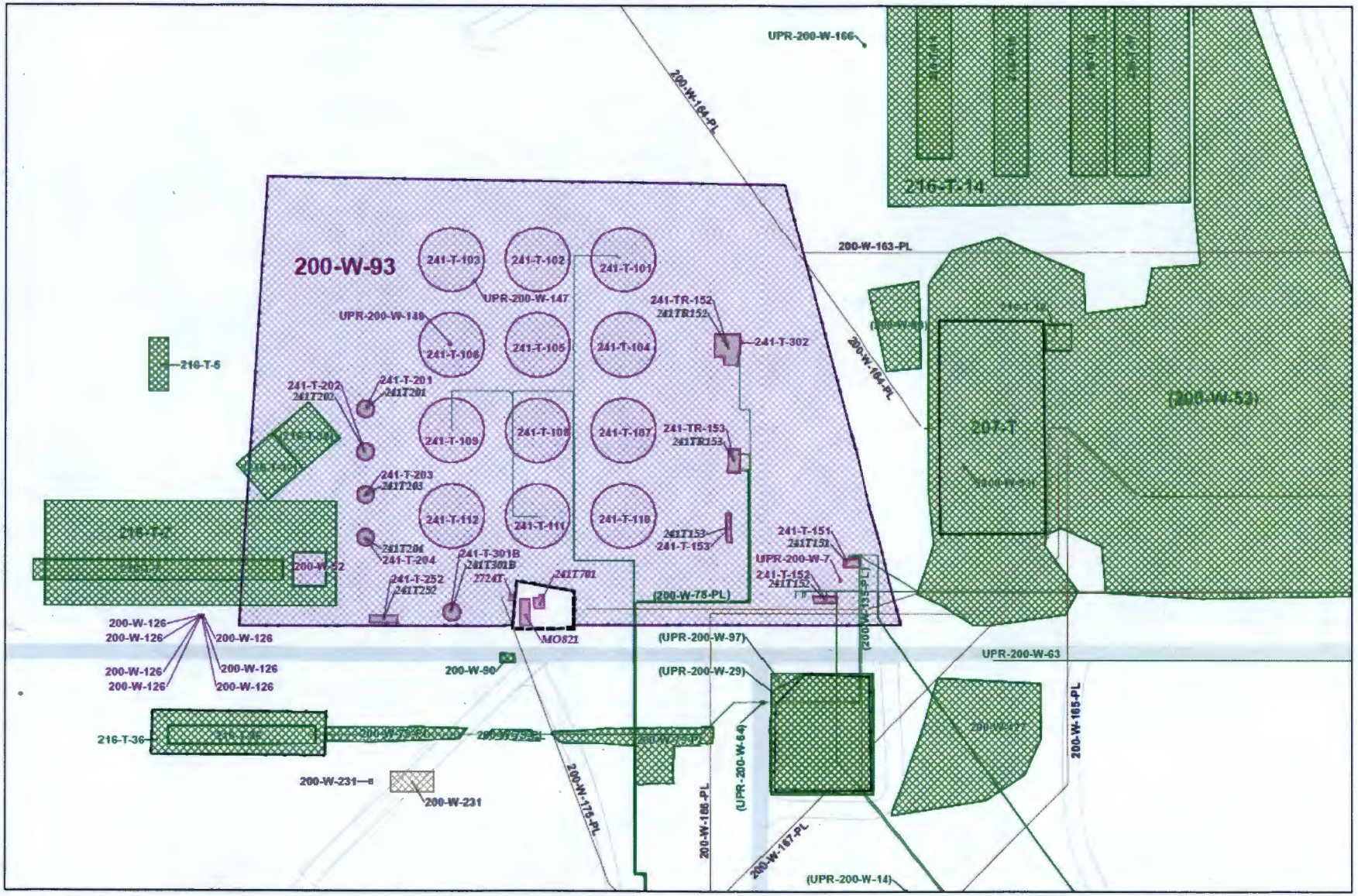
241-T-151 DIVERSION BOX

The 241-T-151 diversion box is located southeast of tank T-110 and directly north of the 241-T-152 diversion box, and is interconnected with tank T-110, 241-U-151 diversion box, 221-T canyon building, and T Farm. The box is 20 ft by 5 ft by 1 ft and has been sprayed with plasticized foam.

241-T-152 DIVERSION BOX

The 241-T-152 diversion box is located southwest of the 207-T retention basin, just north of 23rd Street and interconnects with the 241-T-153 diversion box, 241-TX-153 diversion box, 241-T-155 diversion box, and the 221-T canyon building. The box is located ~10 ft north of 241-T-151 diversion box. The appearance is similar to 241-T-151 diversion box and it has also been coated with a protective foam layer.

Figure 6-1. 241-T Tank Farm and Nearby Facilities.



241-T-153 DIVERSION BOX
The 241-T-153 diversion box is located east of tank T-110 and is interconnected with the 241-TX-153 diversion box, 241-T-155 diversion box, and the 221-T canyon building.

6.2 216-T CRIBS AND TRENCHES

A comprehensive summary of borehole geophysical logging results for WMA T is included in SGW-49498.

216-T-5 TRENCH
This site is located 300 ft north of 23rd Street and 1,000 ft west of the 207-T retention basin. The trench is west of the 216-T-32 crib and north of the 216-T-7 crib and tile field and is enclosed by a light chain barricade.

About 700,000 gal of second-cycle supernatant waste was received from the 221-T canyon building via tank T-112. The waste is high salt, neutral/basic, and includes 345 metric tons of inorganic compounds. The trench is a specific retention trench, and was taken out of service when it received the prescribed liquid waste volume. When deactivated, the aboveground piping was removed and the trench was backfilled. Well W10-1 is used to monitor the trench. Since 1959 the radioactivity has decreased and in 1976 the radiation levels were near background. In May 1955 the trench/crib contained 42 Ci of ^{137}Cs. RPP-26744 shows inventory estimates for discharges to this trench.

216-T-7TF CRIB AND TILE FIELD
The 216-T-7TF crib and tile field are 50 ft north of 23rd Street and 1,000 ft west of the 207-T retention basin. The crib is within the southwest quarter of T Farm while its tile field is outside the tank farm fence. The site received second-cycle supernatant waste from the 221-T canyon building via tank T-112 and cell drainage from tank 5-6 in the 221-T canyon building.

The crib also received waste from the 224-T building after sludge buildup in the 201-T through 204-T tanks caused the closing of the 216-T-32 crib. The site was deactivated by capping the pipeline to the crib and rerouting the effluent to the 216-T-19 crib.

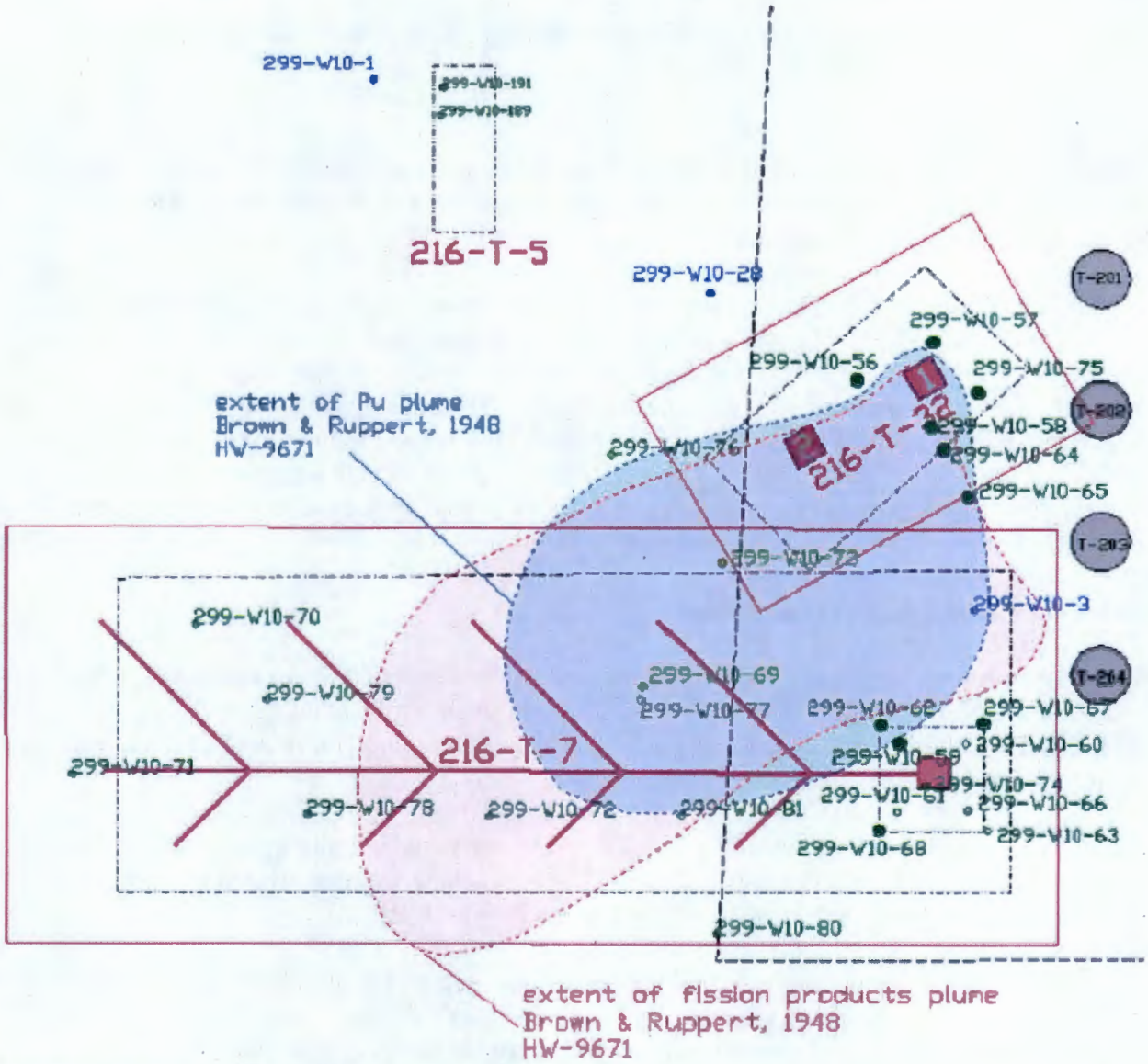
The crib and tile field received ~29,000,000 gal of high-salt and neutral/basic waste containing 5,170 metric tons of inorganic compounds. Radionuclides include: ^{137}Cs, ^{106}Ru, ^{90}Sr, ^{60}Co, ^{238}U, and plutonium. RPP-26744 shows inventory estimates for discharges to the crib and tile field.

Monitoring wells surround this crib and tile field (see Figure 6-2). Scintillation profiles from well 299-W10-3 suggest radionuclides beneath the 216-T-7 crib have moved downward in the sediment column between 1959 and 1976. The data from this well also indicate that breakthrough to groundwater could have occurred at this site.

The crib is located within the T Farm chain-link fence barricade. The barricade around the tile field consists of a light chain fence that extends west from the tank farm and north of the

216-T-14, 216-T-15, 216-T-16, and 216-T-17 trenches and encloses the 216-T-5 trench. The fence is labeled with both underground and surface contamination signs. The wooden crib in use April 1948 to November 1955 contained 33 Ci of ^{90}Sr and 29 Ci of ^{137}Cs in 1977. The pipeline is capped.

Figure 6-2. Monitoring Wells for Cribs in 241-T Tank Farm.



Reference: HW-9671, *Underground Waste Disposal at Hanford Works.*

216-T-12 TRENCH

The 216-T-12 trench is an inactive waste site located about 300 ft north of 23rd Street and 1,800 ft west of the 224-T building. The unit received ~1.3,000,000 gal of contaminated sludge from the 207-T retention basin reading 15 mR/h at the time of burial. The radioisotopes thought to be present are ^{137}Cs, ^{106}Ru, and ^{90}Sr. RPP-26744 shows inventory estimates for discharges to this trench.

The site was deactivated when sludge was removed from the retention basin and the basin was backfilled with clean soil. This trench is enclosed within a chain barricade surrounding 207-T retention basin and the 216-T-14 through 216-T-17 trenches. The site is not marked.

216-T-14 THROUGH 216-T-17 TRENCHES – Specific Retention Trenches
These trenches are inactive waste sites located ~2,000 ft west of the 224-T building and 50 yards north of the 207-T retention basin. Trenches 216-T-14, 216-T-15, and 216-T-16 each received ~265,000 gal of waste and trench 216-T-17 received ~200,000 gal of first-cycle supernatant waste from the 221-T canyon building via tanks T-104, T-105, and T-106 in T Farm. The waste is high salt and is neutral/basic. The radioisotopes thought to be present are ^{137}Cs, ^{106}Ru, and ^{90}Sr. The inorganics known to be discharged to these locations are fluoride, nitrite, phosphate, sodium, sodium aluminate, sodium hydroxide, sodium silicate, and sulfate. RPP-26744 shows inventory estimates for discharges to these trenches.

The sites were deactivated after they reached the prescribed liquid waste volume for the specific retention trench in the 1960s. The aboveground piping was removed and the unit backfilled. In May 1970, radioactive russian thistles were found growing on these units and had a maximum reading of 15 mR/h. To clean these sites, the weeds were removed and the entire surface of the radiation zone was treated with Trisden-dimethylamine salts of Trichlor Obenzonic. The herbicide treatment was completely effective until the summer of 1976, when a few nonradioactive weeds appeared.

These trenches are enclosed within a light barricade. Labeled concrete posts identify the trenches. Approximately 200 ft east of the trenches and across the railroad tracks is a temporary drill rig area exclusion zone and three surface contamination sites. Two of the surface contamination zones are "spot" contamination marked by a small enclosure. The third zone is ~40 ft by 20 ft and encloses several small yellow plastic radiation flags.

216-T-32 CRIB
The 216-T-32 crib is located 250 ft north of 23rd Street and 750 ft west of the 207-T retention basin within the confines of T Farm. The crib consists of two wooden vaults, 40 ft apart. The cribs were fed by a single line leading from the 201-T tank.

The site received waste from the 224-T building via the 241-T-201 tank in T Farm. The crib received ~8,000,000 gal of transuranic-contaminated liquid waste containing 2,616 metric tons of inorganic compounds. Radionuclides include ^{137}Cs, ^{106}Ru, ^{90}Sr, ^{60}Co, ^{238}U, and plutonium. The site was deactivated in May 1952 by blanking the line to the crib. The line to the crib east of the 241-T-151 and 241-T-152 diversion boxes was blanked; however, drawing H-2-44511, *Area Map 200 West "T" Plant Facilities*, Sheet 134, shows tank 201 tank series connected directly to the crib. RPP-26744 shows inventory estimates for discharges to this crib. Figure 6-2 indicates the extent of plutonium and fission products in the soils in 1947 prior to the T-7 crib being activated.

The crib is monitored by eight drywells. Low levels of radiation have been detected between 8 and 35 in. bgs. The wooden crib in use November 1946 to May 1952 contained 15 Ci of ^{90}Sr,

13 Ci of ^{137}Cs, 3.2 kg plutonium and 22.7 kg uranium in 1978. The pipeline to the crib blanked east of the T-151 and 152 Diversion Boxes.

216-T-36 CRIB

The 216-T-36 crib is located southwest of T Farm and south of the 216-T-7 Tile Field. This crib received ~140,000 gal of steam condensate, equipment decontamination waste, and miscellaneous waste from the 221-T and 221-U Buildings. It also received decontamination waste from the 2706-T Building. The crib operated between 1967 and 1973. In 2000 the vent risers were sealed, a layer of clean gravel was placed over the contamination area on the pipeline east of the crib and the area was down posted to a Radioactive Material area. RPP-26744 shows inventory estimates for discharges to this crib.

6.3 207-T RETENTION BASIN

The 207-T Retention Basin is a concrete structure, divided into two sections, with a 3.8 million-L (1 million-gal) capacity. The basin received cooling water effluent from the 221-T and 224-T complexes. The basin effluent was released to the 216-T-4-1 and 216-T-4-2 ditches. It is reported in WIDS and RHO-CD-673 that the 216-T-4-1 ditch received over 11 billion gal of waste from the 207-T Retention Basin between 1944 and 1972. The amount of waste sent to the 216-T-4-2 ditch is unknown. An inlet structure is on the east side and an outlet structure on the west side, adjacent to the outside walls of the retention basin. Approximately 1,830 m (6,000 ft^3) of 61-cm- (24-in.-) diameter vitrified clay pipeline was used to convey waste water to and from the basin. Periodically the sludge that accumulated on the bottoms of the basins was cleaned out. The sludge was placed in holes located around the perimeter of the basin and covered with clean dirt. One of these holes is documented as 216-T-12. Additional holes were probably dug and filled with sludge, but not individually documented.

An area located north of the 207-T Basin was originally designated as UPR-200-W-166 (alias UN-216-W-31). The contaminated soil was scraped and placed on top of the 216-T-14 through 216-T-17 trenches and covered with clean soil. In 1992 additional contamination was identified east of the 207-T Basin in 1994; it was assumed to be from the same source and also called UPR-200-W-166. In May 1996, 3 to 18 in. of the contaminated soil east of the 207-T Basin was scraped and placed inside the basin as fill material. The basin was then capped with 18 to 24 in. of clean dirt. The area was downposted from a Surface Contamination Area to Underground Radioactive Material.

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TFC-ENG-CHEM-D-42, Rev. B-6, "Tank Leak Assessment Process," Washington River Protection Solutions, LLC, Richland, Washington.

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WHC-EP-0873, 1996, *Engineering Evaluation of Alternatives: Managing the Assumed Leak from Single-Shell Tank 241-T-101*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-ER-337, 1994, *Engineering Report Managing the Assumed Leak from Single-Shell Tank 241-T-111*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

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APPENDIX A

241-T FARM TANK LEAK ASSESSMENT MEETING SUMMARIES

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LIST OF MEETING MINUTES

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REFERENCES A-24

LIST OF TERMS

BBI	Best-Basis Inventory
DOE	U.S. Department of Energy
ECOLOGY	Washington State Department of Ecology
FIC	Food Instrument Corporation (gauge)
HRLS	high rate logging system
ILL	interstitial liquid level
LEL	Lower explosive limit
LOW	liquid observation well
ORP	DOE Office of River Protection
P&T	pump and treat
PER	problem evaluation request
PUREX	Plutonium Uranium Extraction (Plant)
RAS	Radiation Assessment System
REDOX	Reduction-Oxidation (S Plant)
SGLS	spectral gamma logging system
SST	single-shell tank
TBP	tri-butyl phosphate
TOC	total organic carbon
UPR	unplanned release
WMA	Waste Management Area
WRPS	Washington River Protection Solutions, LLC

Waste Type Abbreviations

1C	Bismuth phosphate process first cycle decontamination waste
1C1	Bismuth phosphate process first cycle decontamination waste and coating waste (1944-1949)
224	224 Building lanthanum fluoride finishing waste
2C	Bismuth phosphate process second cycle decontamination waste
BL	221-B Plant low-level waste
CSR	cesium recovery by ion exchange waste
CW	cladding (coating) waste
CWP2	PUREX cladding waste, aluminum clad fuel (1961-1972)
CWR1	REDOX cladding waste, aluminum clad fuel (1952-1960)
IX	ion exchange waste
MW	metal waste
T1-Saltcake	Saltcake from the 1951-1956 242-T Evaporator campaign

MEETING SUMMARY

washington river protection solutions

From: L. A. Fort
Phone: 376-3753
Location: Ecology Office,
Date: March 19, 2013
Subject: Tank Farm Leak Inventory Assessments

To: Distribution/Attendees

Attendees:

Jim Alzheimer, ECOLOGY
Mike Barnes, ECOLOGY
Joe Caggiano, ECOLOGY
Les Fort, WRPS
Paul Henwood, S. M. Stoller

PURPOSE:
The purpose of these meetings are to resume tank farm release inventory assessments specifically for the T and TX tank farms, review the assessment process, and review previous T and TX tank farm meeting summaries and conclusions. This meeting discussed the release assessment information prepared addressing designated assumed leaking tanks T-101, T-103, and T-106.

Review Previous Meeting Summaries and Actions:
The draft meeting summaries for March 5, 2013 were reviewed and approved. It was noted that, although not discussed at the March 5 meeting, the 200 West pump and treat operations have affected groundwater flow direction and velocity beneath TX Farm. It was clearly expressed that using the TY Farm results for the groundwater section of the TX Farm assessment report may not be applicable. One or more up-gradient wells at TX were used as extraction wells during the limited pump and treat operation before the current 200 West groundwater treatment system came online. It was advised that the groundwater section of the TX Farm assessment report needs to reflect the conditions at TX Farm and should not merely use the TY Farm leak assessment report section. Probably should also note that the limited P&T affected the water table elevation and groundwater flow direction in TX Farm; the expanded P&T is likely to do the same depending on volume and location of extraction wells.

Assessment of tanks T-101 and T-103 and T-106
Information presented and discussed by the assessment team will be included in the T Farm assessment report. A brief summary of the T tank Farm history and current conditions of all the farm tanks was presented as an introduction; as well as picture and placement orientation of the interim surface barrier that resides over the center of the tank farm. Also provided as part of the introduction was a brief summary of the seven tanks currently classified as "assumed leakers" in HNF-EP-0182 (recognizing that tank T-106 has been designated as a confirmed leaker in many related documents). In other farms, the assessment team has not always agreed with the designations in Hanlon.

T-101

Tank T-101 was filled with coating waste (535,000 gal) in 1963 that was stored until early 1969. An unplanned release occurred in early 1969 when the tank was overfilled (539,000 gal) and an undetermined amount of tank waste overflowed to the soil column through a spare fill line. Following the overflow most of the metal waste was transferred. The tank did not receive additional waste until 1972 when the tank received waste from the SX and BX Tank Farms. Tank T-101 was reclassified as non-complexed waste. The tank was removed from service in 1979. Tank T-101 was declared an assumed leaker in October 1992 (occurrence report RL-WHC-TANKFARM-1192-0073) based on a liquid level decrease of 2.6 inches, formulating the basis for the estimated leak volume of 7,500 gallons. An engineering evaluation of alternatives (WHC-EP-0873) for addressing the 1992 occurrence report findings found that the surface level gage in tank T-101 has largely corrected itself since the midyear 1992 reading and it was doubted that a leak had occurred. The liquid portion of the stored waste in tank T-101 was pumped in 1993 by directive from Ecology. Spectral gamma logging of the drywells about tank T-101 clearly shows a large contamination plume that corresponds to the location of the spare lines. The information obtained from in-tank liquid-level observations made in 1992 remains as the only evidence that the integrity of tank T-101 failed and as the reason for the tank's classification as an assumed leaker.

The assessment team also discussed the corrosion aspects of TBP waste (since tank T-101 received the process test waste in 1953) and the affects this waste has on instigating stress corrosion cracking. Previous corrosion work performed in the 1980s and 1990s provided mitigation strategies.

There was discussion on the tank T-101 drywell plume in that it clearly illustrates there was a release from the spare in-lets and further assessment is warranted. It was also discussed that this particular case could be used as a basis in future waste release determinations. The assessment team concluded that the TFC-ENG-CHEM-D-42 Tank Leak Assessment Process be undertaken for tank T-101.

The assessment team discussed the concept of establishing a priority for the tanks to undergo the TFC-ENG-CHEM-D-42 Tank Leak Assessment Process. To date six assessments have been completed and currently there are three assessments in progress (AX-102, C-101, and B-107). Also to date there has been an additional 40 tanks identified needing to undergo the TFC-ENG-CHEM-D-42 Tank Leak Assessment Process. An action was given for L. Fort to talk with Don Harlow/Dennis Washenfelder about establishing a priority list of tanks to undergo the TFC-ENG-CHEM-D-42 Tank Leak Assessment Process and the possibility of increasing the number of assessment completed per year.

T-103

Tank T-103, was classified in March 1974 as having questionable integrity based on a .3 inch liquid level decrease, which took place from November 1973 to February 1974 (LET-051480, *Review of Classification of 4 Hanford Single Shell [SST] Questionable Integrity Tanks*). Initial classification of questionable integrity is documented as an inlet line overflow (SD-WM-TI-356, *Tank 103-T*). No Occurrence Report was generated. Subsequent analysis by various groups referenced herein identifies four possible explanations for classification of questionable integrity for tank T-103. These explanations include cascade line overflow, erratic liquid level readings

due to irregularly shaped floating solids on the liquid level surface, grout seal failure on the inlet lines, and general cooling of waste materials.

While there is no single explanation that conclusively defines the source of the liquid level decrease which inspired the classification of questionable integrity, it is postulated that if the leak in tank 241-T-103 had occurred, it was likely very high up in the tank near the inlet lines. The likelihood of a release from T-103 became evident during the investigation of a leak from adjacent tank T-106. The assessment team concluded that the TFC-ENG-CHEM-D-42 Tank Leak Assessment Process be undertaken for tank T-103.

T-106

At the end of March 1973, tank T-106 contained approximately 78,000 gal of liquid and sludge, consisting primarily of REDOX coating waste with smaller amounts of B Plant low-level waste and ion-exchange waste. On April 4, 1973, transfers of ion-exchange waste from tank T-107 to tank T-106 via the cascade through tank T-105 began. Tank T-106 was declared a confirmed leaker on June 8, 1973 on the basis of observed decreases in the liquid level of ~42 inches equivalent magnitude inside tank T-106 and elevated radiation counts in drywell 50-08-11 (299-W 10-51) in May and June 1973. The tank was removed from service and pumped to a minimum heel in June 1973. In July 1974, the tank was further pumped down to a residual layer of less than 6 in.

On the basis of in-tank liquid-level measurements, an estimated 115,000 gal of liquid waste leaked from tank T-106 into the vadose zone. The history, status, fate and impact of the 115,000 gallon radioactive waste tank leak from tank T-106 have been studied since 1973 is well documented in RHO-ST-14 (Routson, et al, 1979) and subsequent studies. Furthermore, characterization of the gamma-ray-emitting contamination in the vadose zone surrounding tank T-106 clearly indicates that a very extensive subsurface contaminant plume exists around and below the base of the tank. The leak source is located on the southeast side of the tank, nearest to drywells 50-06-05 and 50-06-17. The plume extends radially outward as much as 100 feet from the leak source.

The assessment team concluded that documentation clearly shows that tank T-106 integrity had failed and the waste volume released has a basis; no further action is warranted.

ACTIONS:

1. L. Fort: Prepare and distribute March 19, 2013 Meeting Summary
2. L. Fort: Prepare the discussions for tanks T-107, T-108, and T-109.
3. L. Fort/J. Field: Prepare TX-Farm leak inventory assessment report
4. L. Fort/J. Field to talk to Don Harlow//Dennis Washenfelder about establishing a priority list of tanks to undergo the TFC-ENG-CHEM-D-42 Tank Leak Assessment Process and the possibility of increasing the number of assessment completed per year.
5. All: Review meeting summary. Send redline comments to J. Field.

NEXT MEETING:

April 2, 2013, 1:00 to 2:30. Assess leak inventory for tanks T-107, T-108, and T-109.

MEETING SUMMARY

washington river protection solutions

From: J. G. Field
Phone: 376-3753
Location: Ecology Office,
Date: April 2, 2013
Subject: Tank Farm Leak Inventory Assessments

To: Distribution/Attendees

Attendees:

Jim Alzheimer, ECOLOGY
Mike Barnes, ECOLOGY
Joe Caggiano, ECOLOGY
Jim Field, WRPS
Les Fort, WRPS
Paul Henwood, S. M. Stoller
Jeremy Johnson, ORP

PURPOSE:
The purpose of these meetings are to resume tank farm release inventory assessments specifically for the T and TX tank farms, review the assessment process, and review previous T and TX tank farm meeting summaries and conclusions. This meeting discussed the release assessment information prepared addressing designated assumed leaking tanks T-107, T-108, and T-109.

Review Previous Meeting Summaries and Actions:
The draft meeting summaries for March 19, 2013 were reviewed and approved. A sentence suggesting that the T-106 contaminant plume has remained stable since 1974 was removed. As discussed, logging of drywells in 2008 showed that contaminant migration is continuing. It was noted that T farm assessments need to consider not only historical gamma logging and 1998 SGLS logging results, but also the results of 2008 drywell logging and characterization in support of barrier planning.

Regarding the action to investigate the status and priority of recommended TFC-ENG-CHEM-D-42 assessments it was found that there is currently no funding for new assessments. An action was taken to send assessment team members the status of leak inventory assessments and recommendations (RPP-23681 assessments) and TFC-ENG-CHEM-D-42 assessments conducted as a result of the leak inventory assessments.

The TX farm report is being developed. Due to the schedule to complete the report it was determined that the historical tank waste table included in previous reports will not be included in the TX or T-Farm reports. However, a more complete figure showing tank waste history will be included. This figure will be taken from the Historical Tank Estimate for the Northwest Quadrant of the Hanford 200 Area, WHC-SD-WM-ER-351 and includes most of the information that would have been in the tables.

Assessment of tanks T-107 and T-108 and T-109
Information presented and discussed by the assessment team will be included in the T Farm assessment report.

T-107 Assessment
First-cycle decontamination (1C1) waste was added to tank T-107 in the first quarter of 1945. Based on the waste transfer history, the sludge stored in tank T-107 is comprised of 147,700 gallons of 1C/CW sludge from the 221-T Bismuth Phosphate Plant, 8,400 gallons of Tri-Butyl Phosphate Plant and 16,900 gallons of PUREX coating removal waste that contains interstitial liquids. The tank was declared a "questionable integrity" tank in April 1976 and removed from service when gross gamma logging measurements in drywell 50-07-03 indicated a radiation peak at 42 ft. The tank was classified as an "assumed leaker" in 1984.

The maximum waste height recorded for tank T-107 was 536,000 gal, 24 in. below the top of the steel liner; however, photographs presented indicate that the tank may have been filled to above the liner and the spare inlet level. The waste-level measurement device (Food Instrument Corporation [FIC] unit) provided erratic waste-level measurements from June, 1973 through March, 1976. The FIC indicated that the tank waste level may have decreased by about 0.4 in (~ 1,100 gal) between September, 1975 and January, 1976 (WHC-SD-WM-TI-356).

Drywell 50-07-03, located on the east side of tank T-107, showed increased radiation monitoring readings from 300 to 1,100 cps between July 1975 and March 1977, then slowly decreased. Drywell 50-07-07 radiation readings have decreased since 1974 (RPP-6088). Although the radiation was detected at depths near the tank base, Occurrence report 76-60 concluded that the slow increase in radiation indicates the radioactivity was ruthenium and "suggests a contamination source other than a tank leak." Although some of the radioactivity in 1976 was likely ruthenium, the evaluation of Historical gamma measurements from 1975 to 1995 (RPP-6088) and SGLS data indicates that ^{60}Co and ^{137}Cs are also present.

A previous assessment concluded, "that there is sufficient evidence to indicate that the activity observed in drywells 50-07-03 and 50-07-07 were likely from a leak near the base of SST T-107" (RPP-20820). However, the location and nature of the plume and in-tank photos indicating the tank may have been overfilled also suggest the possibility of a spare inlet overflow. Characterization near the spare inlets is recommended to further assess the source of ^{137}Cs and ^{60}Co in drywells 50-07-03 and 50-07-07, the inventory of waste released to the soil and tank T-107 integrity. It was determined that the current data is insufficient to estimate a leak volume or inventory for this tank. The assessment team determined that a review of all available information according to the TFC-ENG-CHEM-D-42 procedure was advisable. However, a tank leak can't be ruled out at this time and additional characterization is needed before an assessment is performed.

T-108 Assessment
Waste was first added to tank T-108 in September 1945. Based on the waste transfer history, the waste stored in tank T-108 consists of 3 kgal of T1-Saltcake liquid, 8 kgal of T1-Saltcake, and 5 kgal of 1C sludge. Tank T-108 was removed from service and classified as questionable

integrity in 1974 based on an unexplained decrease in liquid level of 0.3-in. between June 1973 and April 1974 (RHO-CD-896).

In 1975 a 0.6 in liquid level decrease was reported in an occurrence report over a period of three weeks and an increase in radiation was reported in dry well 50-05-06 (OR-75-02). Occurrence report 76-56 followed for increased radiation in drywell 50-08-09. Both occurrence reports and studies in 1978 concluded that the drywell activity was associated with the T-106 tank leak (RHO-CD-213). In OR-78-60 reported increased radiation in drywell 50-08-07, also attributed to a leak from T-106, however, OR-79-75 re-evaluated the source of increased radiation in drywell 50-08-07 and concluded that the cause of the increasing activity of drywell 50-08-07 could not be determined. OR-77-186 reported a 0.75 in increase.

Liquid level measurements were determined to be erratic and inconclusive. Report HNF-WM-ER-351 indicated that the tank was filled above normal capacity in 1974. Consequently a spare inlet overflow may have contributed to radiation observed in the drywells.

For purposes of inventory estimates, the inventory of drywell activity near tank T-108 will be included with tank T-106 estimates. Given the probability of migration from tank T-106 and/or a tank overflow, a tank integrity assessment (TFC-ENG-CHEM-D-42) is recommended for tank T-108. However, a tank leak can't be ruled out at this time and additional characterization may be needed before an assessment is performed.

T-109 Assessment

Waste was initially added to tank T-109 in the fourth quarter of 1945 with the cascade of first cycle decontamination waste from the bismuth phosphate process (1C)) from tank T-108. The waste history shows that most of the C1 waste was removed from the tank and the tank currently contains 62 kgal of T1-Saltcake waste.

The tank was declared questionable integrity in 1974 and was removed from service as a result of increasing activity in drywell 50-09-10 at a depth of 32 ft bgs (RHO-CD-896). Gamma activity in drywells 50-09-01, 50-09-02, 50-09-09 and 50-09-10 has decreased since 1976 (See OR-74-108). The source of drywell activity has been attributed to migration from tank T-106 (GJ-HAN-122).

The waste level data does not indicate a liquid loss from tank T-109; however, report HNF-SD-WM-ER-351 shows that the tank was overfilled to near the spare inlet ports between 1965 and 1970. In 1973 the reported waste level was 5.1 in. below the spare inlets. Photographs show solids in the spare inlet ports, indicating that supernate may have been released from the spare inlet ports to the soil.

Plots of radioactivity in the T tank farm show ^{137}Cs contamination from the surface to 10 ft bgs near tank T-109. There is no contamination detected in drywell 50-09-10 until ~ 39 ft bgs, with ^{60}Co and ^{154}Eu and no ^{137}Cs being detected at this elevation. The ^{60}Co and ^{154}Eu contamination detected in drywell 50-09-10 extends downward to 71 ft bgs. The absence of ^{137}Cs detected in drywell 50-09-10 suggests the contamination source is not located near this drywell and indicate the source of contamination detected in drywell 50-09-10 originated from the tank T-106 leak.

Given the probability of migration from tank T-106 and a tank overflow, a tank integrity assessment (TFC-ENG-CHEM-D-42) is recommended for tank T-109.

ACTIONS:

1. J. Field: Prepare and distribute April 2, 2013 Meeting Summary
2. L. Fort: Prepare the discussions for tanks T-111 and T-102.
3. L. Fort/J. Field: Prepare TX-Farm leak inventory assessment report
4. J. Field: Send tank leak assessment status spreadsheet to team members.
5. All: Review meeting summary. Send redline comments to J. Field.

NEXT MEETING:

April 16, 2013, 1:00 to 2:30. Assess leak inventory for tanks T-111 and T-102.

washington river protection solutions

MEETING SUMMARY

From: J. G. Field
Phone: 376-3753
Location: Ecology Office,
Date: April 24, 2013
Subject: Tank Farm Leak Inventory Assessments

To: Distribution/Attendees

Attendees:

Jim Alzheimer, ECOLOGY
Mike Barnes, ECOLOGY
Joe Caggiano, ECOLOGY
Jim Field, WRPS
Paul Henwood, S. M. Stoller
Jeremy Johnson, ORP

PURPOSE:
The purpose of these meetings are to resume tank farm release inventory assessments specifically for the T and TX tank farms, review the assessment process, and review previous T and TX tank farm meeting summaries and conclusions. This meeting discussed the release assessment information prepared addressing designated assumed leaking tank T-111.

Review Previous Meeting Summaries and Actions:
The draft meeting summary for April 2, 2013 was reviewed and approved. Contents of a "Tank Leak Assessment Status Matrix," included in the summary were discussed. It was observed that waste inventory estimates can be developed based on drywell data. Inventories should be estimated for some of the B and BY tanks where "no basis" is currently listed in the column "New Estimate (gal)." It was agreed that tank C-108 should be listed separately in the matrix because further investigations are in progress to assess ^{60}Co movement in drywells near tank C-108. Finally, it was suggested that characterization recommendations in tank farm leak assessment reports be included in the matrix, as applicable, and the matrix should note when characterization is recommended prior to TFC-ENG-CHEM-D-42 assessments. WRPS will update the matrix accordingly.

Mike Barnes enquired as to any schedule or funding for recommended TFC-ENG-CHEM-D-42 assessments and characterization. There is currently no schedule or funding for these tasks.

Tank T-111 Assessment
Tank T-111 was brought into service during the fourth quarter of 1945 when second cycle decontamination (2C) waste cascaded from tank T-110. From 1952 to 1956, tank T-111 was used to cascade 2C and lanthanum fluoride waste (224) from the lanthanum fluoride finishing process in T-Plant. From 1974 to 1976 supernate was transferred out of the tank. The tank was saltwell pumped between 1990 and 1995 and declared interim stabilized in 1995.

Tank T-111 was characterized as questionable integrity and declared inactive in 1976 based on a 0.3 in liquid level decrease in 1974 (WHC-SD-WM-TI-356). Questionable integrity tanks were re-designated as assumed leakers in 1984. Several occurrence reports were reviewed for liquid level increases and decreases in tank T-111. A gradual increase in the interstitial liquid level of 1.5 in. was observed between 1980 and 1992. The increase was followed by an abrupt 1.6 in. decrease in the interstitial liquid level in 1993. The ENRAF and LOW levels again gradually increased between about 1997 and 2008 and have continued to decrease from 2008 to present. Of interest is that the rate of increase and rate of decrease of the waste surface and interstitial liquid levels are nearly parallel. The panel noted that for a tank leak, the solids surface level (measured by the ENRAF) would be expected to decrease at a slower rate than the interstitial liquid level, measured by the LOW. Also discussed, was the general uncertainty associated with ILL measurements in sludge.

In-tank photographs and historical surface level measurements show that the tank was filled above the cascade level, indicating the possibility of a spare inlet or cascade line release. If this occurred, it would have been between 1957 and 1973.

Tank T-111 was added to the Organics Watch List in 1994 because of high energetic results from safety screening analyses of core samples. The TOC was analyzed for the purpose of determining the fuel content of the tank waste. The TOC results exceeded the threshold for fuel content concerns, however, it was determined that because of the high moisture content of the waste, the high TOC would not impact tank safety.

Historical drywell data and SGLS data indicate that surface spills have occurred, but do not indicate leakage from tank T-111. The gamma activity located in drywells 50-11-11 and 50-08-07 is attributed to a leak from tank T-106.

Several assessments have been conducted to assess whether tank T-111 was leaking or is currently leaking:

A 1979 review concluded that tank T-111 should remain classified as "Questionable Integrity" (RHO-CD-896).

An Integrity Investigation of tank T-111 done in February 1994, reviewed riser levels, evaporation losses, FIC and LOW equipment, and potential gas build-up and releases and drywell data and concluded,

"Review of the above information shows:

1. SL and ILL are both showing a decrease
2. The decrease cannot be accounted for
3. Riser elevations are within reasonable range, and
4. Drywell data is inconclusive"

The report also concluded that, "it cannot be stated that the tank is not leaking. ...the tank should be re-classified as an assumed re-leaker. Emergency pumping preparations should commence immediately." (TFC60-74-016).

In May, 1994 a report was prepared providing investigation findings and recommended actions for safe management of the tank T-111 waste (WHC-SD-WM-ER-337). The report states, "The tank appears to have emitted built-up gases (i.e. burped) or leaked liquids. Presently, there is no way to distinguish between the two activities." The report notes that the gradual increase in the waste level (1.5 in. between 1980 and 1992) followed by a rapid decrease (1.6 in. in 1993) is similar in pattern to the waste behavior observed in tanks on the hydrogen watch list. However, it is much longer." An evaluation concluded that if the level decrease was due to gas release it would not have exceeded 25% of the LEL and the tank was not recommended to be added to the flammable gas watch list. As a result, "the safest and most prudent management action is to classify tank T-111 as an assumed leaker and prepare the tank for pumping on an emergency basis."

In November 2012, PER-2012-1977 was submitted for liquid level decreases greater than 3 standard deviations and recommending additional assessments. PER-2013-0056 was submitted 1/13/2013 to track assessments, this PER is in progress. On 2/15/2013, tank T-111 was reported by the governor's office and in the media as a possible re-leaker. On 2/16/2013 a shift operations emergency notification was submitted (PER-2013-0262) and required notifications to DOE and offsite agencies were initiated for liquid level decreases in tank T-111. Additional investigations of tank T-111 and a report documenting investigations are in progress. The tank leak inventory assessment team determined that a leak volume estimate and recommendations for this tank should be deferred until the report is completed.

A discussion by the team regarding soil contamination around the tank revealed that only two of the 10 drywells around tank T-111 have been monitored since the tank began indicating liquid level decreases in the 2007 timeframe. These two drywells (50-08-19 and 50-08-07 were monitored only below 70 ft in depth in 2008. A recommendation was considered to log these drywells to update the soil contamination profile. This information would be important to help corroborate the findings in the pending report.

ACTIONS:

1. J. Field: Prepare and distribute April 24, 2013 Meeting Summary
2. L. Fort/J. Field: Prepare the discussions for tanks T-102 and UPR's
3. J. Field: Prepare TX-Farm leak inventory assessment report
4. All: Review meeting summary. Send redline comments to J. Field.

NEXT MEETING:

April 30, 2013, 1:00 to 2:30. Assess leak inventory for UPR's and tank T-102.

washington river protection solutions

MEETING SUMMARY

From: J. G. Field
Phone: 376-3753
Location: Ecology Office,
Date: April 30, 2013
Subject: Tank Farm Leak Inventory Assessments

To: Distribution/Attendees

Attendees:

Jim Alzheimer, ECOLOGY
Mike Barnes, ECOLOGY
Joe Caggiano, ECOLOGY
Jim Field, WRPS
Paul Henwood, S. M. Stoller
Jeremy Johnson, ORP
Beth Rochette, ECOLOGY
Maria Skorska, ECOLOGY

PURPOSE:
The purposes of these meetings are to resume tank farm release inventory assessments specifically for the T and TX Tank Farms, review the assessment process, and review previous T and TX tank farm meeting summaries and conclusions. This meeting discussed the unplanned releases in and near T-Farm and tank T-102, currently classified as a sound tank.

Review Previous Meeting Summaries and Actions:
The draft meeting summary for April 24, 2013 was reviewed and approved. A question was asked whether 224 waste in tank T-111 was sent to the T-200 tanks between 1952 and 1956 before being transferred to a crib or was sent directly to a crib. RPP-13873 shows that the T-200 tanks were filled in1952 and 224 and waste was redirected to the T-110 through T-112 tanks. Waste from these tanks was sent directly to the T-7 crib and tile field. A paragraph was added to the meeting summary to document the team recommendation to re-log the drywells around the tank in support of integrity evaluations for tank T-111.

Unplanned Releases
Potential waste losses through spare inlets and a table of unplanned releases in T Farm were discussed. The following sources were reviewed to compile a list of unplanned releases:

- DOE/RL-88-30, rev. 22, 2013, *Hanford Site Waste Management Units Report*, Fluor, Richland WA
- RPP-RPT-29191, 2006, *Supplemental Information Hanford Tank Waste Leaks*, CH2MHILL Hanford Company, Richland WA
- RHO-CD-673, 1979, Handbook 200 Area Waste Sites, Rockwell Hanford Operations, Richland WA

- Waste status summary report for the single-shell tanks from January 1945 through December 1980 (various reports)
- Review of radiation incident reports and T Farm occurrence reports

Release volumes or inventory estimates were not available for most of the unplanned releases. Based on SGLS data and plume visuals in the addendum to the T Farm report (GJO-HAN-27), the inventory of unplanned releases in T farm in the top 10 ft bgs was ~25 Ci of ^{137}Cs (decayed to 1/1/2001). The release volume associated with this inventory depends on the type of waste released. If all of the waste released was 1C or 2C waste (the dominant waste type currently stored in T Farm tanks) the release volume would have ranged from 24,000 gal to over 1 million gal. A combination of these and other waste types was likely released.

In addition to the information presented, a more complete list of current UPR's presented in RPP-PLAN-25942, *Waste Management Area Integration Study Waste Management Area T,* and described in the WIDS data base will be included in the T Farm assessment report. The report will identify consolidated UPRs and specific UPR's in each consolidated area. Specific UPRs discussed were UPRs 200-W-78 and 79, UPR 200-W-14, UPR 200-W-127, UPR 200-W-12, UPR-200-W-97, UPR-200-W-29. A list of Historical Occurrence reports for T Farm was reviewed. The list included several releases along Camden Avenue. Releases near TX and TY Farms and not associated with T Farm were identified and will be included in the TX and TY Farm assessment reports; only releases near T-Farm will be included in the T Farm assessment report.

A description of the T-207 basins and discussion of waste received will be added to the section describing facilities near T Farm and a logging report for 200-DV-1 (SGW-49498,) will be referenced and discussed in the T farm assessment report.

Tank T-102 Assessment

Tank T-102 received metal waste (MW) beginning in 1945 and stored MW through 1957. Most of the MW was transferred and the tank received and transferred PUREX cladding waste (CWP2) and cesium recovery waste (CSR) through 1974. The tank was declared interim stabilized in March 1981 and is currently listed as sound (HNF-EP-0182).

Tank waste level histories and in-tank photographs that were reviewed show the tank was filled above the cascade level between 1965 and 1970. Occurrence reports identify water intrusions into the tank in 1983 and 1989. The tank currently contains 13,000 gal of supernate, well in excess of the interim stabilization criteria of 5,000 gal. However, in 1996 it was recommended that this tank not be pumped for the following reasons (WHC-SD-WM-ER-622, *Recommendation for Interim Stabilization of SSTs B-104, BX-103, T-102 and T-112*):

1. The tank liquid level appears to be stable and does not have any intrusion problems,
2. The tank is sound and is not experiencing any leakage,
3. It is not cost effective to pump this tank.

1983 photographs show that ENRAF in tank T-102 is measuring a liquid surface that appears to extend across the tank. The liquid level increased by 1.8 inches between March 1981 and

December 1983. However, liquid surface level measurements have showed no sign of intrusion and have remained relatively steady since isolation work was completed in 1984 (OR-83-16).

Gamma radioactivity measured in drywells 50-01-09 and 50-02-08 and 50-02-09 was attributed to migration from tanks T-101 and T-103, respectively and possibly T-106. However, the source of a narrow peak of ^{137}Cs activity at about ~40 ft bgs (near the base of the tank) in drywell 50-02-05 has not been explained. Total gamma plots show that gamma activity increased between 1990 and 1994, then gradually decreased. SGLS baseline measurements at the 40 ft level in 1998 reported a concentration of 1850 pCi/g. However, dead time was high and it was acknowledged that the concentration may be higher than measured. The well was not re-logged using a High Rate Logging System (HRLS) at that time because the detector did not appear to be saturated. Four RAS gamma measurements were obtained between July 2001 and 2003. In Sept. 2008 SGLS measurements showed higher dead time and indicated the detector was saturated. HRLS measurements obtained in 2009 showed that the ^{137}Cs concentration in drywell 50-02-05 increased from ~2,000 pCi/g to ~50,000 pCi/g.

As a result of the ^{137}Cs increase, the tank was further evaluated and additional investigations were recommended in an attempt to explain the increase in the ^{137}Cs concentration in drywell 50-02-05 (WRPS-091156, "Drywell 50-02-05 Investigation Plan"). Monthly gamma logging followed by quarterly logging was conducted in 50-02-05 and several surrounding drywells. Initial results are reported in Appendix B of the T-Farm re-baseline logging report (RPP-RPT-44202, *Hanford Geophysical Logging Project Spectral Gamma Re-Baseline Logging for the T-Farm Interim Surface Barrier)*. The logging report states that the increase in ^{137}Cs in drywell 50-02-05 "is a clear indication that there has been a contamination event or that existing contamination has been remobilized." "RAS data collected between 2008 and 2010 indicate that gamma activity has stabilized." It has been about three years since the drywell has been measured.

Based on a maximum 10 ft peak width at drywell 52-02-05 and a 1974 sample from tank T-102, a leak volume of less than 100 gal was estimated. This volume may be too small to detect with ENRAF measurements.

A tank leak integrity assessment (TFC-ENG-CHEM-D-42) is recommended for this tank.

In addition to monitoring, WRPS-091156 and RPP-RPT-44202 recommend direct pushes be done to investigate the potential of waste contamination in the vicinity of drywell 50-02-05 which is in the vicinity of the spare inlet ports at approximately the four o'clock position. Total gamma and moisture logs in the direct push casings will help determine the extent of the contamination and whether moisture is a contributing factor in the migration of contaminants. If possible, the direct push casings should remain in place for periodic monitoring of gamma activity levels and vadose zone moisture content. Finally, an effort should be made to obtain samples of the contaminated soil. Geochemical and radiological analyses of sample results may provide clues as to mechanisms enabling ^{137}Cs migration and help determine the true concentration and extent of the contamination.

ACTIONS:

1. J. Field: Prepare and distribute April 30, 2013 Meeting Summary
2. L. Fort/J. Field: Prepare the discussions for tanks T-104, T-105 and T-110
3. All: Review meeting summary. Send redline comments to J. Field.

NEXT MEETING:

May 14, 2013, 1:00 to 2:30. Assess tanks T-104, T-105 and T-110.

MEETING SUMMARY

washington river protection solutions

From: J. G. Field
Phone: 376-3753
Location: Ecology Office,
Date: May 14, 2013
Subject: Tank Farm Leak Inventory Assessments

To: Distribution/Attendees

Attendees:

Jim Alzheimer, ECOLOGY
Mike Barnes, ECOLOGY
Joe Caggiano, ECOLOGY
Jim Field, WRPS
Les Fort, WRPS
Mike Greene, WRPS
Jeremy Johnson, ORP
Rick McCain, S. M. Stoller
Maria Skorska, ECOLOGY

PURPOSE:
The purposes of these meetings are to resume tank farm release inventory assessments specifically for the T and TX Tank Farms, review the assessment process, and review previous T and TX tank farm meeting summaries and conclusions. This meeting discussed tanks T-104, T-105 and T-110, currently categorized as being sound tanks.

Review Previous Meeting Summaries and Actions:
Comments on the draft meeting summary for April 30, 2013 were discussed. The April 30th meeting summary was approved after incorporating the comments. A clarification was added to show that based on drywell SGLS data, unplanned release ^{137}Cs estimates were for the top 10 ft bgs. It was suggested that boundaries for WMA T characterization be developed for unplanned releases and facilities near T Farm as part of the WMA T performance assessment. It was also suggested to include information on the current ENRAF status and the extent of the liquid pool in tank T-102. Other identified changes were to clarify the presented drywell information and note the unplanned releases near TY and TX farms are included in those reports, as applicable.

Leak volume estimates for tanks TX-104, TX-105 and TX-107 were provided by Stan Sobczyk of the Nez Perce. As recommended by Stan in his correspondence, the estimated waste release volumes from tanks TX-104 and TX-105 will be comprised such that his estimates will be reported as lower ranges and the estimates based on the GJO-HAN-16 TX farm addendum report as upper ranges in the TX Farm assessment. Estimates provided for tank TX-107 releases were similar to those described in GJO-HAN-16.

It was noted that a draft tank T-111 evaluation (RPP-RPT-54964) was undergoing an ORP review. The draft report concludes that tank T-111 may have leaked as much as 2,100 gal of waste between 2002 and 2009. The report notes that it is not a formal leak assessment (TFC-ENG-CHEM-D-42). Jeremy Johnson of ORP indicated that a meeting was held recently where it was decided that a formal leak assessment would not be required unless a change in the current tank integrity classification was anticipated (assumed leaker to sound, sound to assumed leaker). Conclusions and recommendations from RPP-RPT-54964 will be incorporated in the T Farm Tank Leak Inventory Assessment Report.

Tank T-104 Assessment

Tank T-104 received first cycle decontamination waste (1C) from the T-Plant bismuth phosphate process beginning in March 1946 and was filled by August 1946. The tank continued to receive 1C waste from T-Plant and to cascade waste to tank T-105 until 1954 when supernate was transferred to the 241-T-14 trench. Supernate was transferred to tanks TY-103 and AW-102 in 1969 and 1992. In-depth tank T-104 historical waste information is provided in RPP-16129, *Origin of Waste in Single-Shell Tank 241-T-104*.

The tank was jet pumped until a flow rate of < 0.05 gpm was reached and was declared interim stabilized in November 1999. The tank is currently listed as sound containing 317 kgal of 1C sludge.

In-tank photographs show the spare inlet nozzles are filled with solids and tank level histories indicate that the tank was filled above the cascade level in the early 1950s and waste may have been released from spare inlet nozzles.

The ENRAF gage is contacting solids in this tank and liquid observation well (LOW) neutron measurements show the interstitial liquid level (ILL) in the tank is gradually increasing. Reasons for the increase were discussed. There are no occurrence reports indicating intrusions or liquid level decreases for this tank and photographs show no sign of intrusions. Increases in the ILL may be due to slow equilibration in low permeability waste and/or retained gas build-up. It was noted that the surveillance figures presented may be misinterpreted because the reference level for the LOW measurements was the bottom of the tank and the reference level for the manual tape was the top of the tank dish. The manual tape was removed in 1995 and the reference level for the ENRAF was set at the bottom of the tank. Also discussed were capillary height, porosity and drainable porosity estimates for the tank waste and LOW measurements. WRPS will provide meeting attendees with an SST report that defines and describes these estimates (RPP-5556).

Gamma radioactivity measured in drywells show no sign of releases from this tank other than surface releases. Gamma activity in drywells 50-04-08 and 50-04-10 is attributed to releases from tanks T-101 or T-106.

The assessment team concluded that the tank appears to be sound and no release inventory was assigned for this tank.

Tank T-105 Assessment

Tank T-105 received 2C waste from the T-Plant bismuth phosphate process beginning in 1946. Waste cascaded from tank T-105 to tank T-106 from 1947 to the first quarter of 1948 when waste was sent to the T-107 crib. The tank received 1C waste from the tank T-104 cascade from the second quarter of 1948 through first quarter of 1949. In 1951supernate was transferred out of the tank and the tank received 1C waste from tank T-104 until the third quarter of 1954. Supernate was then transferred to a crib and tank TX-118. The tank began receiving cladding waste (CW) at the beginning of 1955, and was full by the end of 1956. Tank T-105 received supernate from tank S-107 in 1965. In 1967, Hanford Site laboratory operations waste was transferred to tank 241-T-105 and from 1967 to 1968, supernate was transferred to tank TX-118 as feed to the 242-T Evaporator. In 1968 and 1969, tank 241-T-105 received decontamination waste, a wash solution from equipment decontamination efforts at T-Plant. Tank T-105 received transfers from other SSTs of liquid waste mixtures containing B-Plant low-level waste (BL) and ion exchange waste (IX) in 1973. Most of the tank supernate was transferred to tank T-106 in the same year. In 1974, supernate waste was transferred to tank S-110. Small supernate transfers from saltwell pumping were made from tanks T-101 and AY-102 in 1976 and 1984, respectively. In-depth tank T-105 historical waste information is provided in RPP-16764, *Origin of Waste in Single-Shell Tank 241-T-105*.

The tank was declared inactive in 1976, interim stabilized in June 1987, and intrusion prevention was completed in September 1988. Tank T-105 is currently listed as sound containing 24 kgal of CWR1 sludge, 2 kgal of 1C sludge and 72 kgal of 2C sludge.

Tank photographs and level history presented indicate that the tank was not filled above the cascade or spare inlet levels and past liquid level measurements do not indicate liquid level changes other than those due to transfers and pumping of the tank. There are no occurrence reports for liquid level changes for this tank.

Several occurrence reports were issued for increases in drywell activity near tank T-105. The ^{137}Cs surface activity measured in drywells around the tank indicates that surface spills may have occurred. Increased gamma activity in drywells 50-05-06 and 50-05-07 is attributed to migration of the T-106 leak (OR-76-175 and OR-77-196). Gamma activity in drywells 04-10 and 04-08 appears to be horizontal migration, but the direction of migration has not been determined. It was suggested that further review of historical gamma logging data may be useful to better understand interactions and migration of contaminants in the vadose zone.

The source of increased gamma activity in drywell 50-02-05 observed in 2009 measurements appears to be near tank T-102. However, T-105 is also a possible source. The assessment team concluded that no further actions are needed for tank T-105 pending results of tank T-102 investigations and assessments. No release inventory was assigned for this tank.

Tank T-110 Assessment

Tank T-110 received 2C waste from T-Plant in December 1944 and from the first quarter of 1948 until the third quarter of 1956. From the second quarter of 1952 to the first quarter of 1953, the tank also received lanthanum fluoride waste (224) from the plutonium concentration facility.

The tank was placed on standby in 1956 and was inactive and full until the second quarter of 1974 when waste was sent to tank S-110. Supernate was sent to tank T-101 in 1976 and to tank TX-118 in 1978. Extensive characterization detail is provided in RPP-13873, *Origin of Wastes in Single-Shell Tanks 241-T-110, 241-T-111 and 241-T-112.*

The tank was saltwell pumped in May 1997. The tank was declared interim stabilized in March 1981 and is currently listed as sound containing 370 kgal of waste consisting of 1 kgal of supernate, 10 kgal of 224 sludge and 359 kgal of 2C sludge (RPP-RPT-43168). Tank T-110 was on the Watch List for Flammable Gas due to seasonal fluctuations in waste level.

Photographs show solids in the spare inlet nozzles and historical surface level plots indicate the tank may have been overfilled in the late 1960s and could have been released through the spare inlet ports. No occurrence reports for waste level changes were issued for this tank. Surveillance measurements indicate that the surface level and liquid level gradually increased and cycled annually before pumping in 1997. It was noted that the surveillance figures presented may be misinterpreted because the reference level for the LOW measurements was the bottom of the tank and the reference level for the Food Instrument Corporation (FIC) gauge was the top of the tank dish. (Example: the solids level shown in the historical surface level plots for T-110 after 1981 should be 12 inches higher, the FIC is referenced from the top of the dish and does not need to be adjusted). The FIC was removed in 1995 and the reference level for the ENRAF measurements was set at the bottom of the tank. Increases and cycling in the ILL and surface level measurements before pumping is attributed to retained gas build-up in the waste. After pumping the waste level has remained relatively steady with a slightly decreasing trend.

The only subsurface gamma activity shown in SGLS drywell measurement was on the north side of the tank in drywell 50-07-07, a narrow spike of ^{137}Cs at 45 ft bgs attributed to tank T-107. No occurrence reports were issued for gamma activity for tank T-110 drywells.

It was concluded that the tank appears to be sound and no further evaluations are needed. No release inventory was assigned for this tank.

ACTIONS:

1. J. Field: Prepare and distribute May 14, 2013 Meeting Summary
2. L. Fort/J. Field: Prepare the discussions for tank T-112 and T-200 series tanks.
3. J. Field: Send SST Drainable interstitial liquid report to attendees.
4. L. Fort: Send Mike Johnson's Origin of Waste report for tank T-110 to ECOLOGY
5. All: Review meeting summary. Send redline comments to J. Field.

NEXT MEETING:

May 29, 2013 (Wednesday), 1:00 to 2:30. Assess tank T-112 and T-200 series tanks.

MEETING SUMMARY

washington river protection solutions

From: J. G. Field
Phone: 376-3753
Location: Ecology Office,
Date: May 29, 2013
Subject: Tank Farm Leak Inventory Assessments

To: Distribution/Attendees

Attendees:

Jim Alzheimer, ECOLOGY
Mike Barnes, ECOLOGY
Joe Caggiano, ECOLOGY
Jim Field, WRPS
Les Fort, WRPS
Zach Hanson, ORP Intern
Paul Henwood, S. M. Stoller
Jeremy Johnson, ORP

PURPOSE:
The purposes of these Tank Farm Leak Inventory Assessment meetings are to complete the initial tank farm release inventory assessments, specifically addressing the T and TX Tank Farms. These meetings also review the assessment process and review previous TX tank farm meeting summaries and conclusions. This meeting discussed tanks T-112 and the T-200 series tanks currently designated as being sound tanks.

Review Previous Meeting Summaries and Actions:
The draft meeting summary for May 14, 2013 was discussed and approved. The current waste volume estimate for tank T-110 was revised to ensure it was consistent with the latest BBI and the BBI reference (RPP-RPT-43168) was added. An electronic copy of the TX tank farm leak assessment report, distributed for review today, was provided to ECOLOGY requesting that they provide comments by June 17, 2013. A comment disposition meeting is planned for June 25, 2013 to address ECOLOGY comments.

The SST Drainable interstitial liquid report (RPP-5556) and Mike Johnson's Origin of Waste report for tank T-110 (RPP-13873) that were requested in the previous meeting were distributed to meeting participants. Jeremy Johnson (ORP) took an action to send a copy of the completed tank T-111 assessment report (RPP-RPT-54964) to meeting participants.

Stan Sobczyk (Nez Perce Tribe representative) sent a write-up describing his TX-Farm inventory estimates. Most of the content of Stan's write-up and reference to his kriging inventory estimates is included in the TX-Farm report.

The meeting today concludes the FY 2013 leak inventory assessment efforts, addressing the T and TX Tank Farms. Two additional meetings will be scheduled to discuss and resolve (disposition) comments on the TX and T-Farm leak inventory assessment reports. Mike Barnes (ECOLOGY) requested a meeting with the leak assessment team to review tank C-101 and C-105 leak inventory estimates to be provided by the Nez Perce. The Nez Perce estimates are expected later this calendar year (FY 2014). Other RPP-32681 leak inventory assessments may be needed as additional data becomes available.

Tank T-112 Assessment

Tank T-112 received second cycle waste (2C) from the T-Plant bismuth phosphate process beginning in January 1946. Supernate from tank T-112 was sent to a crib in the fourth quarters of 1947 and 1948. The cascade received 2C waste and lanthanum fluoride waste (224) from uranium recovery operations from the fourth quarter of 1948 to the first quarter of 1952. Supernate was sent to a crib in the second quarter of 1955. A spare inlet was used as an outlet to the crib.

Between 1960 and 1973 tank T-112 received decontamination waste from the 221-T evaporator. Supernate was sent to a crib in the second and fourth quarters of 1960, the fourth quarter of 1962, and the second and third quarters of 1966. Beginning in the second quarter of 1967, tank T-112 began exchanging evaporator waste with tank TX-118. This continued until the second quarter of 1972. Supernate was sent to tank TY-103 in the second quarter of 1969.

Supernate was sent from tank T-112 to tank U-107 from the third quarter of 1972 until the second quarter of 1973. The last waste addition to tank T-112 occurred in the second quarter of 1973 when supernate was received from tank T-106. In the second and third quarters of 1974, tank T-112 sent supernate to tank S-110.

Tank T-112 is designated as sound and was declared inactive in 1976. The tank was administratively declared interim stabilized in March 1981 and interim isolated in June 1981. The tank T-112 Best-Basis Inventory (RPP-RPT-47139) shows that there is currently 67 kgal of waste in tank T-112 comprised of 7 kgal of Supernate, 24 kgal of 224-2 Sludge and 36 kgal of 2C sludge.

Tank T-112 is one of the 21 tanks identified in RPP-RPT-50799 that may have had water intrusions.. Although there is no current indication a liquid level increase occurred based on surveillance measurements, the current supernate level in the tank exceeds the stabilization criteria of 5,000 gal. It was recommended in September 1996 that the tank not be pumped because the liquid level appears to be stable, the tank is classified as sound, and it is not cost effective to pump this tank (WHC-SD-WM-ER-622).

Level history plots show that the tank was filled above the spare inlet level between 1951 and 1955. There was no cascade overflow from tank T-112. Surface level measurements were made using an FIC gage until 1995 when an ENRAF gage was installed.

Documented in Occurrence report 77-201 was a liquid level decrease in 1977attributed to "movement of the FIC plummet over an irregular surface." There were no other occurrence reports related to liquid led level changes for this tank.

Drywell total gamma and SGLS data indicate that there are no subsurface contamination plumes that can be attributed to waste releases from tank T-112. The ^{137}Cs data indicate that surface spills may have occurred in the vicinity of the tank, and ^{60}Co detected in drywells around tank T-112 is attributed to migration of waste from the tank T-106 leak or other subsurface waste migration.

The assessment team concluded that tank T-112 appears to be sound as currently designated and no release inventory is assigned for this tank.

T-200 Series Tank Assessment

According to RPP-13300, tank T-201 was not part of any tank cascade. Tank T-201 went into service in 1952, receiving lanthanum fluoride finishing waste (224) from T-Plant. The tank was filled later that year. Tank T-204 was connected in a cascade with tanks T-203 and T-202. Solids contained in the 224-T Concentration building waste from the lanthanum fluoride finishing process were allowed to settle in tanks T-204 through T-202. Liquid was gravity discharged from the last tank in the cascade (tank T-202) to cribs. The sludge waste type corresponds to this lanthanum fluoride finishing (224) waste type which was also predicted in LA-UR-96-3860.

Tank T-201 received lanthanum fluoride finishing waste (224) from T-Plant in 1952 and was declared inactive in 1976. The only other transfers of waste associated with this tank occurred in 1976, when supernate was transferred to tank T-101 and again during 1977 and 1981 when supernate was pumped in support of stabilization efforts.
Pumping to remove liquids started in 1977. The tank was finally interim stabilized in April 1981; intrusion prevention (interim isolation) was also completed in 1981. The final stabilization designation was made administratively; therefore, a small amount of liquid remains in tank T-201. The tank is currently designated as sound. Tank T-201 contains 30 kgal of waste comprised of 2 kgal of supernate and 28 kgal of 224 sludge (RPP-RPT-43171).

Liquid level increases were measured in 1980, 1983 and 1986. The saltwell pump pit was identified as a likely pathway for liquid intrusions to the tank (WHC-SD-WM-TI-356). Although the ground around the pump pit was covered with plastic and built up above grade with top soil, surveillance measurements indicate continued intrusions into the tank. At the current rate of intrusions, the liquid level in tank may exceed the stabilization criteria (5,000 gal) by 2016 (RPP-RPT-50799). The tank appears to be sound as currently designated and no waste release inventory is assigned for this tank.

Tank T-202 is connected to tanks T-203 and T-204 by a 3-in. diameter line that enables waste transfers from one tank to the other. Because there is no vertical offset in the connection from one tank to the others, the tanks are not cascaded but rather tied together. This tank went into service in 1952, receiving lanthanum fluoride finishing (224) waste from T-Plant. Tank T-202 was filled later that year and supernate was transferred to cribs. The only other transfers of waste

associated with this tank occurred in 1976 when supernate was transferred to tank T-101 and from 1976 through May 1979 when supernate was pumped in support of stabilization efforts. Tank T-202 was declared inactive in 1976 and was interim stabilized in August 1981; intrusion prevention (interim isolation) was completed in 1981. Tank T-202 currently contains 20 kgal of 224 sludge (RPP-RPT-43172). No drywell data exists for tank T-202. Liquid level measurements show annual cycling and a gradual decrease between 1993 and about 2007. Except for diurnal cycling, the surface level appears to have stabilized after 2007. The tank appears to be sound as currently designated and no release inventory is assigned for this tank.

Tank T-203 began receiving lanthanum fluoride finishing waste in 1952 from 221-T Plant. The tank was filled later that year. Supernate waste was then sent to the cribs during mid-1952. The final activity involving tank T-203 was the sending of supernate waste to tank T-101 in 1976. Tank T-203 is currently designated as sound and was declared inactive in 1976. Interim stabilization and intrusion prevention were completed in 1981. Tank T-203 currently contains 36 kgal of 224 sludge (RPP-RPT-43173).

Liquid level measurements indicate that the surface level has gradually decreased since about 2002. The gradual decrease in liquid level is accounted for by evaporation estimates and surface level cycling indicates the presence of retained gas, which could also contribute to surface level changes.

Tank T-204 is connected to tanks T-202 and T-203 by a 3-in. diameter line that enables waste transfers from one tank to the other. Because there is no vertical offset in the connection from one tank to the others, the tanks are not cascaded but rather tied together. This tank went into service in 1952, receiving lanthanum fluoride (224) waste from T-Plant. Tank T-204 was filled later that year and transferred supernate to tank T-203. Tank T-204 is designated as sound and was declared inactive in 1976. The tank was interim stabilized in 1981; intrusion prevention (interim isolation) was also completed in 1981. Tank T-204 contains 36 kgal of 224 sludge (RPP-RPT-43174).

Like tank T-203, liquid level measurements indicate that the surface level has gradually decreased since about 2002. The gradual decrease in liquid level is accounted for by evaporation estimates and surface level cycling indicates the presence of retained gas, which may also contribute to surface level changes.

Assessment for Tank T-203 and T-204

No drywells were installed to monitor the T-200 series tanks. Several drywells were installed around the T-7 and T-32 cribs in T-Farm near the T-200 series tanks, however, given the level of gamma activity for 224 waste, these drywells have not indicated waste releases have occurred from these tanks.

A Single-Shell Tank Level Decrease Evaluation Plan was developed to address the investigation of unexplained surface level and interstitial liquid level decreases for the group of 20 single-shell tanks (SSTs) identified in the plan with level decreases greater than -0.07 inches per year (WRPS-1301005). In letter WRPS-1301195, WRPS is to complete the evaluation of the 20 single shell tanks by no later than January 31, 2014. Preliminary information provided by

John Schofield, who is conducting the evaluation, indicated that the liquid level decreases in tanks T-203 and T204 are likely attributed to evaporation and/or settling of the waste; indicating that the subject tanks should continue to be designated as sound.

ACTIONS:

1. J. Field: Prepare and distribute May 28, 2013 Meeting Summary
2. L. Fort/J. Field: Prepare T Farm leak inventory assessment report.
3. J. Field: Send SST Drainable interstitial liquid report to attendees.
4. L. Fort: Send Mike Johnson's Origin of Waste report for tank T-110 to ECOLOGY
5. All: Review meeting summary. Send redline comments to J. Field.

NEXT MEETING:

June 25, 2013, 1:00 to 2:30. Disposition TX-Farm report comments.

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APPENDIX B

241-T TANK FARM INFORMATION SUMMARIES: FOR TANKS CLASSIFIED AS ASSUMED LEAKERS

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LIST OF TERMS

Abbreviations and Acronyms

bgs	below ground surface
CASS	Computer Automated Surveillance System
FIC	Food Instrument Corporation (gauge)
HDW	Hanford Defined Waste
LOW	liquid observation well
MW	metal waste
PUREX	Plutonium Uranium Extraction (Plant)
REDOX	Reduction-Oxidation (S Plant)
SGLS	spectral gamma logging system
TBP	tri-butyl phosphate
TMACS	Tank Monitor and Control System

Waste Types

1C	First-cycle decontamination waste from the bismuth phosphate process
1C1	First-cycle decontamination waste from the bismuth phosphate process (1944-1949)
224	224 Building lanthanum fluoride process waste
224-2	224 Building lanthanum fluoride process waste (1950-1956)
2C	Second-cycle decontamination waste from the bismuth phosphate process
CW	Cladding waste, aluminum clad fuel
CWR1	REDOX cladding waste, aluminum clad fuel (1952-1960)
CWR2	REDOX cladding waste, aluminum clad fuel (1961-1966)
IX	Ion exchange waste
T1SltCk	242-T Evaporator campaign saltcake (1951-1956)

B1.0 TANK 241-T-101

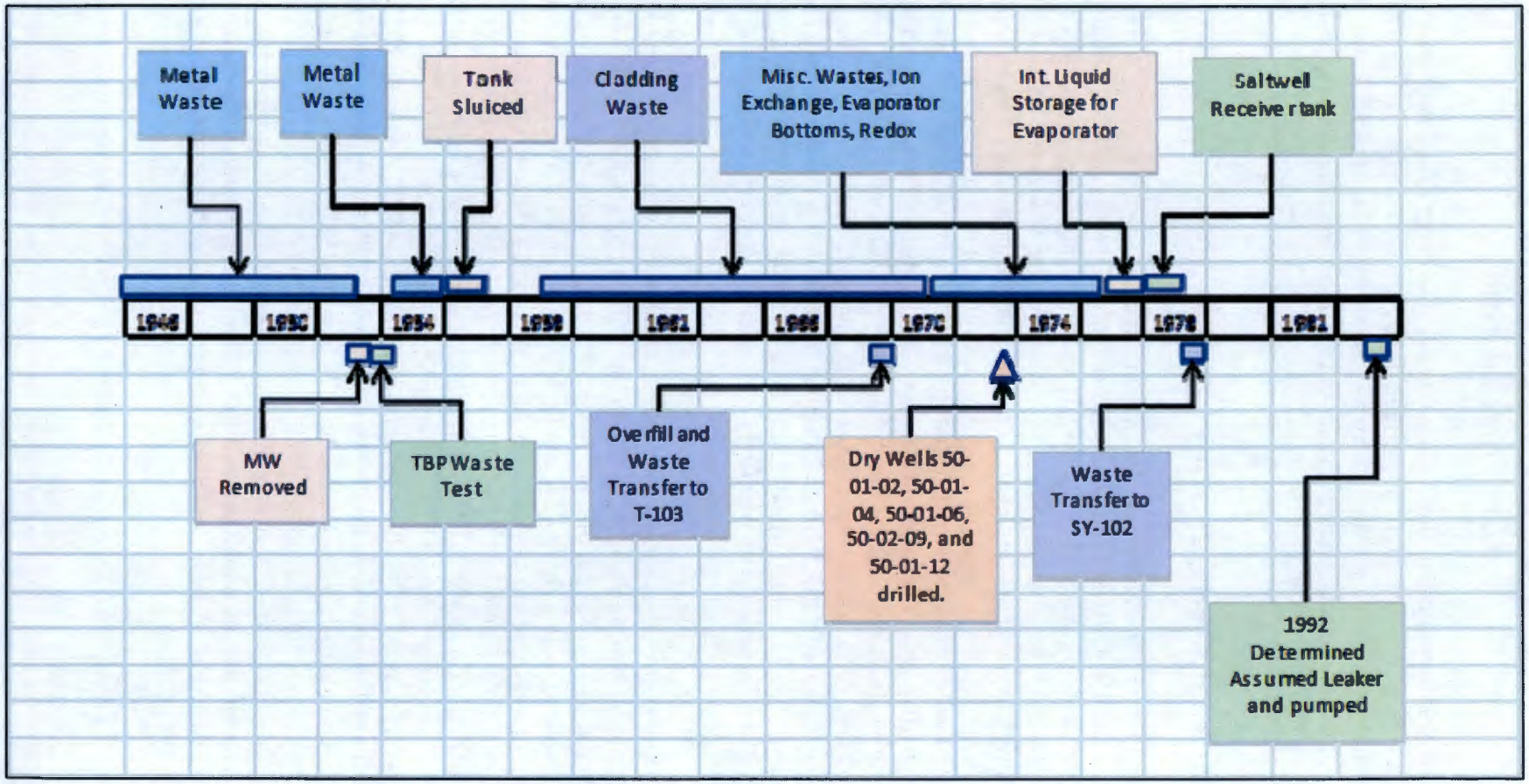
This section provides information on the historical waste loss event associated with tank 241-T-101 (T-101). Waste operations for tank T-101 are summarized in Figure B1-1. Figure 3-2 of the main text shows a plan view of a typical tank in 241-T Tank Farm (T Farm) with the location of the pump pit, sluice pit, spare inlet nozzles (N1, N2, N3 and N4) and tank risers.

B1.1 TANK 241-T-101 WASTE HISTORY

Tank T-101 is the first tank in the cascade series with tanks 241-T-102 (T-102) and 241-T-103 (T-103). In December 1944, metal waste from 221-T Plant (T Plant) was sent to tank T-101, and by September 1945, the tank was full (528,000 gal) and cascading waste into tank T-102. The metal waste was stored in the tank until mid-1953, when the waste was sluiced and removed from the tank. After the waste was removed from the tank, the tank was filled (530,000 gal) with ferrocyanide sludge produced by scavenging of waste from uranium recovery processes. By late 1953, ~254,000 gal of waste was transferred to other tanks and 256,000 gal of tank waste was sent to cribs for disposal. The remaining tank waste was flushed with water and transferred to other tanks. During 1954, the tank sat empty. In early 1955, metal waste from T Plant began filling the tank; by mid-1955, the waste was cascading into tank T-102. Sluicing operations to remove metal waste began in early 1956 and dropped the liquid level to the heel of the tank. Between 1957 and early 1963, small quantities of metal coating waste from T Plant were stored in the tank. By mid-1963, tank T-101 was filled with coating waste (535,000 gal) that was stored until early 1969.

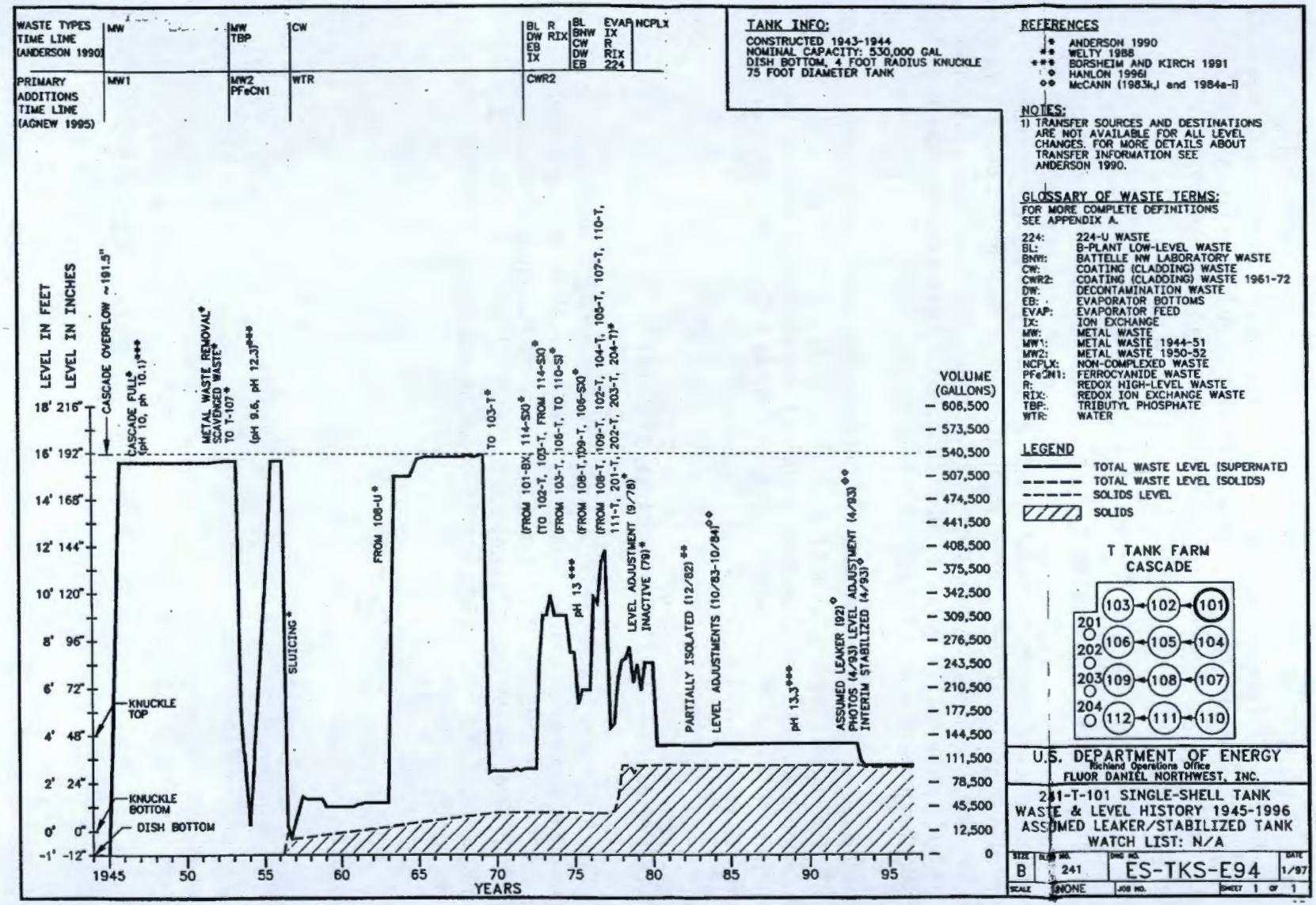
An unplanned release occurred in early 1969 when the tank was overfilled (539,000 gal) and an undetermined amount of tank waste overflowed to the soil column through a spare fill line. Following the overflow, 447,000 gal of metal waste was transferred to tank T-103. The tank did not receive additional waste until mid-1972. In mid-1972, waste from the 241-SX and 241-BX Tank Farms was added to the tank. By late 1972, tank T-101 was transferring and storing a mixture of wastes, including 221-B Plant (B Plant) low-level waste, evaporator bottom waste, Reduction-Oxidation (S Plant) (REDOX) ion-exchange waste, decontamination waste, Battelle Northwest Laboratory waste, REDOX coating waste, and 224 T-Building waste. Evaporator feed waste was added to the tank from 1976 to early 1978. Between 1972 and 1978, the tank waste volume did not exceed 403,000 gal. In early 1978, the waste in tank T-101 was reclassified as non-complexed waste. From late 1978 to early 1980, small quantities of non-complexed waste were transferred to double-shell tank 241-SY-102. The tank was removed from service in 1979. Figure B1-2 shows quarterly tank transfer levels and history. Additional tank waste transfer information is included in WHC-MR-0132, *A History of the 200 Area Tank Farms*, LA-UR-97-311, *Waste Status and Transaction Record Summary (WSTRS Rev. 4)* and tank waste summary reports.

Figure B1-1. Tank 241-T-101 Waste Operations Summary.



MW = metal waste TBP = tri-butyl phosphate

Figure B1-2. Tank 241-T-101 Quarterly Waste Fill History.



Reference: HNF-SD-WM-ER-351, *Historical Tank Content Estimate for the Northwest Quadrant of the Hanford 200 West Area.*

B1.2 INTEGRITY OF TANK 241-T-101

Tank T-101 was declared an assumed leaker on October 4, 1992 (HNF-SD-RE-TI-178, *Single-Shell Tank Interim Stabilization Record*) with a leak volume of 7,500 gal based on a liquid level decrease of 2.6 in. (Occurrence Report RL--WHC-TANKFARM-1992-0073, *Apparent Decrease in Liquid Level in Single Shell Underground Storage Tank 241-T-101; Leak Suspected; Investigation Continuing*).

B1.3 INTERIM STABILIZATION

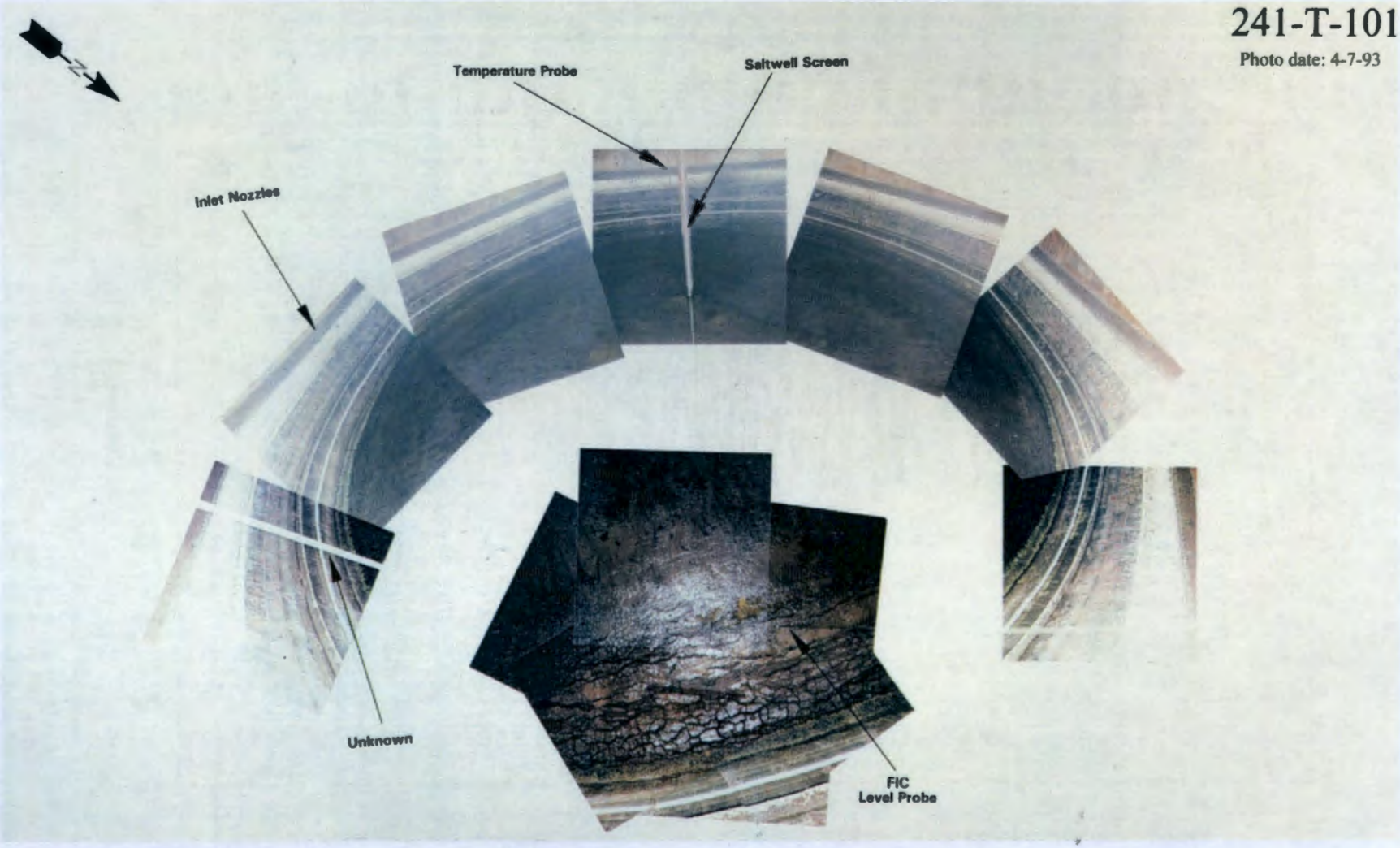
The tank was jet pumped starting on March 12, 1993. Multiple campaigns resulted in the removal of 25,300 gal of waste. During the final campaign, on April 6, 1993 ~1.5 rad/hr was detected near the flushing valves in the tank T-101 pump pit and transfers were stopped. Engineering estimated that 700 gal of supernate and 15,800 gal of drainable interstitial liquid remained in the tank when it was declared stabilized (HNF-SD-RE-TI-178).

As of April 2005 the tank was estimated to contain 99,000 gal of waste consisting of 37,000 gal of REDOX cladding waste, aluminum clad fuel (1961-1966) (CWR2) sludge and 62,000 gal of saltcake from the last 242-T Evaporator campaign (1965-1976) (RPP-RPT-43159, *2009 Auto-TCR for Tank 241-T-101*). Figure B1-3 shows a mosaic photograph of the tank surface on April 7, 1993.

B1.4 TANK 241-T-101 TEMPERATURE HISTORY

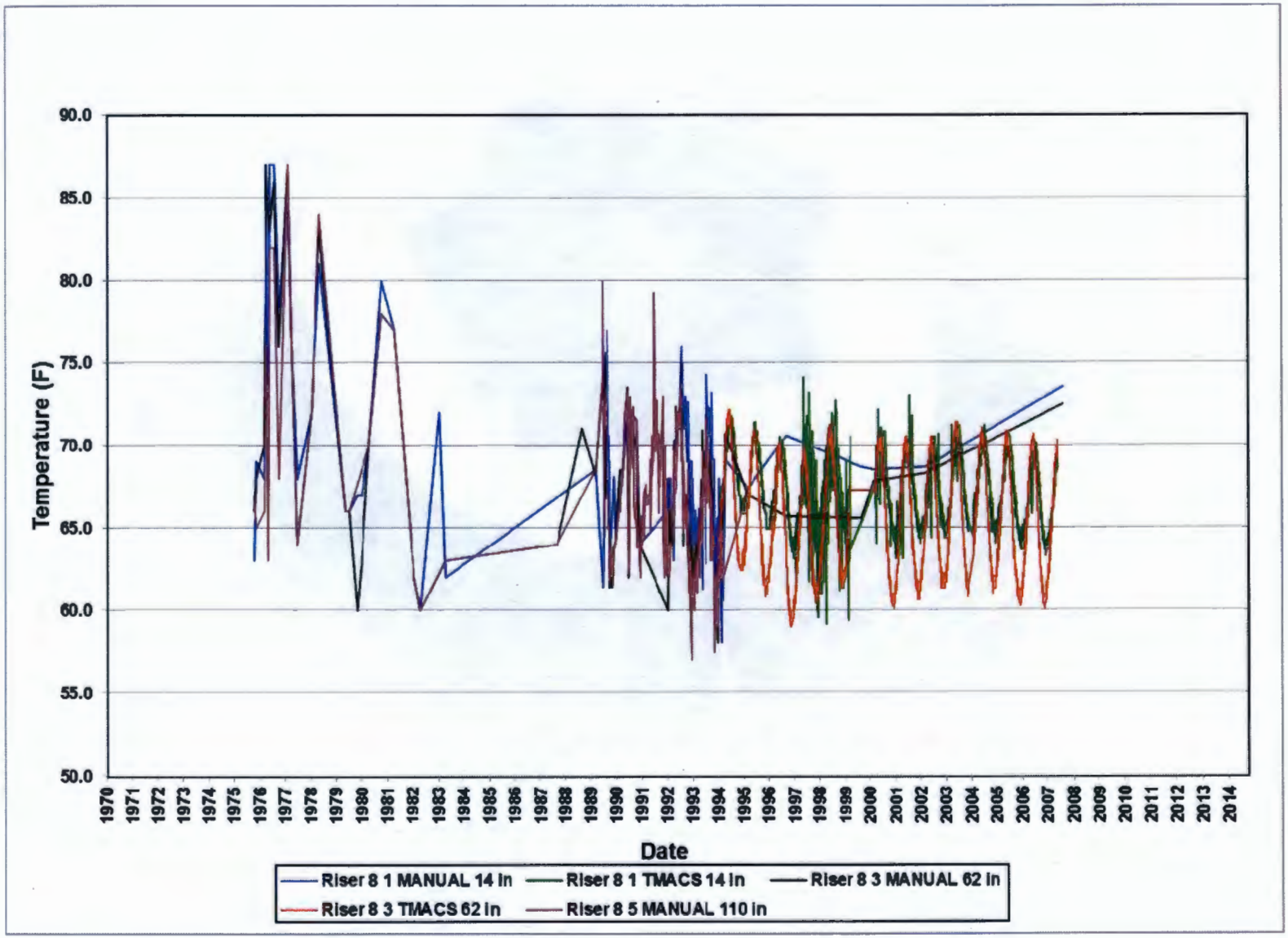
The tank temperature is monitored by a single thermocouple tree located in riser 8. No temperature measurements were found before 1976. Figure B1-4 shows tank waste temperatures for tank T-101 from 1976 to 2007. During this period the maximum waste temperature was ~87 °F in 1976. By 1995 the temperature decreased to below ~70 °F. The tank temperature varies seasonally between ~60 and ~70 °F. No temperature measurements have been obtained for this tank since 2007.

Figure B1-3. Tank 241-T-101 Waste Surface Photo Mosaic.



Reference: HNF-SD-WM-ER-351, *Historical Tank Content Estimate for the Northwest Quadrant of the Hanford 200 West Area.*

Figure B1-4. Tank 241-T-101 Waste Temperature Measurements.



TMACS = Tank Monitor and Control System

B1.5 DATA REVIEW AND OBSERVATIONS

The following sections contain discussions of the tank surface level, drywell logging data and borehole sampling.

B1.5.1 Tank Surface Level Measurements

Tank liquid level measurements before 1973 were not available, other than from the transfer data in waste process reports (Figure B1-2). Figure B1-2 indicates that liquid waste may have been filled above the cascade/spare inlet level in tank T-101 between 1964 and 1969. Table B1-1 shows surface levels and surface level changes from 1973 to 1987. Figure B1-5 shows surface level measurements and liquid observation well (LOW) neutron and gamma interstitial liquid level measurements from 1981 to 2013. Figure B1-5 shows that jet pumping of the tank waste in 1993 and the readjustment of the baseline in 1996 correlates with the amount of waste transferred during jet pumping.

The following occurrence reports were issued for tank T-101 liquid level decreases.

- Occurrence Report 75-17, *Decreasing Liquid Level in Tank 101-T*: Identified that tank T-101 waste surface level decreased in excess of 0.5 in. following a 15-in. transfer from tank 241-T-109 (T-109). No increases in radiation detected in adjacent drywells.

- RL--WHC-TANKFARM-1992-0073 (October 16, 1992): On September 18, 1992 the tank T-101 liquid level was noted to have dropped 2.6 in. from a previously established liquid level of 44.2 inches. The level decrease was noted following maintenance of the tank T-101 level indicator (Food Instrument Corporation gauge [FIC]) which had been operating only sporadically since December 1991. No reliable data was obtained between December 2, 1991 and July 6, 1992. The liquid level has remained steady at 41.5 in. since October 4, 1992. On October 4, 1992, the tank was declared to be an assumed leaker. Total leakage to date is estimated to be ~7,500 gal.

SD-WM-TI-356, *Waste Storage Tank Status and Leak Detection Criteria* states that "the contamination in wells 50-01-04, 50-10-06 and 50-00-03 originated from a leak through a spare fill line and was a result of the tank being overfilled in an attempt to utilize the cascade line to tank T-102. Activity in drywell 50-01-09 is attributed to leakage of the cascade line."

B1.5.2 Drywell Logging Data

Six drywells surround tank T-101 (50-01-02, 50-00-03, 50-01-04, 50-01-06, 50-01-09, and 50-01-12); Figures B1-6, B1-7 and B1-8 show the 1999 reported spectral gamma logging system (SGLS) results for these drywells. Figure B1-9 provides tank T-101 historical gamma logging results.

Table B1-1. Tank 241-T-101 Liquid Level Measurements and Changes (1973 to 1987). (sheet 1 of 2)

Date	Liquid level (in.)	Baseline ref.	Change from previous reading (in.)	Cumulative change (in.)	Comments
06/15/73	119.30		-	-	
07/24/73	119.30		-	-	Stable
07/25/73	108.40		-	-	Calibration
10/30/73	108.55		+0.15	+0.15	Calibration
11/17/73	108.55		-	+0.15	Readings fluctuate
02/22/74	108.90		+0.35	+0.50	Slow increase
07/09/74	109.20		+0.30	+0.80	Slow increase (readings fluctuate ±0.50)
07/27/74	89.85		-	+0.80	Transferring
10/15/74	89.80		-0.05	+0.75	Stable. Instrument check.
10/31/74	89.50		-0.30	+0.45	Unexplained decrease
01/25/75	89.50		-	+0.45	Stable
01/30/75	133.70		-	+0.45	Transfer
02/11/75	133.80		+0.10	+0.55	Stable
02/14/75	148.50		-	+0.55	Transfer
03/11/75	147.90		-0.60	-0.05	Steady decrease
03/17/75	64.40		-	-0.05	Transfer
04/08/75	64.30		-0.10	-0.15	Stable
04/27/75	68.10		-	-0.15	Transfer
05/07/75	68.50		+0.40	+0.25	Unexplained increase
06/04/75	68.55		+0.05	+0.30	Stable
06/21/75	71.10		-	+0.30	Transfers
09/12/75	71.50		+0.40	+0.70	Slow increase
09/13/75	71.20		-0.30	+0.40	FIC flushed
11/15/75	71.20		-	+0.40	Stable
02/10/76	70.75		-0.45	-0.05	Slow decrease
03/17/76	118.10		-	-0.05	Active salt well receiver
04/05/76	118.10		-	-0.05	Stable
12/14/76	141.70		-	-0.05	Active salt well receiver
02/08/77	141.65		-0.05	-0.10	Stable
02/10/77	51.40		-	-0.10	Transfer
02/26/77	51.40		-	-0.10	Stable
02/27/77	52.10		-	-0.10	Received salt wells
03/17/77	52.10		-	-0.10	Received salt wells
06/07/77	52.50		+0.10	0	Stable
06/08/77	52.90		-	0	Line flush
06/14/77	53.05		+0.15	+0.15	Slow increase
06/15/77	53.80		-	+0.15	Line flush

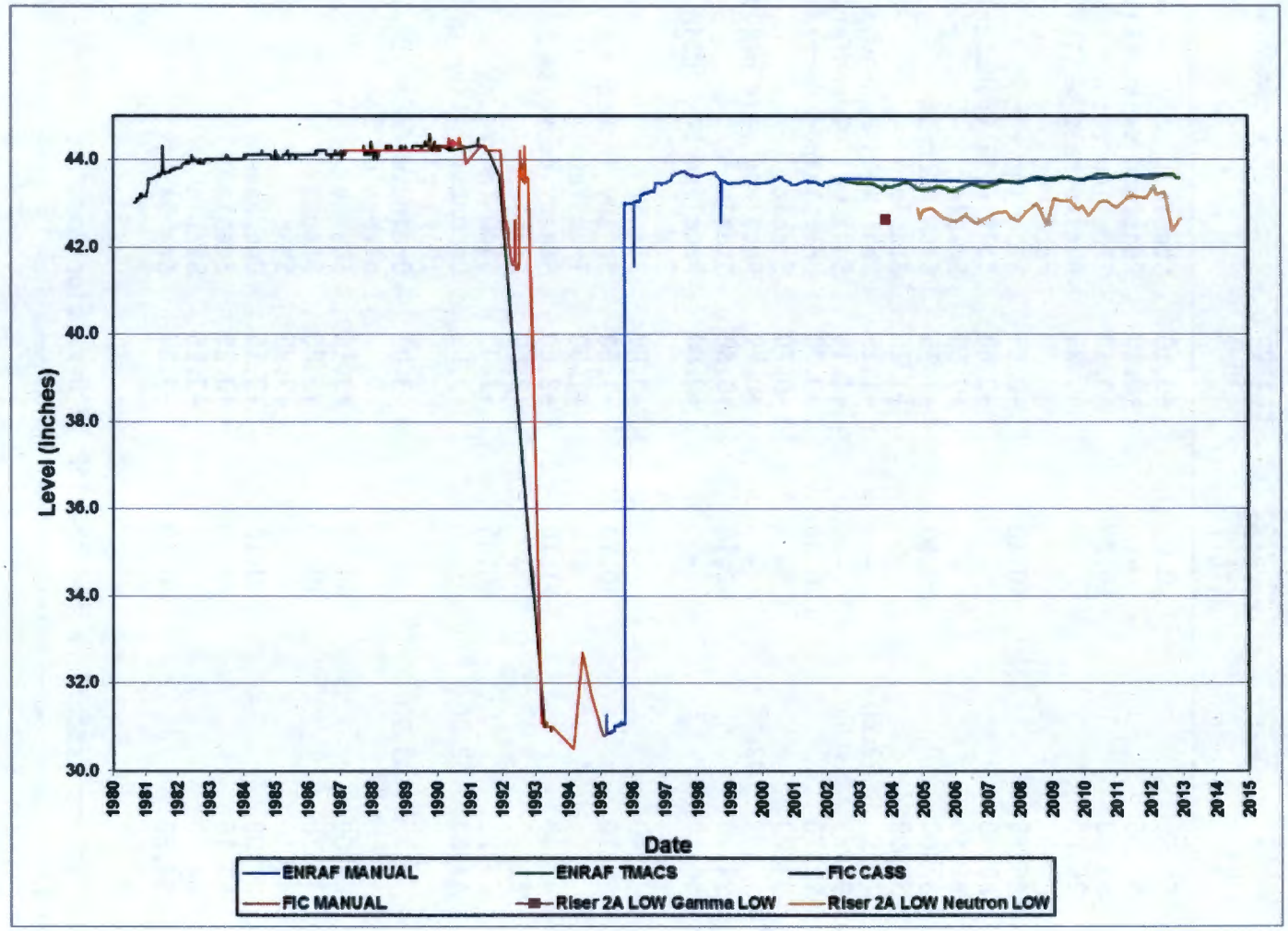
Table B1-1. Tank 241-T-101 Liquid Level Measurements and Changes (1973 to 1987). (sheet 2 of 2)

Date	Liquid level (in.)	Baseline ref.	Change from previous reading (in.)	Cumulative change (in.)	Comments
06/22/77	53.75		-0.05	+0.10	Stable
06/23/77	53.85		-	+0.10	Received salt wells
07/31/77	54.10		+0.25	+0.35	Slow increase
10/16/77	85.25		-	+0.35	Active salt well receiver
11/12/77	85.55		+0.30	+0.65	Slow increase
11/15/77	86.50		-	+0.65	Salt well transfers
01/06/78	86.50		-	+0.65	Stable
01/31/78	87.00		+0.50	+1.15	Slow increase
04/01/78	87.00		-	+1.15	Stable
04/27/78		89.60	-	+1.15	Salt well receiver
05/03/78	90.15		-	+1.15	Salt well transfers
05/09/78	89.70		-0.45	+0.70	Unexplained decrease
05/25/78	89.70		-	+0.70	Stable
01/02/79		83.90	-	+0.70	Received salt wells
02/15/79	84.00		+0.10	+0.80	Stable
03/30/79	84.40		-	+0.80	Received box drain and S.W.
05/04/79	84.40		-	+0.80	Stable
09/12/79	85.10		+0.70	+1.50	Steady increase
09/28/79		41.70	-	+1.50	Transfer
06/11/80	42.80		+1.10	+2.60	Steady decrease
12/03/80	42.80		-	+2.60	Stable
06/01/81	43.25		+0.45	+3.05	Slow increase
06/02/81	43.60	42.00	-	+3.05	Decontamination of 101-T pit
08/09/82		43.90	-	+3.05	Drainage from 152-TR diversion box
08/22/83	44.00		+0.10	+3.15	Stable
08/08/84	44.10		+0.10	+3.25	Stable
03/11/85	44.10		-	+3.25	Stable
05/13/85	44.00		-0.10	+3.15	Decrease
08/05/85	44.10		+0.10	+3.25	Stable
07/14/86	44.10		-	+3.25	Stable
09/08/87	44.20		+0.10	+3.35	Stable

NOTE: 101-T is the Catch Tank for the 152-TR Diversion Box.

Reference: SD-WM-TI-356, *Waste Storage Tank Status and Leak Detection Criteria.*

Figure B1-5. Tank 241-T-101 Waste Surface Level Measurements.

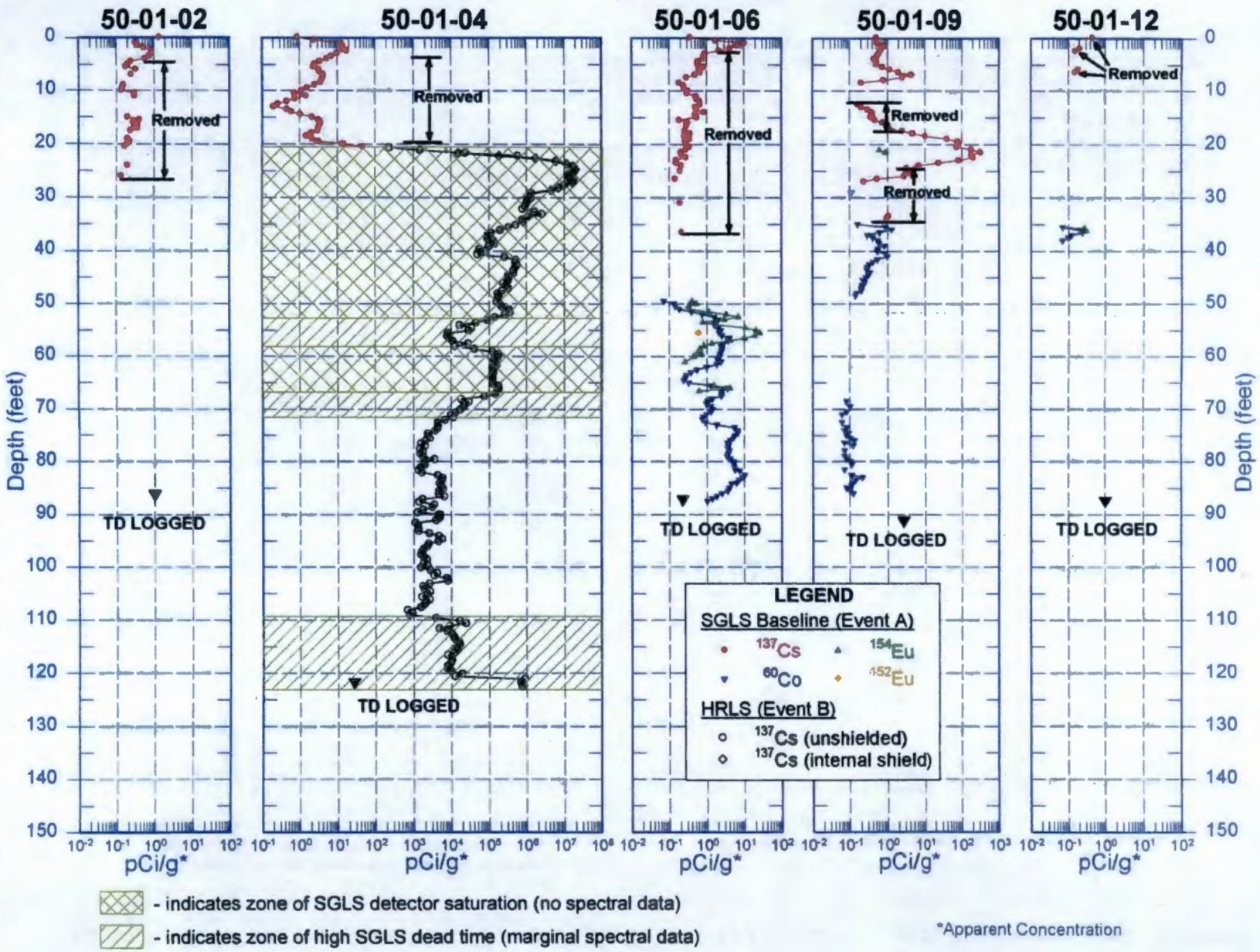


Note: Surface level measurement changed to bottom of tank (12-in. off-set) after October 1995 measurement.

CASS = Computer Automated Surveillance System
LOW = liquid observation well
FIC = Food Instrument Corporation (gauge)
TMACS = Tank Monitor and Control System

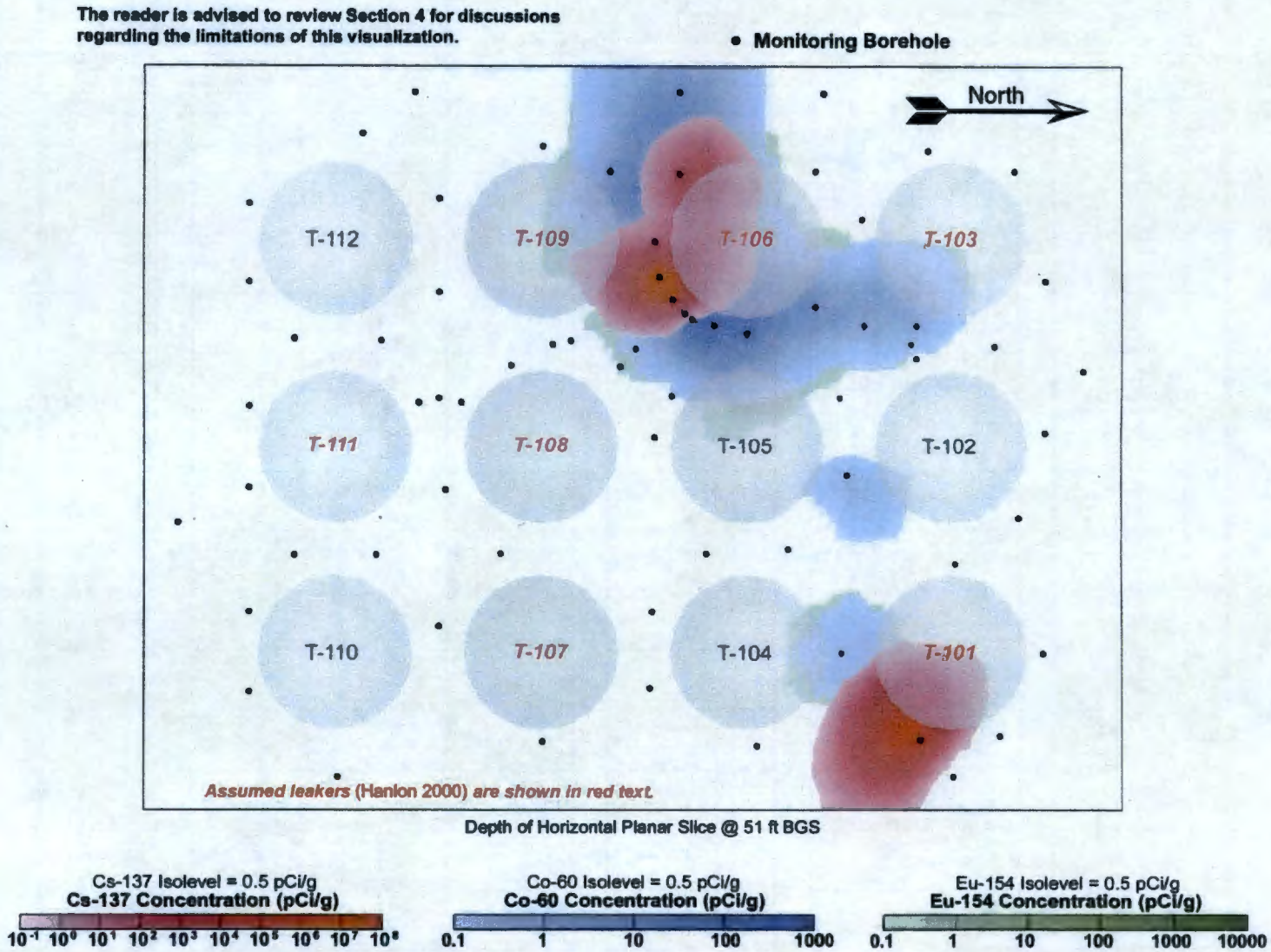
Honeywell Enraf is a product of Honeywell Process Solutions, Strahlenbergerstr. 110-112, 63067 Offenbach, Germany.

Figure B1-6. 1998 Spectral Gamma Logging Results for Drywells near Tank 241-T-101.



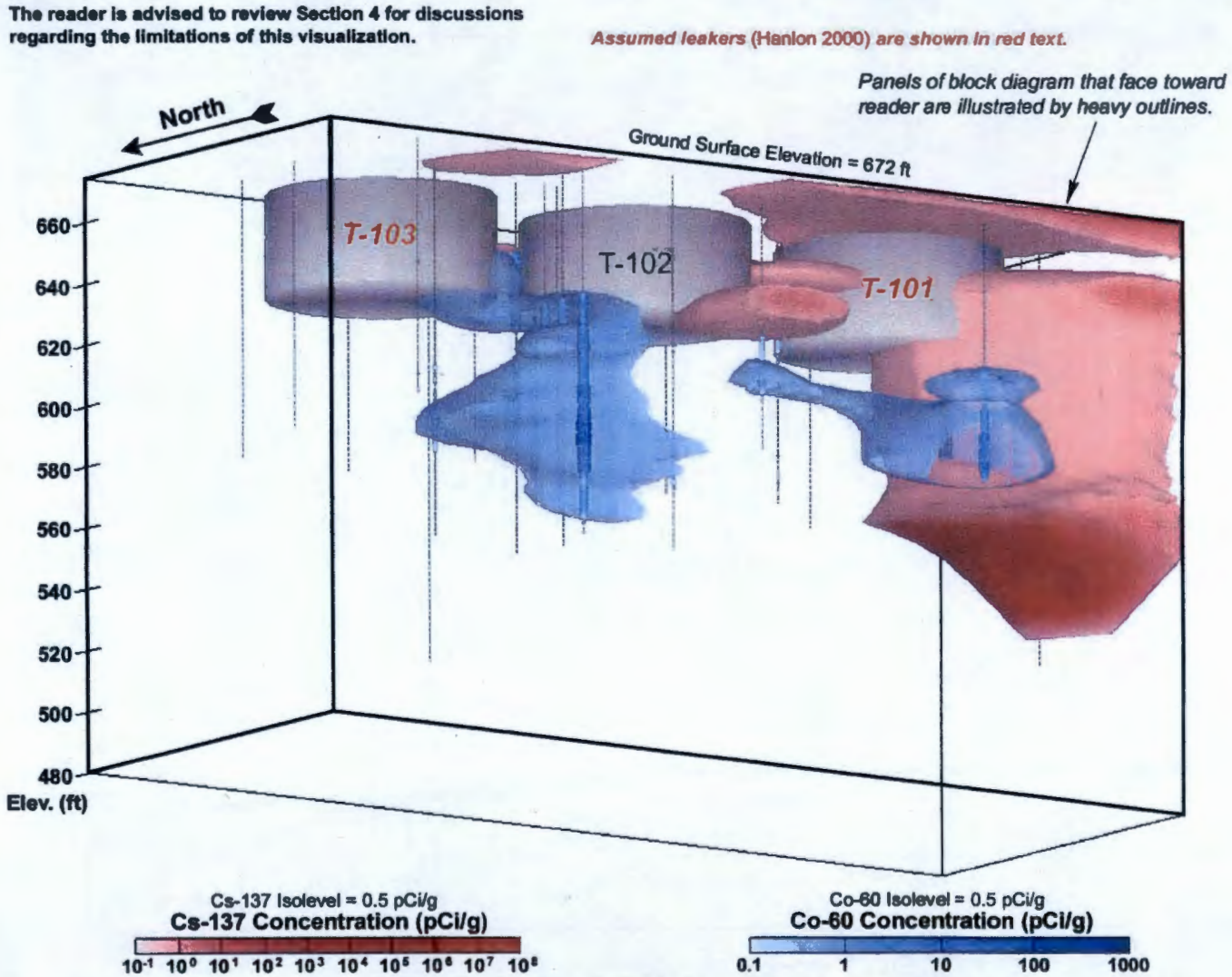
Reference: GJO-99-101-TARA/GJO-HAN-27, *Hanford Tank Farms Vadose Zone: Addendum to the T Tank Farm Report.*

Figure B1-7. Visual Schematic of 241-T Tank Farm Drywell Logging Results at 51 feet Below Ground Surface.



Reference: GJO-99-101-TARA/GJO-HAN-27, *Hanford Tank Farms Vadose Zone: Addendum to the T Tank Farm Report.*

Figure B1-8. Cross Section Showing Drywell Logging Results for Tanks 241-T-101 and 241-T-103.



Hanlon 2000 = HNF-EP-0182-143, *Waste Tank Summary Report for Month Ending February 29, 2000.*

Source: GJO-99-101-TARA/GJO-HAN-27, *Hanford Tank Farms Vadose Zone: Addendum to the T Tank Farm Report.*

Figure B1-9. Tank 241-T-101 Historical Gamma Logging Results. (sheet 1 of 3)

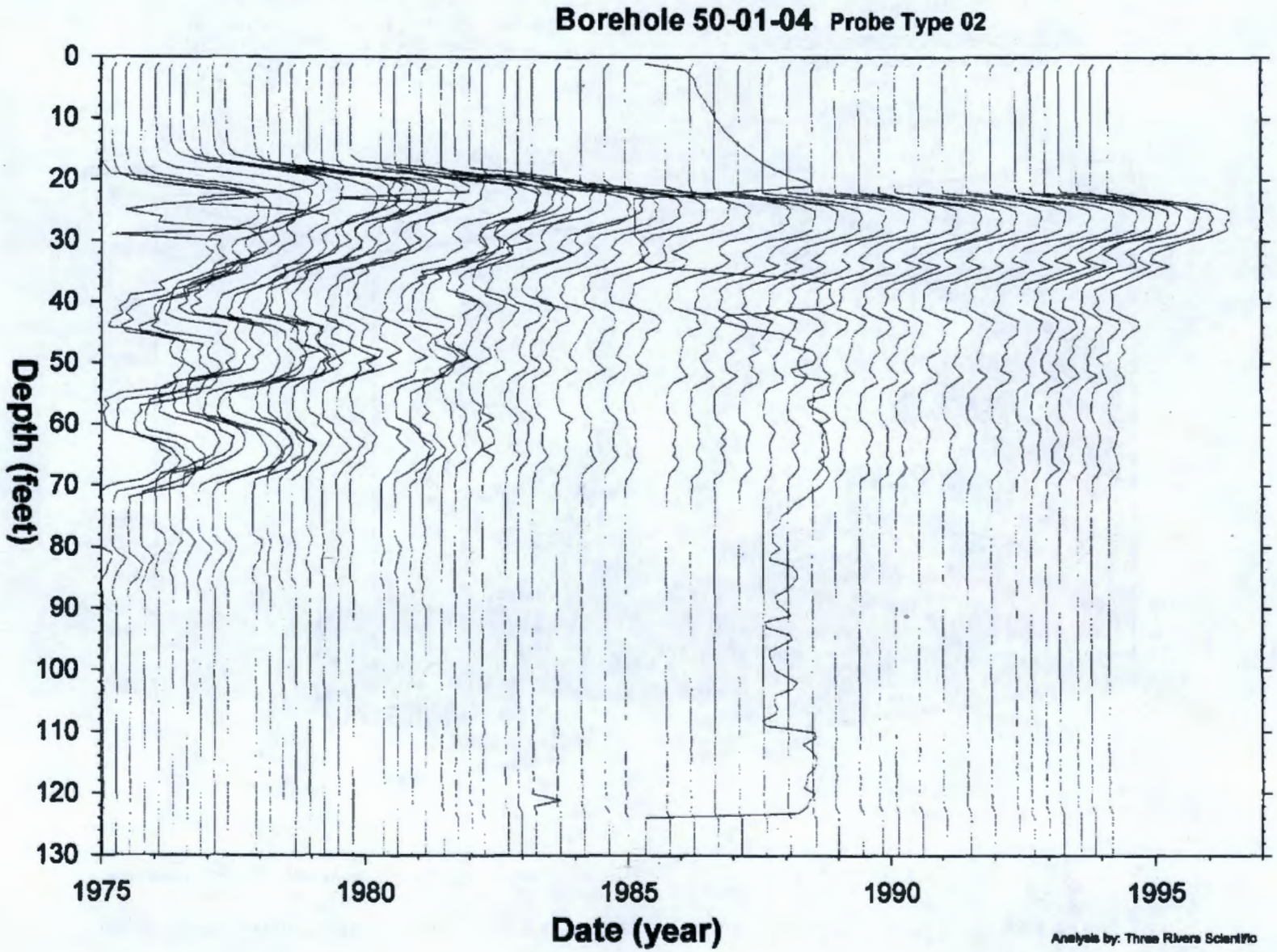


Figure B1-9. Tank 241-T-101 Historical Gamma Logging Results. (sheet 2 of 3)

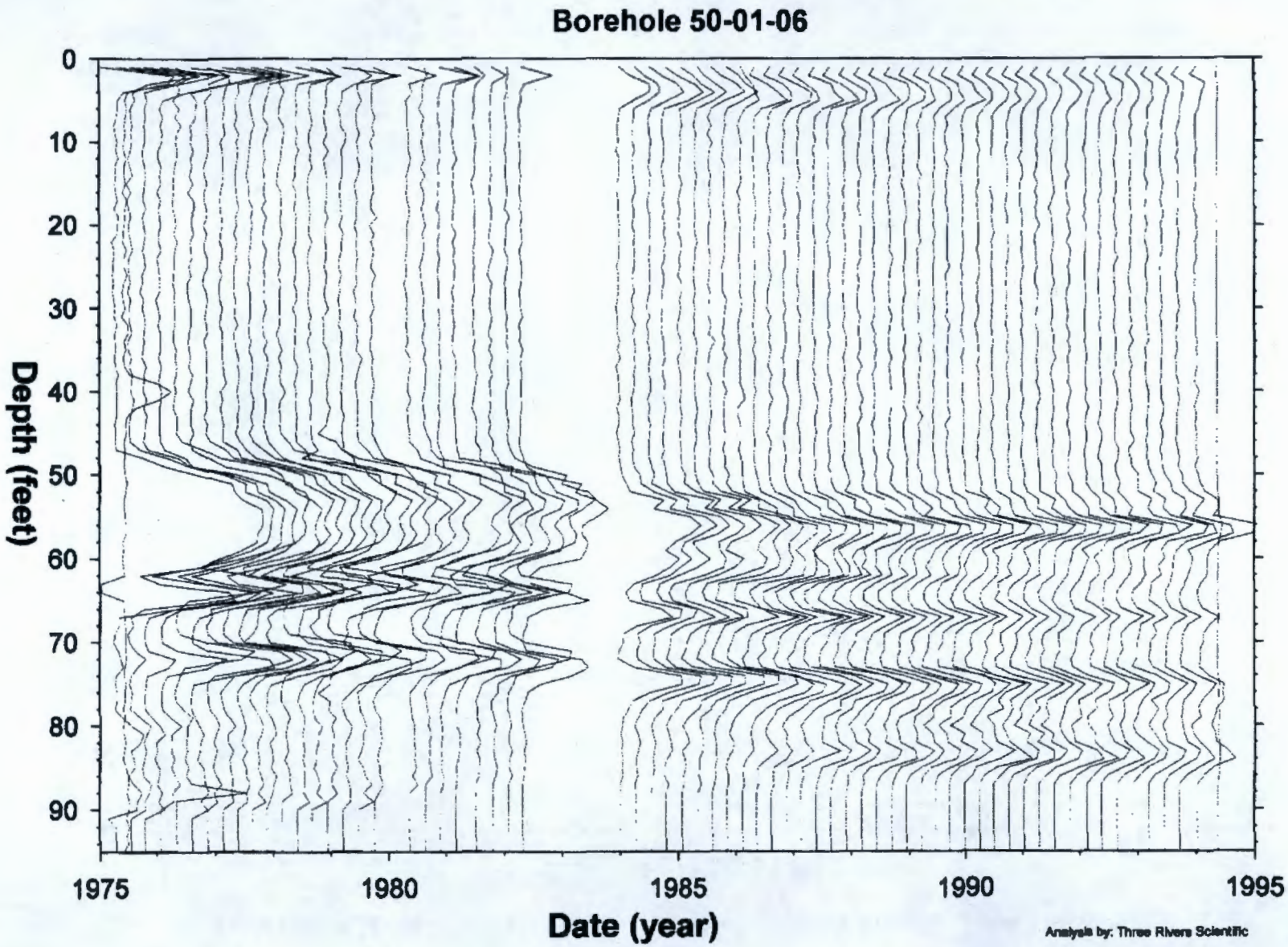
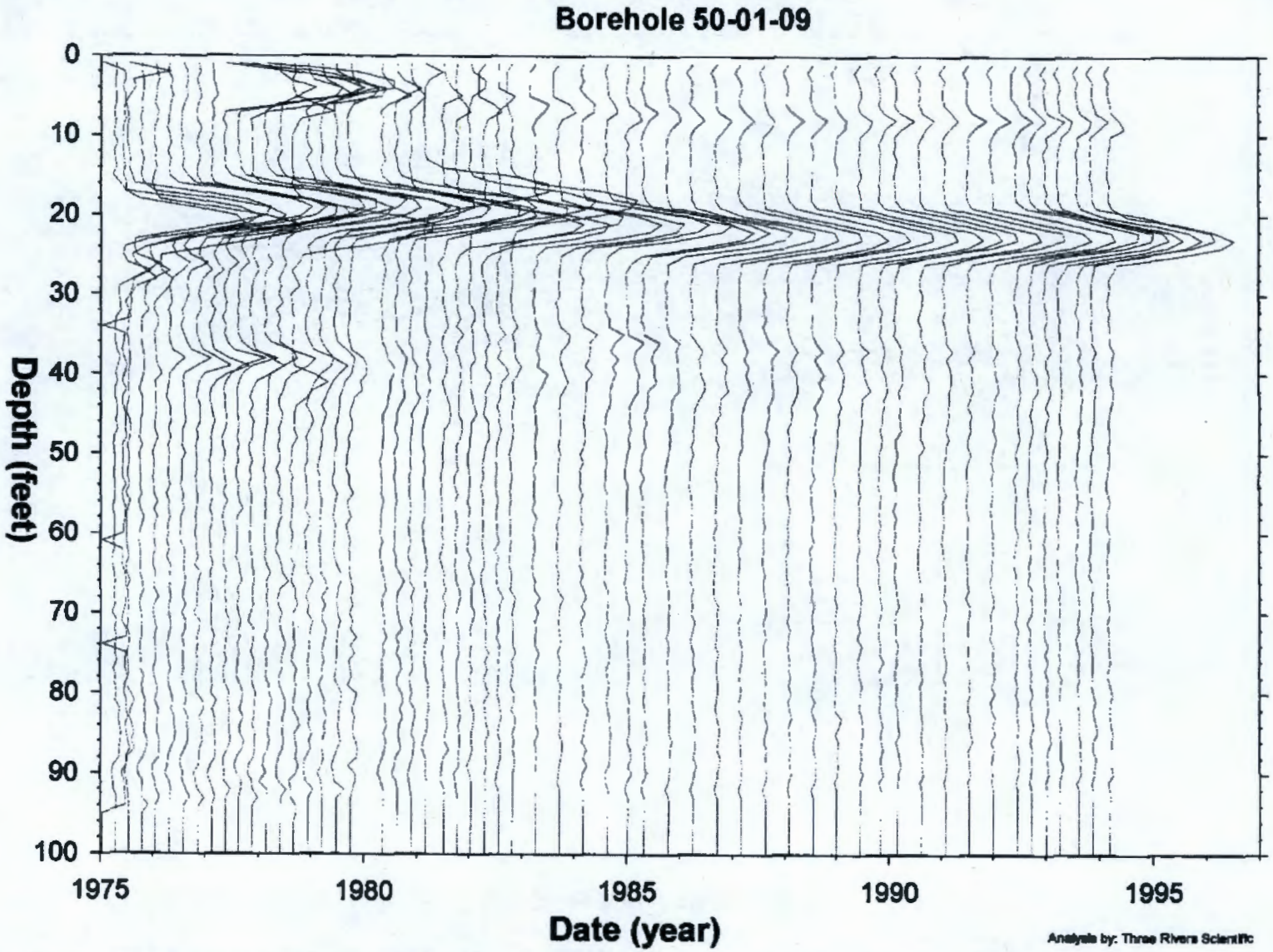


Figure B1-9. Tank 241-T-101 Historical Gamma Logging Results. (sheet 3 of 3)



Reference: RPP-6088, *Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-T Tank Farm – 200 West.*

Cesium-137 contamination was detected near the ground surface and the shallow subsurface in the vicinity of all of the boreholes. This contamination could have resulted from surface spills, airborne contamination releases, or a combination of these. The contamination has migrated down into the sediments by precipitation infiltration, and, in some cases, may have been driven down along the borehole during the drilling.

A large ^{137}Cs plume was encountered on the southeast side of tank T-101 between 20 and 122.5 ft. This contamination was present before 1973, when borehole 50-01-04 was installed. The SGLS detector became saturated from 21 to 53 ft and 59 to 68 ft because of a high radiation field. A large volume of contamination appears to have leaked to the soil column between 1968 and 1969, when tank T-101 was overfilled during normal tank farm operations. Previous investigations have identified the spare fill lines associated with tank T-101 as the probable source of the leak. While a leak volume has not been quantified, document WHC-SD-WM-ER-320, *Supporting Document for the Northwest Quadrant Historical Tank Content Estimate Report for T Tank Farm* reports that up to 300,000 gal may have leaked; however, the accuracy of the estimate is not validated. This volume estimate is equivalent to more than half the stated capacity of the tank and does not appear to be consistent with the assumption of overfilling.

Historical total gamma results (RPP-6088, *Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-T Tank Farm – 200 West*) for drywells 50-01-04, 50-01-06, and 50-01-09 show evidence of contamination plumes that were most likely present before the drywells were drilled (Figure B1-9).

Measured ^{137}Cs concentrations as high as 10,000 pCi/g were detected in the Ringold Formation by the SGLS between 109 and 122.5 ft in borehole 50-01-04. In nearby borehole 50-00-03, low levels of ^{137}Cs contamination were measured between 128 and 139 ft that probably correlate with the high ^{137}Cs concentrations detected in borehole 50-01-04. The SGLS data suggest that the maximum extent of the plume has not been determined because the contamination occurs at the bottom of the logged intervals in both boreholes.

The plume from tank T-101 is widespread and is identified in other boreholes by ^{60}Co and ^{154}Eu contamination. A large ^{60}Co, ^{154}Eu, and ^{152}Eu plume was identified between tanks T-101 and 241-T-104 (T-104) in borehole 50-01-06 from 50 to 88 ft. A 1975 investigation inferred that this plume originated from the direction of borehole 50-01-04. More of this plume is identified by deep ^{60}Co contamination west of tank T-104 from 68 to 88 ft and 68 to 95 ft in boreholes 50-04-10 and 50-04-08, respectively. West and north of tank T-101, ^{60}Co contamination was identified from 68 to 86 ft and 35 to 38 ft in boreholes 50-01-09 and 50-01-12, respectively. Most of the plume appears to be orientated in a southwesterly direction, passing under most of tank T-101 and parts of tanks T-104 and 241-T-105 (T-105).

Report RPP-RPT-44202, *Hanford Geophysical Logging Project Spectral Gamma Re-Baseline Logging for the T-Farm Interim Surface Barrier* states that significant contaminant migration has occurred since the baseline data were acquired in approximately 1998. The dominant radionuclide exhibiting migration is ^{60}Co.

B2.0 TANK 241-T-103

This section provides information on the historical waste loss event associated with tank T-103. Waste operations for tank T-103 are summarized in Figure B1-1. Figure 3-2 of the main text shows a plan view of a typical tank in T Farm with the location of the pump pit, sluice pit, spare inlet nozzles (N1, N2, N3 and N4) and tank risers.

B2.1 TANK 241-T-103 WASTE HISTORY

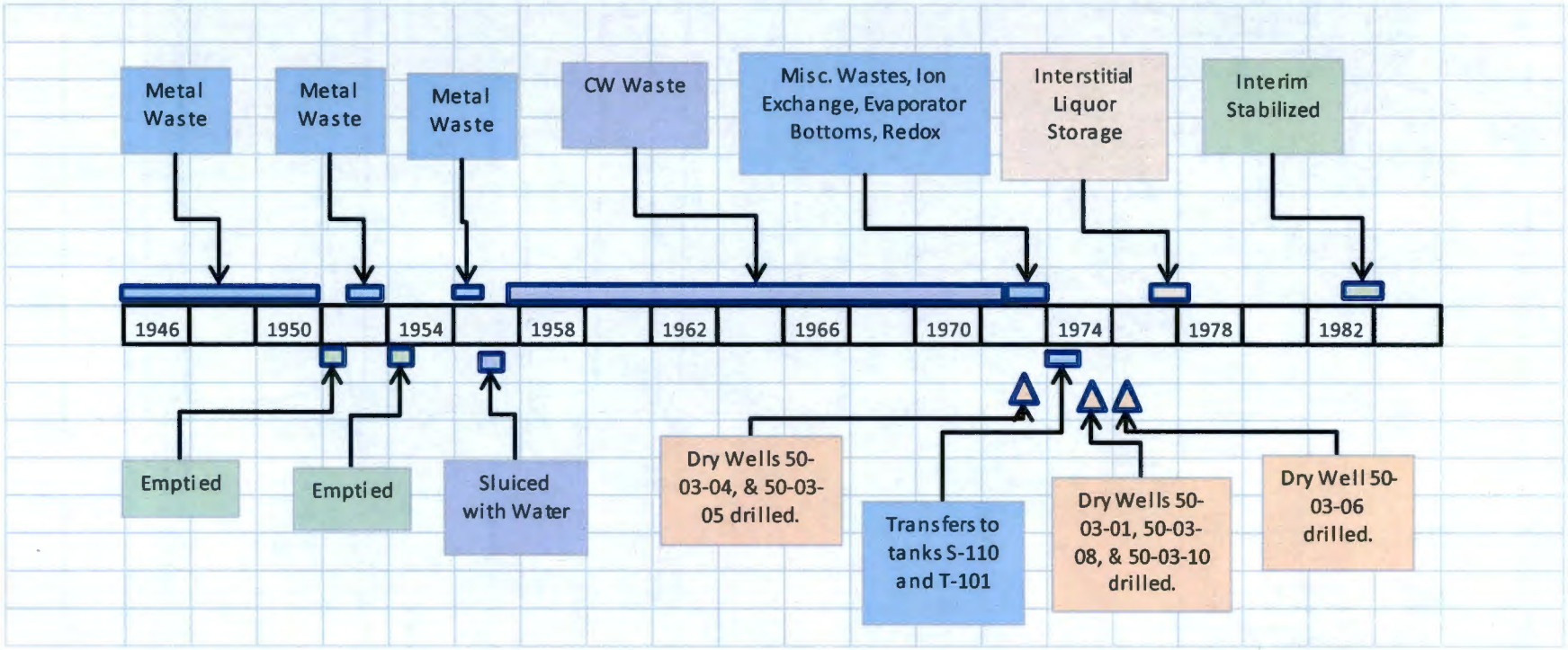
Tank T-103 began receiving metal waste from the cascade overflow line connected to tank T-102 in November 1945 and was full in February 1946. The tank underwent a metal waste removal process in 1953, and was declared empty on December 15, 1953. Tank T-103 was filled with metal waste again in June 1955. During 1956, the supernate was pumped to tank 241-TX-115 and the remaining heel of sludge was sluiced. From 1957 to 1972, the tank received and stored coating waste. From 1972 to 1974, the tank received and stored a mixture of B Plant low-level waste, ion-exchange waste, evaporator bottom waste, REDOX ion exchange (IX) waste, REDOX high-level waste, and coating waste. Figure B2-2 shows quarterly tank transfer levels and history. Additional tank waste transfer information is included in WHC-MR-0132, LA-UR-97-311 and tank waste summary reports.

B2.2 INTEGRITY OF TANK 241-T-103

Tank T-103 was classified in March 1974 as having questionable integrity based on a 0.3-in. liquid level decrease, which took place from November 1973 to February 1974 (LET-051480, "Review of Classification of Four Hanford Single-Shell "Questionable Integrity (QI)" Tanks"). Initial classification of questionable integrity is documented as an inlet line overflow (SD-WM-TI-356). No Occurrence Report was generated. Subsequent analysis by various groups referenced herein identifies four possible explanations for classification of questionable integrity for tank T-103. These explanations include cascade line overflow, erratic liquid level readings due to irregularly shaped floating solids on the liquid level surface, grout seal failure on the inlet lines, and general cooling of waste materials.

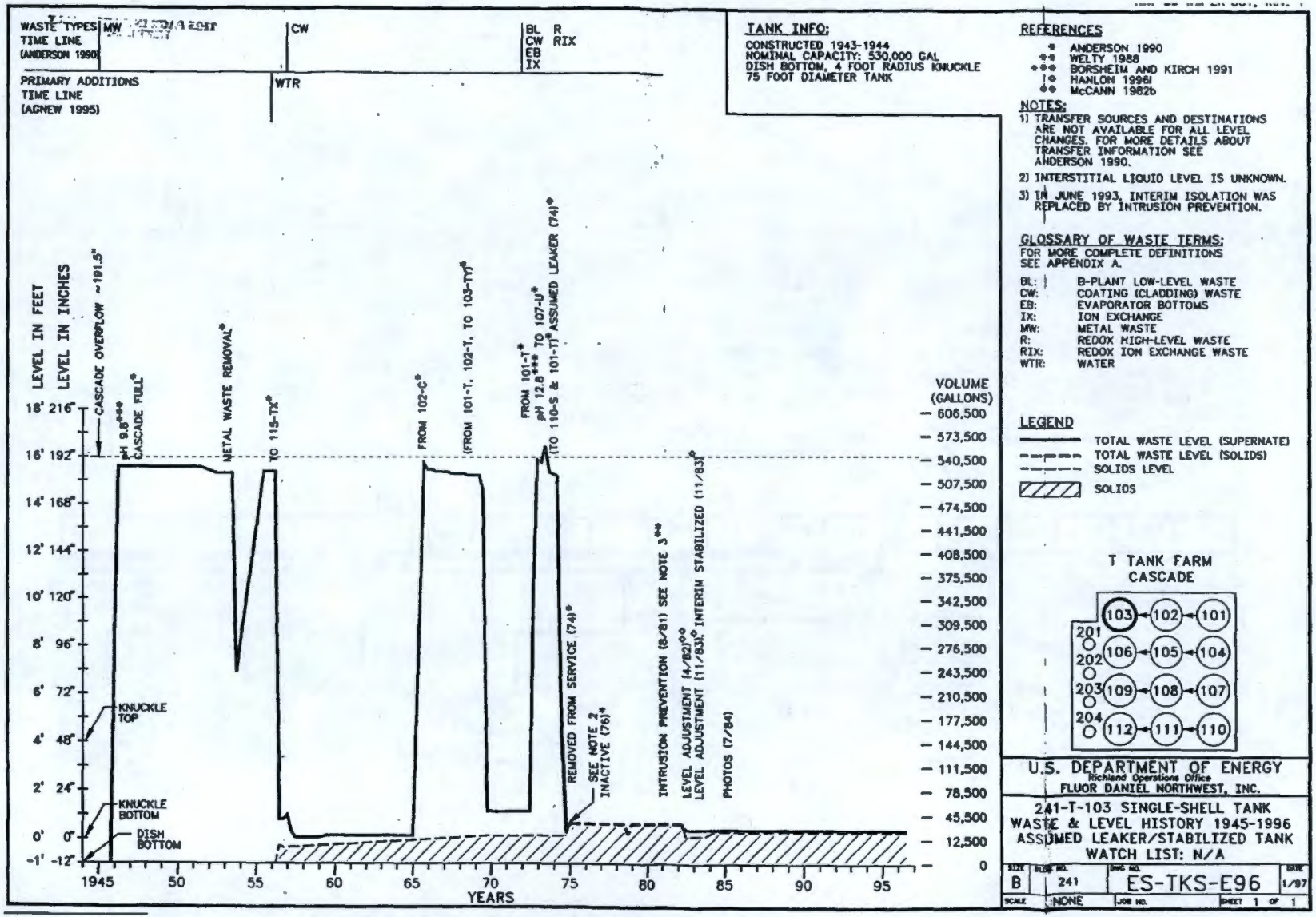
Figure B2-2 shows the cascade overflow level at 191.5 inches. From June 1973 through March 1974, the tank consistently held more than the operational liquid level of 184.4 in. and exceeded the cascade overflow level of 191.5 in. with a peak measurement of 197.5 in. in June 1973. Figure B2-3 presents the tank T-103 waste surface level measurements for June 13, 1973 through August 5, 1973. This figure shows a declining trend in the waste surface level from 197.5 to 196.4 in. for this period. The liquid level in tank T-103 was reduced to ~184.5 in. by transferring supernate to tank 241-U-107 on August 4 and 5, 1973. Subsequent transfers of supernatant and saltwell pumping have lowered the waste level in tank T-103 to ~17.4 in. (~27,000 gal) from the center of the tank bottom as of March 2004.

Figure B2-1. Tank 241-T-103 Waste Operations Summary.



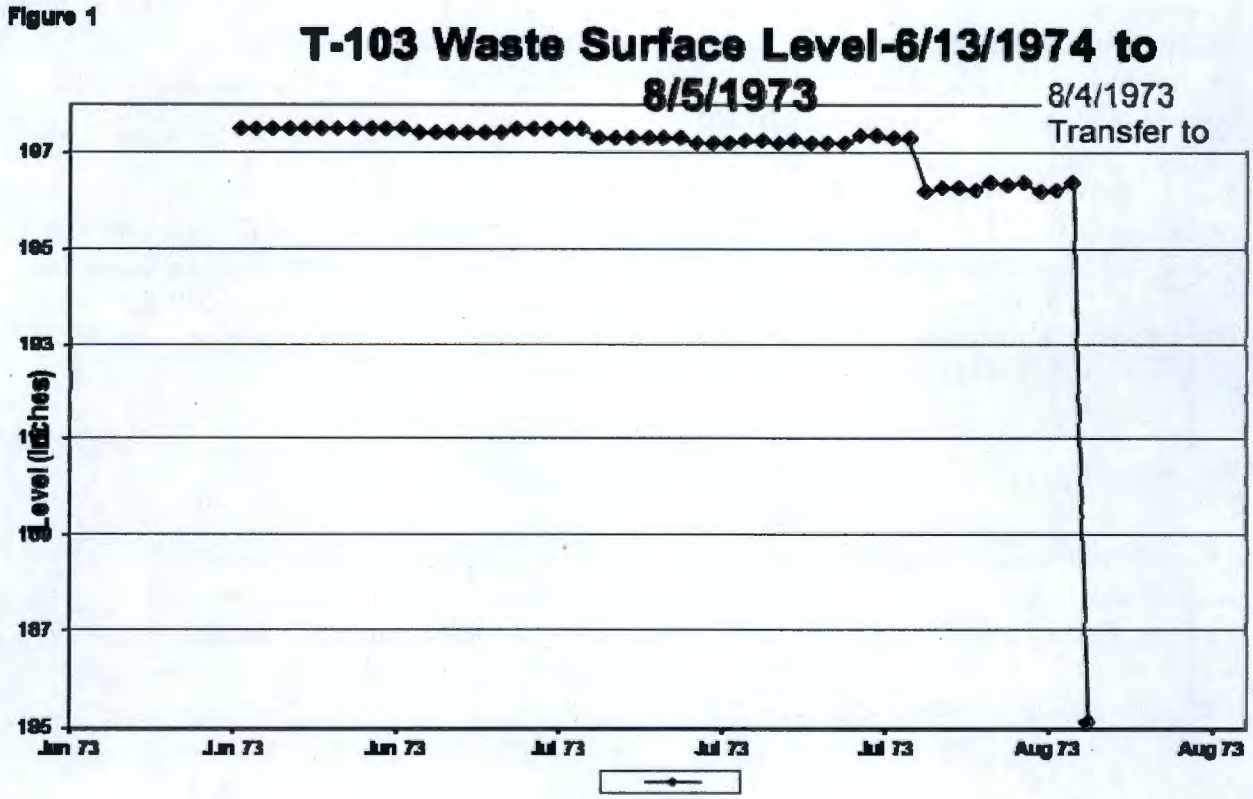
CW = cladding waste, aluminum clad fuel

Figure B2-2. Tank 241-T-103 Quarterly Waste Fill History.



Reference: HNF-SD-WM-ER-351, *Historical Tank Content Estimate for the Northwest Quadrant of the Hanford 200 West Area.*

Figure B2-3. Tank 241-T-103 Waste Surface Level for June through August 1973.



Further, the distribution of the leak in the soil sediments relative to the depth and location of radioactivity detected in drywell 50-03-04 indicates a grout seal failure on the tank fill line. Thus, liquid level and soil data support a hypothesis that a tank overfill generated a possible leak.

Gamma activity in drywell 50-03-04 shows the contamination begins at 20 ft below ground surface (bgs). The activity detected in drywell 50-03-04 indicates the presence of ^{106}Ru and ^{137}Cs, which is consistent with the cesium IX waste that was present in tank T-103. The supernate present in tank T-103 was sampled and analyzed in 1974. The origin of activity detected in drywell 50-03-04 was likely a spare inlet port of the piping system, and a failed grout seal is documented on the tank fill line. Many of the T Farm tanks in the early 1970s contained cesium IX waste and laboratory analyses show these waste contained significant levels of heat-generating radionuclides. This suggests a very small liquid-level decrease over extended periods of time would be expected. Further, it is also documented that the gamma activity in drywell 50-03-04 resembles that of drywells associated with the tank 241-T-106 (T-106) leak. Therefore, the activity in the drywell may be part of the plume from the T-106 leak. Thus, definitively classifying T-103 as a confirmed leaker based on drywell activity is not possible.

Photo documentation recorded on March 29, 1974 suggests that the liquid level surface consists of clear liquid with irregularly shaped floating solids. Given the erratic behavior of the liquid level that is noted in the liquid level log from February 1974 through November 1974, it is possible that the irregularly shaped floating solids are a foam material. Such a material would cause erratic liquid level readings, which makes declaring a true liquid level decrease difficult.

B2.3 INTERIM STABILIZATION

The tank was assessed as interim stabilized in November 1983 with 3,500 gal of drainable liquid. Engineering estimated contents of 3,500 gal of supernate and 22,500 gal of solids (HNF-SD-RE-TI-178). Tank T-103 had intrusions of material between 1978 and 1981. In August 1981 the tank was interim isolated.

As of October 2004 the tank was estimated to contain 27,000 gal of waste consisting of 4,000 gal of supernate and 23,000 gal of REDOX cladding waste, aluminum clad fuel (1952-1960) (CWR1), Plutonium Uranium Extraction (Plant) (PUREX) cladding waste, aluminum clad fuel (1961-1972), and bismuth phosphate process metal waste (1950-1956) sludge (RPP-RPT-43161, *2009 Auto-TCR for Tank 241-T-103*). Figure B2-4 shows a mosaic photograph of the tank surface on July 3, 1984.

B2.4 TANK 241-T-103 TEMPERATURE HISTORY

The tank temperature is monitored by a single thermocouple tree located in riser 8. No temperature measurements were found before 1976. Figure B2-5 shows tank waste temperatures for tank T-103 from 1976 to 2013. During this period the maximum waste temperature was ~78 °F in 1976. By 1983 the temperature decreased to below ~70 °F. The tank temperature varies seasonally between ~55 and ~70 °F.

B2.5 DATA REVIEW AND OBSERVATIONS

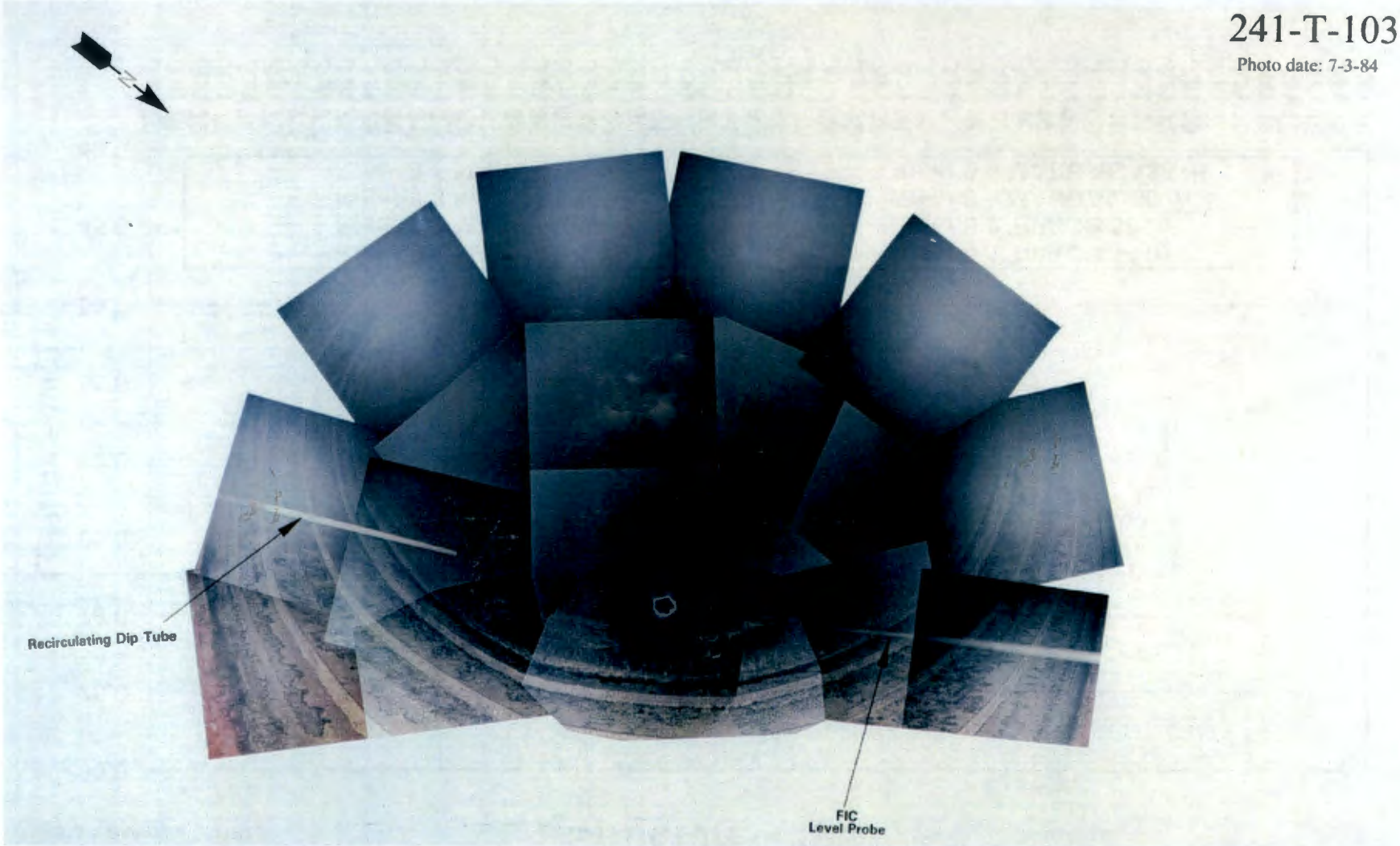
The following sections contain discussions of the tank surface level, drywell logging data and borehole sampling.

B2.5.1 Tank Surface Level Measurements

Tank liquid level measurements before 1973 were not available, other than from the transfer data in waste process reports (Figure B2-2). Figure B2-2 indicates that liquid waste may have been filled above the cascade/spare inlet level in tank T-103 between 1971 and 1973. Table B2-1 shows surface levels and surface level changes from 1973 to 1987. Figure B2-6 shows surface level measurements from 1973 to 2013. The historical information available from other sources do not identify any active leaks from this tank.

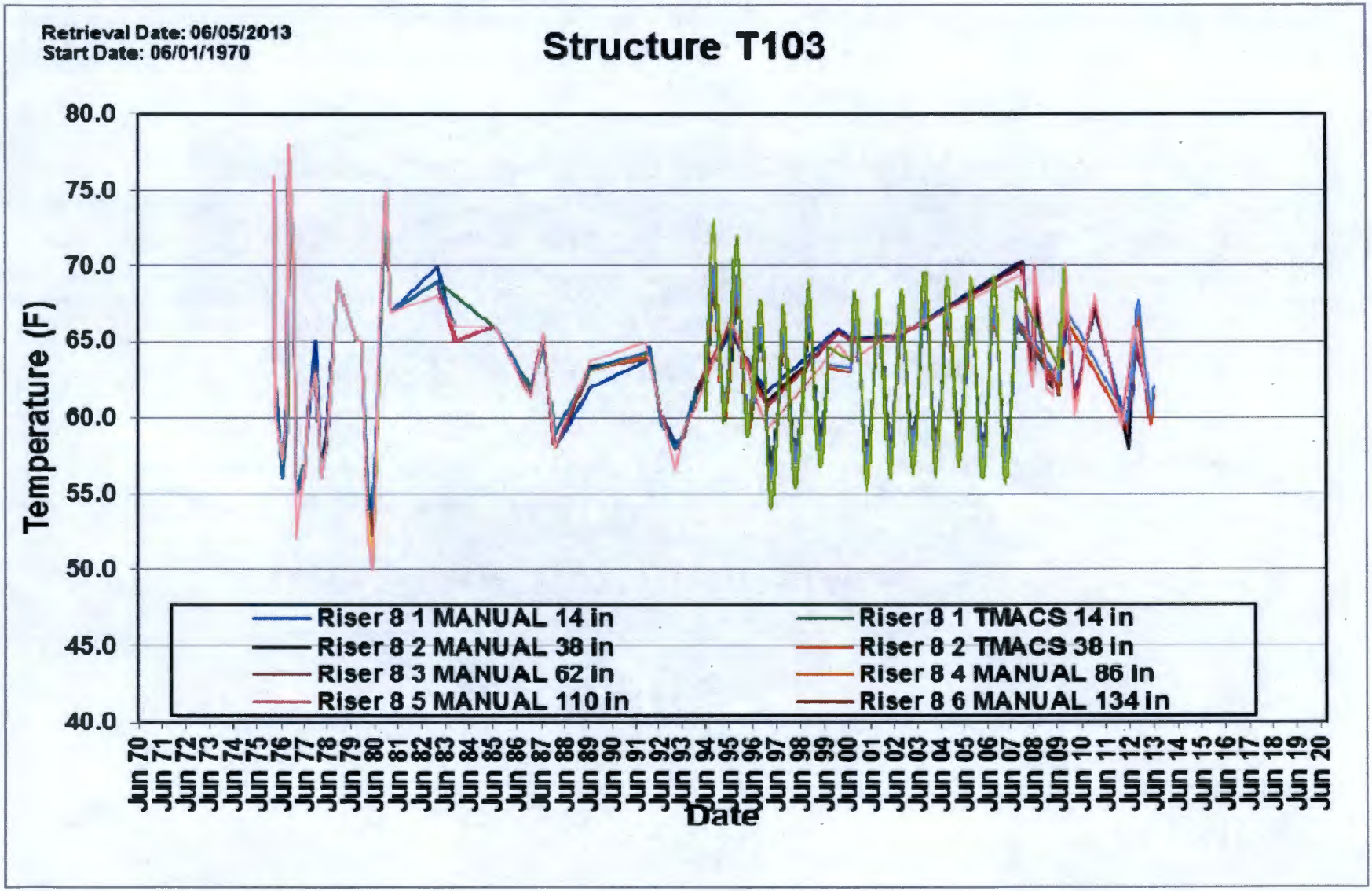
SD-WM-TI-356 states that "the tank was removed from service due to a liquid level decrease in excess of 0.3 inches between November 1973 and February 1974. The radiation in wells 50-03-04, 50-03-05, and 50-04-06 is attributed to the 106-T leak. The contamination at the 20 ft level of well 50-03-04 is due to past leakage from tank T-103 through the spare fill line as a result of overfilling the tank."

Figure B2-4. Tank 241-T-103 Waste Surface Photo Mosaic.



Reference: HNF-SD-WM-ER-351, *Historical Tank Content Estimate for the Northwest Quadrant of the Hanford 200 West Area.*

Figure B2-5. Tank 241-T-103 Waste Temperature Measurements.



TMACS = Tank Monitor and Control System

Table B2-1. Tank 241-T-103 Liquid Level Measurements and Changes (1973 to 1987). (sheet 1 of 2)

Liquid Level.

Date	Liquid level (in.)	Baseline ref.	Change from previous reading (in.)	Cumulative change (in.)	Comments
06/13/73	197.50		-	-	
07/24/73	197.30		-0.20	-0.20	Slow decrease
07/25/73	196.20		-	-0.20	Calibration
08/03/73	196.40		+0.20	0	Slow increase
08/05/73	184.45		-	0	Transfer
02/22/74	183.95		+0.50	-0.50	Slow decrease
03/07/74	184.30		+0.35	-0.15	Calibration and flush FIC
03/29/74	184.50		+0.20	-0.05	Slow increase
04/10/74	55.30		-	-0.05	Transfer
05/19/74	55.00		-0.30	-0.35	FIC flushed
07/09/74	55.25		+0.25	-0.10	Slow increase
07/18/74	4.55		-	-0.10	Transfer
08/01/74	4.60		+0.05	-0.05	Stable
08/02/74	4.75		-	-0.05	New FIC board
02/10/75	4.70		-0.05	-0.10	Stable
02/11/75	4.50		-0.20	-0.30	Unexplained drop
07/28/75	4.50		-	-0.30	Stable
08/28/75	4.90		-	-0.30	Sludge movement
11/21/75	5.80		+0.90	+0.60	Calibration and flush FIC
02/10/76	5.90		+0.10	+0.70	Stable
02/18/76	5.00		-0.90	-0.20	FIC repair
10/11/76	5.20		+0.20	0	Slow increase
05/03/77	4.34		-0.85	-0.85	Steady decrease
05/12/77		3.90	-0.45	-1.30	QA FIC recalibration
01/05/78	3.90		-	-1.30	Stable
01/15/78	4.20		+0.30	-1.00	Slow increase
04/15/78	4.20		-	-1.00	Stable
07/03/78	4.40		+0.20	-0.80	Slow increase
12/23/78	3.90		-0.50	-1.30	Steady decrease
11/18/79	3.90		-	-1.30	Stable
07/18/80	4.90		+1.00	-0.30	Steady increase
07/28/80	4.70		-	-0.30	FIC instrument work
09/12/80	4.70		-	-0.30	Stable
04/17/81		5.00	-	-0.30	Precipitation/O.R. 81-25
12/02/81	5.10		+0.10	-0.20	Stable flush and calibrate FIC
08/10/82	5.40		+0.30	+0.10	Slow increase
08/22/83	5.00		-0.40	-0.30	Readings fluctuate between 5.00 and 6.20

Table B2-1. Tank 241-T-103 Liquid Level Measurements and Changes (1973 to 1987). (sheet 2 of 2)

Liquid Level.

Date	Liquid level (in.)	Baseline ref.	Change from previous reading (in.)	Cumulative change (in.)	Comments
07/05/84	5.10		+0.10	-0.20	Stable
04/22/84	5.00		-0.10	-0.30	Decrease
07/01/85	5.00		-	-0.30	Stable
01/03/86	5.00		-	-0.30	Stable
07/01/86	4.90		-0.10	-0.40	Decrease
07/01/87	4.90			-0.40	Stable

Reference: SD-WM-TI-356, *Waste Storage Tank Status and Leak Detection Criteria.*

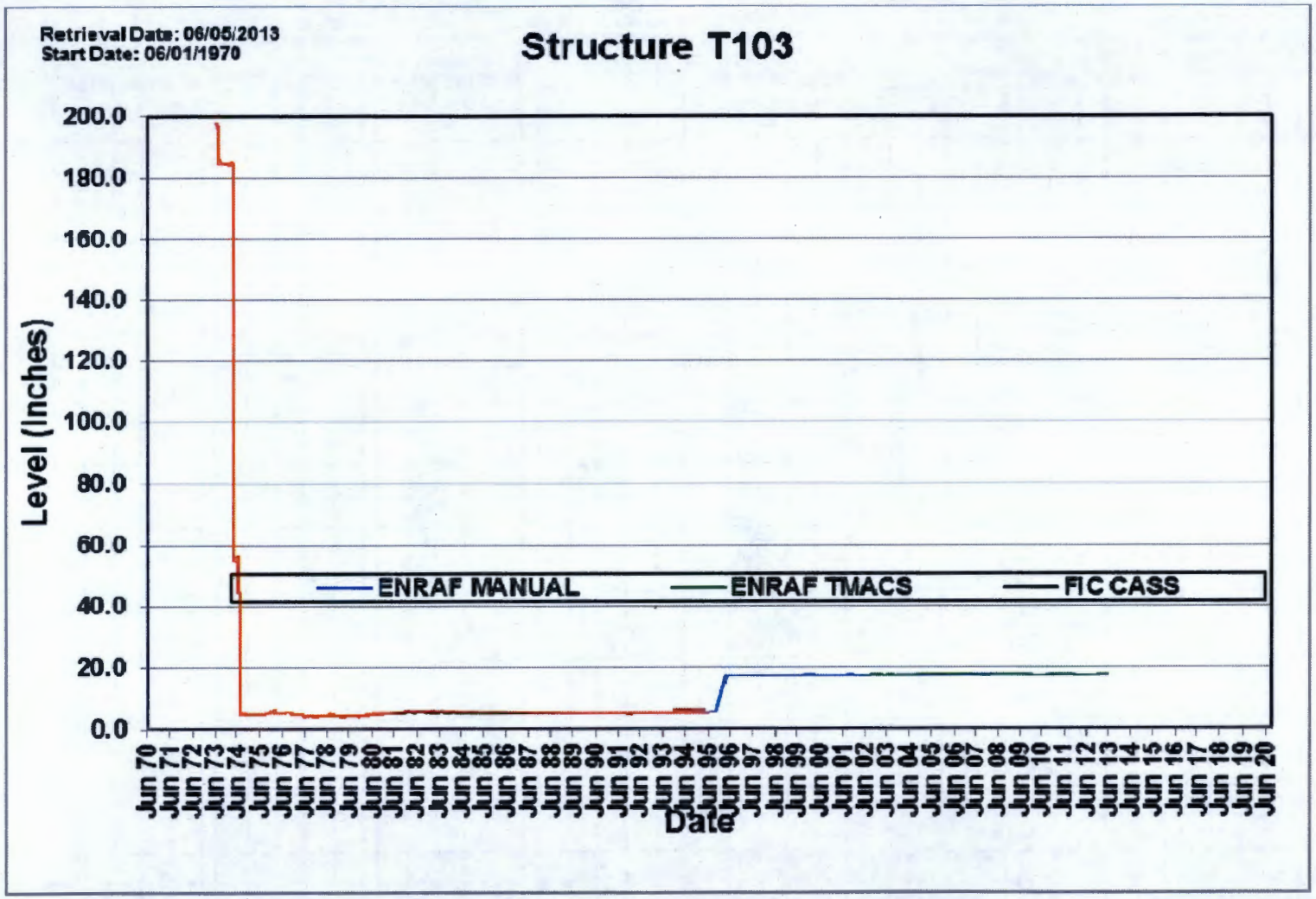
Occurrence Report 81-25, *Liquid Level Increase in Tank 103-T Exceeding the Increase Criterion* was issued in April 1981 because the liquid level exceeded the established increase criterion. The liquid level increase was attributed to precipitation entering the tank through the pump pits.

B2.5.2 Drywell Logging Data

Tank waste losses around tank T-103 were discovered when 16 drywells were installed in April and May of 1973 around tank T-106 to determine the nature and extent of the tank T-106 leak plume. Six drywells surround tank T-103 (50-03-01, 50-03-04, 50-03-05, 50-03-06, 50-03-08, and 50-03-10); Figures B1-7, B1-8 and B2-7 show the 1997 SGLS results for these drywells. Figure B2-8 provides tank T-103 historical gamma logging results for drywells 50-03-04, 50-03-05 and 50-03-06.

Cesium-137 contamination was detected at the ground surface in the immediate vicinity of almost all of the drywells. This contamination is probably attributable to direct radiation from the tank farm surface or from contamination on the surface of nearby equipment. In drywell 50-03-06, it appears that surface contamination has infiltrated ~0.5 ft into the backfill material.

Figure B2-6. Tank 241-T-103 Waste Surface Level Measurements.



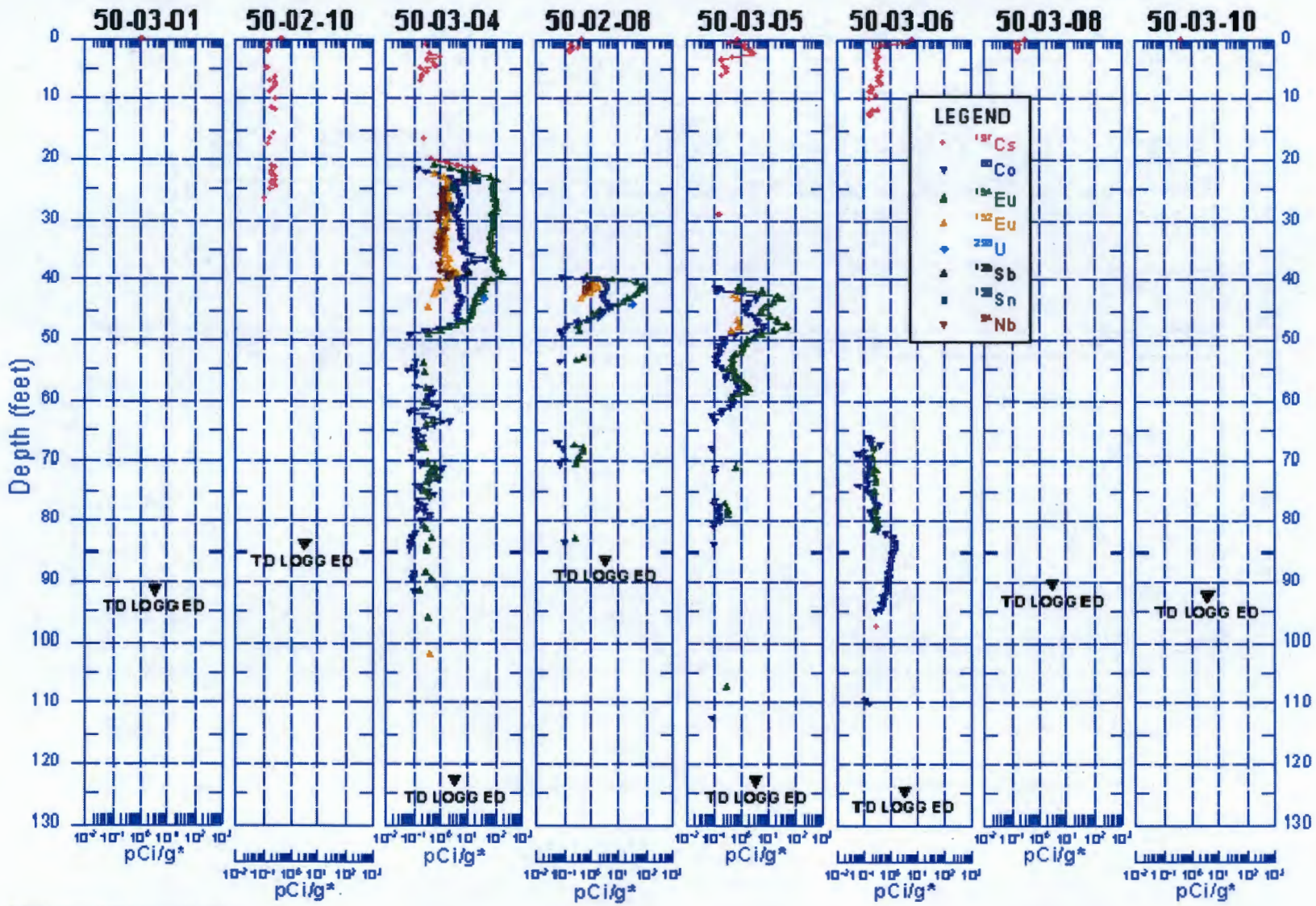
Note: Surface level measurement changed to bottom of tank (12-in. off-set) after October 1995 measurement.

CASS = Computer Automated Surveillance System

TMACS = Tank Monitor and Control System

Honeywell Enraf is a product of Honeywell Process Solutions, Strahlenbergerstr. 110-112, 63067 Offenbach, Germany.

Figure B2-7. 1998 Spectral Gamma Logging Results for Drywells near Tank 241-T-103.



*Apparent Concentration

Reference: GJ-HAN-117, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank T-103.*

Figure B2-8. Tank 241-T-103 Historical Gamma Logging Results for Drywells 50-03-04, 50-03-05 and 50-03-06. (sheet 1 of 3)

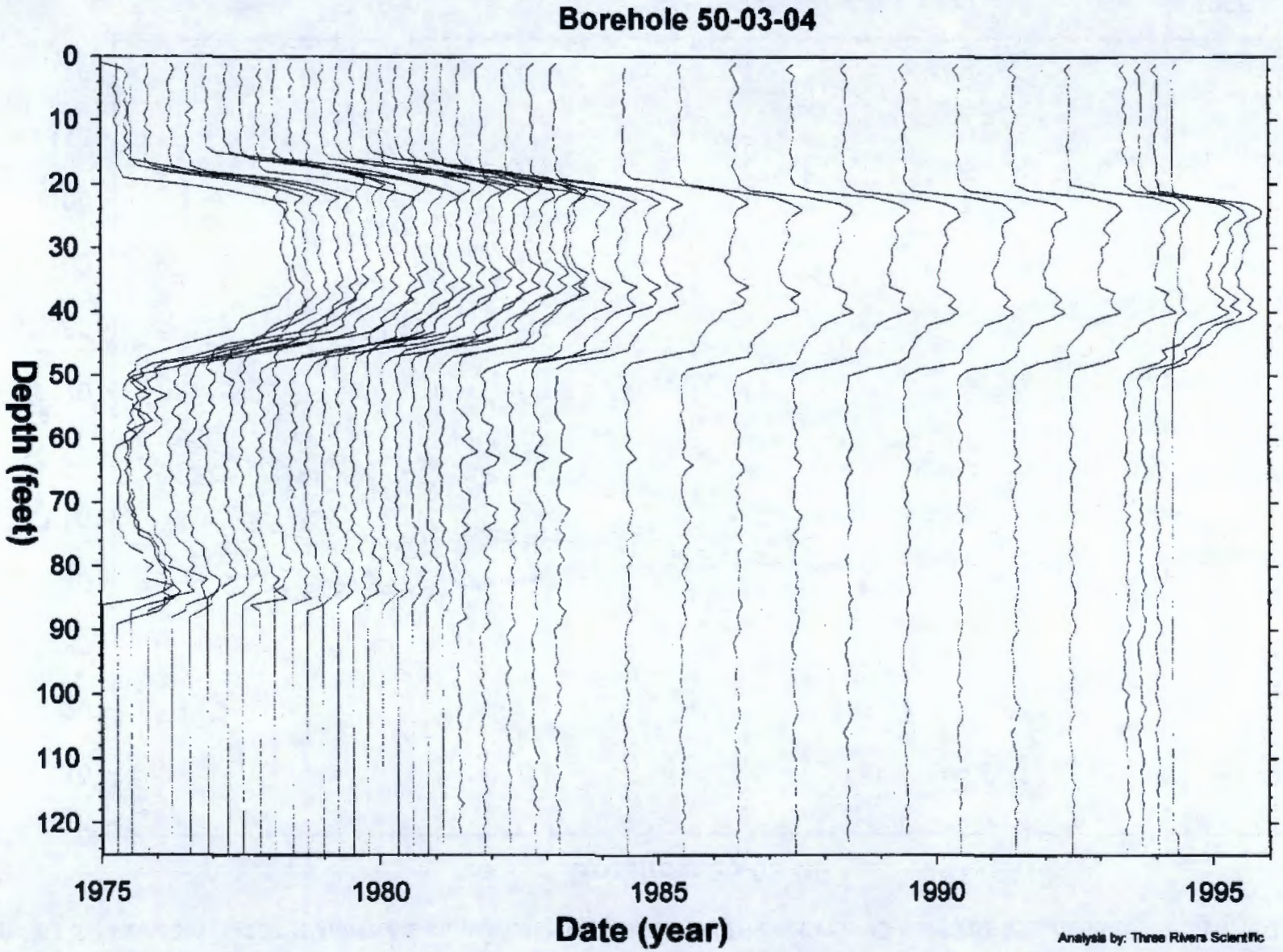


Figure B2-8. Tank 241-T-103 Historical Gamma Logging Results for Drywells 50-03-04, 50 03 05 and 50-03-06. (sheet 2 of 3)

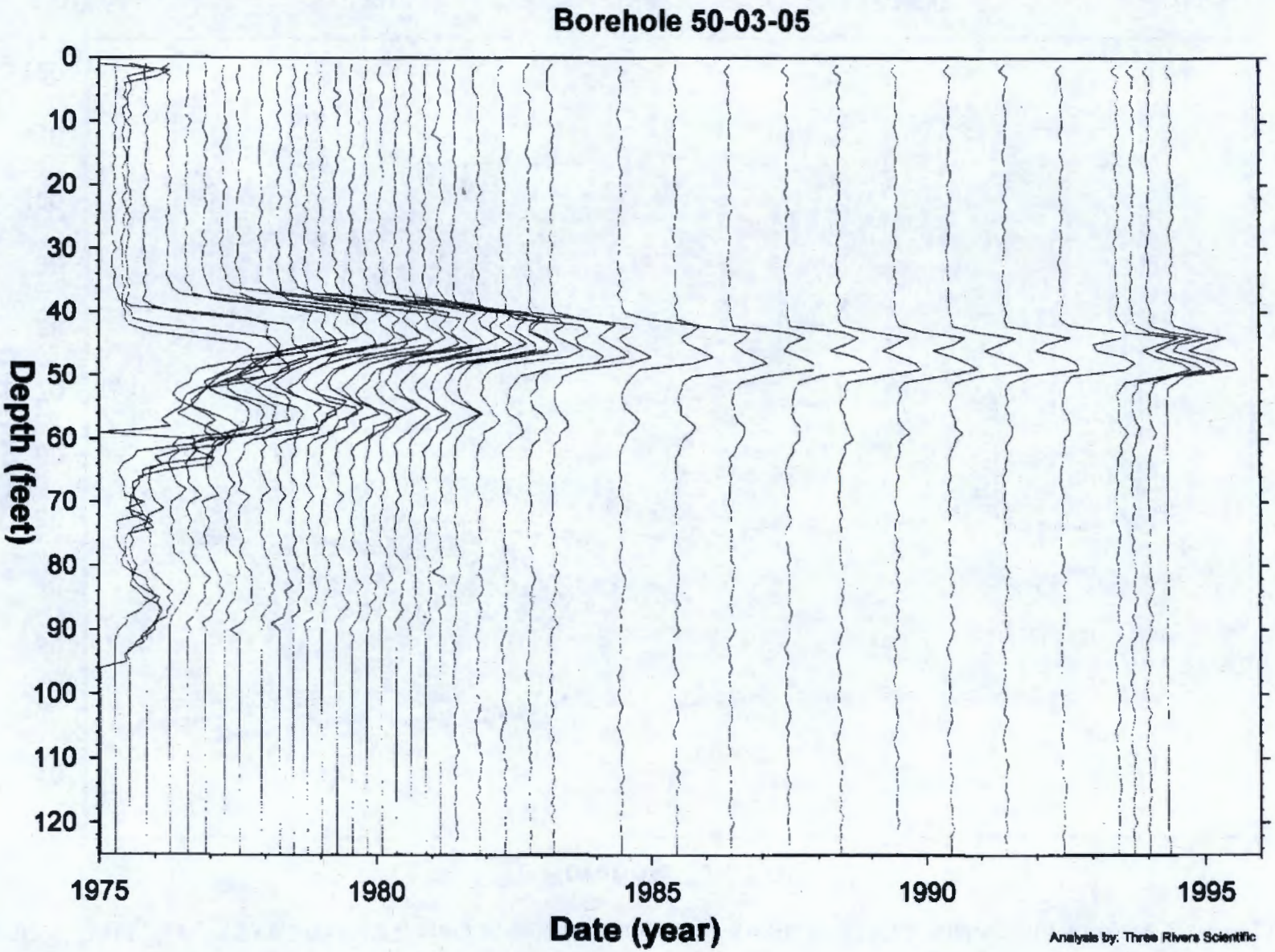
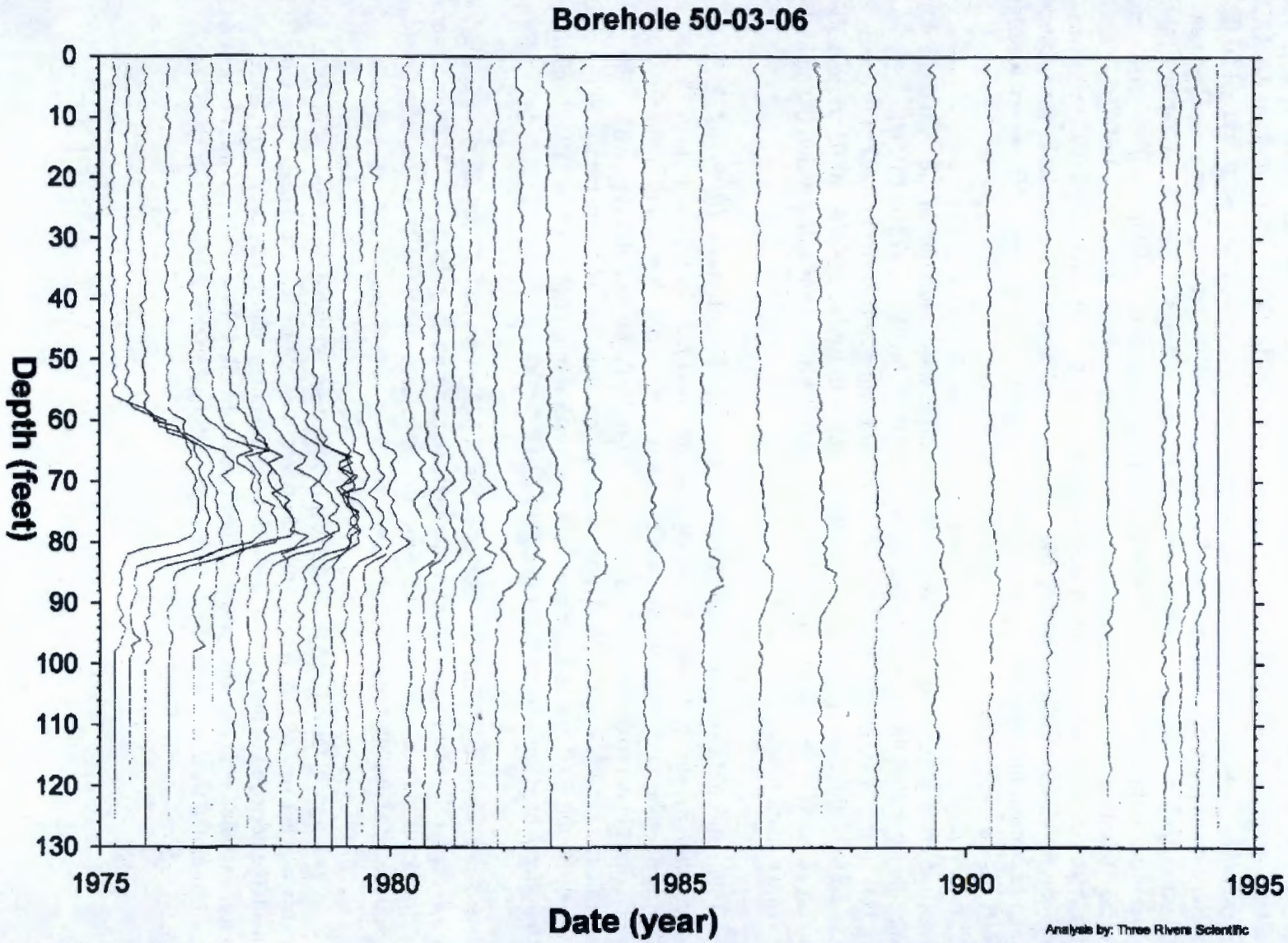


Figure B2-8. Tank 241-T-103 Historical Gamma Logging Results for Drywells 50-03-04, 50 03 05 and 50-03-06. (sheet 3 of 3)



Reference: RPP-6088, *Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-T Tank Farm – 200 West.*

A distinct plume of radionuclide contamination was detected by the SGLS around drywells 50-03-04, 50-02-08, 50-03-05, and 50-03-06. The contamination within this plume appears to be correlatable among these drywells and is believed to be the result of the spare fill line leak on the southeast side of the tank described in ARH-2874, *241-T-106 Tank Leak Investigation*. Less concentrated gross gamma activity was also measured at drywell 50-02-08. The most concentrated activity occurred at drywell 50-03-04 between 24 and 40 ft bgs near a waste transfer pipe line connected to tank T-103 and ~20 ft bgs. Given the proximity of the transfer line to this drywell, a leak from the transfer line was considered the likely discharge source. Based on the distribution of these contaminants, a leak volume of ~1,300 gal was estimated. Separation of the boundaries between the tank T-106 and tank T-103 leaks was considered to lie somewhere between the two tanks, and which of the two leaks were sources of contamination at intermediate drywells (50-03-05, 50-02-08, and 50-02-09) was not readily distinguished.

Historical gross gamma-ray data suggest that the downward migration of the ^{60}Co contamination has occurred within the plume around drywell 50-03-06 between 1975 and 1994. Drywell 50-03-04 appears to penetrate the thickest portion of the contaminant plume and is believed to be the closest drywell to the leak source. Drywells 50-02-08, 50-03-05, and 50-03-06 roughly demarcate the lateral extent of the ^{60}Co and ^{154}Eu contamination within the main body of the contaminant plume.

Mid-1990s spectral gamma measurements at the intermediate drywells (RPP-23752, *Field Investigation Report for Waste Management Areas T and TX-TY*) did not measure ^{106}Ru contamination because of radioactive decay. However, ^{60}Co with mobility similar to ^{106}Ru is concentrated in approximately the same 30- to 50-ft depth interval observed with ^{106}Ru contamination in 1977 and 1978. However, minor amounts of ^{60}Co were measured (~1 pCi/g) between 50 and 80 ft bgs indicating either some vertical migration over the last 20 years or further deep lateral migration of mobile tank T-106 waste.

These data collectively indicate a short-term small leak event that rapidly distributed waste over a small area, followed by longer-term minimal migration in the subsurface. Maximum vertical penetration of the center of mass of the mobile constituents from the T-103 transfer line leak appears to be about 50 ft bgs.

The drywell data obtained and the historical information available from other sources do not identify any active leaks from this tank. However, the data indicate that one or more surface spills have occurred in the past. In addition, a contaminant plume has been intercepted by drywells located near the southeast and south sides of tank T-103. This plume is believed to have originated from a leak in the seal of a spare fill line on the southeast side of the tank, nearest to borehole 50-03-04.

B3.0 TANK 241-T-106

This section provides information on the historical waste loss event associated with tank T-106. Waste operations for tank T-106 are summarized in Figure B3-1. Figure 3-2 of the main text shows a plan view of a typical tank in T Farm with the location of the pump pit, sluice pit, spare inlet nozzles (N1, N2, N3 and N4) and tank risers.

B3.1 TANK 241-T-106 WASTE HISTORY

Tank T-106 was placed into service in June 1947. The tank was gradually filled with second-cycle decontamination waste from the bismuth phosphate process (2C) at T Plant. During the third quarter of 1948, the tank was emptied and refilled with first-cycle waste from the bismuth phosphate process (1C) at T Plant. The tank remained full until early 1954, when the waste was pumped out to a crib. The tank was again filled with 1C waste in June 1954 and remained full until late 1954. The liquid waste was pumped out in early 1955, leaving ~10,000 gal of solids. From 1956 to 1969, tank T-106 received and stored REDOX coating waste from tank 241-S-107. Most of this waste was transferred to tank 241-TY-103 (241-TY Tank Farm) in the third quarter of 1969.

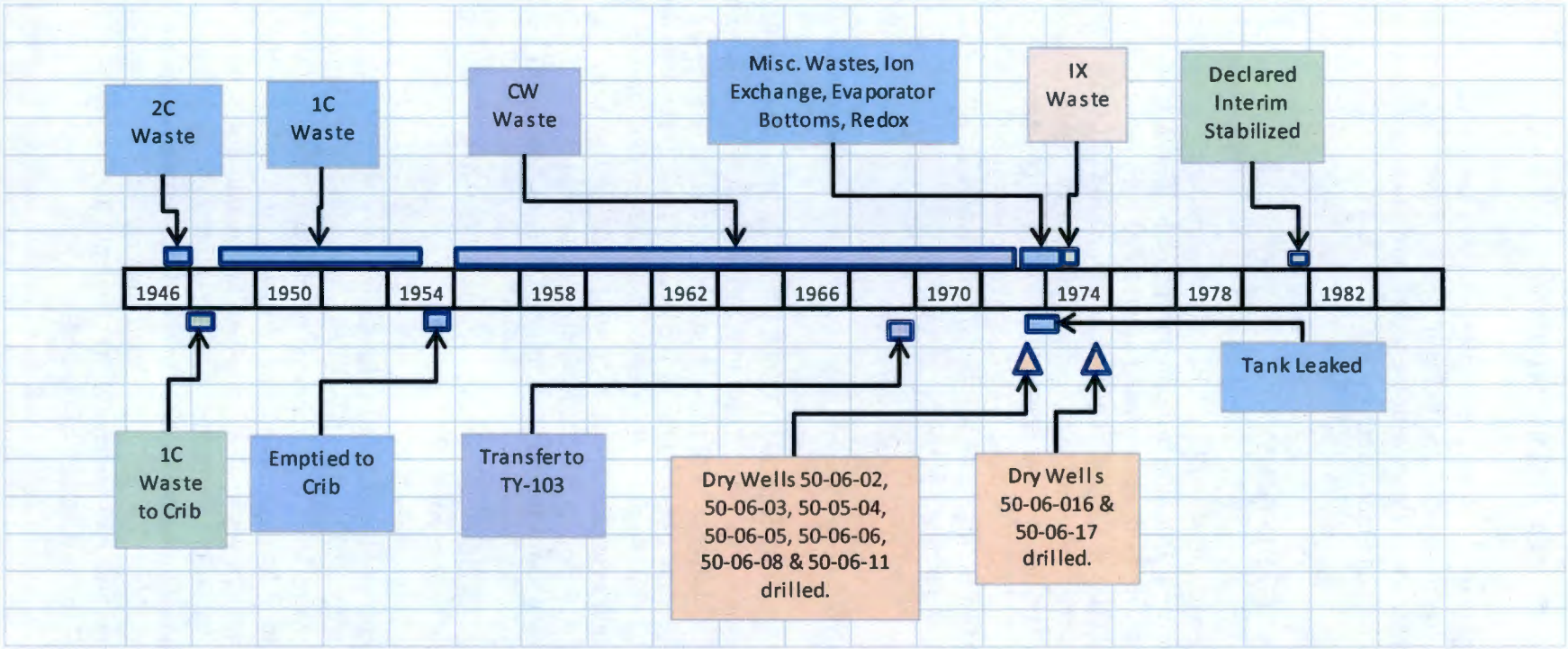
B3.2 INTEGRITY OF TANK 241-T-106

At the end of March 1973, tank T-106 contained ~78,000 gal of liquid and sludge, consisting primarily of REDOX coating waste with smaller amounts of B Plant low-level waste and ion-exchange waste. On April 4, 1973, transfers of ion-exchange waste from tank 241-T-107 (T-107) to tank T-106 via the cascade through tank T-105 began. Tank T-106 was declared a confirmed leaker on June 8, 1973 on the basis of observed decreases in the liquid level inside tank T-106 and elevated radiation counts in borehole 50-08-11 (299-W10-51) in May and June 1973. The tank was removed from service and pumped to a minimum heel in June 1973. In July 1974, the tank was further pumped down to a residual layer of less than 6 inches.

On the basis of in-tank liquid-level measurements, an estimated 115,000 gal of liquid waste leaked from tank T-106 into the vadose zone.

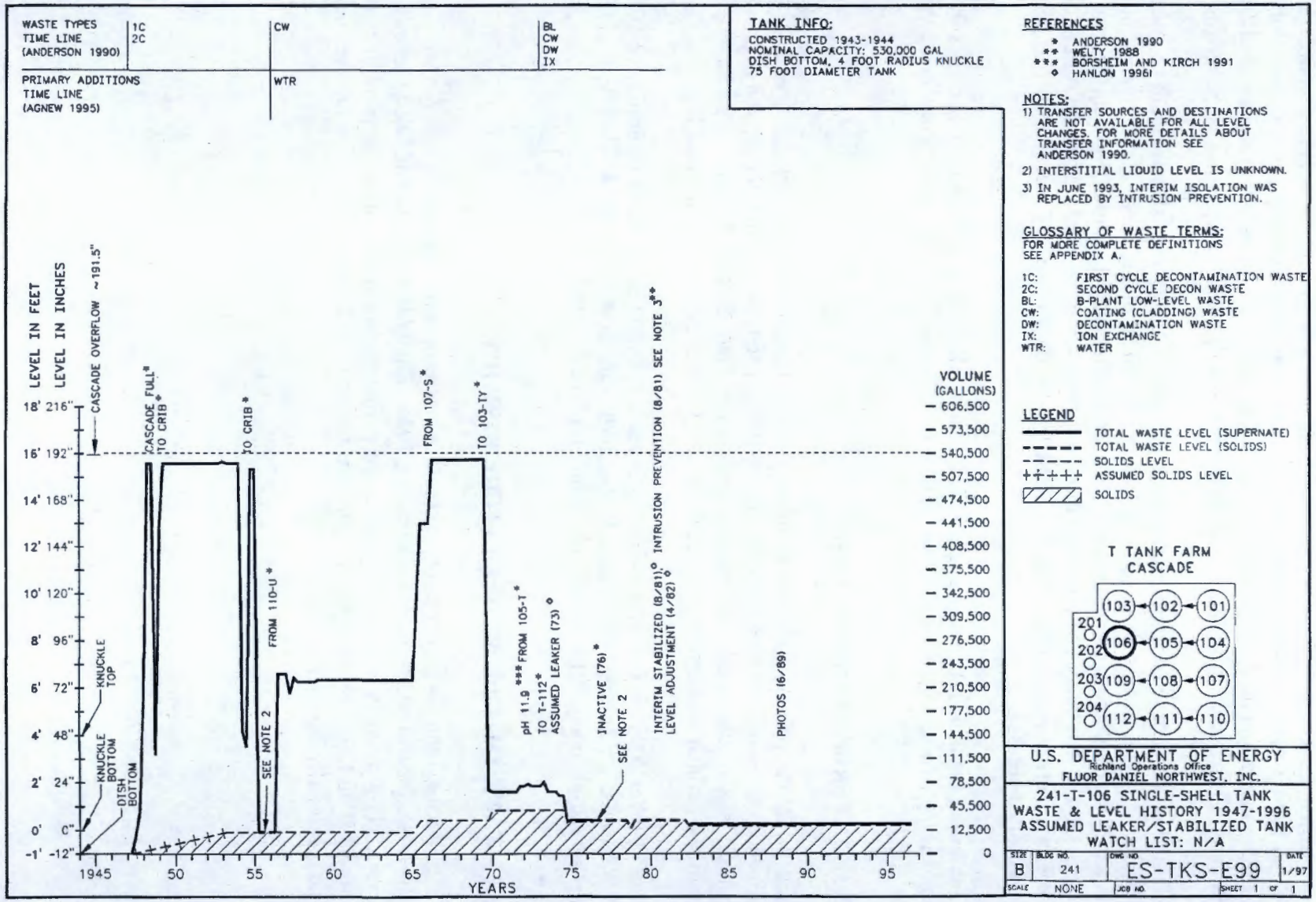
The history, status, fate and impact of the 115,000-gal radioactive waste tank leak from tank T-106 have been studied since 1973 (RHO-ST-14, *High-Level Waste Leakage from the 241-T-106 Tank at Hanford*). As of May 1978, the maximum detected depth of the 1-microcurie per liter (μCi/l) concentration of ^{106}Ru penetration was 33 meters (108 ft) below the ground surface or 29 meters (95 ft) above the regional water table. This maximum depth of penetration was detected in two of the dry wells in T Farm. In no other well has radioactivity greater than 1.0-pCi/l been found deeper than 29 meters (95 ft). This is ~43% of the distance from the bottom of the tank to the water table. The maximum horizontal movement of the 1-μCi/l ^{106}Ru concentration front from the tank was ~23 meters (75 ft) at a depth of 25 meters (82 ft). This distance is approximately equal to the diameter of the tank.

Figure B3-1. Tank 241-T-106 Waste Operations Summary.



1C = First-cycle decontamination (waste) from the bismuth phosphate process
2C = Second-cycle decontamination (waste) from the bismuth phosphate process
CW = cladding (waste), aluminum clad fuel
IX = ion exchange (waste)

Figure B3-2. Tank 241-T-106 Quarterly Waste Fill History.



Reference: HNF-SD-WM-ER-320, *Supporting Document for the Historical Tank Content Estimate for T Tank Farm.*

The rate of frontal movement of radioactivity was qualitatively estimated. A large portion of the movement occurred in 1973, prior to the publication of an initial tank leak status report. From 1973 to 1974, detectable lateral movement occurred in at least some sediment layers. From 1974 to 1978, movement could not generally be detected. However, migration in wells near the leak perimeter was detected in 1978, and the probable cause defined.

Calculations on vadose zone moisture and wetting frontal movement were found to be essentially in qualitative agreement in their assessed lack of movement of any waste above concentration guidelines to the Hanford ground water. Thus, during the hazardous lifetime of the fission products, there will likely be no amount of radioactivity enter the Hanford ground water. Therefore, there appears to be no impact of the leak on the Columbia River (the nearest point of uncontrolled access).

Summary of the tank T-106 waste release is found in ARH-2874, RHO-ST-14, and BHI-00061, *Engineering Evaluation of the GAO/RCED-89-157, Tank 241-T-106 Vadose Zone Investigation.*

B3.3 INTERIM STABILIZATION

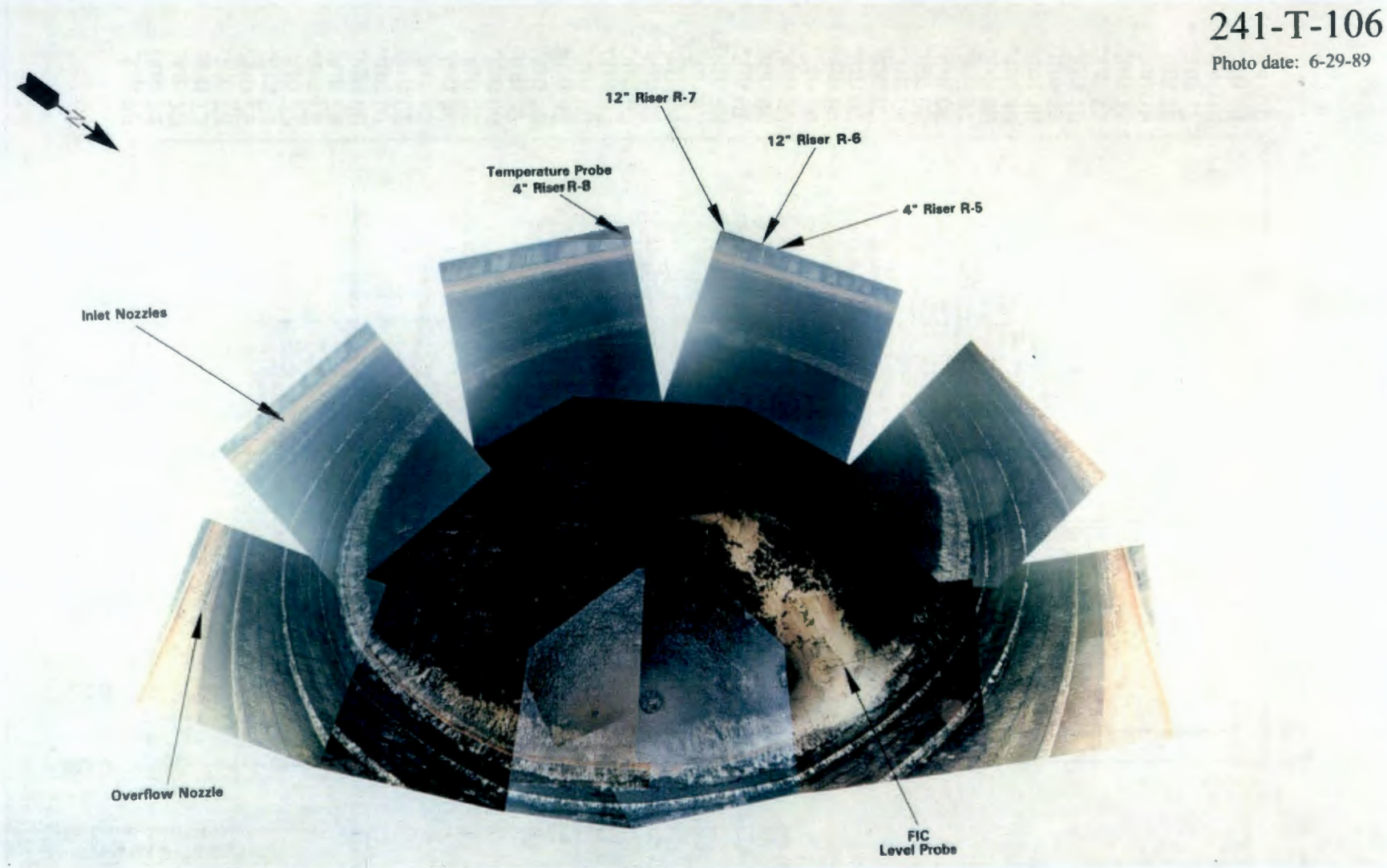
Tank T-106 was primary stabilized in January 1979. The tank was interim stabilized and intrusion prevention was completed in August 1981. The tank remains categorized as an assumed leaker. The interim stabilization evaluation (HNF-SD-RE-TI-178) indicated only a thin liquid pool, which is assumed to have evaporated for this inventory evaluation.

As of October 2004 the tank was estimated to contain 22,000 gal of waste consisting of 1C, CWR1, and CWR2 sludge (RPP-RPT-43164, *2009 Auto-TCR for Tank 241-T-106*). Figure B3-3 shows a mosaic photograph of the tank surface on June 29, 1989.

B3.4 TANK 241-T-106 TEMPERATURE HISTORY

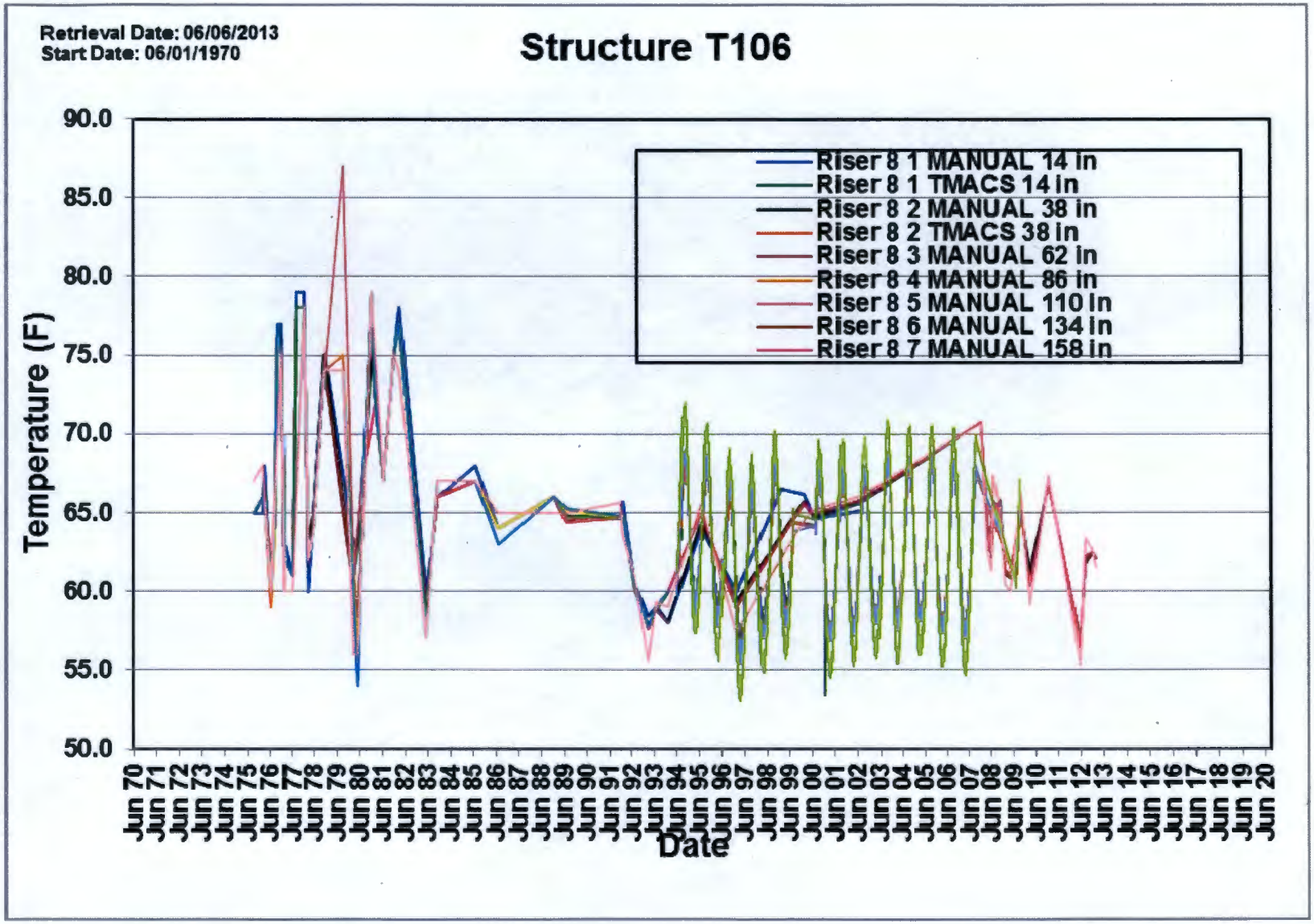
The tank temperature is monitored by a single thermocouple tree located in riser 8. No temperature measurements were found before 1976. Figure B3-4 shows tank waste temperatures for tank T-106 from 1976 to 2013. During this period the maximum waste temperature was about 87 °F in 1979. By 1983 the temperature decreased to below ~70 °F. The tank temperature varies seasonally between ~55 and ~70 °F.

Figure B3-3. Tank 241-T-106 Waste Surface Photo Mosaic.



Reference: HNF-SD-WM-ER-351, *Historical Tank Content Estimate for the Northwest Quadrant of the Hanford 200 West Area.*

Figure B3-4. Tank 241-T-106 Waste Temperature Measurements.



TMACS = Tank Monitor and Control System

B3.5 DATA REVIEW AND OBSERVATIONS

The following sections contain discussions of the tank surface level, drywell logging data and borehole sampling.

B3.5.1 Tank Surface Level Measurements

Tank liquid level measurements before 1973 were not available, other than from the transfer data in waste process reports (Figure B3-2). Figure B3-2 indicates that liquid waste may have been filled above the cascade/spare inlet level in tank T-106 between 1966 and 1970. Table B3-1 shows surface levels and surface level changes from 1973 to 1987. Figure B3-5 shows surface level measurements from 1981 to 2013. SD-WM-TI-356 states that "the tank was removed from service as a confirmed leaker because of a leak estimated to be 115,000 gal. It was pumped to a minimum heel in June 1973 and was further pumped down to a residual layer of less than 6 in. in July 1974." The 1973 report ARH-2874 provides additional information on the tank T-106 leak.

SD-WM-TI-356 identifies that test drillings were made during 1975 to determine the extent of the leak plume for evidence of movement of this contamination. Those test results indicated that the leak plume was essentially stable, though some slow migration had been apparent toward the southeast. The geologic and historical information available from other sources do not identify any active leaks from this tank. However, the data indicate that surface spills and a possible small leak from a pipeline have occurred in the past. The data also indicate that a very extensive subsurface contaminant plume exists around and below the base of the tank. This plume originated from the 1973 tank T-106 leak. The leak source is located on the southeast side of the tank, nearest to boreholes 50-06-05 and 50-06-17. The plume extends radially outward as much as 100 ft from the leak source. Except for some movement of deep ^{60}Co contamination around boreholes 50-06-02 and 50-06-03, the data suggest that the majority of the radionuclides that constitute the contaminant plume have remained stable and have not migrated through the formation sediments since 1974. The vertical extent of the plume could not be determined because of the limited depth of most of the boreholes.

B3.5.2 Drywell Logging Data

Figure B3-6 presents a correlation plot of the measured radionuclide concentration profiles for 6 of the 13 drywells surrounding tank T-106; B3-7 and B3-8 show the 1997 SGLS results for these drywells. Figure B3-9 provides tank T-106 historical gamma logging results for drywells 50-06-04, 50-06-05 and 50-06-06. Near-surface and shallow subsurface ^{137}Cs contamination was detected around most of the drywells. This contamination could have resulted from surface spills, airborne contamination releases, or a combination of these. The contamination may have migrated, in some undetermined manner, down around the outside of the drywells or may have been dragged down during the drilling of the drywells. It is also possible that the contamination has been driven downward into the backfill material by precipitation infiltration. The latter interpretation is supported by shape factor analysis results from drywell 50-06-04, a non-grouted drywell known to be single-cased, that indicate that the ^{137}Cs contamination is generally uniformly distributed in the backfill material as deep as 8 ft around this drywell. Although the shape factor analysis results are limited to only one drywell, it

is possible that at least some of the near-surface ^{137}Cs contamination detected in the other drywells surrounding this tank may be distributed in the backfill material, thus constituting a significant portion of the overall contamination in the shallow vadose zone around this tank.

Table B3-1. Tank 241-T-106 Liquid Level Measurements and Changes (1973 to 1987).

Liquid Level.

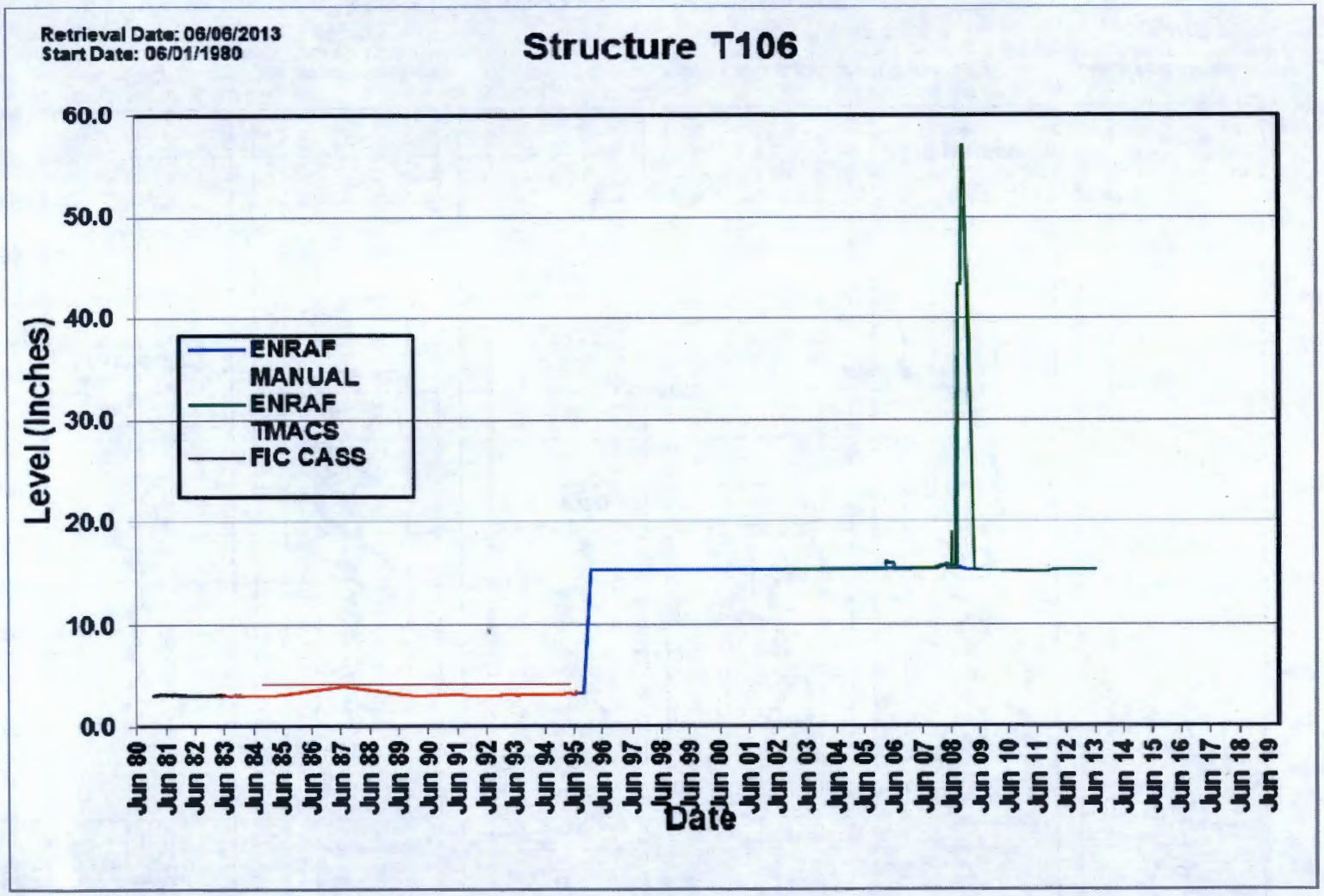
Date	Liquid level (in.)	Baseline ref.	Change from previous reading (in.)	Cumulative change (in.)	Comments
06/13/73	18.50		-	-	
11/11/73	19.15		+0.65	+0.65	Slow increase
11/12/73	18.70		-0.45	+0.20	Unexplained drop
03/04/74	18.90		+0.20	+0.40	Slow increase
03/05/74	17.10		-	+0.40	FIC calibration
07/24/74	17.30		+0.20	+0.60	Slow increase
07/26/74	5.55		-	+0.60	Transfer
09/03/74	5.40		-0.15	+0.45	Slow decrease
09/04/74	3.85		-	+0.45	FIC calibration
11/03/74	3.70		-0.15	+0.30	Slow decrease
10/21/76	3.70		-	+0.30	Stable
02/17/78		3.20	-0.50	-0.20	Very slow decrease
08/05/78	3.20		-	-0.20	Stable
02/23/79	3.10[a]		-	-	Stable
08/13/79	3.20		-	-	Stable
08/26/80	3.20		-	-	Stable
08/12/81	3.10		-	-	Stable
08/11/82	3.10		-	-	Stable
08/21/83	3.20		-	-	Stable
07/02/84	3.10		-	-	Stable
08/01/84		4.20	-	-	Intrusion mode
02/12/85	3.00		-	-	Intrusion mode
07/01/86			-	-	Intrusion mode
09/07/87			-	-	Intrusion mode

[a]Liquid level changes for this tank will not be accumulated because the tank is being salt well pumped, or the FIC and/or manual tape plummet is contacting solids and measurements are primarily to detect intrusions.

Reference: SD-WM-TI-356, *Waste Storage Tank Status and Leak Detection Criteria.*

Zones of elevated ^{137}Cs contamination detected between 12 and 19 ft around drywells 50-06-04 and 50-06-16 may represent surface contamination that has migrated laterally along the surface of the tank dome into this depth region of the backfill material. The shape factor analysis results from drywell 50-06-04 indicate that most of the ^{137}Cs contamination detected around this drywell within this depth region is uniformly distributed in the formation.

Figure B3-5. Tank 241-T-101 Waste Surface Level Measurements.

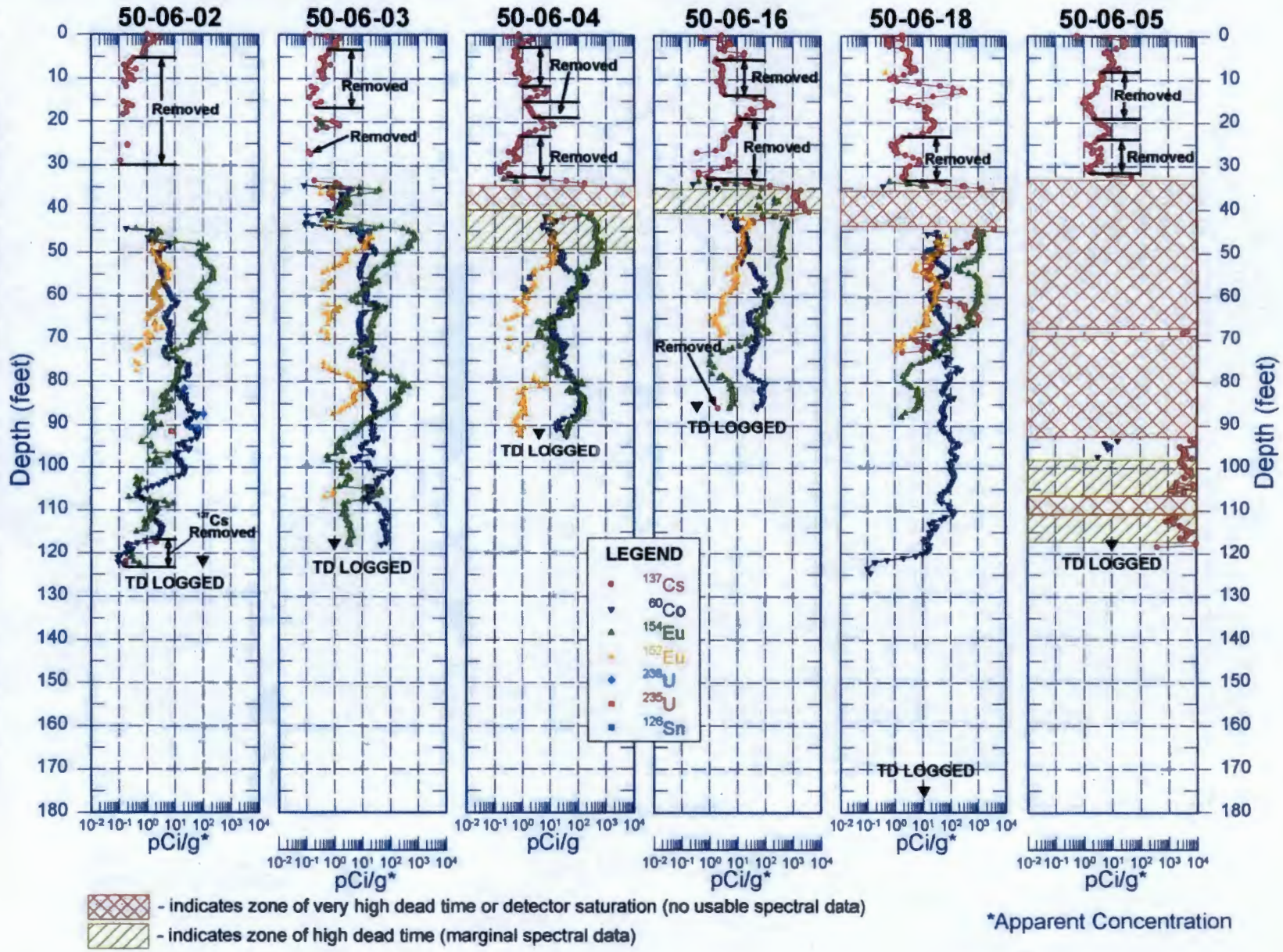


Note: Surface level measurement changed to bottom of tank (12-in. off-set) after October 1995 measurement.

CASS = Computer Automated Surveillance System FIC = Food Instrument Corporation (gauge) TMACS = Tank Monitor and Control System

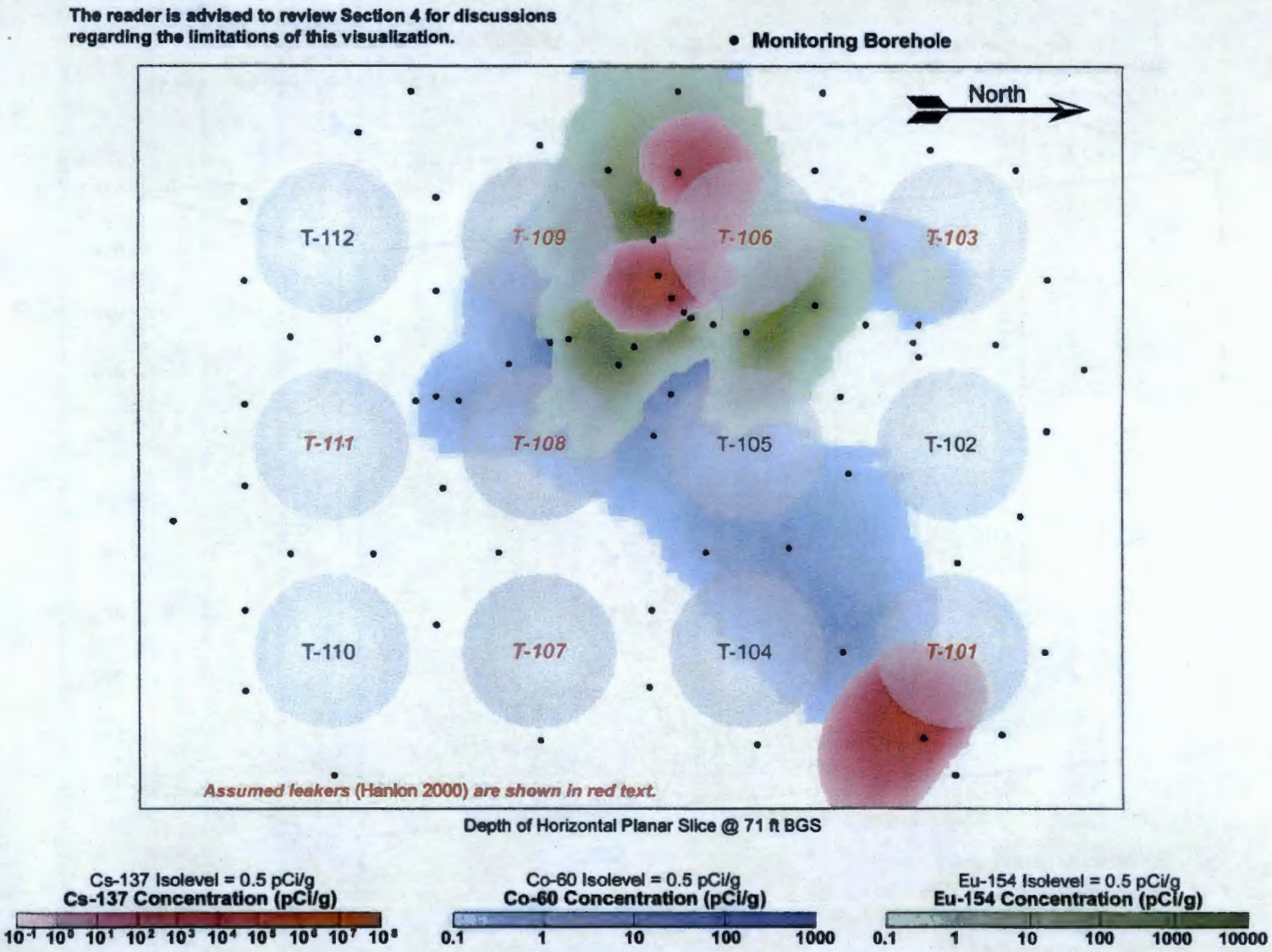
Honeywell Enraf is a product of Honeywell Process Solutions, Strahlenbergerstr. 110-112, 63067 Offenbach, Germany.

Figure B3-6. 1998 Spectral Gamma Logging Results for Drywells near Tank 241-T-106.



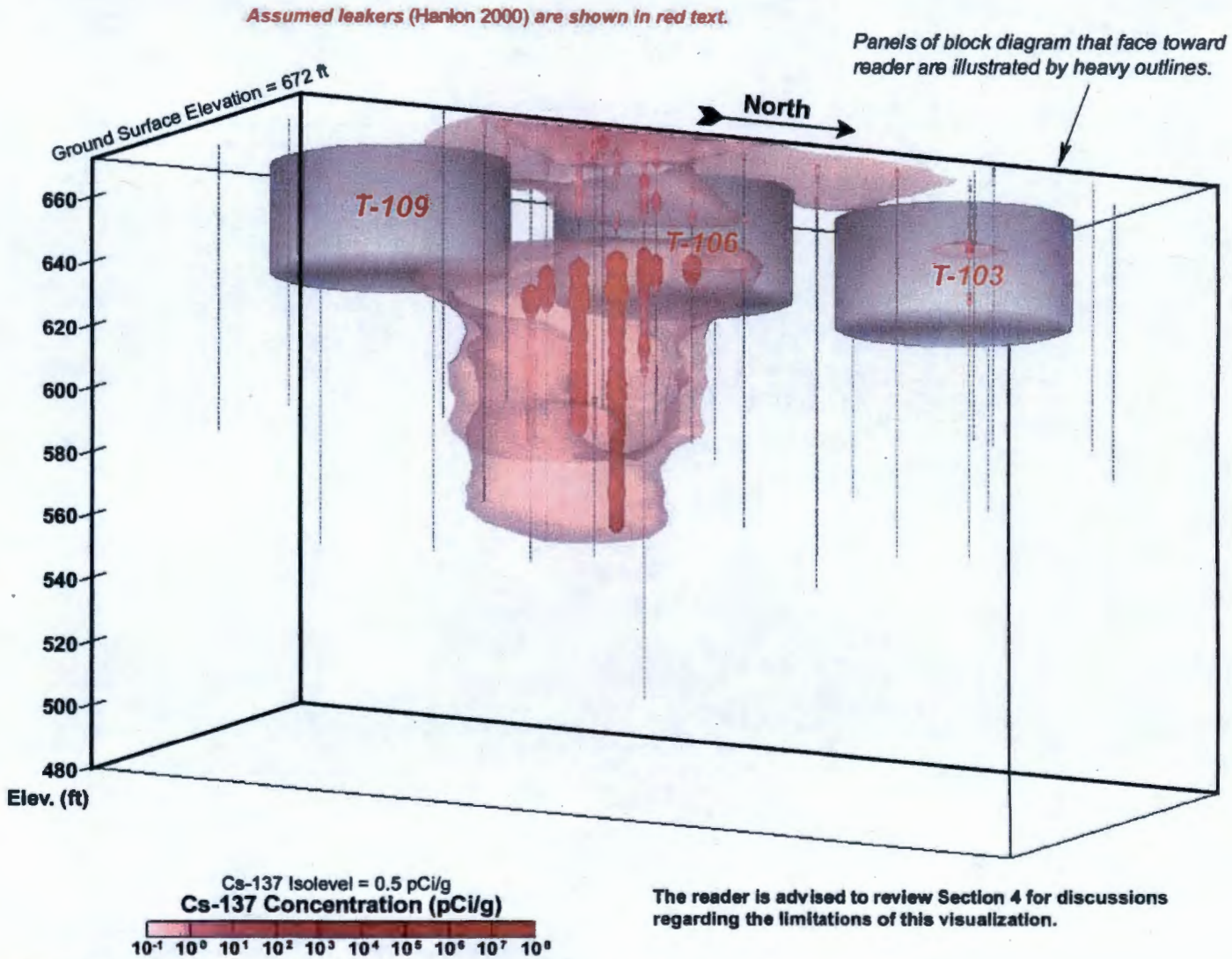
Reference: GJO-99-101-TAR/GJO-HAN-27, *Hanford Tank Farms Vadose Zone: T Tank Farm Report.*

Figure B3-7. Visual Schematic of 241-T Tank Farm Drywell Logging Results at 71 feet Below Ground Surface.



Reference: GJO-99-101-TAR/GJO-HAN-27, *Hanford Tank Farms Vadose Zone: T Tank Farm Report.*

Figure B3-8. Cross Section Drywell Logging Results for Tanks 241-T-103, 241-T-106, and 241-T-109.



Hanlon 2000 = HNF-EP-0182-143, *Waste Tank Summary Report for Month Ending February 29, 2000.*

Source: GJO-99-101-TARA/GJO-HAN-27, *Hanford Tank Farms Vadose Zone: Addendum to the T Tank Farm Report.*

Figure B3-9. Tank 241-T-106 Historical Gamma Logging Results. (sheet 1 of 3)

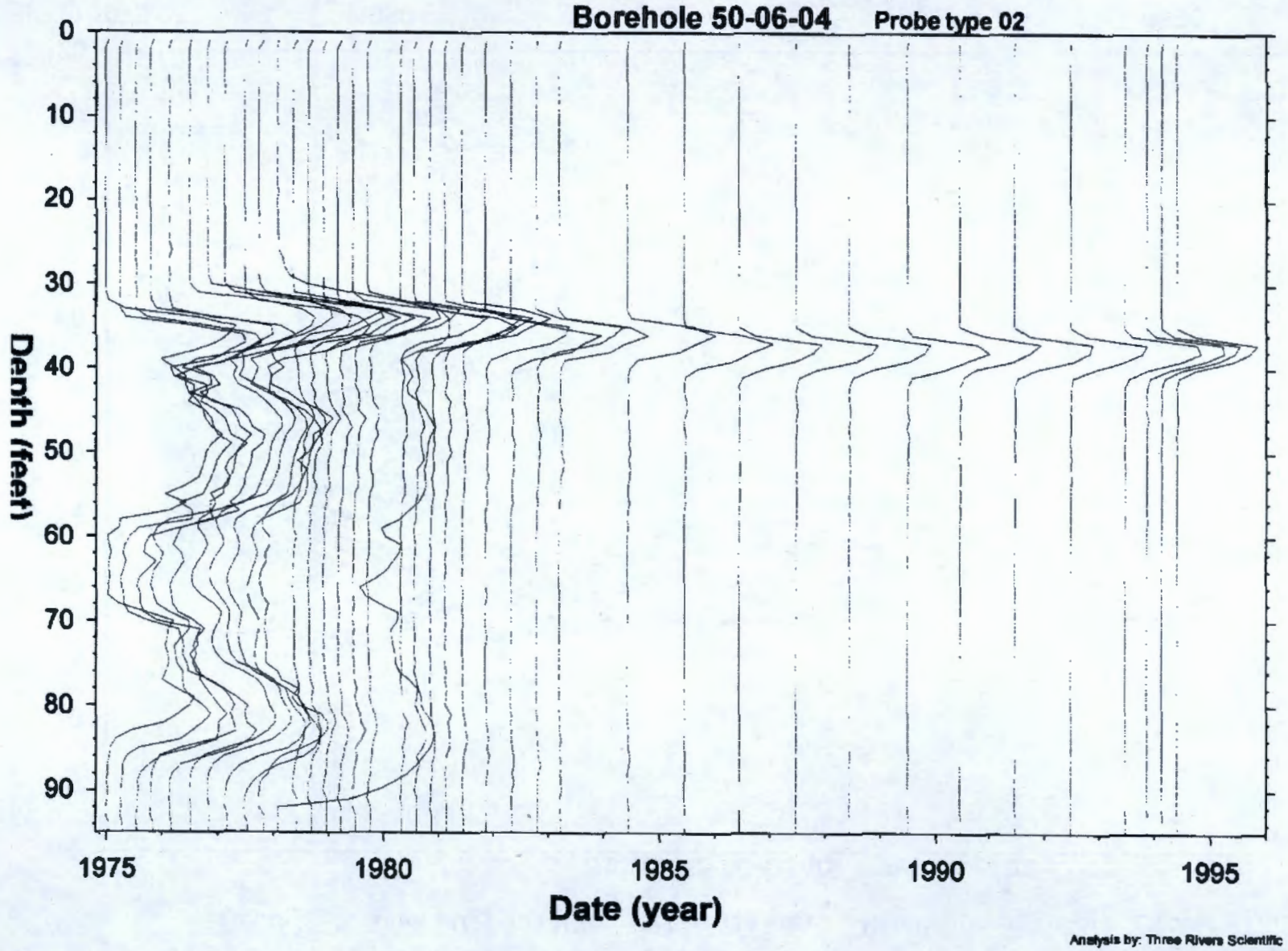


Figure B3-9. Tank 241-T-106 Historical Gamma Logging Results. (sheet 2 of 3)

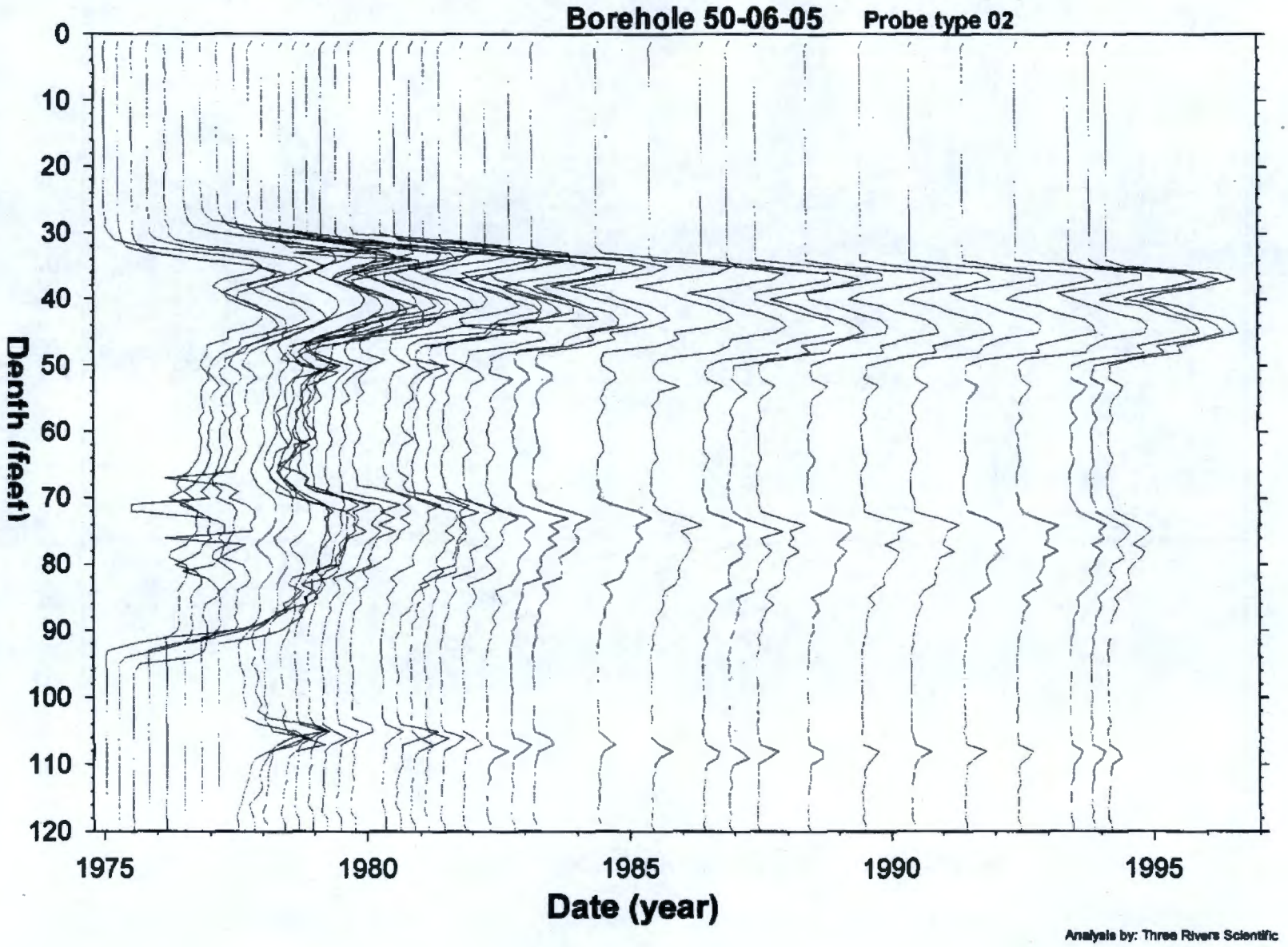
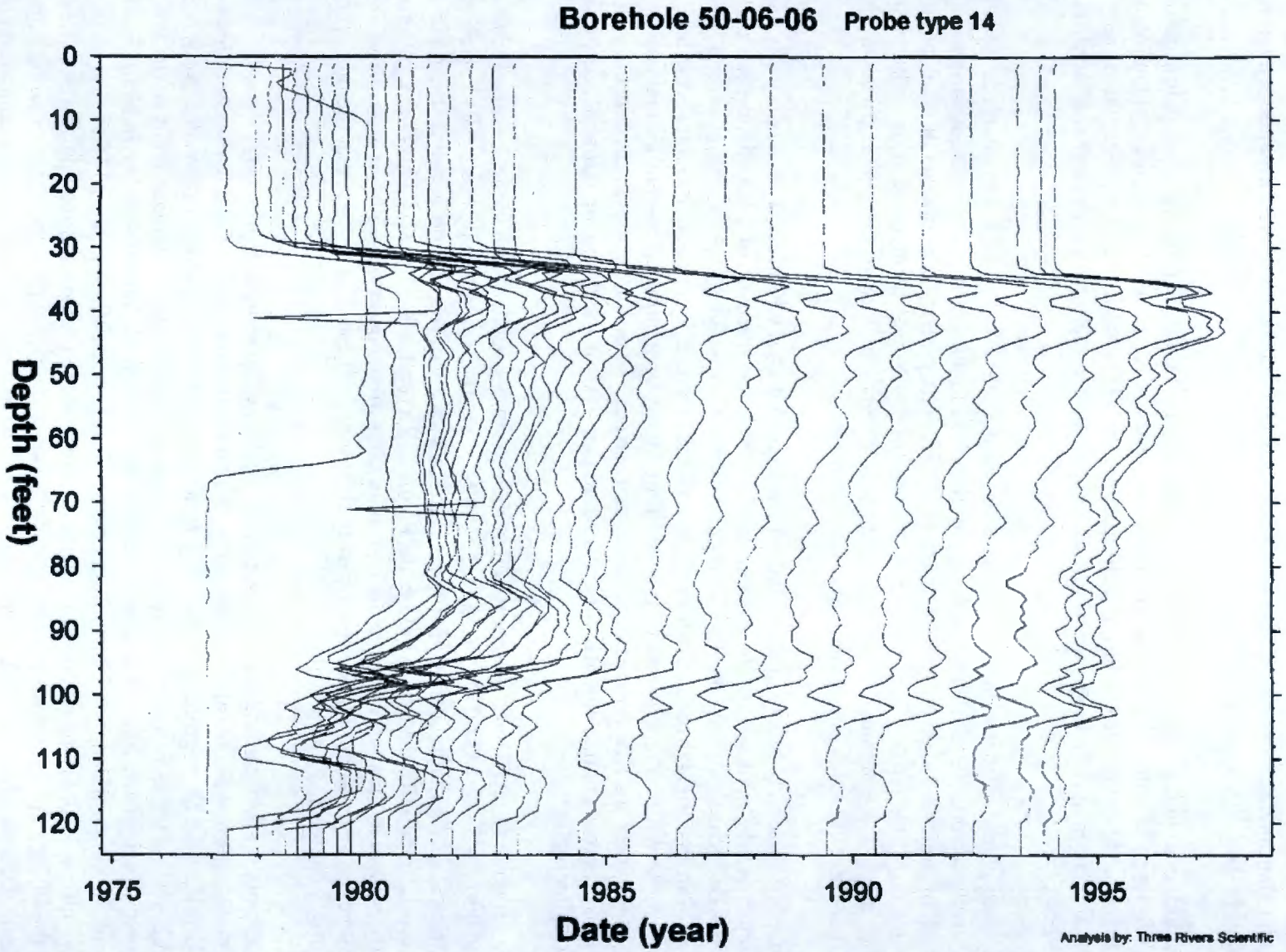


Figure B3-9. Tank 241-T-106 Historical Gamma Logging Results. (sheet 3 of 3)



Reference: RPP-6088, *Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-T Tank Farm – 200 West.*

Small ^{137}Cs peaks detected between 20 and 21 ft in drywells 50-06-03, 50-06-04, 50-06-18, and 50-06-05 may be the result of a transfer line leak near the southeast side of tank T-106. The shape factor analysis results from drywell 50-06-04 indicate that the ^{137}Cs contamination detected around this drywell at this depth is uniformly distributed in the formation with at least some of the ^{137}Cs occurring as a discrete source remote to the drywell.

Regions containing relatively lower concentrations of ^{137}Cs were often detected below each of the zones of elevated ^{137}Cs contamination described above. In most cases, this contamination was probably carried down during drilling of the drywells, but it is also possible that some of the contamination may be the result of further migration of contamination through the backfill material.

A broad plume of contamination was detected by the SGLS below ~33 ft in all of the monitoring drywells surrounding the east, west, and south sides of tank T-106. This contamination is the result of the tank T-106 leak that occurred in 1973. The primary constituents of the contaminant plume are ^{137}Cs, ^{60}Co, ^{154}Eu, and ^{152}Eu. In some of the drywells, occurrences of ^{125}Sb, ^{126}Sn, ^{235}U, and ^{238}U contamination were detected within the main body of the plume; however, the distribution of these contaminants was not extensive.

Zones of extremely high gamma radiation were encountered within most of the drywells that intercepted the main part of this contaminant plume. The intensity of this radiation caused the SGLS detector to saturate during the logging of these zones, yielding no usable spectral data. However, historical gross gamma-ray data collected using a less sensitive Geiger-Mueller detector provided a representative profile of the highly contaminated regions around each drywell where the SGLS detector saturation occurred. On the basis of the rate of decrease in historical gross gamma activity, it is postulated that ^{137}Cs is the dominant radionuclide present in these intervals.

Identified in the RHO-ST-14 report is that the activity associated with the leak consisted of ~40,000 Ci ^{137}Cs, 14,000 Ci ^{90}Sr, and 270,000 Ci "short-lived material" (i.e., ^{106}Ru). However, historical gross gamma data from drywells in the vicinity of the leak do not show the rapid decrease in activity that one would expect with ^{106}Ru (half-life ~1 year). This decay pattern is only evident at the margins of the leak. Decay rates more consistent with ^{137}Cs (half-life ~30 years) are observed in the inner part of the plume. These data suggest that the more mobile ^{106}Ru has migrated much farther.

The highest gross gamma count-rate activity, postulated to represent primarily ^{137}Cs contamination, was measured around drywells 50-06-05 and 50-06-17 along the depth interval of ~32 to 42 ft. The magnitude of the ^{137}Cs contamination in this region of the vadose zone suggests that these drywells are closest to the source of the tank T-106 leak and that the leak probably originated from an area near the bottom of the tank. The SGLS data indicate that the resulting contaminant plume has migrated downward to a depth of at least 119 ft around drywell 50-06-05; however, the total vertical extent of the plume cannot be determined because of the limited depth of this drywell. The ^{137}Cs contamination within the deeper portion of the plume does not appear to be laterally extensive. The absence of deep ^{137}Cs contamination in

adjacent drywells 50-06-06 and 50-06-18 indicates that the lower portion of the ^{137}Cs plume is limited to the region of the vadose zone around drywells 50-06-05 and 50-06-17.

The vertically extensive zone of ^{137}Cs contamination was detected around drywell 50-06-08. No deep ^{137}Cs contamination was detected below 46 ft around adjacent drywell 50-06-06, which lies between drywell 50-06-08 and the suspected contaminant source, suggesting that the ^{137}Cs did not migrate through the vadose zone sediments directly from the contaminant source, but instead migrated laterally along the base of the tank farm excavation and then downward. It is also possible that at least some of the deeper ^{137}Cs contamination migrated in some undetermined manner along the outside of the drywell casing, or was carried down during drilling activities.

Extensive contamination related to the tank T-106 leak was detected in drywells 50-06-02, 50-06-03, 50-06-04, 50-06-16, 50-06-18, 50-06-06, 50-06-08, and 50-00-09. The contamination is correlatable between drywells, indicating that a large plume consisting of these radionuclides has migrated downward and laterally from the leak source through the vadose zone sediments. On the basis of SGLS data collected from these and other monitoring drywells associated with adjacent tanks, the plume appears to have migrated laterally northward below most of tank T-106, southward below the northern and northwestern regions of tanks 241-T-108 (T-108) and T-109, and probably eastward below the western region of tank T-105. In general, the maximum vertical extent of some of the contaminants within the plume could not be determined because of the limited depth of the drywells in T Farm. However, it was possible to determine the vertical extent of the suspected ^{137}Cs contamination around drywell 50-06-17 and the ^{60}Co contamination around drywell 50-06-18. Further discussion of the contaminant penetration around each drywell follows.

Drywell 50-06-17 was initially completed to a depth of 125 ft, but was backfilled to 90 ft a few months later. No anomalous count-rate activity was reported in soil samples collected between 92 and 122 ft during the drilling of the drywell. Furthermore, historical gross gamma log data collected from the deeper portion of the drywell before it was backfilled indicate that no anomalous activity occurred below a depth of about 93 ft. The deepest anomalous activity detected in this drywell corresponds closely with the depth of a caliche layer reported in the drilling log, suggesting that this caliche layer may retard the downward migration of the ^{137}Cs contamination in this region of the vadose zone to some degree.

The available historical gross gamma log data collected from 1975 to 1994 and summaries of this data from 1973 to 1987 presented in document SD-WM-TI-356 suggest that the majority of the radionuclides that constitute the contaminant plume have remained stable and have not migrated through the formation sediments since 1974. However, some movement of radionuclide contamination within the contaminant plume was detected around drywells 50-06-02 and 50-06-03. In drywell 50-06-02, the data suggest that ^{60}Co contamination migrated downward within the contaminant plume from 1973 to 1992. In drywell 50-06-03, the data suggest that continued lateral migration of deep ^{60}Co contamination occurred between 1973 and 1994.

The measured concentrations of radionuclides collected from drywell 50-06-18 using the radiologic logging system in 1994 and the SGLS in 1998 were compared. The data show that the

concentrations of ^{60}Co detected between 74 and 85 ft increased dramatically between 1994 and 1998, suggesting that additional ^{60}Co contamination may have recently moved into this region of the vadose zone. However, the peak ^{60}Co contamination also correlates with the location of the bentonite seal that was placed during the drilling of the drywell in 1993. It is more likely that moisture wicked out of the bentonite seal the formed into the drywell region over time, bringing with it the ^{60}Co and causing an apparent increase in the ^{60}Co concentrations along this interval.

Several monitoring drywells drilled north and east of tank T-106 encountered radioactive contamination near tank T-103 (ARH-2874). Selective gamma energy analysis of soil samples collected from these drywells indicated that the highest concentrations centered on drywell 50-03-04. Subsequent investigations revealed that the contamination originated from a leak from a failed grout seal on a spare fill line on the southeast side of tank T-103. On the basis of the rate of decrease of the historical gross gamma activity, it was discovered that drywells 50-03-06 and 50-06-11 intercepted ^{106}Ru contamination between 40 and 90 ft. In addition, a small plume consisting of ^{60}Co and ^{154}Eu contamination was detected by the SGLS between 66 and 95 ft around drywell 50-03-06. Historical gross gamma log data suggest that the ^{60}Co contamination within the plume probably migrated downward from 75 ft in 1975 to a maximum depth of 90 ft by 1994. Further evaluation of this leak and the resultant contaminant plume is presented in GJ-HAN-120, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank T-106*.

Additional information collected from boreholes C4104 and C4105 near tank T-106 enabled alternate conceptual modeling of the leak events and subsequent migration history (RPP-23752). Vertical migration of tank T-106 waste appears to have been less extensive than lateral migration between 1973 and 1994. The greatest vertical penetration occurred close to the apparent leak location at the southeast portion of tank T-106. In 1973, the maximum contaminated depth was measured in sediment samples at 95 ft bgs from drywells 50-06-06 and 50-06-03. In several of the drywells close to the leak source, positive gross gamma activity was measured down to the drywell bottom (as much as 120 ft bgs) by 1977, but these measured values were trace quantities and considerably lower than activities at 95 ft bgs in the drywell. Further, these data were taken at depth locations made available by secondary drilling that deepened the drywells. Therefore, vertical extension of gamma contamination may have been induced by drilling rather than natural processes.

Further downward movement of tank T-106 waste contaminants will occur, but the rate of migration is uncertain. Stratigraphic controls have exerted considerable influence on the migration of the tank T-106 leak in the vadose zone and continue to do so. The most significant controls appear to be the Cold Creek unit and perhaps the member of Taylor Flats, Ringold Formation. The historical gross gamma data suggest variable degrees of vertical and lateral migration when the leak began, with vertical migration being much more pronounced near the leak source. The recent characterization drywell data and historical gamma analysis indicate subsequent and significant lateral migration of tank T-106 fluids in the Cold Creek unit and member of Taylor Flats, Ringold Formation. Finally, the C4104 and C4105 borehole data indicate minimal vertical migration and a minor shift in the center of mass of mobile constituents in the last 10 years.

B4.0 TANK 241-T-107

This section provides information on the historical waste loss event associated with tank T-107. Waste operations for tank T-107 are summarized in Figure B4-1. Figure 3-2 of the main text shows a plan view of a typical tank in T Farm with the location of the pump pit, sluice pit, spare inlet nozzles (N1, N2, N3 and N4) and tank risers.

B4.1 TANK 241-T-107 WASTE HISTORY

Tank T-107 was the first tank in the cascade series of tanks T-107, T-108, and T-109. First-cycle decontamination (1944-1949) (1C1) waste was added to tank T-107 in the first quarter of 1945.

The waste types received in tank T-107 and their disposition are summarized in Table B4-1. Based on the waste transfer history, the sludge stored in tank T-107 is comprised of 147,700 gal of 1C/cladding waste, aluminum clad fuel (CW) sludge from the 221-T Bismuth Phosphate Plant, 8,400 gal of Tri-Butyl Phosphate Plant waste and 16,900 gal of PUREX coating removal waste that contains interstitial liquids. The interstitial liquids present in the sludge are from the cesium IX process conducted in B Plant.

Historically, tank T-107 waste is expected to have some exothermic properties because of the presence of ferrocyanide in the waste. Analytical data from other ferrocyanide tanks (for example, tanks 241-BY-104, 241-BY-106, 241-BY-108, and 241-C-108) have shown that a large degree of ferrocyanide decomposition likely occurs because of the combined effects of radiation, temperature, and pH in the harsh environments of the high-level radioactive waste tanks. Tank T-107 was at one point on the Ferrocyanide Watch List from 1991 to 1996.

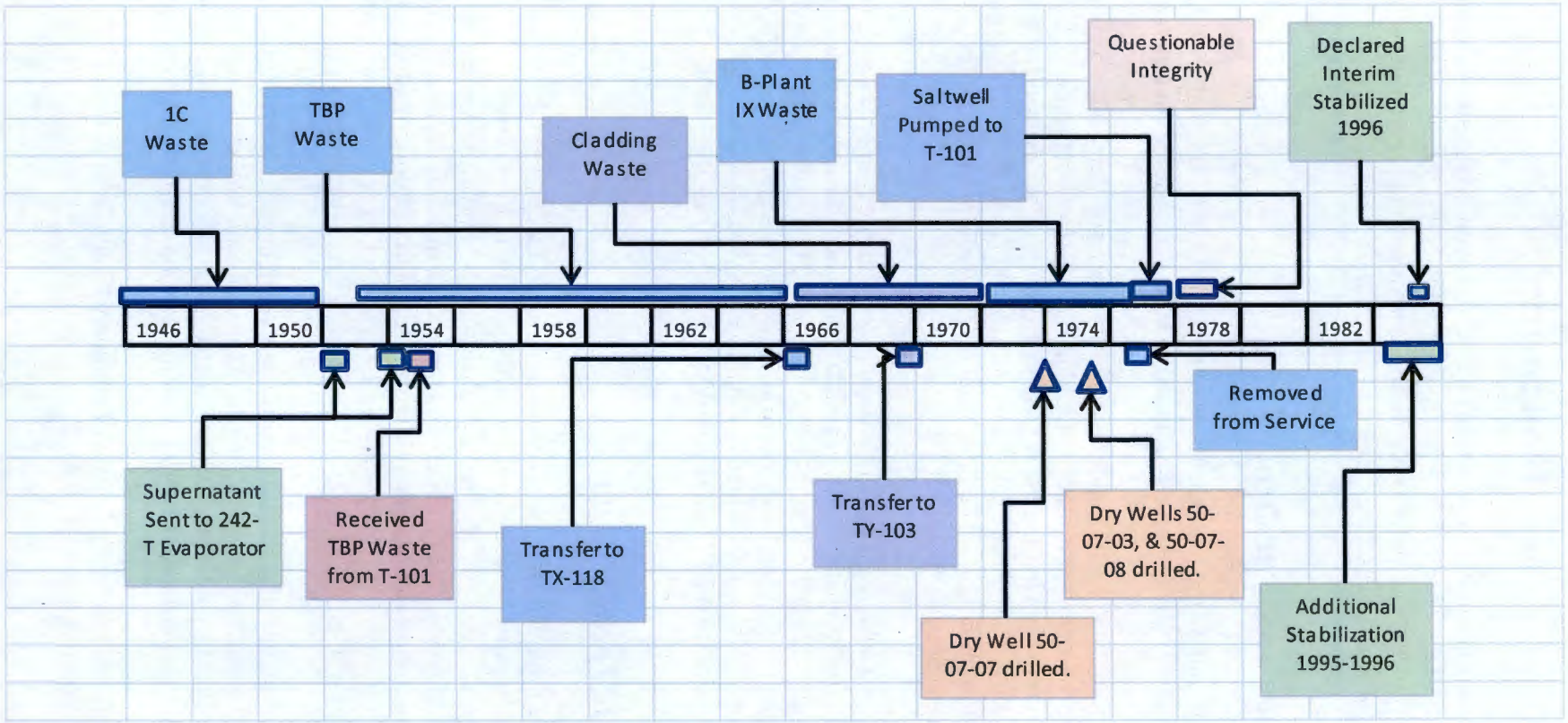
B4.2 INTEGRITY OF TANK 241-T-107

In 1976, tank T-107 was removed from service and designated inactive. In 1979, the integrity of the tank was questioned because of an anomalous activity noted in the drywells (SD-WM-TI-356). Drywell 50-07-07 showed a peak at 42 ft since first monitored in 1974. Drywell 50-07-03 showed a peak at 43 ft when first monitored in 1975. Between July 1975 and March 1977, the peak increased and has been slowly receding since approximately 1977. The tank was declared a "questionable integrity" tank in 1976 and taken out of service when gross gamma logging measurements in borehole 50-07-03 indicated a radiation peak at 42 ft.

Although there was no evidence of a leak from surface-level data collected from within the tank, the tank was reclassified as an "assumed leaker" in 1984. The leak volume of this tank and 19 other tanks in eight different tank farms was estimated to be ~8,000 gal. This value is an average of 150,000 total gallons divided by 19 tanks and may be in error by 100% or more.

Several level adjustments have occurred. A small amount of liquid was pumped to tank 241-AN-103 in the fourth quarter of 1983.

Figure B4-1. Tank 241-T-107 Waste Operations Summary.



IC = First-cycle decontamination (waste) from the bismuth phosphate process IX = ion exchange (waste) TBP = tri-butyl phosphate (waste)

Table B4-1. Waste Transfer History for Tank 241-T-107.

Date	Waste Type	Source	Disposition	Waste Volume in Tank 241-T-107	
				Supernatant (gallons)	Sludge (gallons)
02/1945 to 03/1946	1C/CW	221-T Plant	Received 1,590,000 gallons of 1C/CW waste that cascaded into tanks 241-T-108 and 241-T-109. 1C/CW precipitated during storage.	530,000 total	
03/1951 to 07/1951	1C/CW Supernatant		Transferred 285,000 gallons of supernatant to 242-T Evaporator for concentration and storage.	245,000 total	
11/1952 to 01/1953	TBP Plant Waste	221-U Plant	Received 291,000 gallons of TBP Plant waste into tank 241-T-107 that cascaded to tank 241-T-108 and 241-T-109.	335,000	201,000
08/1953	TBP Plant Waste Supernatant		Transferred 302,000 gallons of supernatant to 242-T Evaporator for concentration and storage.	33,000	201,000
12/1954 to 01/1955	Scavenged TBP Plant Supernatant	Tank 241-T-101	Received 242,000 gallons of scavenged TBP Plant supernatant and 54,000 gallons of flush water.	329,000	201,000
10/1966 to 12/1966	Scavenged TBP Plant Supernatant		Transferred 311,000 gallons of supernatant to 242-T Evaporator for concentration and storage.	22,000	186,000
01/1967 to 06/1967	PUREX Coating Removal Waste	Tank 241-C-102	Received 297,000 gallons of PUREX coating removal waste.	319,000	186,000
10/1969 to 12/1969	PUREX Coating Removal Waste		Transferred 275,000 gallons of supernatant to 242-T Evaporator for concentration and storage.	119,000	109,000
01/1973 to 06/1973	Cesium Ion Exchange Waste	221-B Plant	Received 1,257,000 gallons of B Plant cesium ion exchange process waste and 13,000 gallons of flush water from tank 241-BX-104. Transferred 269,000 gallons to tanks 241-T-108, 378,000 gallons to 241-T-109 and 452,000 gallons to 241-T-105.	293,000	109,000
02/1976 to 09/1995	Supernatant and Interstitial Liquids		Saltwell pumped tank as part of interim stabilization program.	0	173,000

1C/CW = First-cycle decontamination waste from the bismuth phosphate process/cladding waste, aluminum clad fuel
PUREX = Plutonium Uranium Extraction (Plant) TBP = tri-butyl phosphate

Source: RPP-16765, *Origin of Waste in Single-Shell Tank 241-T-107.*

B4.3 INTERIM STABILIZATION

Interim stabilization of tank T-107 was completed in May 1996. The tank was jet pumped and 11,000 gal of waste was removed. The effective porosity of the tank T-107 waste, calculated as the volume of waste pumped divided by the volume in differential height in the waste, was determined to be 0.209; this produced a drainable liquid estimate of 22,400 gal and the pumpable liquid remaining in the tank was calculated to be 12,100 gal (HNF-SD-RE-TI-178).

As of April 2004 the tank was estimated to contain 173,000 gal of waste consisting of 8,000 gal of CWR2 sludge, 17,000 gal of tri-butyl phosphate (TBP) waste, and 148,000 gal of 1C waste (RPP-RPT-43165, *2009 Auto-TCR for Tank 241-T-107*). Figure B4-2 shows a mosaic photograph of the tank surface on July 12, 1984.

B4.4 TANK 241-T-107 TEMPERATURE HISTORY

The tank temperature is monitored by two thermocouple trees located in risers 4 and 5. No temperature measurements were found before 1975. Figure B4-3 shows tank waste temperatures for tank T-107 from 1975 to 2013. During this period the maximum waste temperature was about 92 °F in 1978. By 1985 the temperature decreased to below ~70 °F. The tank temperature varies seasonally between ~55 and ~75 °F.

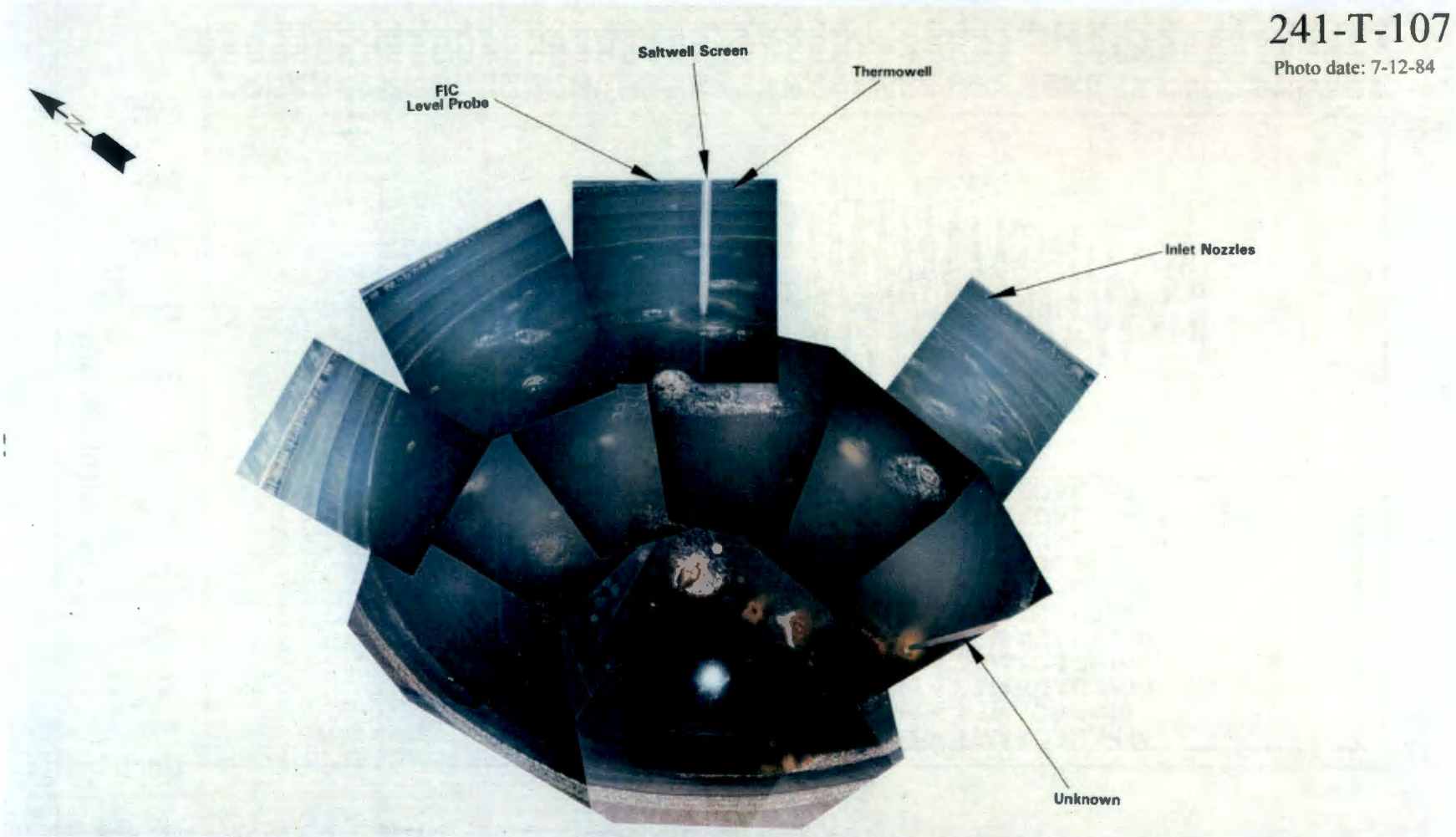
B4.5 DATA REVIEW AND OBSERVATIONS

The following sections contain discussions of the tank surface level, drywell logging data and borehole sampling.

B4.5.1 Tank Surface Level Measurements

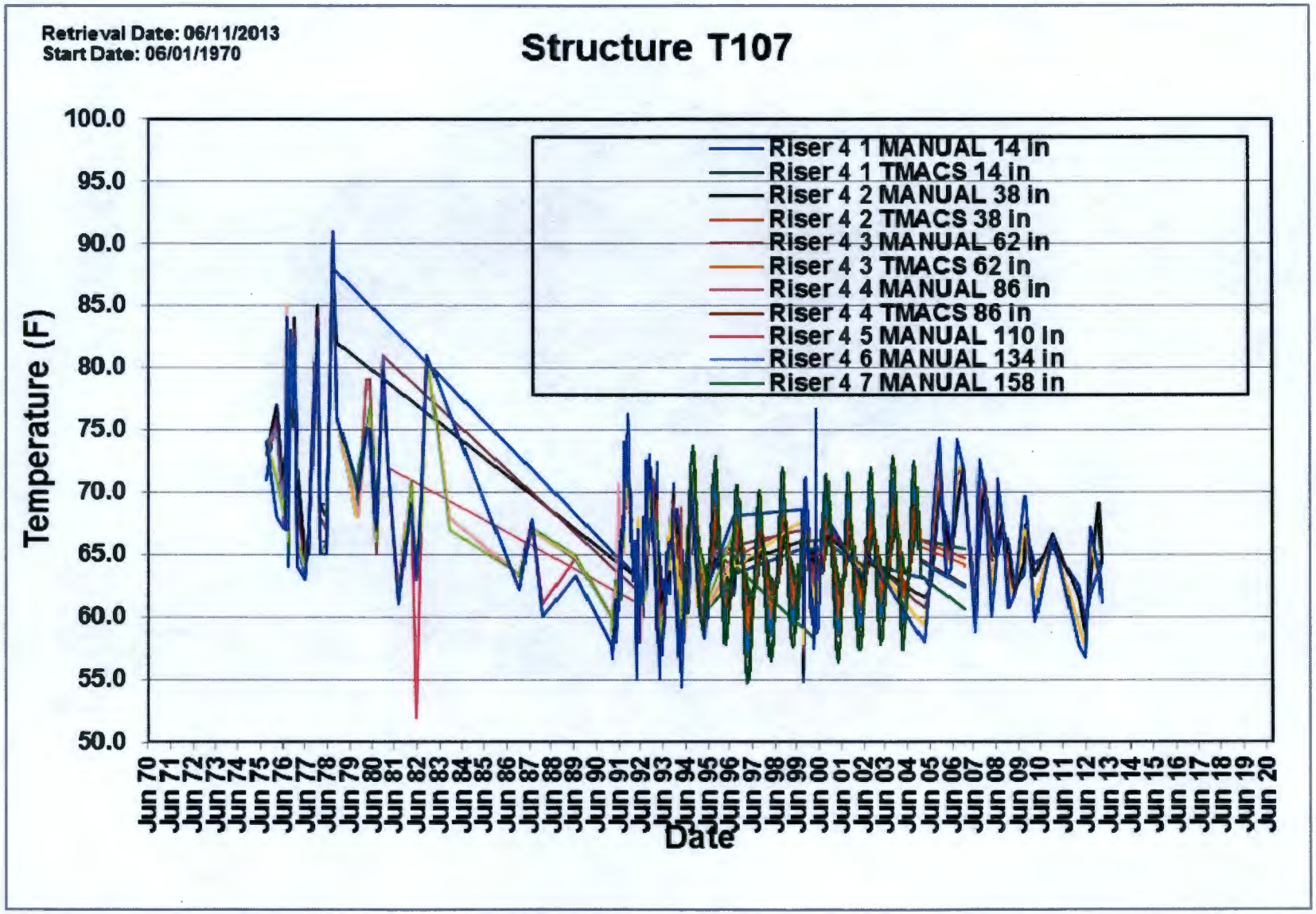
Tank liquid level measurements before 1973 were not available, other than from the transfer data in waste process reports (Figure B4-4). Figure B4-4 indicates that liquid waste may have been filled above the cascade/spare inlet level in tank T-107 in 1953 and again between 1964 and 1966. Table B4-2 shows surface levels and surface level changes from 1973 to 1987. Figure B4-5 shows surface level measurements liquid level measurements from 1981 to 2013. Figure B4-5 shows that jet pumping of the tank waste in 1995 and 1996 and the readjustment of the baseline in 1996 correlates with the amount of waste transferred during jet pumping.

Figure B4-2. Tank 241-T-107 Waste Surface Photo Mosaic.



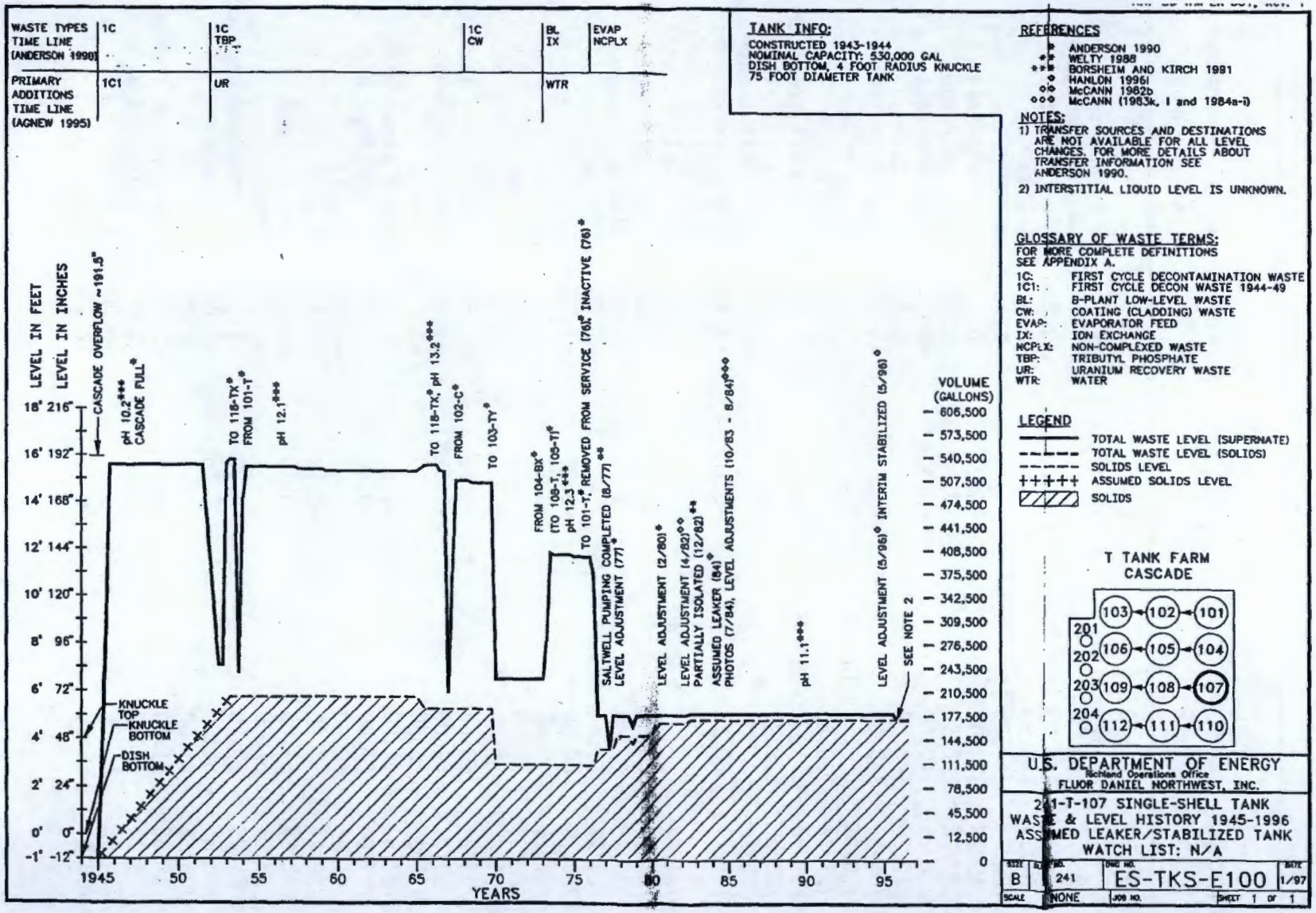
Reference: HNF-SD-WM-ER-351, *Historical Tank Content Estimate for the Northwest Quadrant of the Hanford 200 West Area.*

Figure B4-3. Tank 241-T-107 Waste Temperature Measurements.



TMACS = Tank Monitor and Control System

Figure B4-4. Tank 241-T-107 Quarterly Waste Fill History.



Reference: HNF-SD-WM-ER-351, *Historical Tank Content Estimate for the Northwest Quadrant of the Hanford 200 West Area.*

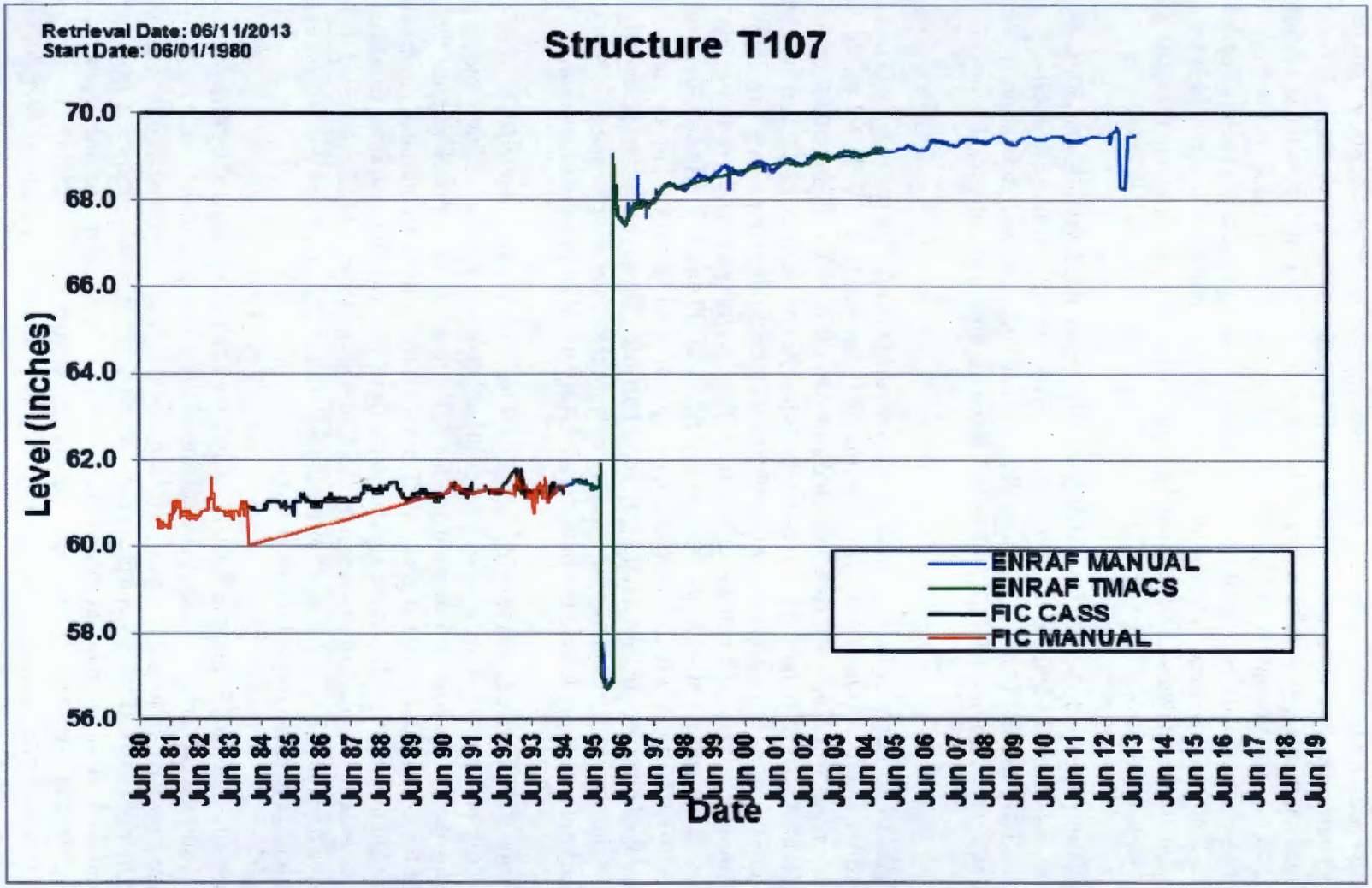
Table B4-2. Tank 241-T-107 Liquid Level Measurements and Changes (1973 to 1987).

Liquid Level.

Date	Liquid level (in.)	Baseline ref.	Change from previous reading (in.)	Cumulative change (in.)	Comments
06/13/73	141.70		-	-	
07/25/73	141.90		+0.20	+0.20	Slow increase
07/26/73	140.20		-	-	Calibration
10/27/73	140.50		+0.30	+0.50	Slow increase
08/01/74	140.50		-	+0.50	Stable
08/02/74	140.70		-	+0.50	New FIC installed
12/19/74	140.90		+0.20	+0.70	Slow increase
05/17/75	140.50		-0.40	+0.30	Slow decrease
09/16/75	140.90		+0.40	+0.70	Slow increase
09/17/75	140.60		-	+0.70	FIC flush
03/05/76	140.60		-	+0.70	Stable
03/10/76		130.40	-	+0.70	Transfer
04/27/76	130.40		-	+0.70	Stable
05/01/76		123.40	-	+0.70	Salt well transfers
05/30/76	123.40		-	+0.70	Stable
07/28/76		59.30		+0.70	Salt well transfers
08/30/77	60.10		+0.70	+1.40	Slow increase despite salt well transfers
09/01/77		60.40	-	+1.40	Salt well flushed
12/07/77	60.55		+0.15	+1.55	Slow increase
02/28/78	60.40		-0.15	+1.40	Slow decrease
12/29/78	60.40		-	+1.40	Stable
04/08/79	60.20		-0.20	+1.20	Stable
08/09/79	60.40		+0.20	+1.40	Stable
08/24/80	60.40		-	+1.40	Stable
06/04/81	60.40		-	+1.40	Stable
06/05/81	60.65		+0.25	+1.65	Unexplained increase
10/10/81	61.00		+0.35	+2.00	Steady increase
08/11/82	60.80		-0.20	+1.80	Stable
10/22/82	61.20		-0.40	+2.20	Unexplained rise
11/23/82	60.80		-0.40	+1.80	Unexplained drop
08/31/83	60.80		-	+1.80	Stable
07/15/84	60.90		+0.10	+1.90	Stable
09/02/84	61.00		+0.10	+2.00	Unexplained increase
09/30/84	61.00		-	+2.00	Stable
04/01/85	60.80		-0.20	+1.80	Unexplained decrease
07/15/85	61.00		+0.20	+2.00	Increase
08/05/85	61.00		-	+2.00	Stable
10/07/85	61.20		+0.20	+2.20	Unexplained increase
04/15/86	61.00		-0.20	+2.00	Unexplained decrease
07/14/86	61.00		-	+2.00	Stable
09/08/87	61.10		+0.10	+2.10	Stable

Reference: SD-WM-TI-356, *Waste Storage Tank Status and Leak Detection Criteria.*

Figure B4-5. Tank 241-T-107 Waste Surface Level Measurements.



Note: Surface level measurement changed to bottom of tank (12-in. off-set) after February 1996 measurement.

CASS = Computer Automated Surveillance System FIC = Food Instrument Corporation (gauge) TMACS = Tank Monitor and Control System

Honeywell Enraf is a product of Honeywell Process Solutions, Strahlenbergerstr. 110-112, 63067 Offenbach, Germany.

B4.5.2 Drywell Logging Data

Occurrence Report 76-60, *Monitoring Dry Well Has Shown Increase in Radiation Approaching the Action Criteria* was issued for tank T-107 drywell logging addressing drywell 50-07-03, showing a gradual increase in radiation approaching a doubling of count from the conditions measured in October to November 1975. Previous to that, the drywell had shown a drop in radiation. This drywell and drywell 50-07-07 both show radiation peaks at depths directly related to the bottom of the tank. The extent of the radiation is moderate in size and spread (depth). Radioisotope analysis has identified the source as ruthenium, which may be from another source than the tank.

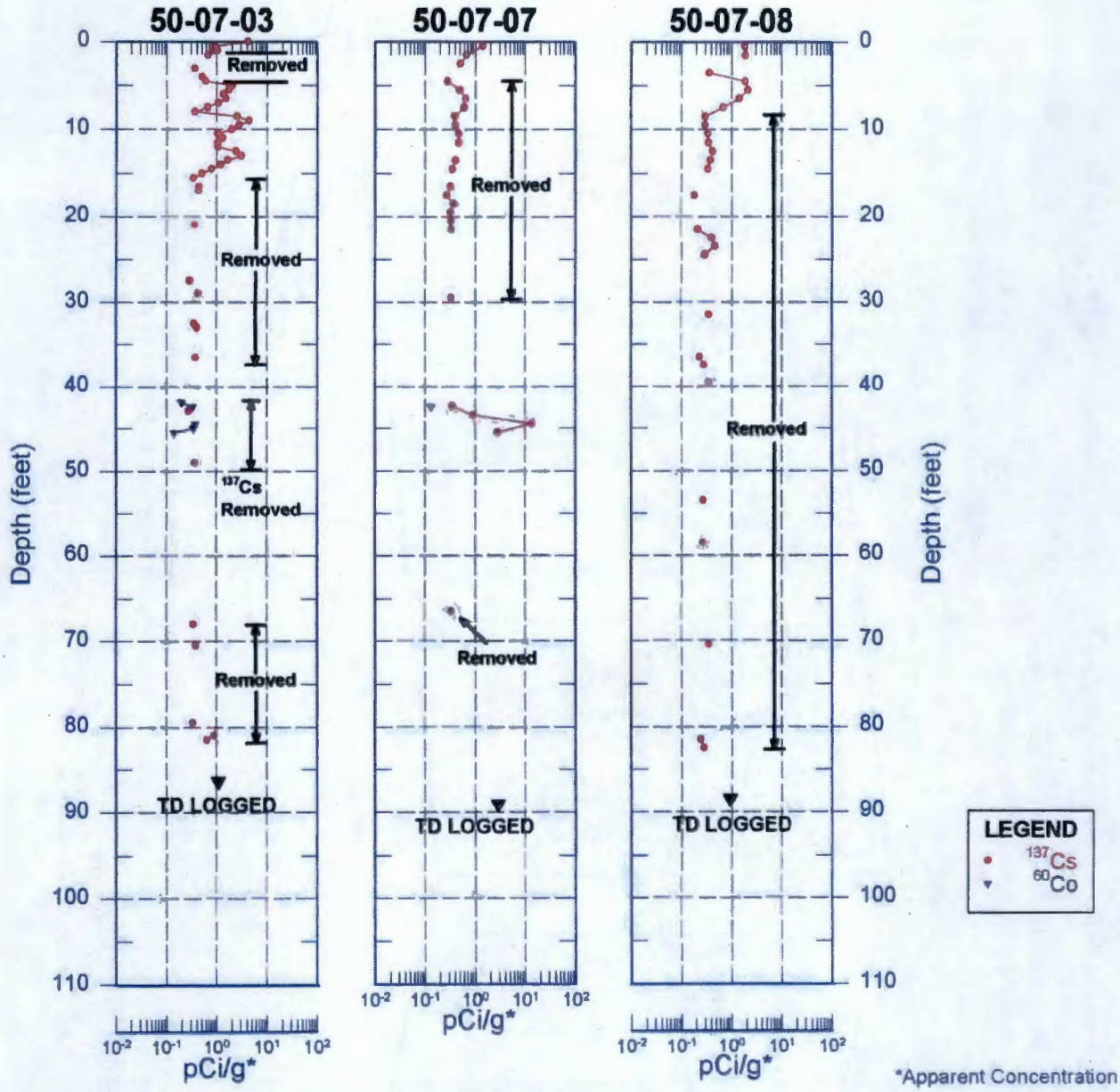
Five drywells surround tank T-107 (50-07-03, 50-07-07, 50-07-08, 50-04-05, and 50-04-07); Figures B1-7, B4-6 and B4-7 show the 1999 reported SGLS results for these drywells (GJO-99-101-TARA/GJO-HAN-27, *Hanford Tank Farms Vadose Zone: Addendum to the T Tank Farm Report*). Figure B4-8 provides the historical gamma logging results for tank T-107.

It was reported in GJ-HAN-2, *Vadose Zone Characterization Project at the Hanford Tank Farms Tank Summary Data Report for Tank T-107* that the first evidence that tank T-107 was a potential leaker was in 1975, when data collected from drywells 50-07-03 and 50-07-07 indicated elevated gamma radiation at depth intervals just below the base of the tank. These measured activity levels have decreased over time so that the gross gamma logs now show near-background levels (i.e., 50 counts per second). The spectral gamma drywell log data indicate low concentrations at 44 ft of ^{137}Cs in drywell 50-07-07 and low concentrations of ^{60}Co in drywell 50-07-03. It is likely that ^{60}Co was the major original constituent of the source and has since decayed away because of a relatively short half-life. However, it is not clear whether the source of the contaminants is from the surface or the subsurface. Furthermore, it is not known if the contamination detected in both drywells originated from a common source.

Measurements of the drywells surrounding tank T-107 have common characteristics from which conclusions can be based. Log data for each drywell indicate surface contamination to varying degrees and depths. Lithology information and the 11K plots for each drywell suggest the existence of finer-grained material at about 40 ft and 81 ft in depth. Discontinuous intervals of low ^{137}Cs concentrations are shown throughout each drywell in varying amounts. Contaminants are indicated, although sometimes almost nondetectable, in both zones of finer-grained material in four of five drywells. Log data for all of the drywells show that drywell 50-07-07 is the only drywell with no contamination at both intervals.

The implication of the data is that the drywells may have been compromised by downward migration of surface contaminants along the outside of the drywell casings. Surface contaminants may have followed this preferential pathway and accumulated in finer-grained material further down the drywell. Surface contamination may also have migrated from the surface along the tank sides and collected in the formation at the heel of the tank, or there could be subsurface leaks from a tank. Contamination may exist from a combination of these sources. The presence of two steel casings and grout in the drywells makes it difficult to interpret the radioelement concentration information.

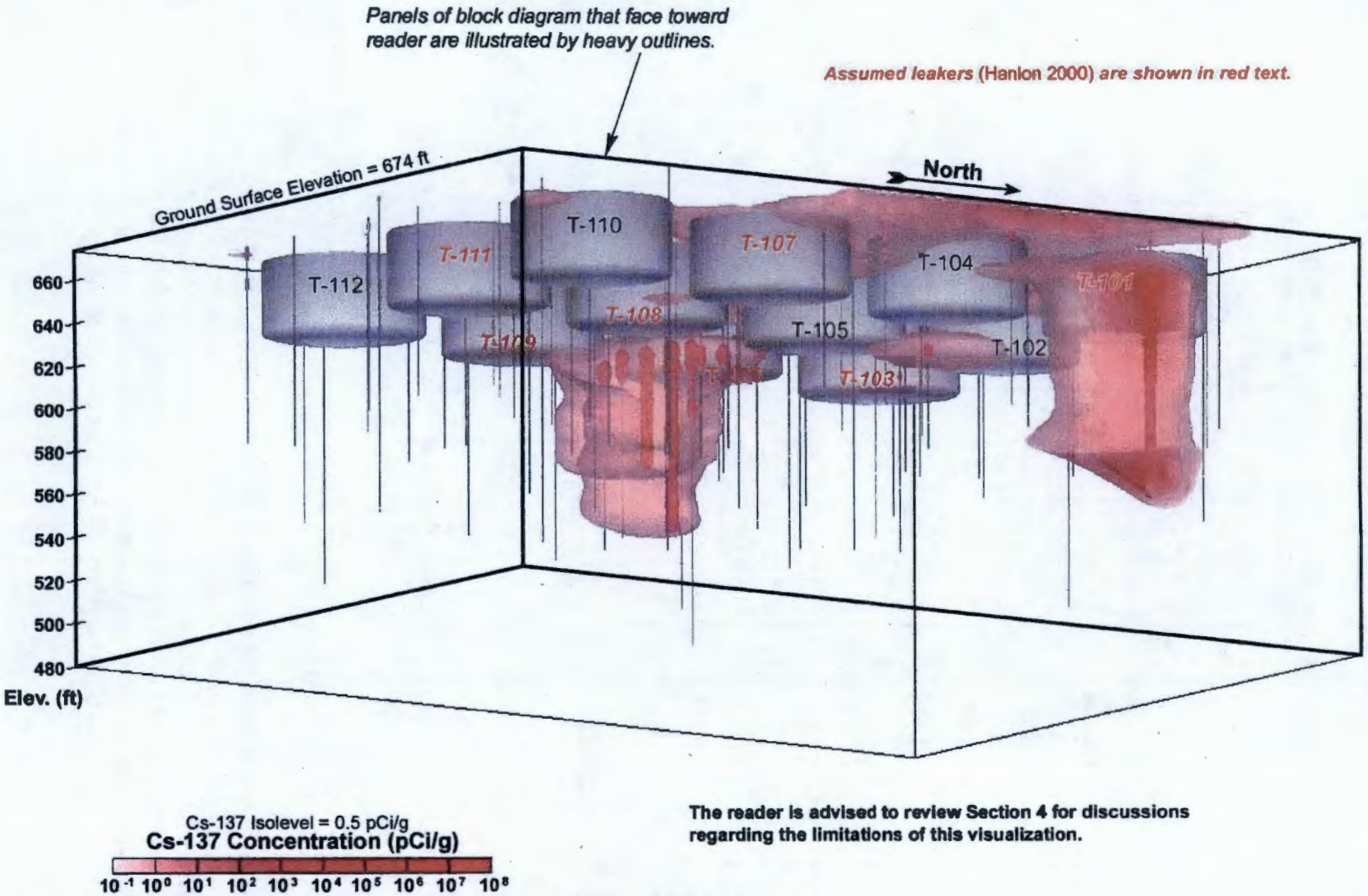
Figure B4-6. 1998 Spectral Gamma Logging Results for Drywells near Tank 241-T-107.



Reference: GJO-99-101-TARA/GJO-HAN-27, *Hanford Tank Farms Vadose Zone: Addendum to the T Tank Farm Report.*

It is conceivable that when the top 20 ft of the drywells in the tank T-107 vicinity were sealed with grout in 1981, additional surface contaminants were prevented from migrating to the subsurface along the outside of the casing. Additional logging of these drywells may provide information about the success of that corrective action. However, it is unlikely additional logging will be able to definitively determine the source of the contamination (i.e., if the tank is leaking or surface contamination migrated down the outside of the drywell or tank).

Figure B4-7. Cross Section Showing Drywell Logging Results for Tanks 241-T-101 and 241-T-103.



Hanlon 2000 = HNF-EP-0182-143, *Waste Tank Summary Report for Month Ending February 29, 2000.*

Source: GJO-99-101-TARA/GJO-HAN-27, *Hanford Tank Farms Vadose Zone: Addendum to the T Tank Farm Report.*

Figure B4-8. Tank 241-T-107 Historical Gamma Logging Results. (sheet 1 of 3)

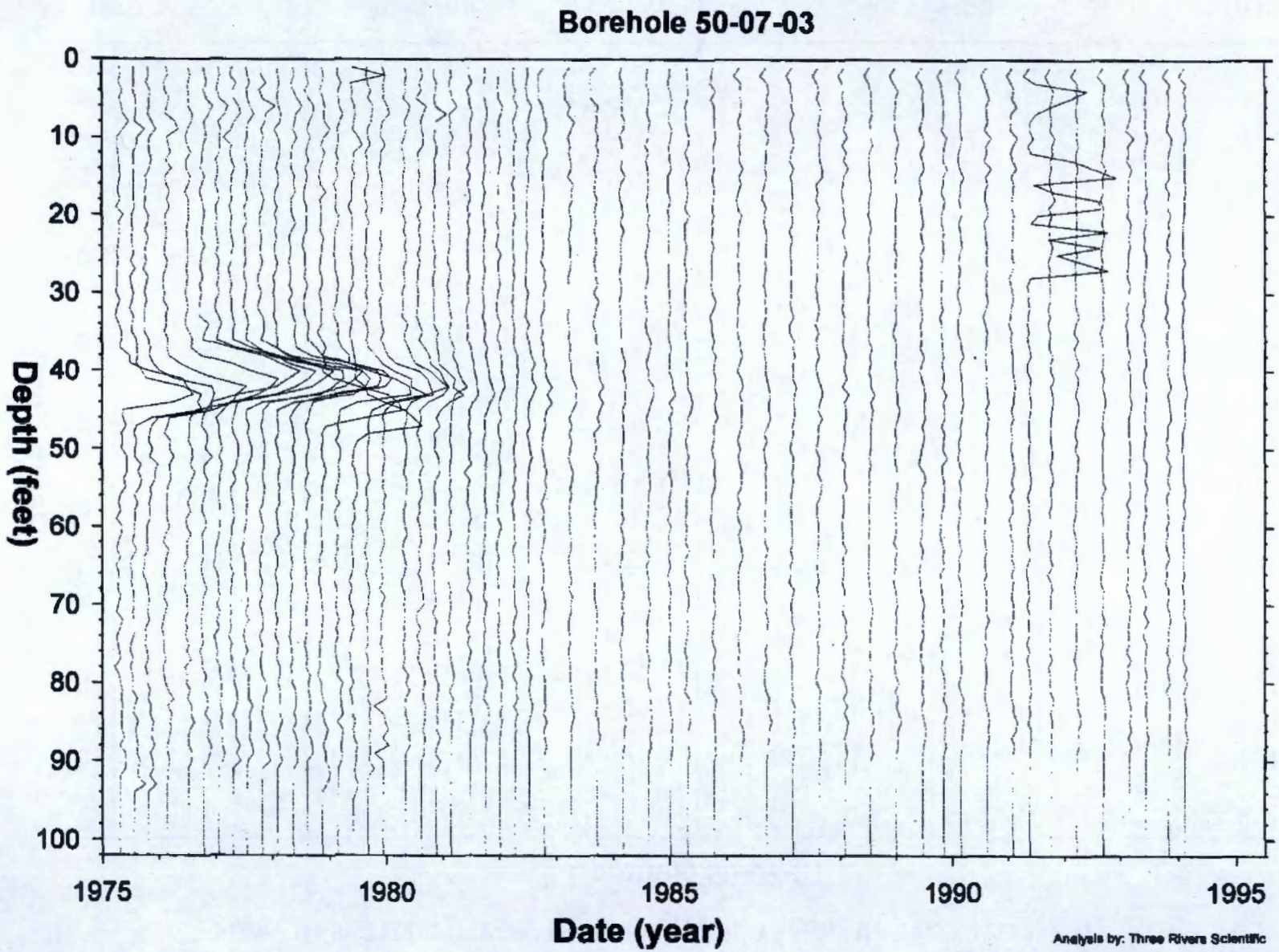


Figure B4-8. Tank 241-T-107 Historical Gamma Logging Results. (sheet 2 of 3)

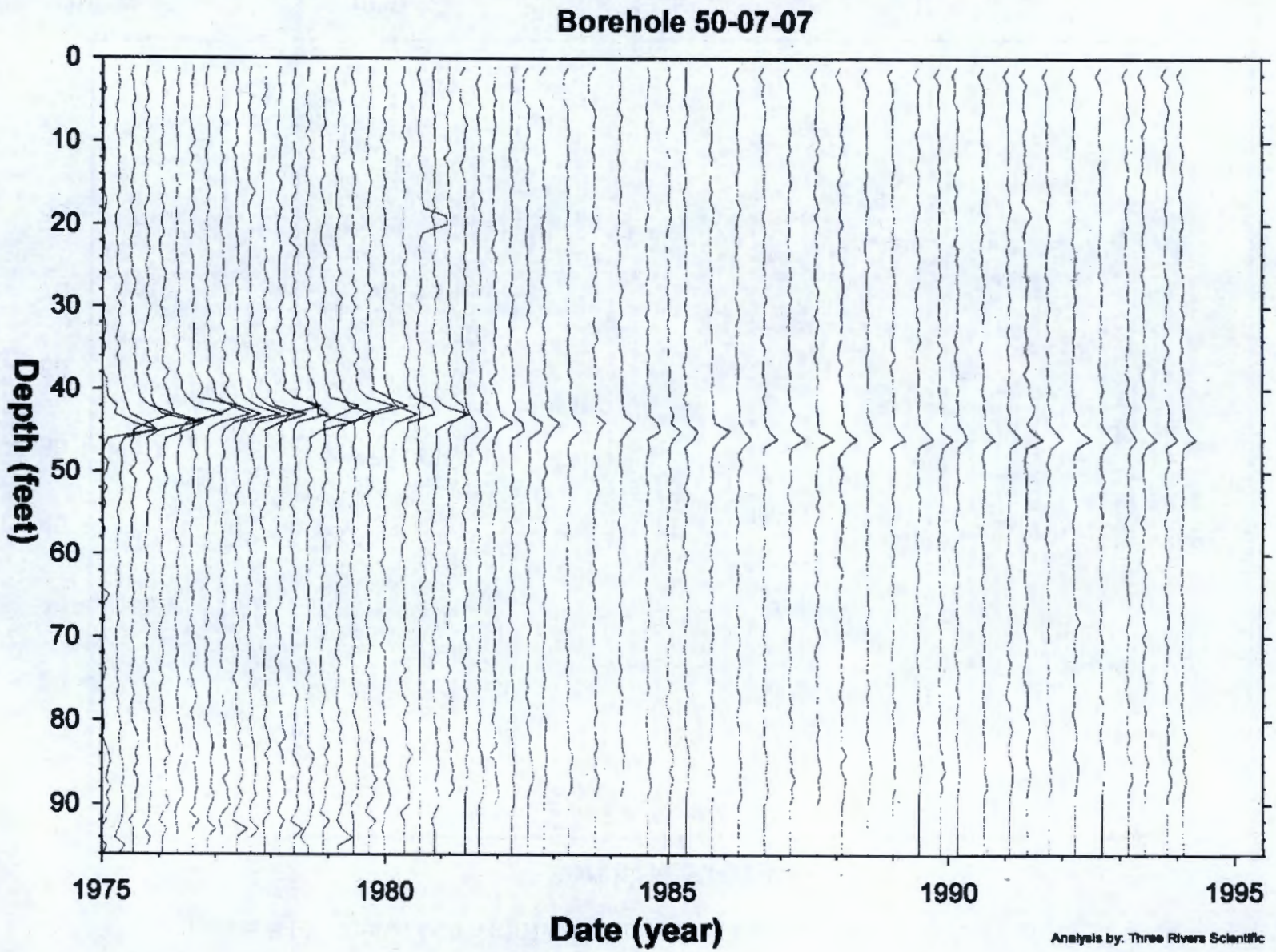
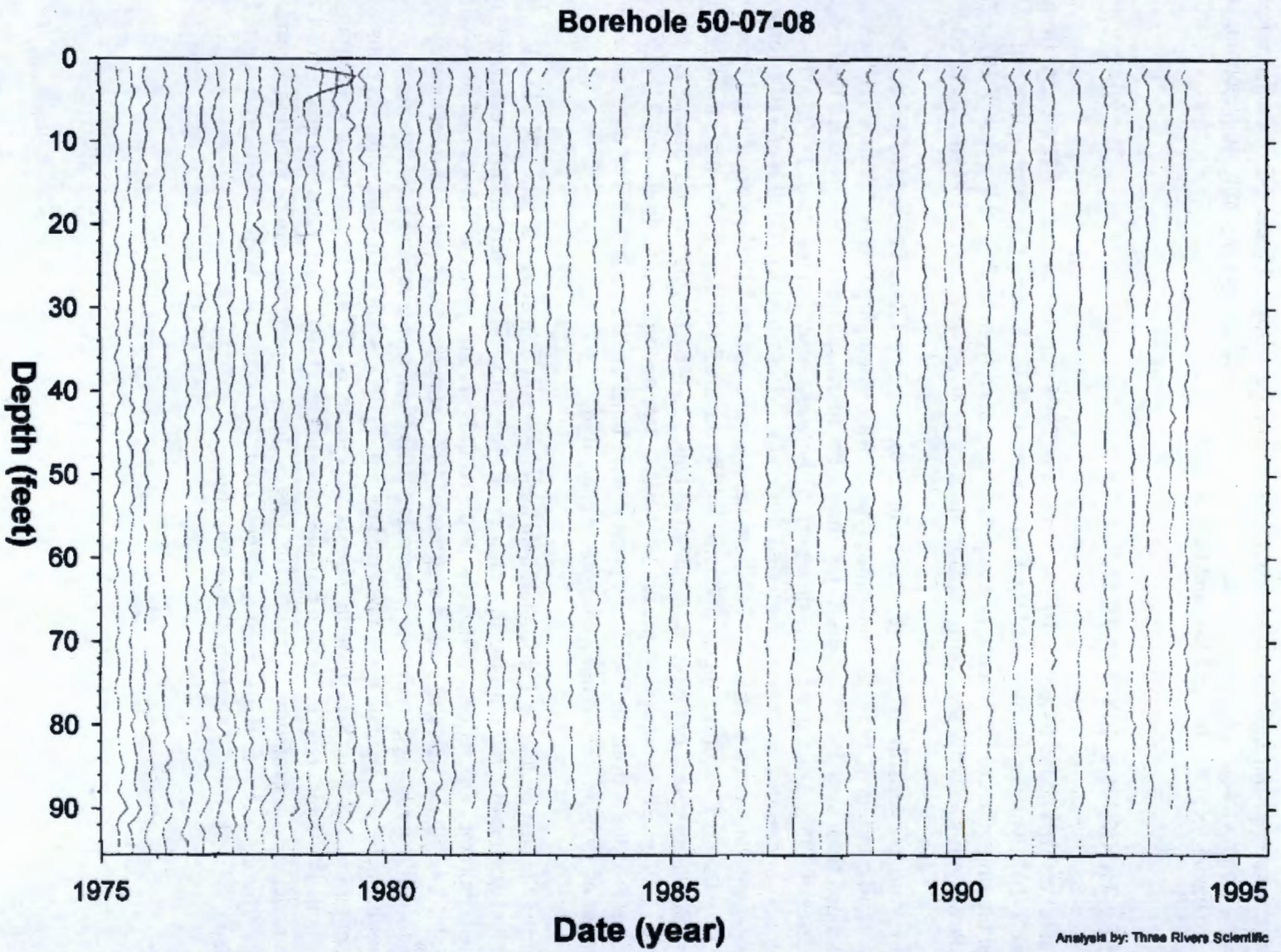


Figure B4-8. Tank 241-T-107 Historical Gamma Logging Results. (sheet 3 of 3)



Reference: RPP-6088, *Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-T Tank Farm – 200 West.*

B5.0 TANK 241-T-108

This section provides information on the historical waste loss event associated with tank T-108. Waste operations for tank T-108 are summarized in Figure B5-1. Figure 3-2 of the main text shows a plan view of a typical tank in T Farm with the location of the pump pit, sluice pit, spare inlet nozzles (N1, N2, N3 and N4) and tank risers.

B5.1 TANK 241-T-108 WASTE HISTORY

Waste was first added to tank T-108 in September 1945 with the cascade of 1C1 waste from tank T-107, which continued until the first quarter of 1946. During the fourth quarter of 1945 and the first quarter of 1946, the 1C1 supernate cascaded from tank T-108 to tank T-109. Following this activity, the entire cascade of tanks T-107, T-108, and T-109 was declared full.

Supernate, presumably 1C1 waste, was pumped to tank 241-TX-118 (TX-118) during the second and third quarters of 1951. An unknown type of waste, thought to be 1C1 and/or TBP waste, cascaded from tank T-107 to tank T-108 during the fourth quarter of 1952 through the first quarter of 1953. During the same time period, the waste cascaded into tank T-109. Historical records suggest that the waste transferred from tank T-108 was also 1C1 and/or TBP. Supernate was again transferred to tank TX-118 from the second quarter of 1951 until the third quarter of 1953. Historical records suggest that tank T-108 contained 1C1 and TBP waste; therefore, it is assumed that these waste types were added to tank TX-118. During the first quarter of 1954, tank T-108 received supernate, presumably evaporator bottoms waste, from tank 241-TX-117. Saltcake bottoms from the 242-T Evaporator were transferred into tank T-108 during the fourth quarter of 1955 as a result of an evaporator campaign.

During the first quarter of 1967, additional supernate was transferred to tank TX-118. From the second quarter of 1967 until the first quarter of 1968, tank T-108 intermittently received Hanford Site Laboratory Operations waste. Historical records are unclear as to the original source of this waste. During the first and second quarters of 1973, supernate was pumped from tank T-107. Historical records suggest that the supernate was B Plant low-level and/or IX waste. Simultaneously, supernate was transferred to tank T-109. Additional supernate was transferred from tank 241-S-110 (S-110) during the second quarter of 1974. The last major waste transfer for tank T-108 involved the transfer of supernate to tank T-101 during the first quarter of 1975. More detailed information on tank T-108 wastes storage operations can be found in reports RPP-16765, *Origin of Waste in Single-Shell Tank 241-T-107* and WHC-MR-0132. Figure B5-2 shows the tank T-108 Quarterly Waste Fill History.

Figure B5-1. Tank 241-T-108 Waste Operations Summary.

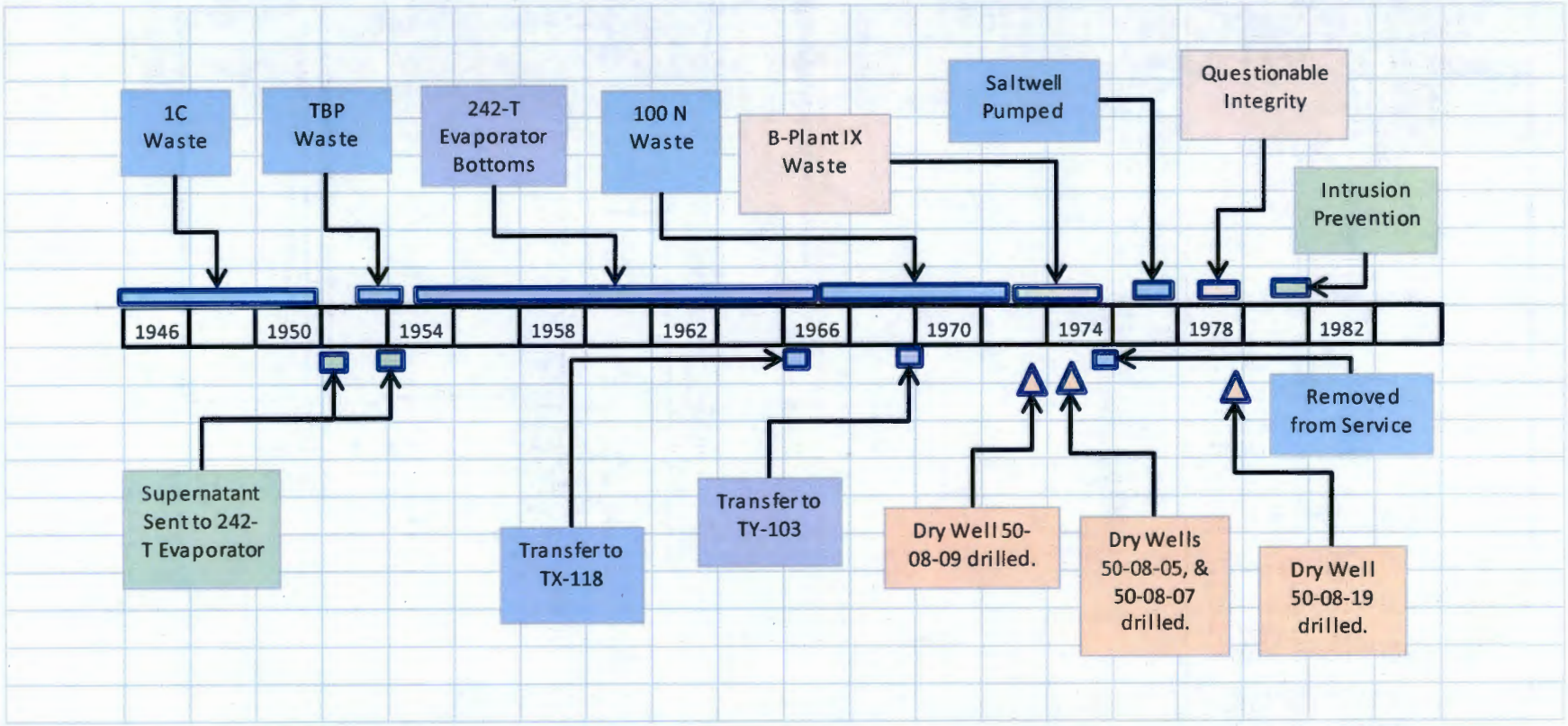
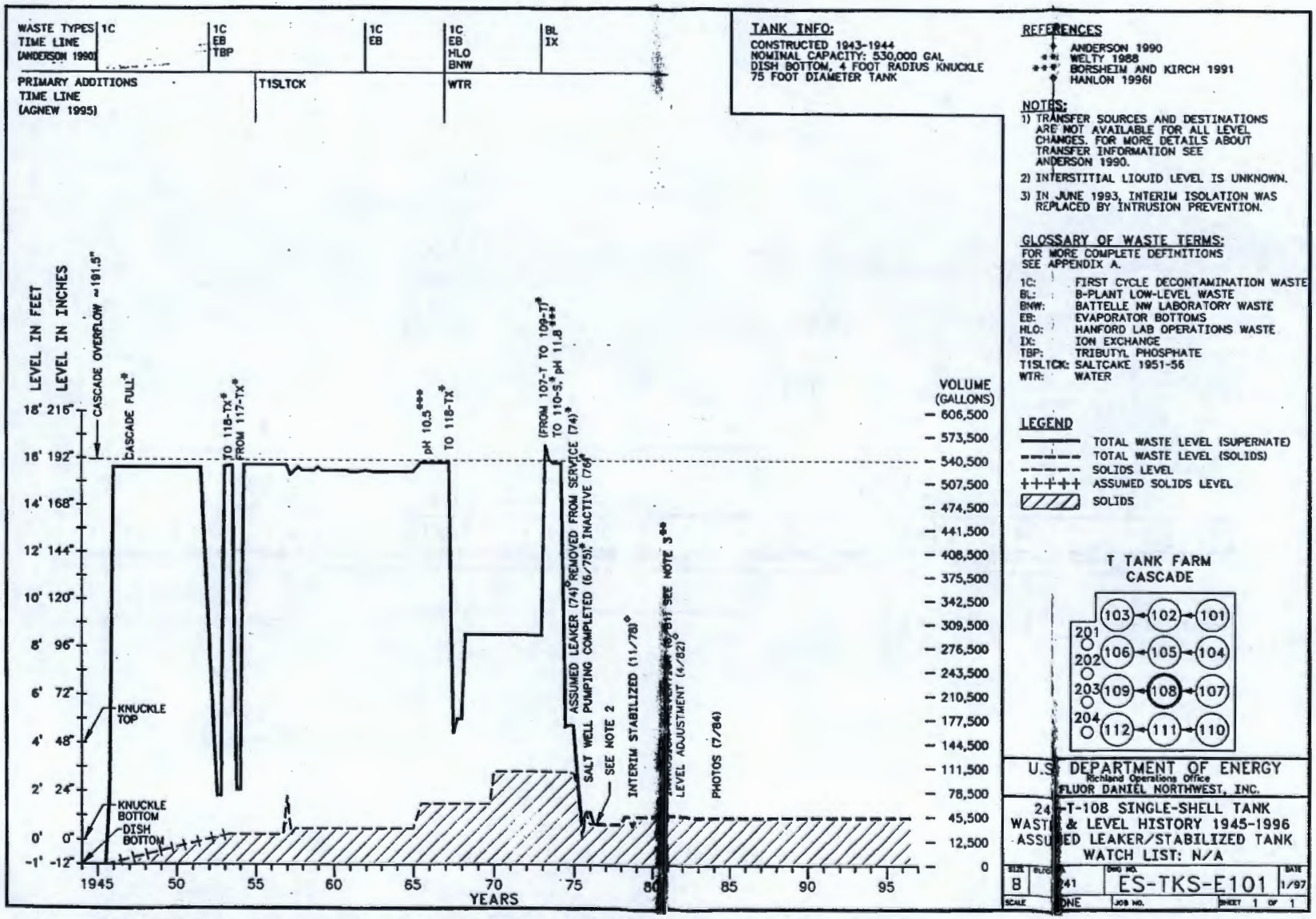


Figure B5-2. Tank 241-T-108 Quarterly Waste Fill History.



Reference: HNF-SD-WM-ER-351, *Historical Tank Content Estimate for the Northwest Quadrant of the Hanford 200 West Area.*

B5.2 INTEGRITY OF TANK 241-T-108

Tank T-108 was identified as questionable integrity on April 28, 1974 (RHO-CD-896, *Review of Classification of Nine Hanford Single-Shell "Questionable Integrity" Tanks*) based on a 0.3-in. liquid level decrease from 190.3 to 190.0 in. between August 1973 and April 1974. Approximately 366,000 gal of supernate were transferred from tank T-108 to tank S-110 for processing in the 242-S Evaporator on April 25, 1974 (RHO-CD-896). Tank T-108 contained ~62,000 gal of supernate and 106,000 gal of sludge following this transfer.

B5.3 INTERIM STABILIZATION

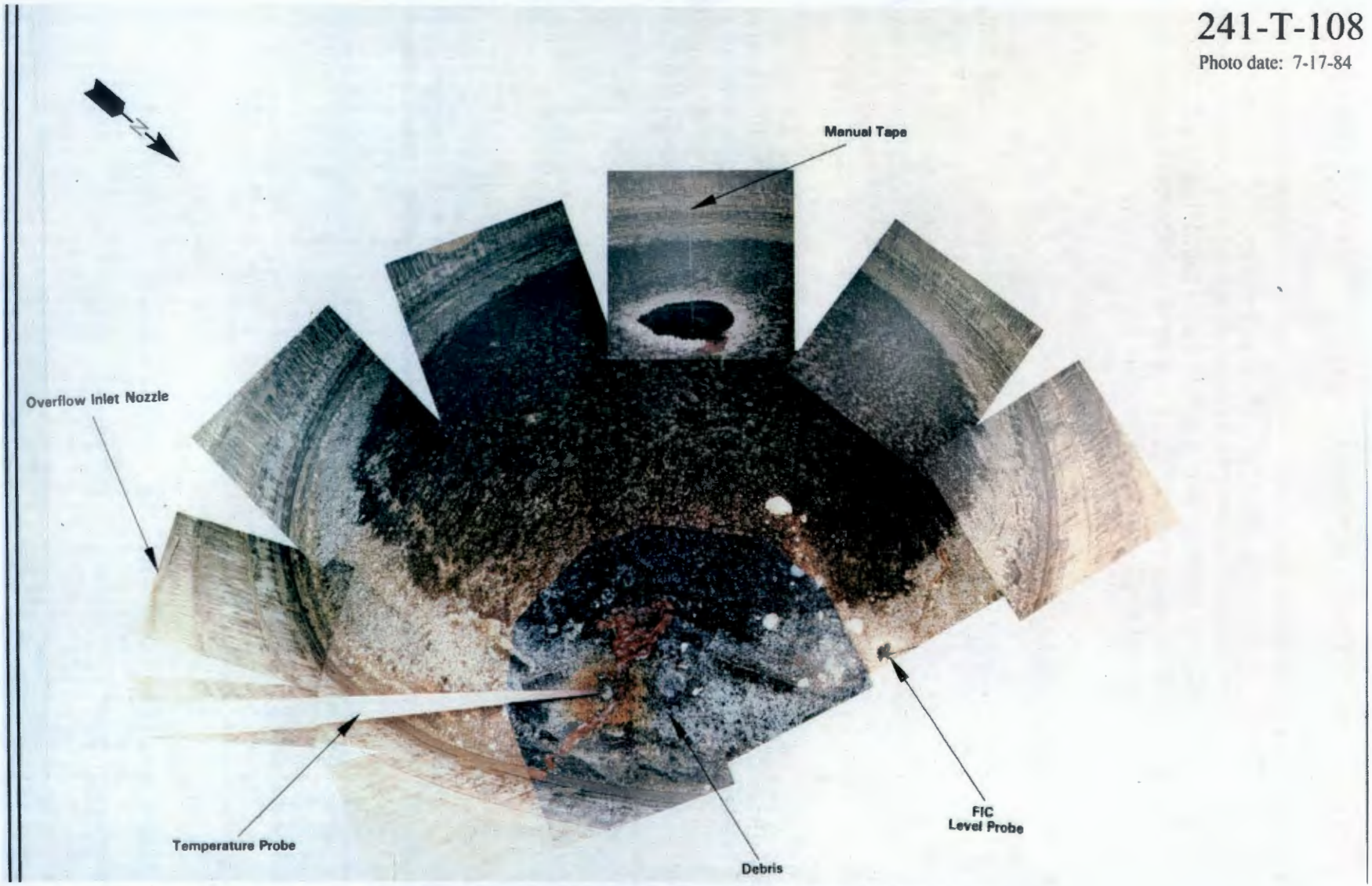
A saltwell pump was installed in February 1975 and liquid was removed from tank T-108 to tank T-101 from February 1975 through June 1975. The liquid level in tank T-108 was reported to decrease from 27.3 in. to 13.1 in. following saltwell pumping. In-tank photographs taken in October 1977 indicate that there is a pool of ~100 gal of liquid and ~95% of the waste surface is solids. The tank was declared interim stabilized as of November 30, 1978 based on this information (HNF-SD-RE-TI-178). Intrusion prevention for tank T-108 was completed in June 1981.

Tank T-108 (RPP-RPT-43166, *2009 Auto-TCR for Tank 241-T-108*) contains 16,000 gal of waste. Figure B5-3 is a composite of photographs showing a damp saltcake surface with a small pool containing ~100 gal of liquid in the center of the tank. The Best-Basis Inventory has tank T-108 waste comprised of 3,000 gal of saltcake from the 1951-1956 242-T Evaporator campaign (T1Sltck) liquid, 8,000 gal of T1Sltck, and 5,000 gal of 1C sludge.

B5.4 TANK 241-T-101 TEMPERATURE HISTORY

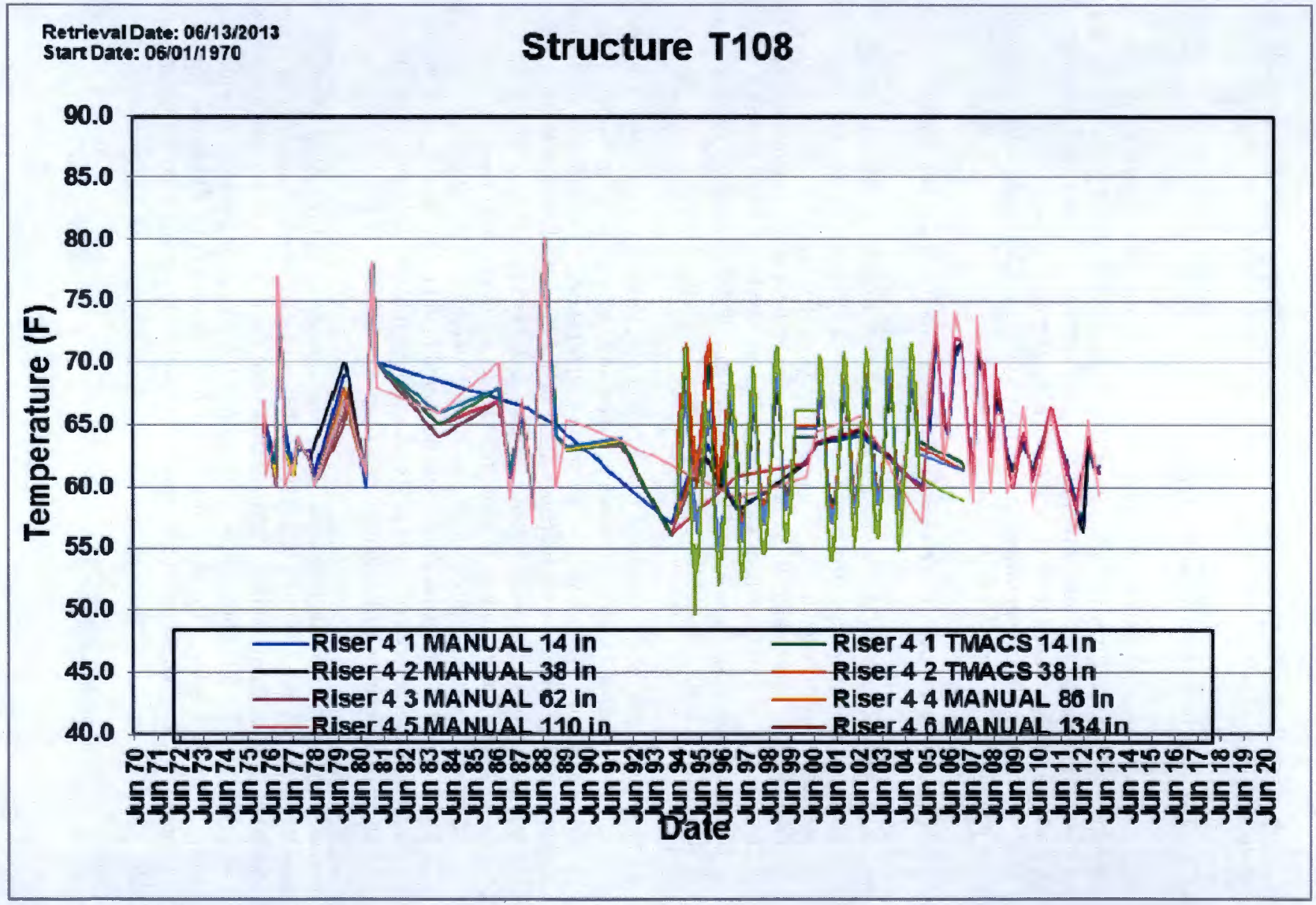
The tank temperature is monitored by a single thermocouple tree located in riser 4. No temperature measurements were found before 1976. Figure B5-4 shows tank waste temperatures for tank T-108 from 1976 to 2013. During this period the maximum waste temperature was about 80 °F in 1988. By 1990 the temperature decreased to below ~70 °F. The tank temperature varies seasonally between ~55 and ~70 °F.

Figure B5-3. Tank 241-T-108 Waste Surface Photo Mosaic.



Reference: HNF-SD-WM-ER-351, *Historical Tank Content Estimate for the Northwest Quadrant of the Hanford 200 West Area.*

Figure B5-4. Tank 241-T-108 Waste Temperature Measurements.



TMACS = Tank Monitor and Control System

B5.5 DATA REVIEW AND OBSERVATIONS

The following sections contain discussions of the tank surface level, drywell logging data and borehole sampling.

B5.5.1 Tank Surface Level Measurements

Tank liquid level measurements before 1973 were not available, other than from the transfer data in waste process reports (Figure B5-2). Figure B5-2 indicates that liquid waste may have been filled above the cascade/spare inlet level in tank T-108 between 1965 and 1967, and again in 1973. Table B5-1 shows surface levels and surface level changes from 1973 to 1987. Figure B5-5 shows surface level measurements from 1973 to 2013. Figure B5-5 shows that saltwell pumping of the tank waste in 1974.

The following occurrence reports were issued for tank T-108 liquid level decreases.

- Occurrence Report 75-51, *Decreasing Liquid Level in Tank 108-T* identified a 0.6-in. decrease in tank T-108 liquid level in March 1975. However, this liquid level decrease was attributed to the FIC gauge contacting the sludge surface, with the pool of liquid in tank T-108 about 18 in. below the point at the side of the tank where the liquid level measurements are taken. Occurrence Report 75-51 does provide tank T-108 liquid level measurements from April 30, 1974 through July 23, 1975 and drywell readings for this same period.

- Occurrence Report 77-186, *Tank 108-T Liquid Level Increase Exceeding Criterion*, issued November 14, 1977 indicates that a liquid level increase of 0.75-inches was detected in tank 241-T-108. The occurrence report states: "Photographs taken on 4-6-77 show the liquid level tape's plummet suspended above a pool of clear liquid approximately ten feet in diameter. The pool is defined by a ring of salt cake crystals rising several inches above the surrounding sludge. Photographs taken on 10-19-77 show no change in the appearance of the pool or surrounding crystals. The tape was flushed on 10-19-77 with no immediate change in measured liquid level. On 10-20-77 the liquid level measurement returned to 12.00 inches, where it has since remained (11-13-7). There have been no inadvertent water additions to this tank."

A review of eight sets of available in-tank T-108 photographs taken from April 8, 1974 (waste surface level 190 in.) through July 1984 (FIC level 4.4 in.) showed no evidence of structural damage to the side-walls of the tank. A small amount of foam can be seen present on the waste surface in the April 8, 1974 photograph. Corrosion of the inlet piping is evident, which could be indicative of the tank being filled above the 210-in. level at some time. Otherwise, these photographs show the liquid pool in the center of the tank with the surrounding saltcake and sludge.

Table B5-1. Tank 241-T-108 Liquid Level Measurements and Changes (1973 to 1987).

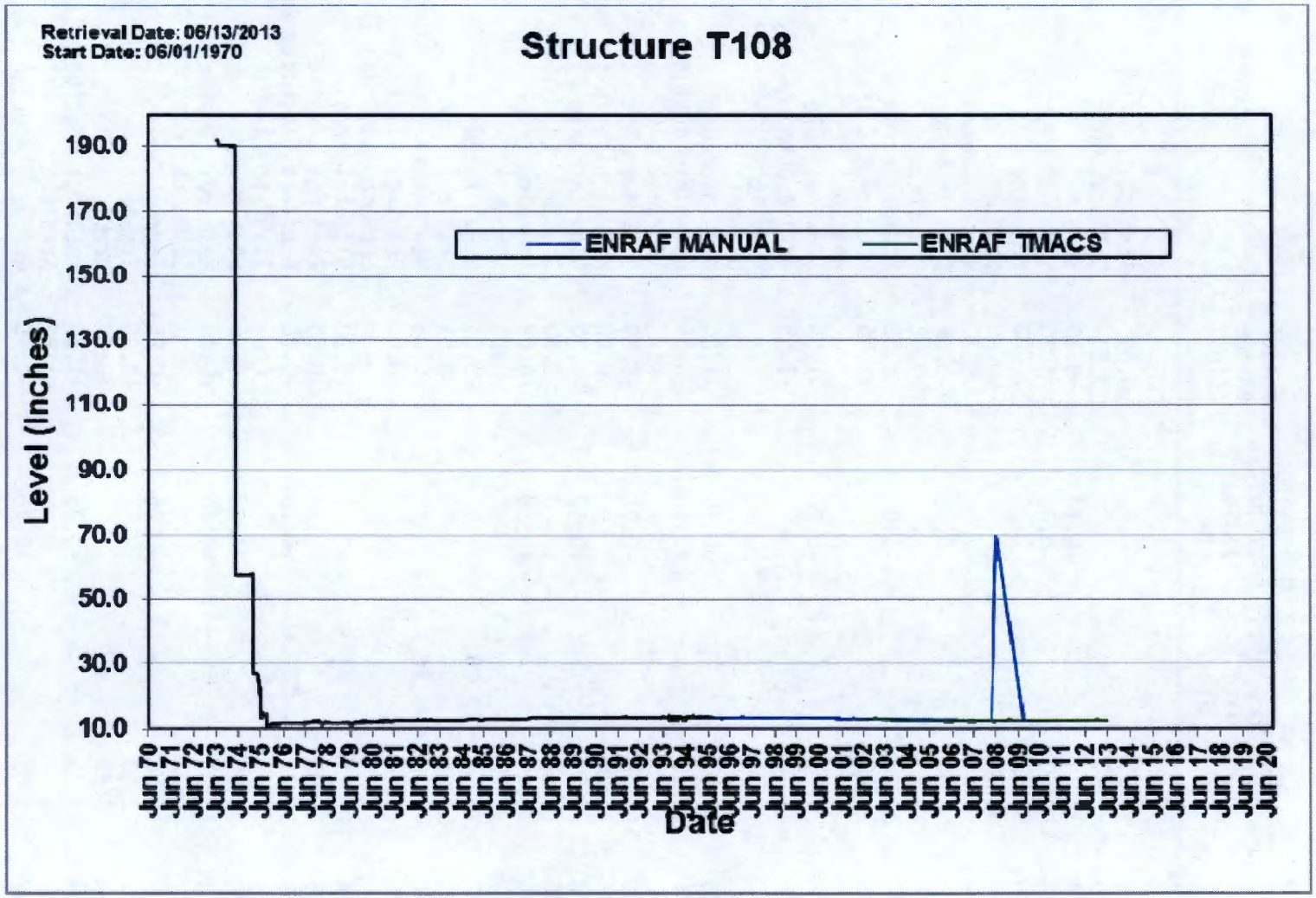
Liquid Level.

Date	Liquid level (in.)	Baseline ref.	Change from previous reading (in.)	Cumulative change (in.)	Comments
06/13/73	191.90		-	-	
07/25/73	191.90		-	0.00	Stable
07/26/73	190.20		-	0.00	Calibration
08/31/73	190.30		+0.10	+0.10	Stable
04/24/74	190.00		-0.30	-0.20	Slow decrease
04/29/74	57.30		-	-0.20	Transfer
08/01/74	57.30		-	-0.20	Stable
08/02/74	57.45		-	-0.20	New FIC Board
01/26/75	57.60		+0.15	-0.05	Slow increase
01/29/75	27.20		-	-0.05	Transfer
04/29/75	26.20		-1.00	-1.05	Steady decrease
04/30/75	21.00		-	-1.05	FIC erratic (Manual Reading)
06/09/75	20.50		-0.50	-1.55	Slow decrease
06/25/75	13.10		-	-1.55	Active pumping--now reading sludge with FIC plummet
07/02/75	13.00		-0.10	-1.65	Slow decrease
07/03/75	14.10		+1.10	-0.55	Unexplained sludge increase
09/10/75	13.85		-0.25	-0.80	Slow decrease
09/10/75	11.00		-	-0.80	Manual tape installed*
02/01/76	11.50		+0.50	-0.30	Slow increase
08/21/76	11.50		-	-0.30	Stable
08/22/76	11.75		+0.25	-0.05	Increase
06/10/77	11.75		-	-0.05	Stable
11/15/77		12.25		-0.05	O.R. 77-186
01/26/78	12.25		-	-0.05	Stable
01/31/78		11.50	-	-0.05	New manual tape
08/25/78	11.50			-0.05	Readings fluctuate between 11.50 and 12.00
08/26/78	11.75		+0.25	+0.20	Slight increase
06/09/79	11.00		-0.75	-0.55	Readings erratic
10/18/79	11.75		+0.75	+0.20	Readings fluctuate from 11.00 to 12.00
09/20/80	12.00		+0.25	+0.45	Stable
08/12/81	12.25		+0.25	+0.70	Readings fluctuate from 12.00 to 12.50
08/11/82	12.50		+0.25	+0.95	Same as above
08/22/83	12.50		-	+0.95	Stable
07/02/84	12.50		-	+0.95	Stable
07/01/85	12.75		+0.25	+1.20	Readings fluctuate
07/01/86	12.75			+1.20	Stable
07/01/87	13.00		+0.25	+1.45	Gradual increase

NOTE: The manual tape is being used because it is contacting liquid. The FIC gage is dry.

Reference: SD-WM-TI-356, *Waste Storage Tank Status and Leak Detection Criteria.*

Figure B5-5. Tank 241-T-108 Waste Surface Level Measurements.



Note: Surface level measurement changed to bottom of tank (12-in. off-set) after October 1995 measurement.

TMACS = Tank Monitor and Control System

Honeywell Enraf is a product of Honeywell Process Solutions, Strahlenbergerstr. 110-112, 63067 Offenbach, Germany.

B5.5.2 Drywell Logging Data

Nine drywells surround tank T-108 (50-05-06, 50-07-08, 50-08-05, 50-08-07, 50-08-19, 50-08-08, 50-08-09, 50-09-02, and 50-08-11); Figures B3-8, B4-9 and B5-6 show the 1999 reported SGLS results for some of these drywells (GJO-99-101-TARA/GJO-HAN-27). Figure B5-7 provides some historical gamma logging results for three drywells about tank T-108.

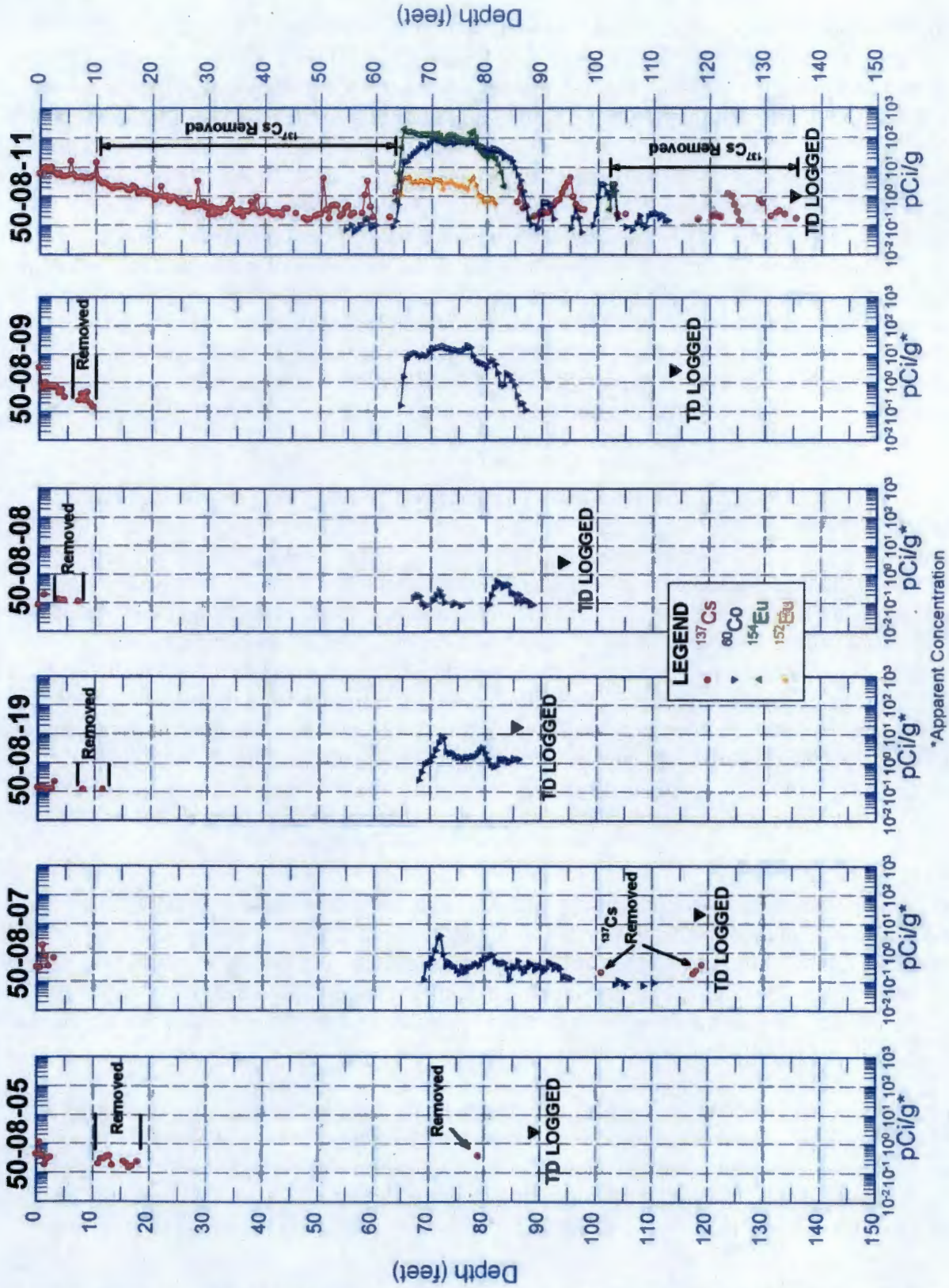
In January 6, 1975, ARHCO Occurrence Report 75-02, *Increasing Dry Well Radiation Levels Adjacent To Waste Tanks 105-T and 108-T* was issued to document an observed increase in radiation measurements in drywell 50-05-06, which is located between tanks T-105 and T-106. The increase in measured radiation was attributed to the migration of waste that had leaked in May 1973 from tank T-106. Occurrence Report 76-56, *Dry Well Radiation Increase Exceeding Action Criteria*, issued April 9, 1976 discusses increased radiation measured in drywell 50-08-09, which was also attributed to migration of waste that had previously leaked from tank T-106. Occurrence Report 78-60, *Dry Well Radiation Increase Exceeding Criterion*, issued June 9, 1978 discusses increased radiation measured in drywell 50-08-07, which was also attributed to migration of waste that had previously leaked from tank T-106.

Occurrence Report 79-75, *Reevaluation of Occurrence Report 78-60: Dry Well Radiation Increase Exceeding Criterion*, issued August 1, 1979 re-evaluated the measured radiation reading in drywell 50-08-07 as reported in Occurrence Report 78-60 given the continuing increase in the peak radiation readings. Occurrence Report 79-75 stated: "Two exploratory wells were installed during the course of the investigation, 50-08-19 and 50-11-11. Analysis conducted in wells 50-08-19, 50-08-07, and 50-11-11 by multi-channel analyzer indicates the presence of ^{106}Ru and the absence of ^{137}Cs." "Drilling core samples taken from well 50-08-19 at the 72 foot level revealed extremely wet silt ("muddy"). Samples from the 50-11-11 well at 69 foot level encountered wet soil conditions." "For two years there has been unusual climatic conditions occurring during the winters. During periods of snow accumulation, "chinooks" (warm winter winds) occurred and the snow was rapidly melted. This water could have run down the ungrouted wells or tank risers and could account for a water driving force at the lower levels".

Occurrence Report 79-75 concluded: "...the exact cause of the increasing activity of well 50-08-07 could not be determined. Based on the climatic conditions and the saturated soil conditions found while drilling the exploratory wells, excessive subsurface water could have channeled either 106-T plume or previously unidentified material into the vicinity of dry well 50-08-07." "From the investigation, it is impossible to determine whether the activity being moved is from the 106-T plume or another source".

In 1979 exploratory drywells 50-11-11 and 50-08-19 were drilled because the activity in drywell 50-08-07 continued to increase. The source of activity in drywell 50-08-07 was reevaluated with the conclusion that tank T-106 is a questionable source of activity in drywell 50-08-07 and the activity is migrating from the direction of tank T-108. SD-WM-TI-356 states that the drywell activity around tank T-108 is associated with the tank T-106 release.

Figure B5-6. 1998 Spectral Gamma Logging Results for Drywells near Tank 241-T-108.



Reference: GJO-99-101-TARA/GJO-HAN-27, *Hanford Tank Farms Vadose Zone: Addendum to the T Tank Farm Report.*

Figure B5-7. Tank 241-T-108 Historical Gamma Logging Results. (sheet 1 of 3)

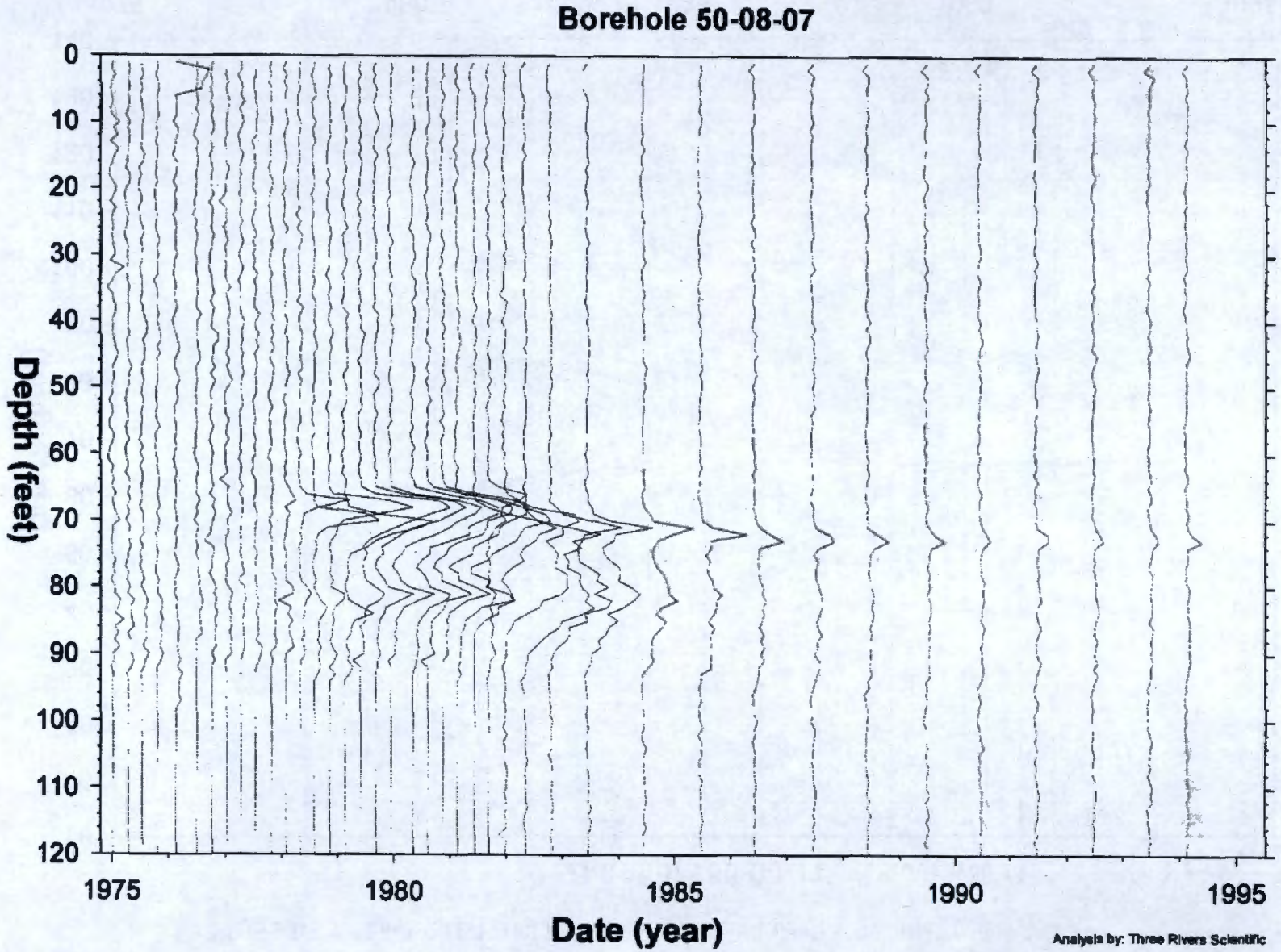


Figure B5-7. Tank 241-T-108 Historical Gamma Logging Results. (sheet 2 of 3)

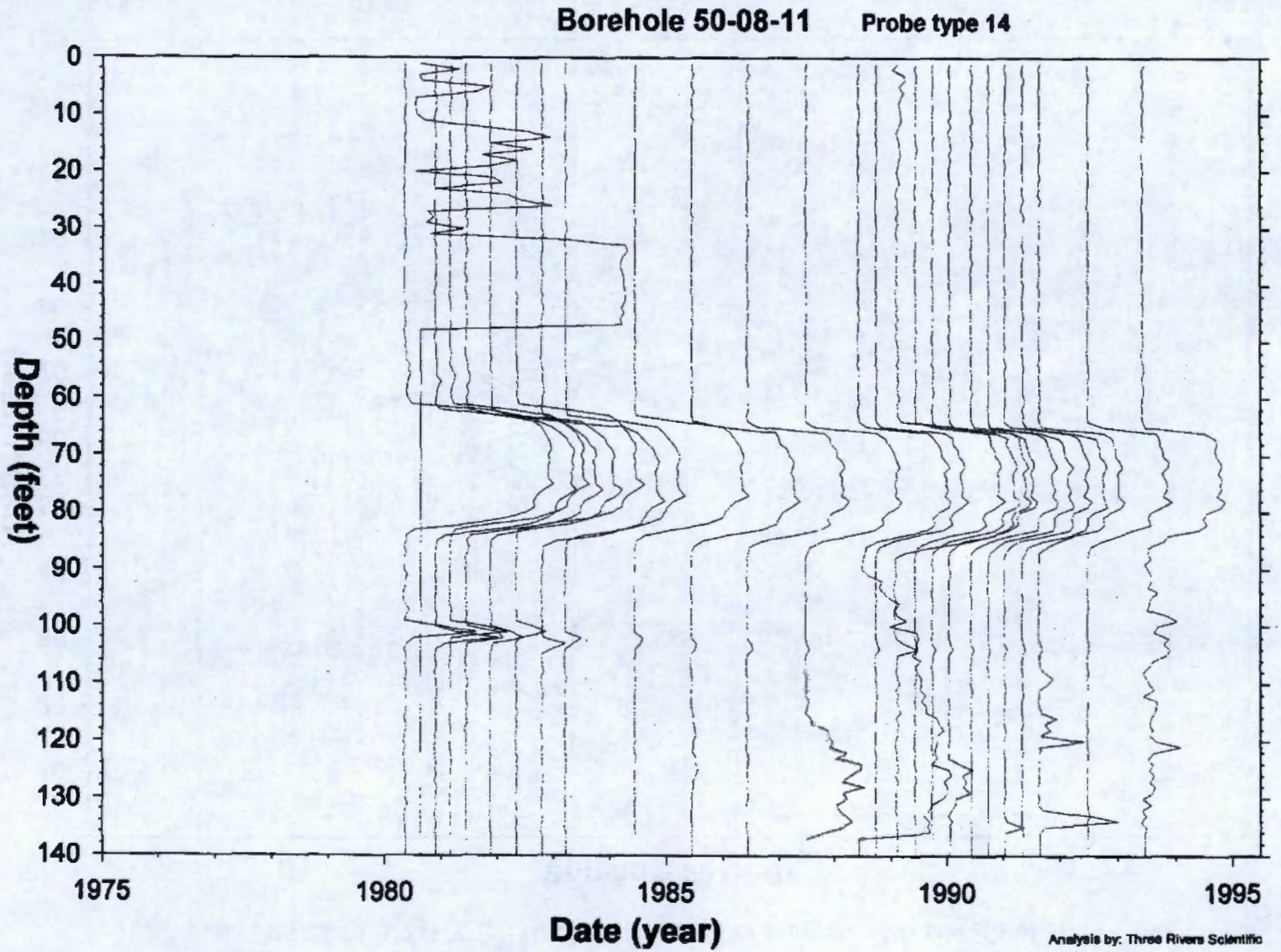
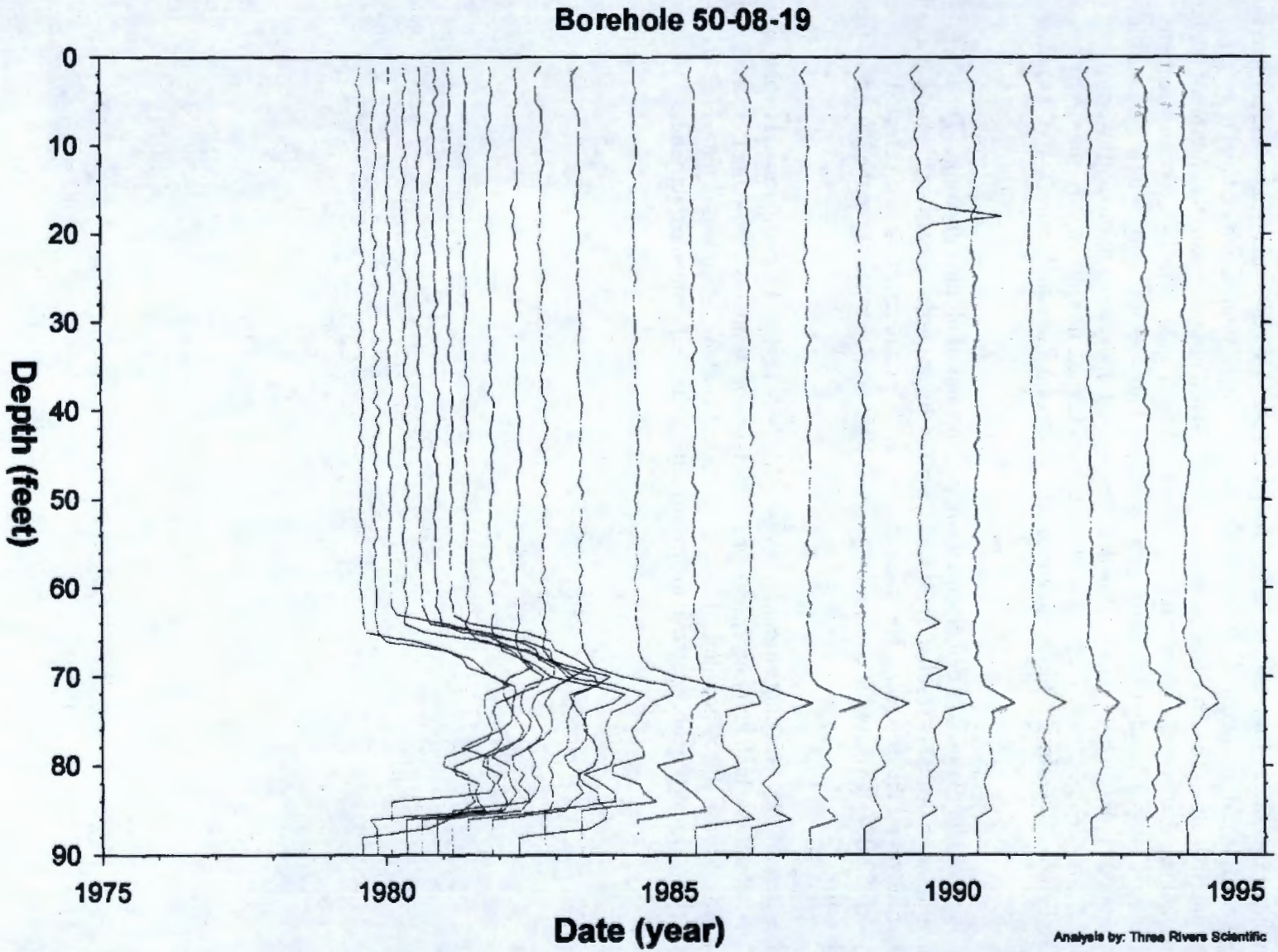


Figure B5-7. Tank 241-T-108 Historical Gamma Logging Results. (sheet 3 of 3)



Reference: RPP-6088, *Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-T Tank Farm – 200 West.*

It was reported in GJ-HAN-121, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank T-108* that ^{60}Co contamination occurs at the shallowest depth (54.5 ft) in drywells to the northwest of tank T-108 (i.e., near tank T-106); the depths of these occurrences increase to the southeast (i.e., away from tank T-106). No detectable ^{60}Co contamination was identified in the drywells furthest from tank T-106, possibly because the contamination occurs below the maximum depth of the drywells, or because the ^{60}Co did not migrate to this region of the tank farm. On the basis of the historical gross gamma data, it appears that ^{60}Co contamination (detected as anomalously high gross gamma activity) arrived at the drywells at various times. Anomalous gross gamma activity was detected earliest in drywells to the northwest of tank T-108 (i.e., near tank T-106) and at later times to the southeast (i.e., further from tank T-106). Therefore, a likely source of this ^{60}Co contamination is tank T-106, a known leaker.

Cesium contamination was detected in the upper portions of all nine drywells. The ^{137}Cs contamination probably resulted from surface spills that migrated downward into the backfill material around the drywells. The most extensive ^{137}Cs contamination was detected in drywell 50-08-11, where the contamination was detected intermittently to the bottom of the drywell.

The extent of the ^{137}Cs contamination in drywell 50-08-11 may be partly caused by the presence of perforations, which may increase the migration of contamination, although the mechanism that would cause this is not understood. Cesium-137 contamination was detected in several drywells and was probably carried downward during drywell deepening activities.

B6.0 TANK 241-T-109

This section provides information on the historical waste loss event associated with tank T-109. Waste operations for tank T-109 are summarized in Figure B6-1. Figure 3-2 of the main text shows a plan view of a typical tank in T Farm with the location of the pump pit, sluice pit, spare inlet nozzles (N1, N2, N3 and N4) and tank risers.

B6.1 TANK 241-T-109 WASTE HISTORY

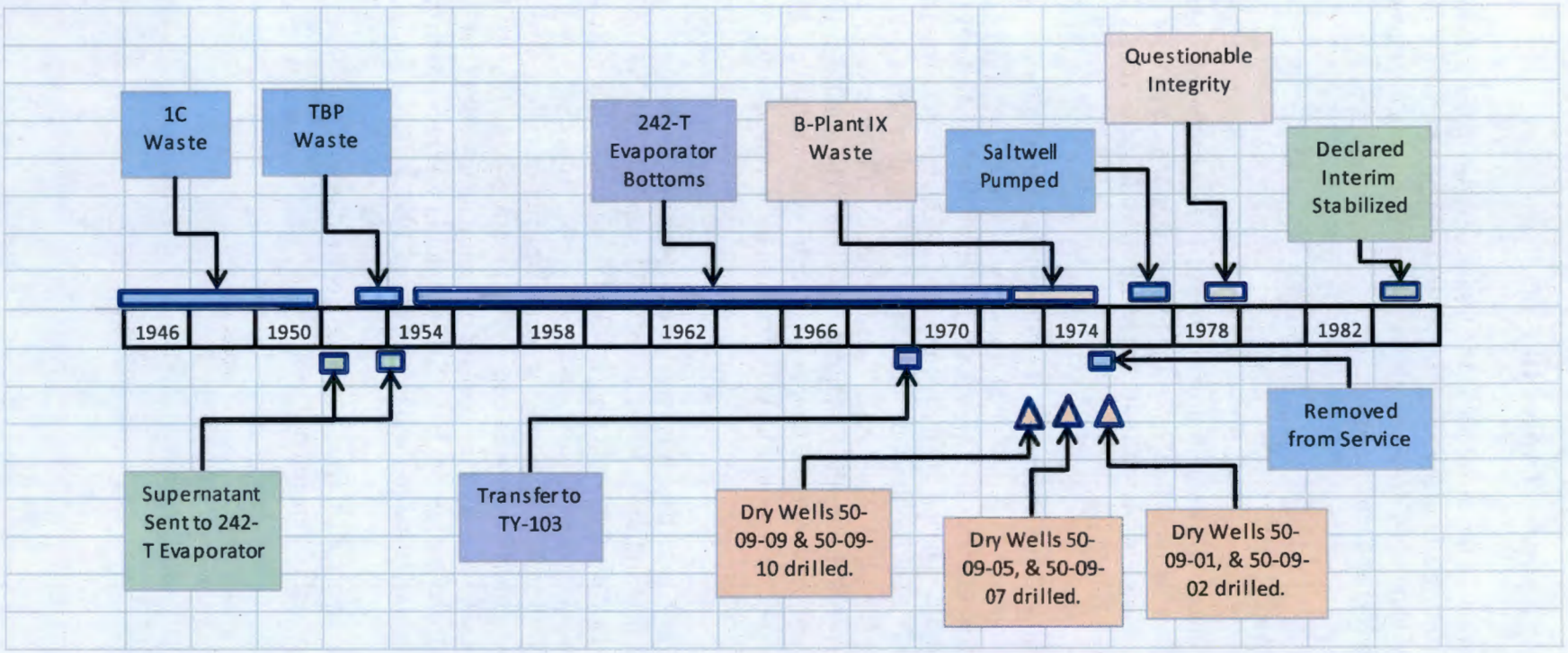
Waste was initially added to tank T-109 in the fourth quarter of 1945 with the cascade of 1C waste from tank T-108. Because tank T-109 was the third tank in the cascade, it is unlikely that it received any 1C waste solids. In March 1946, the entire cascade series (tanks T-107, T-108, and T-109) was declared full.

Supernate was pumped from tank T-109 to tank TX-118 during the second quarter of 1951. Uranium recovery waste was intermittently cascaded from tank T-108 to tank T-109 from the fourth quarter of 1952 to the first quarter of 1953. Again, it is likely that all of the waste cascaded to tank T-109 was liquid. During the third quarter of 1953, supernate was transferred from tank T-109 to tank TX-118. During the fourth quarter of 1953 and the first quarter of 1954, tank T-109 received supernate from tank 241-TX-117. Additionally, T1SltCk was pumped from the 242-T Evaporator to tank T-109 during the first quarter of 1954. The addition of T1SltCk was probably a major solids contribution to the tank even though it was a relatively low-volume transfer. There were no transfers into or out of tank T-109 from the second quarter of 1954 through the third quarter of 1969.

During the fourth quarter of 1969, supernate was transferred from tank T-109 to tank 241-TY-103. During the first and second quarters of 1973, supernate was pumped to tank T-109 from tank T-108. Historical records suggest that the supernate may have been B Plant low-level waste, Battelle Northwest waste, and/or IX waste. Supernate was transferred to tank T-109 from tank 241-T-111 (T-111) during the second quarter of 1974. Also, during the same time period, supernate was transferred from tank T-109 to tank S-110. Finally, the last major waste transfer for tank T-109 involved the transfer of supernate to tank T-101 during the first quarter of 1975 and the second quarter of 1976. Saltwell liquid was pumped from tank T-109 in support of tank stabilization in the third quarter of 1983.

Tank T-109 is characterized as an assumed leaker and was declared inactive in 1976. The tank had intrusion prevention completed in September 1988.

Figure B6-1. Tank 241-T-109 Waste Operations Summary.



1C = First-cycle decontamination (waste) from the bismuth phosphate process IX = ion exchange TBP = tri-butyl phosphate

B6.2 INTEGRITY OF TANK 241-T-109

Tank T-109 was identified as being of questionable integrity in June 1974 (RHO-CD-896) based on observed increases in drywell 50-09-10 radiation readings between February 1974 and June 1974. Occurrence Report 74-108, *Symptoms of Leakage from Liquid Level Drop and Dry Well Activity in Waste Tank 109-T* documented an accumulated decrease in the remnant sludge layer of 0.3 in. and the increase in radiation readings measured in drywell 50-09-10 at a depth of 36 to 39 ft and drywell 50-06-06 at a depth of 39 ft. Adjacent drywells 50-09-05, 50-09-07, and 50-09-09 do not indicate an increase in measured radioactivity.

B6.3 INTERIM STABILIZATION

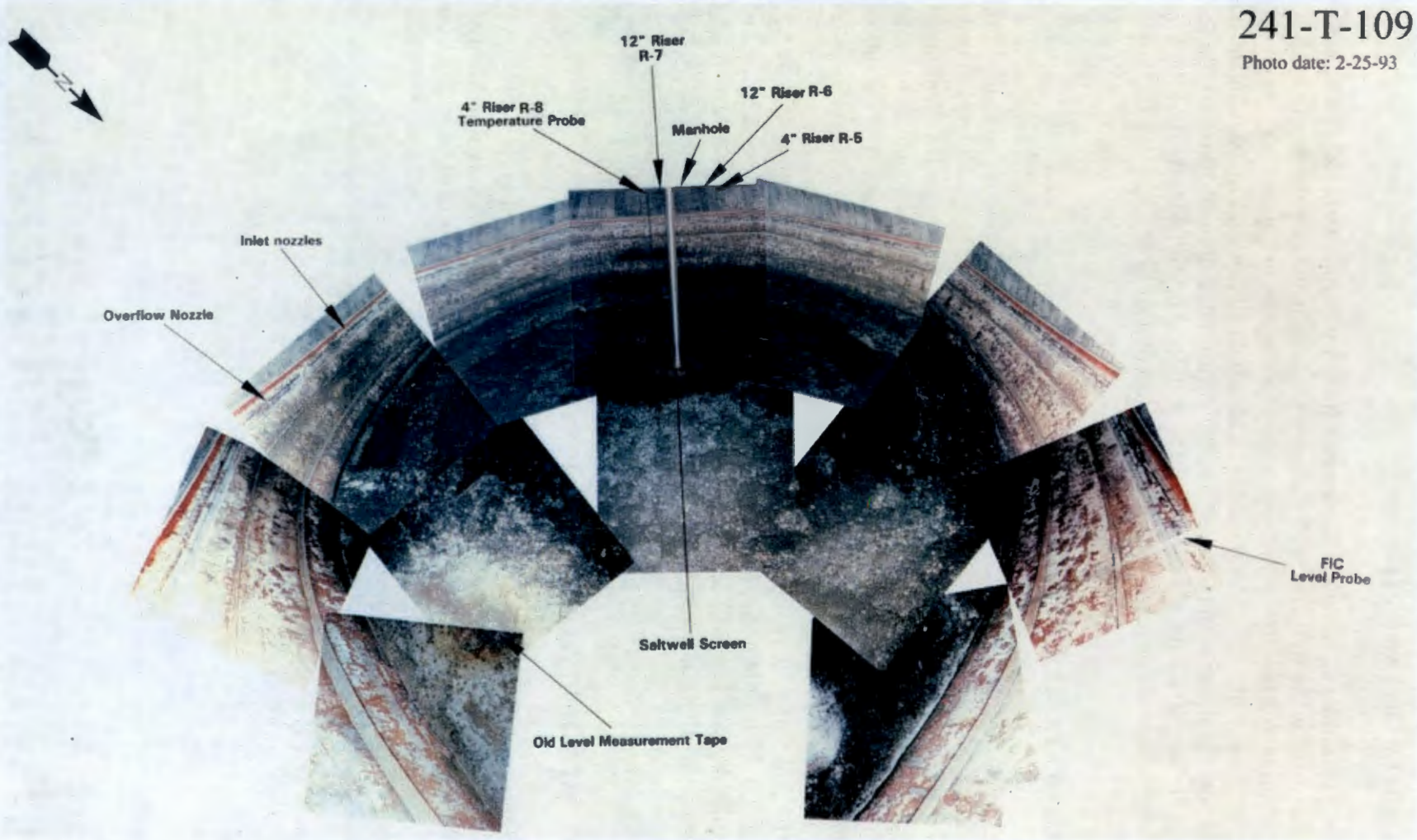
A saltwell pump was installed in tank T-109 in February 1975 and liquid was removed from tank T-109 to tank T-101 from February 1975 through May 1978. The liquid level in tank T-109 was reported to decrease from 49.5 in. to 20.5 in. or 64,900 gal following saltwell pumping. In-tank photographs taken on July 23, 1984 showed that the waste surface appears to be dry sludge with no supernate present. The tank was declared interim stabilized as of December 20, 1984 based on this information (HNF-SD-RE-TI-178).

The tank T-109 tank interpretive report (RPP-RPT-43167, *2009 Auto-TCR for Tank 241-T-109*) reports that tank T-109 contains 62,000 gal of waste. Photos taken in 1993 (Figure B6-2) indicate a mostly dry, uneven surface, with highly sloped edges of waste. The Best-Basis Inventory has tank T-109 waste comprised of 10,000 gal of T1Sltck liquid, and 52,000 gal of T1Sltck.

B6.4 TANK 241-T-109 TEMPERATURE HISTORY

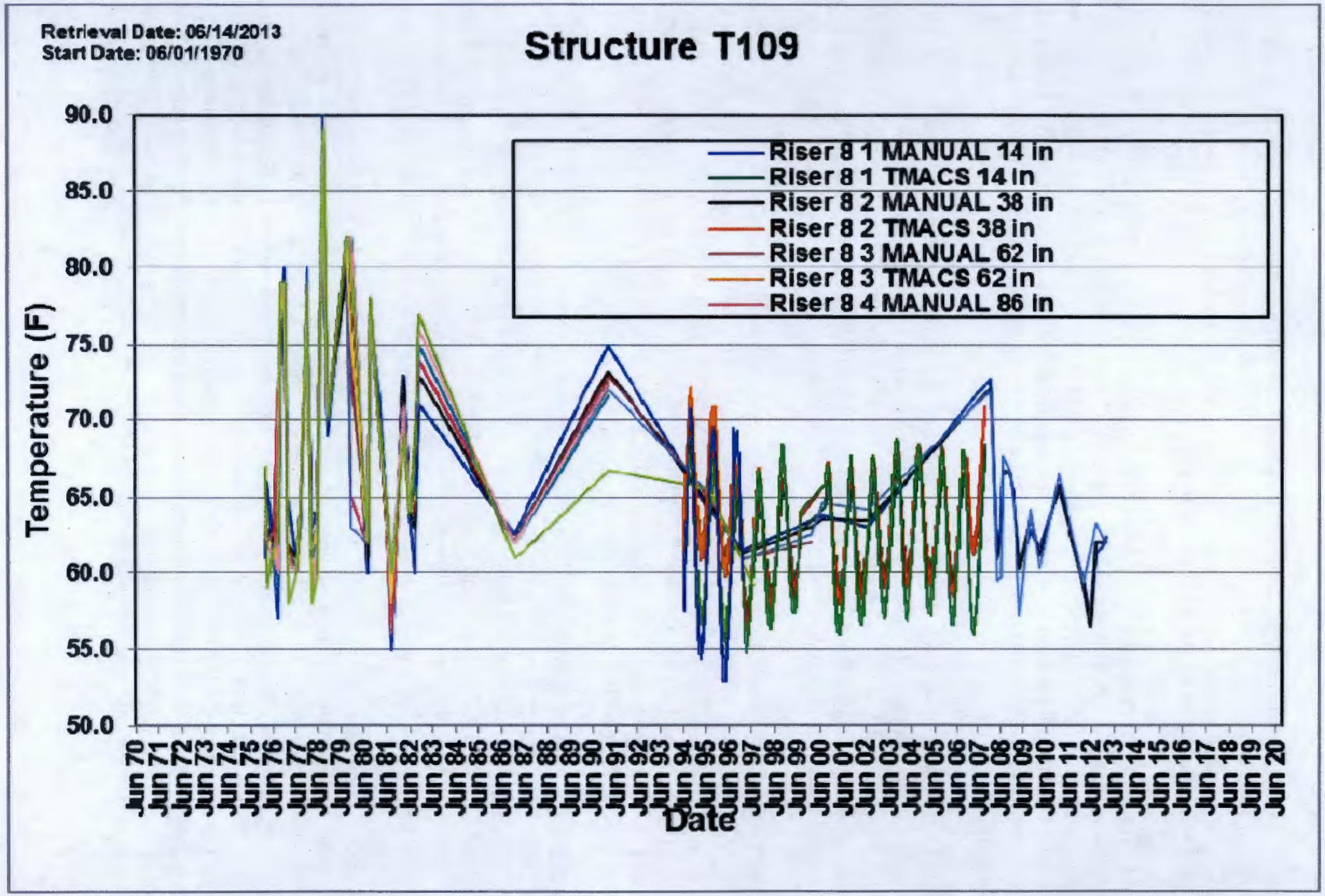
The tank temperature is monitored by a single thermocouple tree located in riser 8. No temperature measurements were found before 1976. Figure B6-3 shows tank waste temperatures for tank T-109 from 1976 to 2013. During this period the maximum waste temperature was ~89 °F in 1978. By 1982 the temperature decreased to below ~75 °F. The tank temperature varies seasonally between ~55 and ~75 °F.

Figure B6-2. Tank 241-T-109 Waste Surface Photo Mosaic.



Reference: WHC-SD-WM-ER-351, *Historical Tank Content Estimate for the Northwest Quadrant of the Hanford 200 West Area.*

Figure B6-3. Tank 241-T-109 Waste Temperature Measurements.



TMACS = Tank Monitor and Control System

B6.5 DATA REVIEW AND OBSERVATIONS

The following sections contain discussions of the tank surface level, drywell logging data and borehole sampling.

B6.5.1 Tank Surface Level Measurements

Tank liquid level measurements before 1973 were not available, other than from the transfer data in waste process reports (Figure B6-4). Table B6-1 shows surface levels and surface level changes from 1973 to 1987. Figure B6-5 shows surface level measurements and LOW neutron and gamma interstitial liquid level measurements from 2002 to 2013. Figure B6-5 shows the readjustment of the baseline in 1996 correlates with the amount of waste transferred during jet pumping.

Figure B6-4 shows that the total waste volume stored in tank T-109 was revised to 541,000 gal (~205.6 in.) in January 1957 (HW-48144, *Chemical Processing Department Waste – Status Summary January 1, 1957 – January 31, 1957*) and revised again to 552,000 gal (~209.6 in.) in the first six months of calendar year 1965. The sludge level was measured in the first six months of calendar year 1965 and determined to be ~128,000 gal.

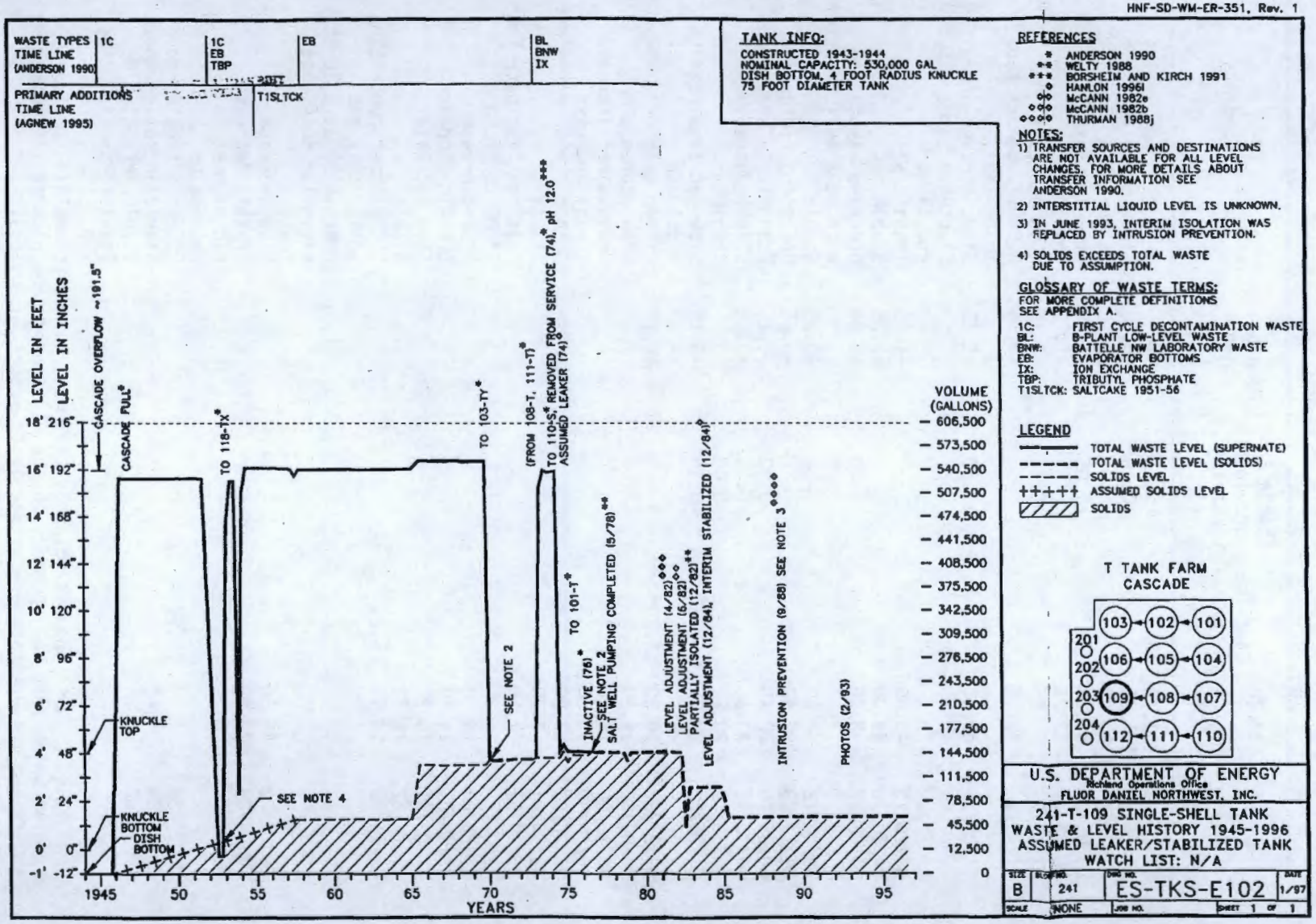
Tank T-109 was removed from service because of questionable integrity as a result of increasing activity found in dry wells (SD-WM-TI-356). Since 1976, activity in all dry wells has steadily decreased; although this tank is still considered to be an assumed leaker. Drywells are the only means of leak detection because the FIC plummet is contacting solids. During the past review period the dry well activity has remained stable (RHO-CD-213, *Waste Storage Tank Status and Leak Detection Criteria 200 East Area*).

B6.5.2 Drywell Logging Data

Nine drywells surround tank T-109 (50-09-01, 50-09-02, 50-08-09, 50-09-05, 50-09-07, 50-09-09, 50-09-10, 50-00-09, and 50-06-06). Figures B3-9, B6-6 and B6-7 show the 1999 reported SGLS results for these drywells (GJO-99-101-TARA/GJO-HAN-27). Figure B6-8 provides some historical gamma logging results for three drywells about tank T-109.

As documented in GJ-HAN-122, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank T-109*, Figure B6-6 presents a correlation plot of radionuclide concentration profiles for six drywells surrounding tank T-109. The radionuclides ^{137}Cs, ^{60}Co, ^{154}Eu, ^{152}Eu, ^{125}Sb, and ^{126}Sn were detected. The concentrations of these radionuclides were detected on the north side of tank T-109, near tank T-106. A leak from tank T-106 is the most likely source of this contamination because the depth at which high contamination levels are encountered increases away from tank T-106 and the contamination levels of these radionuclides decrease away from tank T- 106. The total depth reached by contaminants on the north side of tank T-109 could not be determined because contamination was detected to the bottoms of the drywells.

Figure B6-4. Tank 241-T-109 Quarterly Waste Fill History.



Reference: HNF-SD-WM-ER-351, *Historical Tank Content Estimate for the Northwest Quadrant of the Hanford 200 West Area.*

Table B6-1. Tank 241-T-109 Liquid Level Measurements and Changes (1973 to 1987).

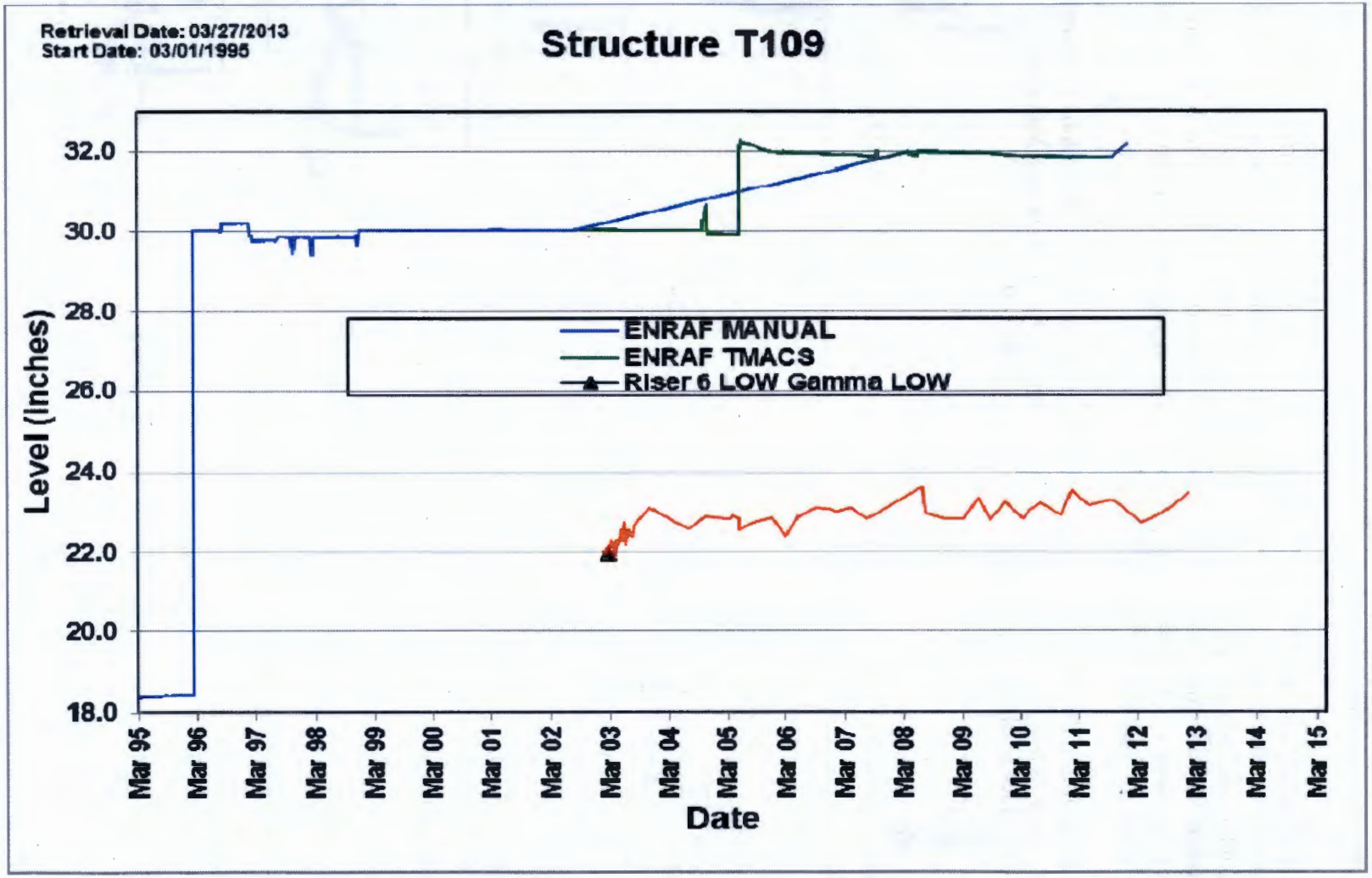
Liquid Level.

Date	Liquid level (in.)	Baseline ref.	Change from previous reading (in.)	Cumulative change (in.)	Comments
06/13/73	191.40		-	-	
07/25/73	191.50		+0.10	+0.10	Slow increase
07/26/73	190.00		-	+0.10	Calibration
05/01/74	191.05		+1.05	+1.15	Slow increase
05/24/74	52.25		-	+1.15	Transfers
07/02/74	51.85		-0.40	+0.75	Slow decrease
07/03/74	49.00		-	+0.75	FIC Off. manual tape installed
04/08/75	49.50		+0.50	+1.25	Slow increase--readings fluctuate between 50.00 and 49.00
04/26/75	49.00		-	+1.25	Transfers
04/20/76	49.00		-	+1.25	Stable
04/08/77	48.00		-1.00	+0.25	Decrease associated with salt well transfer
05/10/78	48.00		-	+0.25	Stable
05/11/78	20.50		-	+0.25	Now using FIC gage
08/05/78	20.40		-0.10	+0.15	Essentially stable
08/16/78	20.30		-0.10	+0.05	Slight decrease
08/15/79	20.25		-0.05	0	Stable
01/06/80	20.10		-0.15	-0.15	Slow decrease readings fluctuate
03/27/80	16.80	17.20*	-	-0.15	FIC in hole
05/09/80	16.80				Slow decrease
05/12/80	18.50				Unexplained increase
05/15/80	17.80				Steady decrease
08/26/80	17.80				Stable
01/14/81	17.70				Stable
02/19/81	17.50				Readings fluctuate from 17.00 to 17.60
07/25/81	16.00				Slow decrease
08/10/81	16.80				Erratic increase
11/07/81	16.20				Slow decrease
11/24/82	16.20				Stable
05/11/83	14.95	15.20			FIC plummet contacting solids in a small depression at a lower elevation near edge of tank.
09/09/83	15.30				Slow decrease
03/09/84	13.90				Erratic decrease
03/10/84	5.75				FIC plummet in depression
06/27/84		16.70			FIC in intrusion mode
08/20/84	4.65				Stable/intrusion mode
07/14/86					Stable/intrusion mode
09/07/87					Stable/intrusion mode

*Liquid level changes for this tank will not be accumulated because the tank is being salt well pumped, or the FIC and/or tape plummet is contacting solids and measurements are primarily to detect intrusions.

Reference: SD-WM-TI-356, *Waste Storage Tank Status and Leak Detection Criteria.*

Figure B6-5. Tank 241-T-109 Waste Surface Level Measurements.



Note: Surface level measurement changed to bottom of tank (12-inch off-set) after October 1995 measurement.

LOW = liquid observation well

TMACS = Tank Monitor and Control System

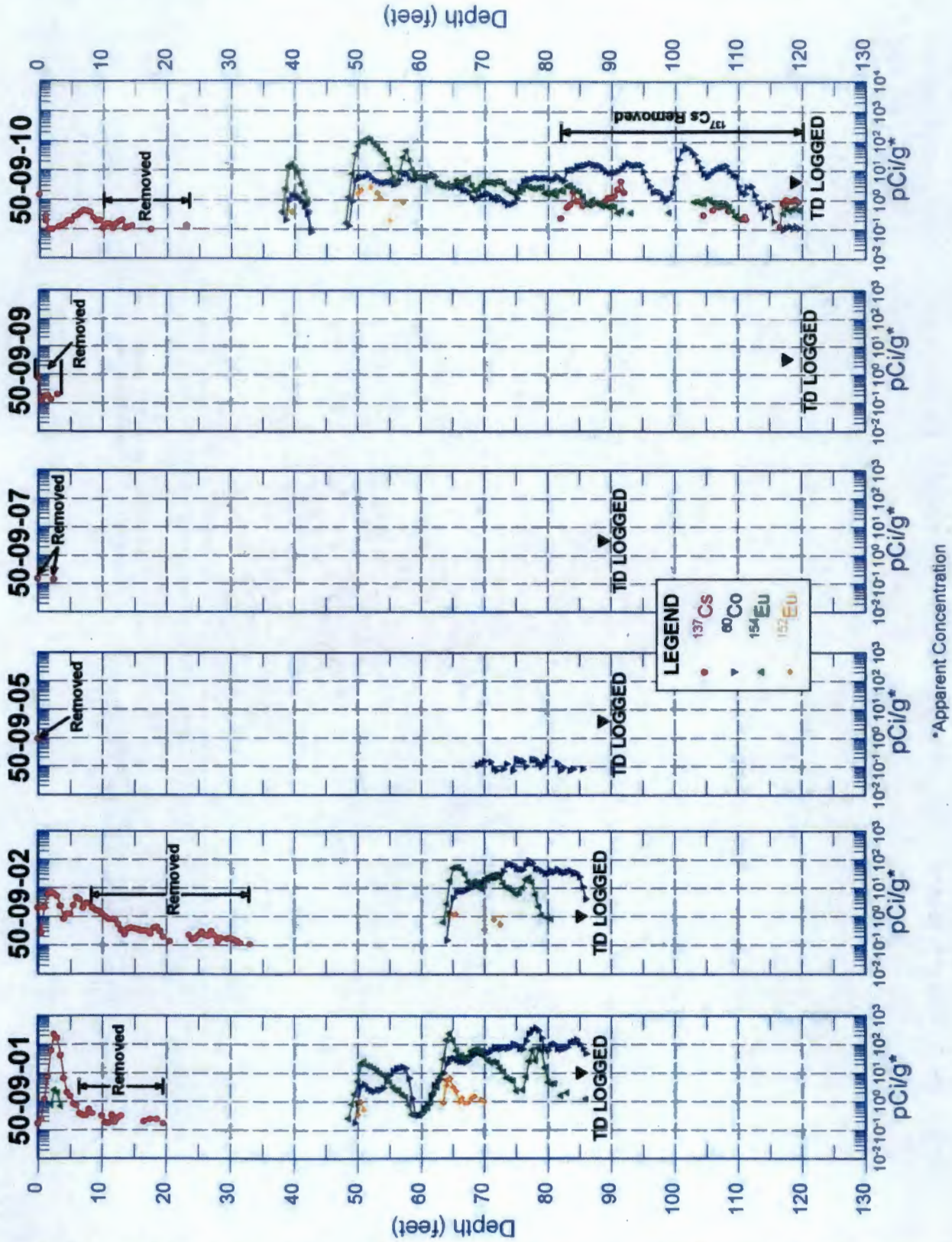
Honeywell Enraf is a product of Honeywell Process Solutions, Strahlenbergerstr. 110-112, 63067 Offenbach, Germany.

The ^{137}Cs contamination detected in the upper 31 ft of drywells on the north side of tank T-109 is probably the result of surface spills and/or near-surface pipeline leaks. Contamination from these releases was probably carried down to some extent during drilling operations.

On the basis of the contaminant distribution observed in drywells around tank T-109, it appears that a leak in the vicinity of tank T-106 spread laterally at the base of the tank farm excavation (~39 ft). Contaminants migrated downward through various stratigraphic units. The Plio-Pleistocene unit does not appear to have acted as a very effective barrier to downward migration of the contaminants as indicated by the lack of changes in the contaminant profiles above and below the caliche zones.

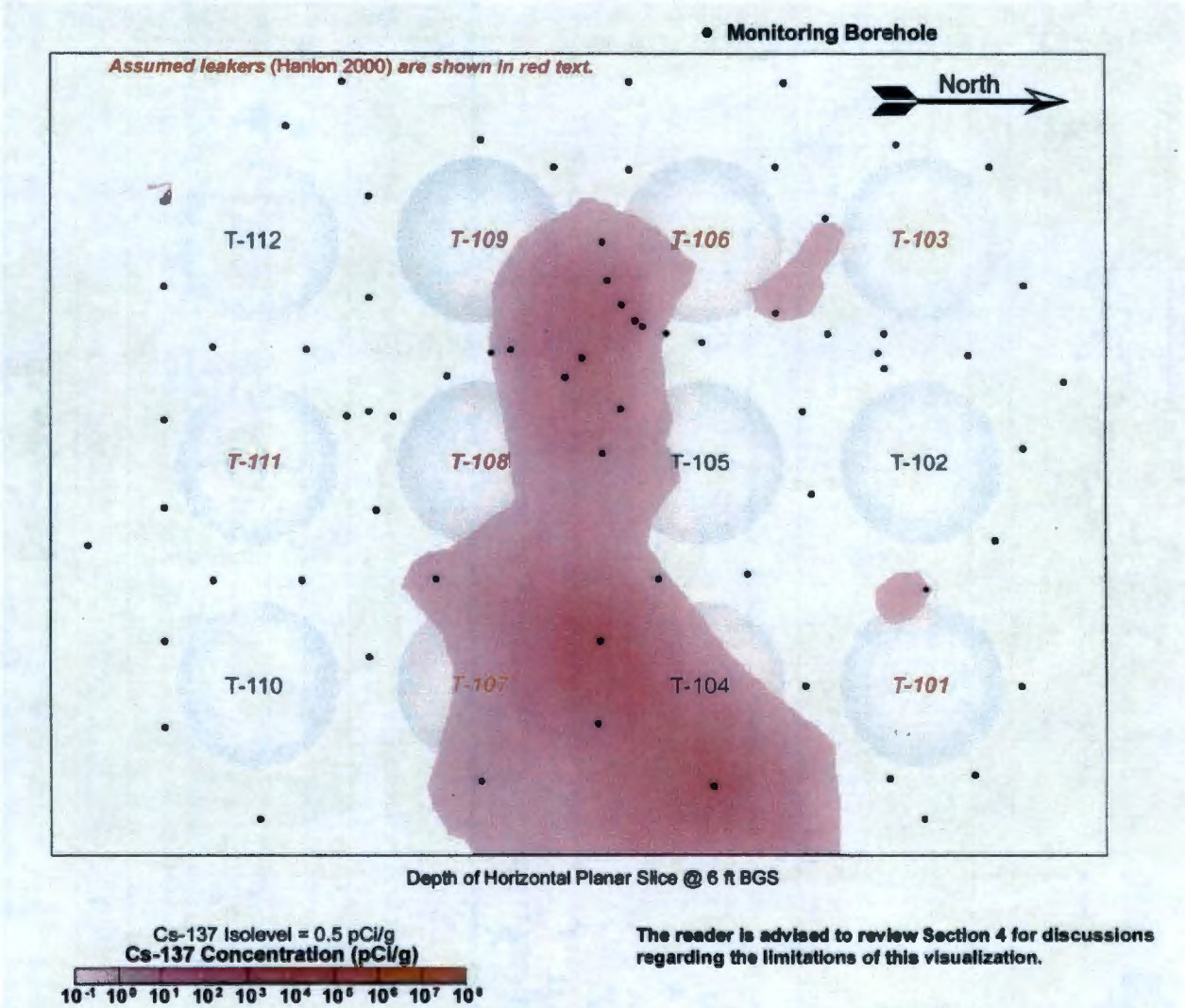
The characterization of the gamma-ray-emitting contamination in the vadose zone surrounding tank T-109 indicates that the likely source of this contamination is probably a leak from tank T-106. Surface spills may have also occurred near tank T-109.

Figure B6-6. 1998 Spectral Gamma Logging Results for Drywells near Tank 241-T-109.



Reference: GJO-99-101-TARA/GJO-HAN-27, *Hanford Tank Farms Vadose Zone: Addendum to the T Tank Farm Report.*

Figure B6-7. Visual Schematic of 241-T Tank Farm Drywell Logging Results at 6 feet Below Ground Surface.



BGS = below ground surface

Hanlon 2000 = HNF-EP-0182-143, *Waste Tank Summary Report for Month Ending February 29, 2000.*

Source: GJO-99-101-TARA/GJO-HAN-27, *Hanford Tank Farms Vadose Zone: Addendum to the T Tank Farm Report.*

Figure B6-8. Tank 241-T-109 Historical Gamma Logging Results. (sheet 1 of 3)

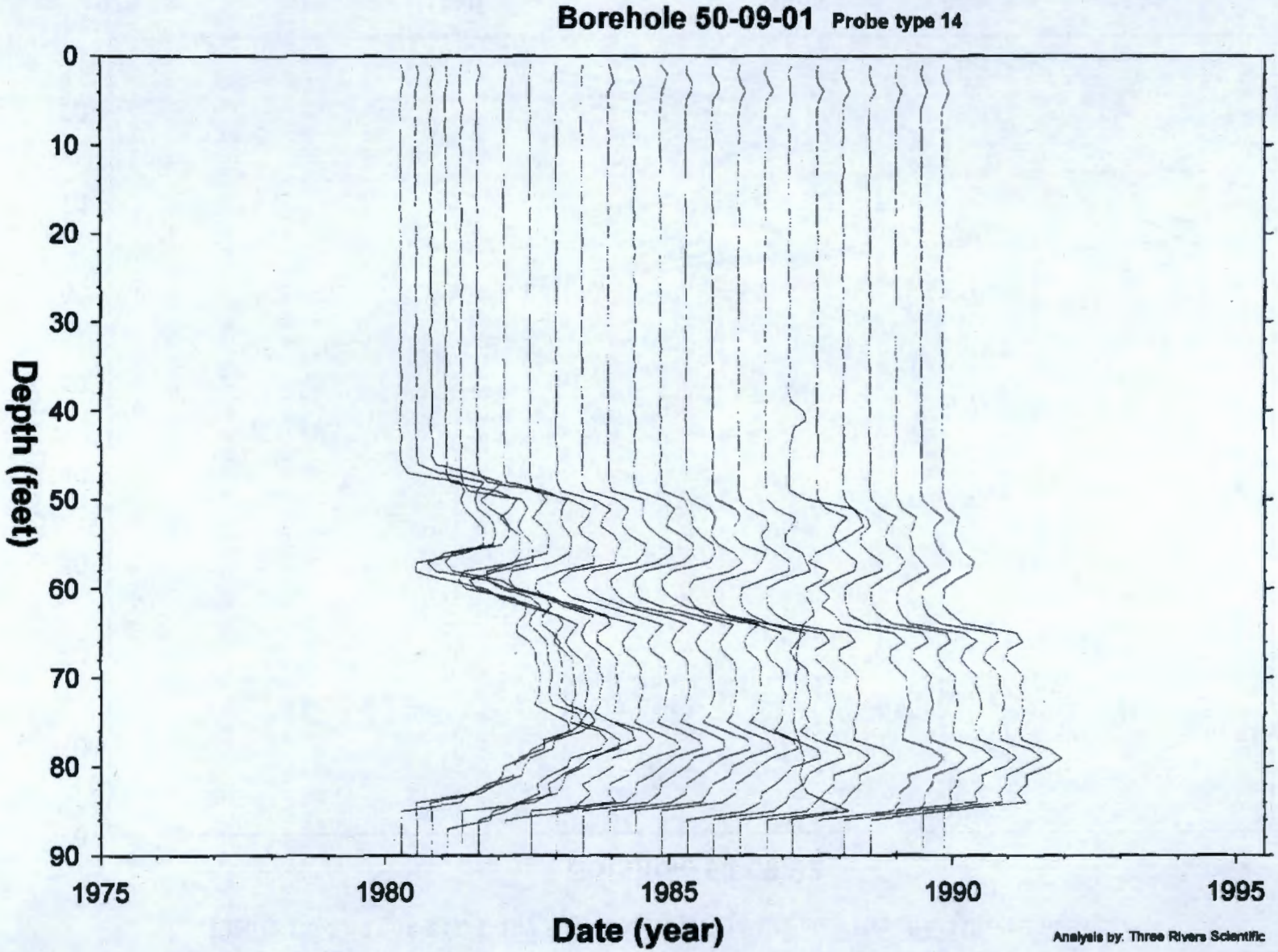


Figure B6-8. Tank 241-T-109 Historical Gamma Logging Results. (sheet 2 of 3)

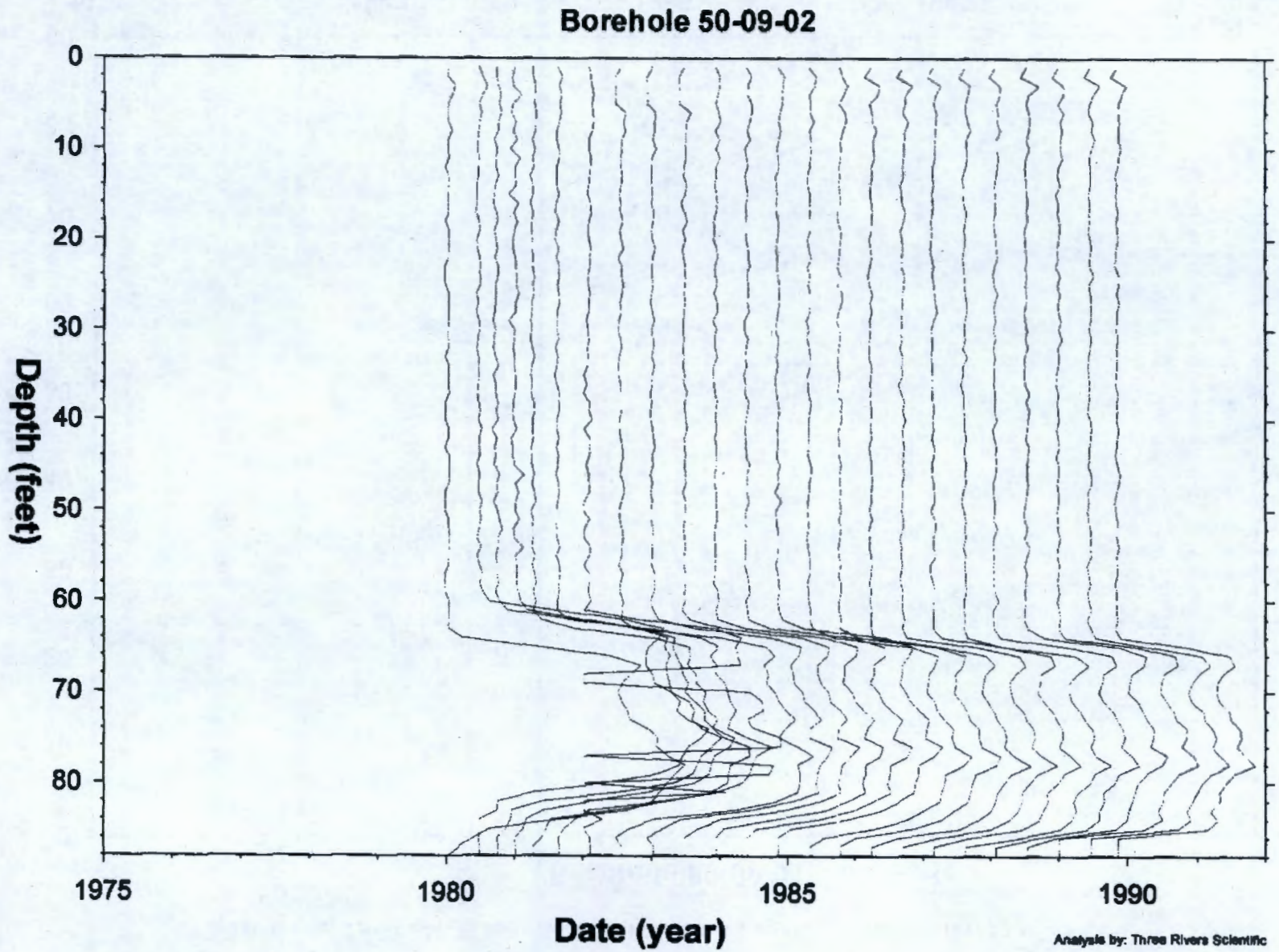
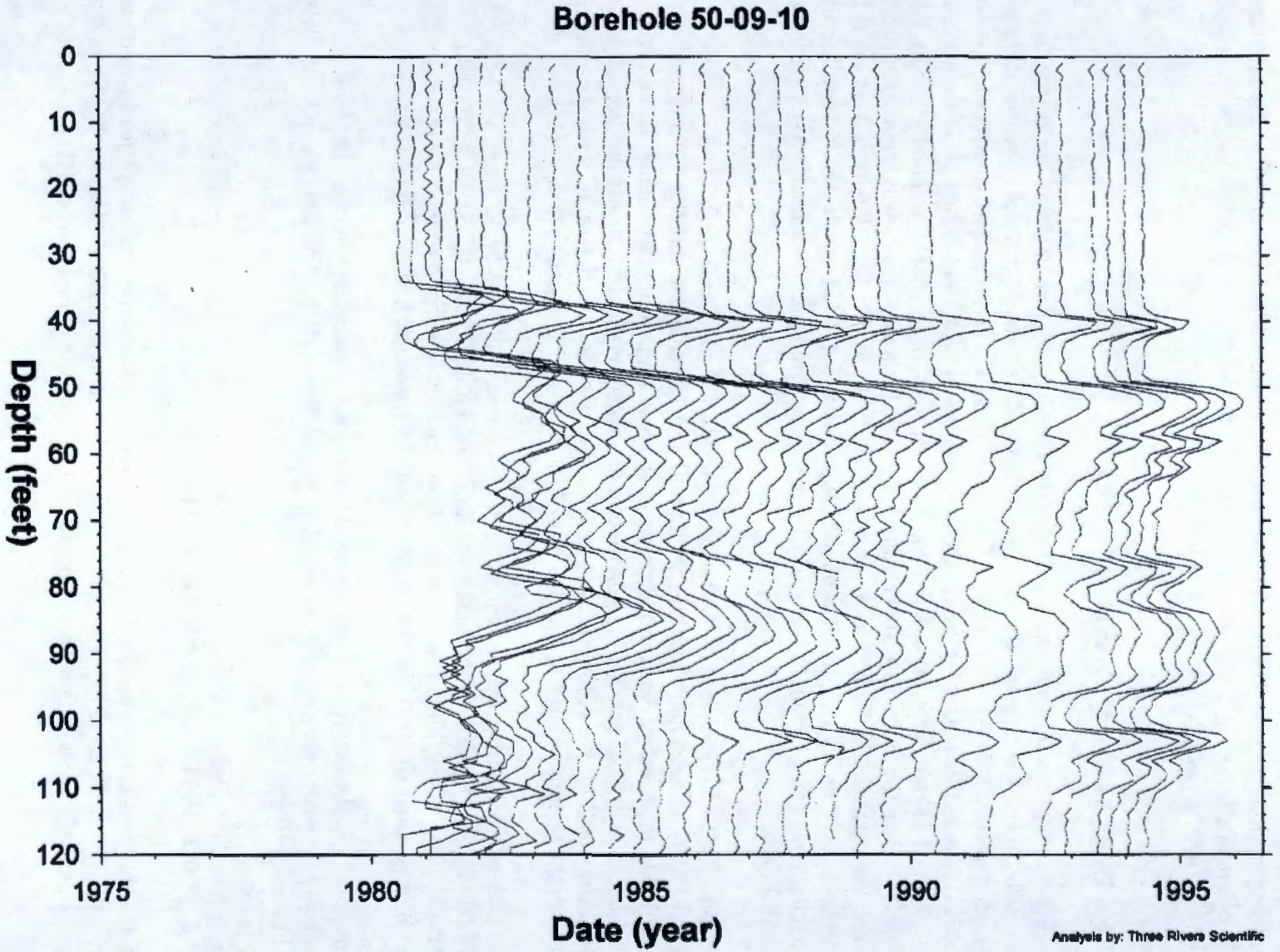


Figure B6-8. Tank 241-T-109 Historical Gamma Logging Results. (sheet 3 of 3)



Reference: RPP-6088, *Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-T Tank Farm – 200 West.*

B7.0 TANK 241-T-111

This section provides information on the historical waste loss event associated with tank T-111. Waste operations for tank T-111 are summarized in Figure B7-1. Figure 3-2 of the main text shows a plan view of a typical tank in T Farm with the location of the pump pit, sluice pit, spare inlet nozzles (N1, N2, N3 and N4) and tank risers.

B7.1 TANK 241-T-111 WASTE HISTORY

Tank T-111 was brought into service during the fourth quarter of 1945 with a cascade from tank 241-T-110 of 2C waste. The tank was filled with 2C waste, at which time the waste was cascaded to tank 241-T-112 (T-112). Cascading continued until the third quarter of 1946, when tank T-112 was filled. During the third and fourth quarters of 1947, nearly all of the supernate of tank T-111 was transferred to crib T-006. The cascading of 2C waste resumed in the first quarter of 1948. When the entire cascade became full, waste from tank T-112 was transferred to a crib. This cycle continued until the fourth quarter of 1952. From 1952 to 1956, tank T-111 was used to cascade 2C and 224 Building lanthanum fluoride waste (224) from the lanthanum fluoride finishing process in T Plant to a crib. In 1995, supernatant waste was transferred from the tank to crib T-005.

In report RPP-13873, *Origin of Wastes in Single-Shell Tanks 241-T-110, 241-T-111 and 241-T-112*, it is stated that water flushes through process equipment in the T Plant were not specified in the Hanford Site monthly reports or waste status summary reports in the period of 1956 through 1959. Tank T-111 was filled to the overflow pipeline during this period, without any cause noted for the volume changes. Therefore, it cannot be determine with certainty whether the water used to wet equipment in T Plant was discharged to tank T-111.

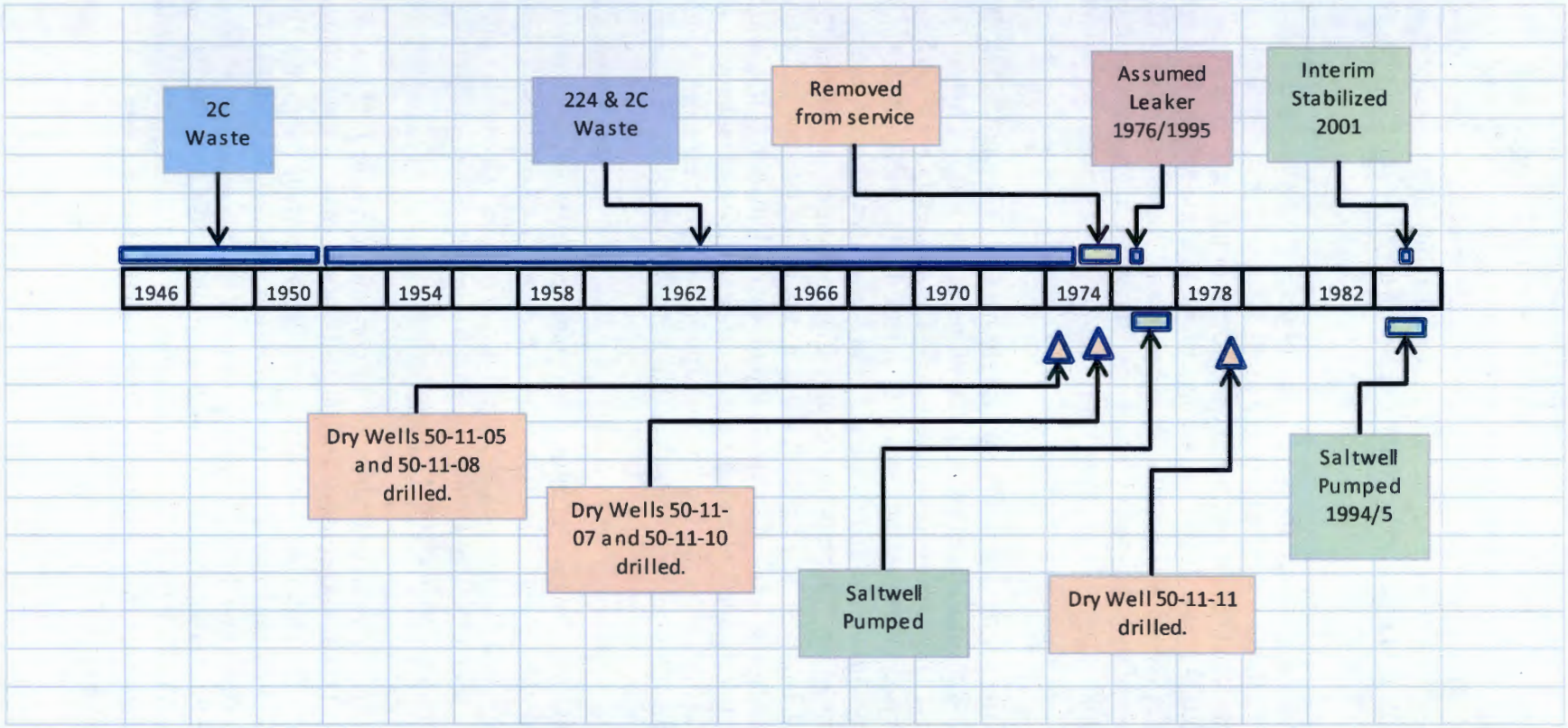
The tank contents remained unchanged until the second quarter of 1974. From 1974 to 1976, 238,000 L (63,000 gal) of supernate were transferred to tanks S-110, T-101, T-109, and 241-TX-109. Saltwell liquid was pumped from the tank in support of tank stabilization efforts in the fourth quarter of 1990, the fourth quarter of 1994, and the first quarter of 1995.

Tank T-111 is characterized as an assumed leaker and was declared inactive in 1976. Tank T-111 was on the Organics Watch List from 1994 to 1998. The tank was interim stabilized in February 1995.

B7.2 INTEGRITY OF TANK 241-T-111

Tank T-111 was categorized as having questionable integrity after an unexplained liquid level decrease of 0.30 in. in 1974. The tank is now classified as an assumed leaker. Drywells are the only source of leak detection because of the solids contained in the tank (RHO-CD-213).

Figure B7-1. Tank 241-T-111 Waste Operations Summary.



224 = 224 Building lanthanum fluoride process (waste)

2C = Second-cycle decontamination (waste) from the bismuth phosphate process

HNF-SD-WM-ER-540, *Tank Characterization Report for Single-Shell Tank 241-T-111* stated the maximum dry weight exothermic value was 3,316 J/g for core 33, segment 2. Tank T-111 was the only T Farm tank to have exceeded the thermal criteria. The results show that a significant fuel source is located in the top layers of the waste. Generally, the water content of these segments was over 60%. Therefore, there is little probability of a propagating exothermic reaction occurring. Tank T-111 was added to the Organic Watch List in 1994 because of the energetic results from the safety screening analyses.

The total organic carbon was analyzed for the purpose of determining the fuel content of the tank waste. The results established a decision threshold of 30,000 g/g (dry weight basis) for total organic carbon. All individual results were well below the action limit after being converted to dry weight (mean of 13,000 μg/g). However, the upper limit to a one-sided 95% confidence interval on the tank mean was 45,800 g/g on a dry weight basis, which exceeds the threshold level. However, because of the high moisture content of the waste, the total organic carbon results do not impact tank safety. The organic complexant issue was closed for all single-shell tanks in 1998.

A review of nine tanks (including tank T-111) was performed in 1979 and 1980 (RHO-CD-896). From this review tank T-111 was classified as of questionable integrity. A May 1994 document (WHC-SD-WM-ER-337, *Engineering Report Managing the Assumed Leak from Single-Shell Tank 241-T-111*) comprised the action plan to jet pump tank T-111. HNF-4872, *Single-Shell Tank Leak History Compilation* reported that tank T-111 was classified as an assumed leaker and removed from service in 1974. The basis for this classification was an unexplained liquid level decrease of more than 0.3 inches. The report stated that tank T-111 was one of 24 tanks for which the leak volume estimate is based solely on liquid level calculations. It is also one of the 18 "typical" tanks used to estimate leak volume for 19 other single-shell tanks with assumed leaks that could not be estimated by surface level measurements. The estimated leak volume for tank T-111 was less than 1,000 gal as reported in HNF-EP-0182, *Waste Tank Summary Report for Month Ending February 28, 2013*.

A tank T-111 waste tank Integrity Investigation was conducted in 1995 (reported in RPP-RPT-54964, *Evaluation of Tank 241-T-111 Level Data and In-Tank Video Inspection*) that concluded "it cannot be stated that the tank is not leaking. The most reasonable conclusion at this time is that the tank should be classified as an assumed leaker. Emergency pumping preparations should commence immediately."

Report RPP-RPT-54964 provides an evaluation of the conditions in tank T-111 as of April 1, 2013. Tank T-111 was suspected of leaking in 1974 and most of the free liquid was pumped out at that time. The tank was saltwell pumped using a turbine pump in 1976 through 1978. From 1978 to 1993 the tank had an apparent intrusion of over 1.5 in., but in 1993 the liquid level began to decrease and the tank was suspected of leaking again. A jet pump was installed and additional liquid removed to the extent practical in 1994 and 1995. From 1995 to 2006 the tank liquid level had a nominal 1-in. increase before the liquid level began to drop again. The liquid level has been decreasing since 2006 with the decrease rate accelerating with time.

The volume of liquid leaked from the tank from 1995 to April 2013 is estimated to range between 1,000 and 3,900 gal, with the most probable leak volume ~ 2,100 gal. The leak rate as of April 1, 2013 is estimated to range between 2.0 and 3.1 gal per day, with the most probable rate ~2.8 gal per day.

B7.3 INTERIM STABILIZATION

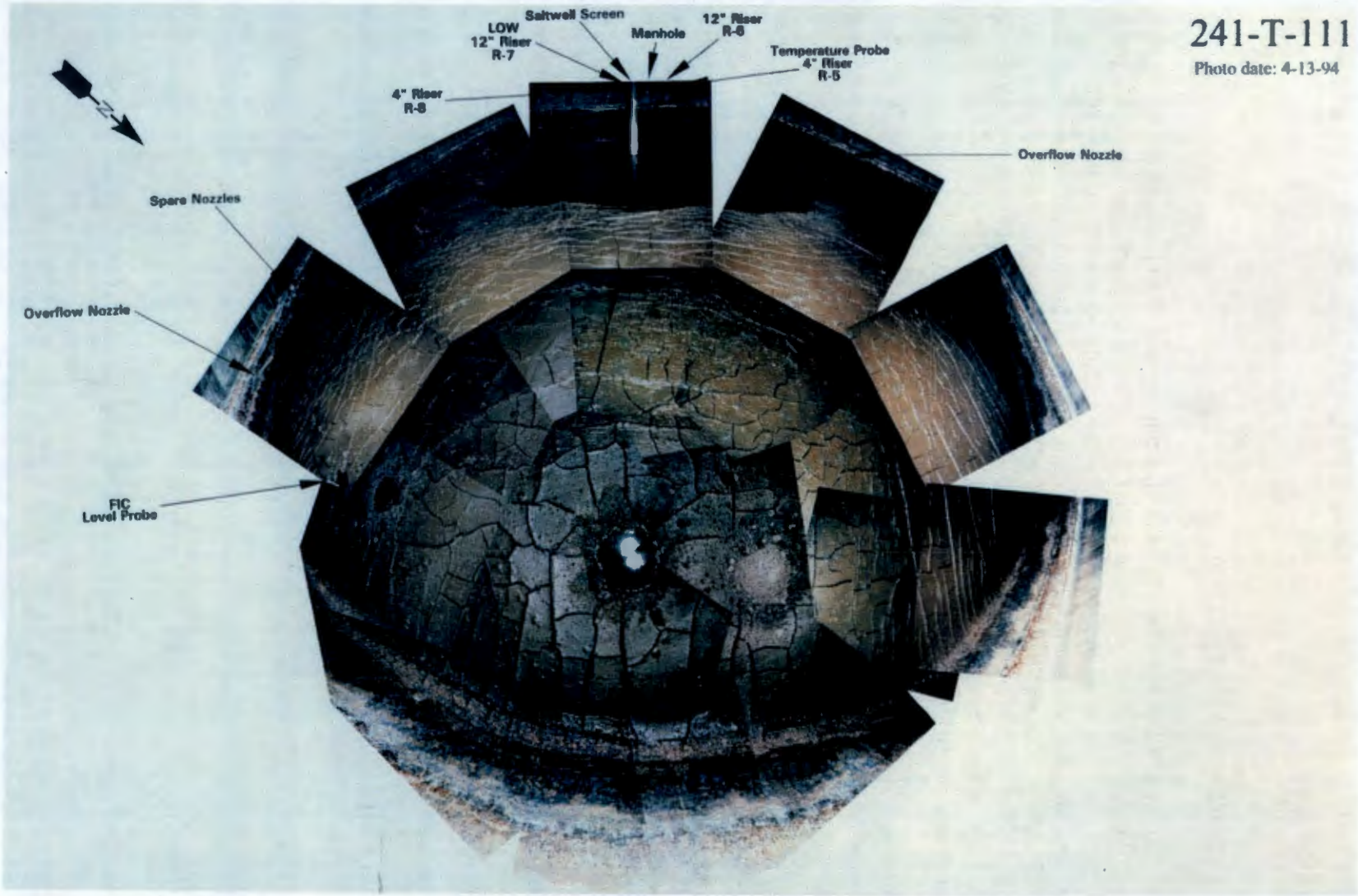
HNF-SD-RE-TI-178 documented that saltwell pumping tank T-111 removed 9,600 gal of waste in 1994 through 1995. It was determined that the refill rate averaged less than 0.02 gpm when saltwell pumping concluded in February 1995. The calculated porosity of this effort was 10.5%, leaving ~34,200 gal of drainable interstitial liquid. The decrease in the LOW reading since mid-2007 reflects an interstitial liquid volume of ~840 gal, and surface subsidence is much greater at ~7,700 gal. Waste surface level data for tank T-111 indicated that the surface level decreased 4.5 in. from 1991 to 1997 which corresponds to ~12,400 gal. Closer review of the data shows that the difference has been closer to ~3.2 in. (8,800 gal).

From the tank T-111 tank interpretive report (RPP-RPT-43169, *2009 Auto-TCR for Tank 241-T-111*), the Best-Basis Inventory shows that there are currently 447,000 gal of sludge comprised of 239,000 gal of 1950 to 1956 224 Building lanthanum fluoride process waste (224-2) sludge and 208,000 gal of 2C sludge. The Hanford Defined Waste (HDW) model (LA-UR-96-3860, *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 4*) predicts 36,000 gal of 224 sludge and 420,000 gal 2C sludge in tank T-111. Tank T-111 currently contains one defined waste phase consisting of two waste types (224-2 and 2C). Other tanks with a 224-2 inventory include tanks 241-T-110, T-112, 241-T-202, 241-T-203, and 241-T-204. Other tanks with a 2C inventory include tanks T-105, 241-T-110, and T-112. Figure B7-2 shows a mosaic photograph of the tank surface on April 13, 1994.

B7.4 TANK 241-T-111 TEMPERATURE HISTORY

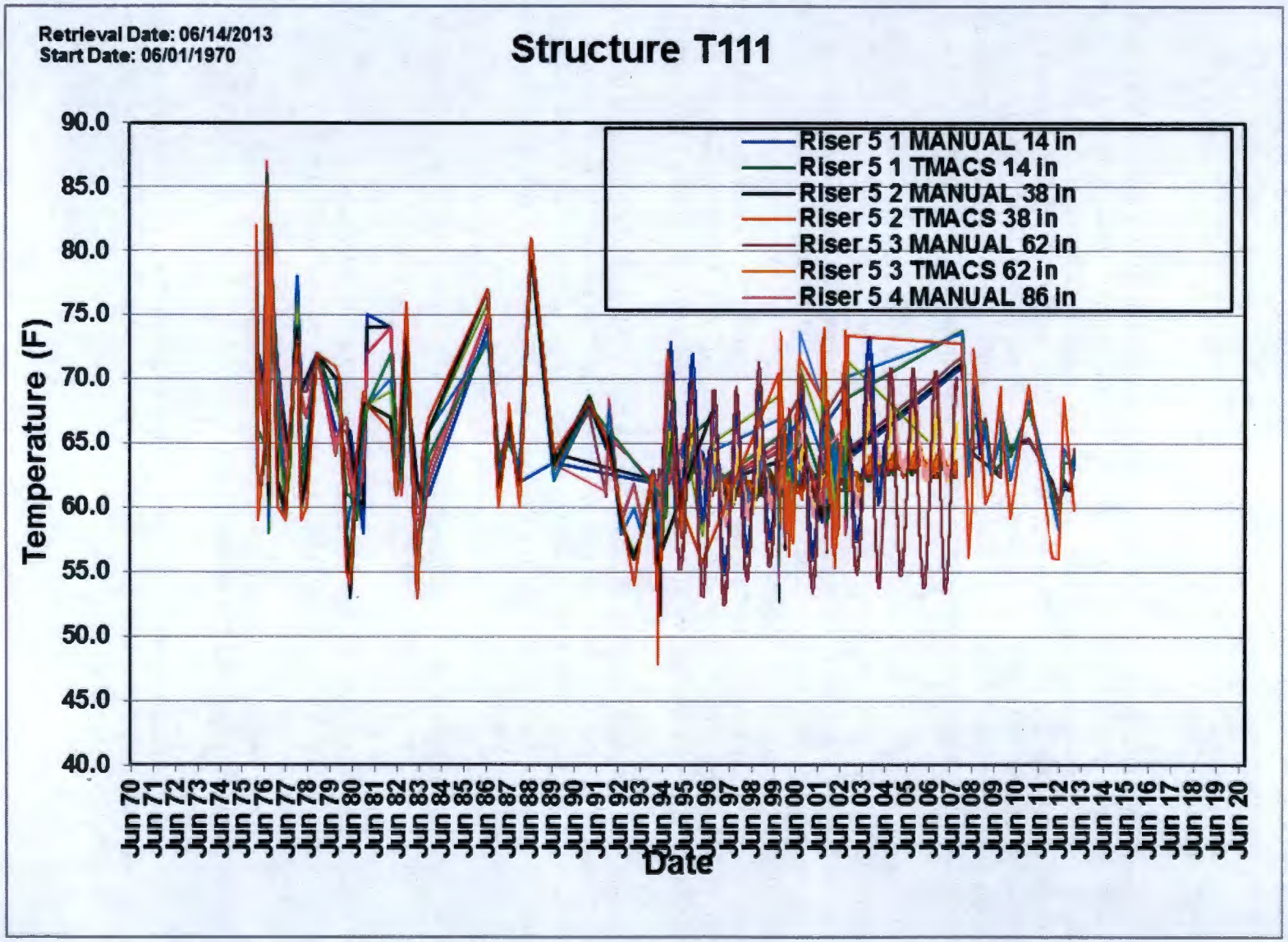
The tank temperature is monitored by a single thermocouple tree located in riser 5. No temperature measurements were found before 1976. Figure B7-3 shows tank waste temperatures for tank T-111 from 1976 to 2013. During this period the maximum waste temperature was about 86 °F in 1976. By 1989 the temperature decreased to below ~75 °F. The tank temperature varies seasonally between ~55 and ~75 °F.

Figure B7-2. Tank 241-T-111 Waste Surface Photo Mosaic.



Reference: WHC-SD-WM-ER-351, *Historical Tank Content Estimate for the Northwest Quadrant of the Hanford 200 West Area.*

Figure B7-3. Tank 241-T-111 Waste Temperature Measurements.



TMACS = Tank Monitor and Control System

B7.5 DATA REVIEW AND OBSERVATIONS

The following sections contain discussions of the tank surface level, drywell logging data and borehole sampling.

B7.5.1 Tank Surface Level Measurements

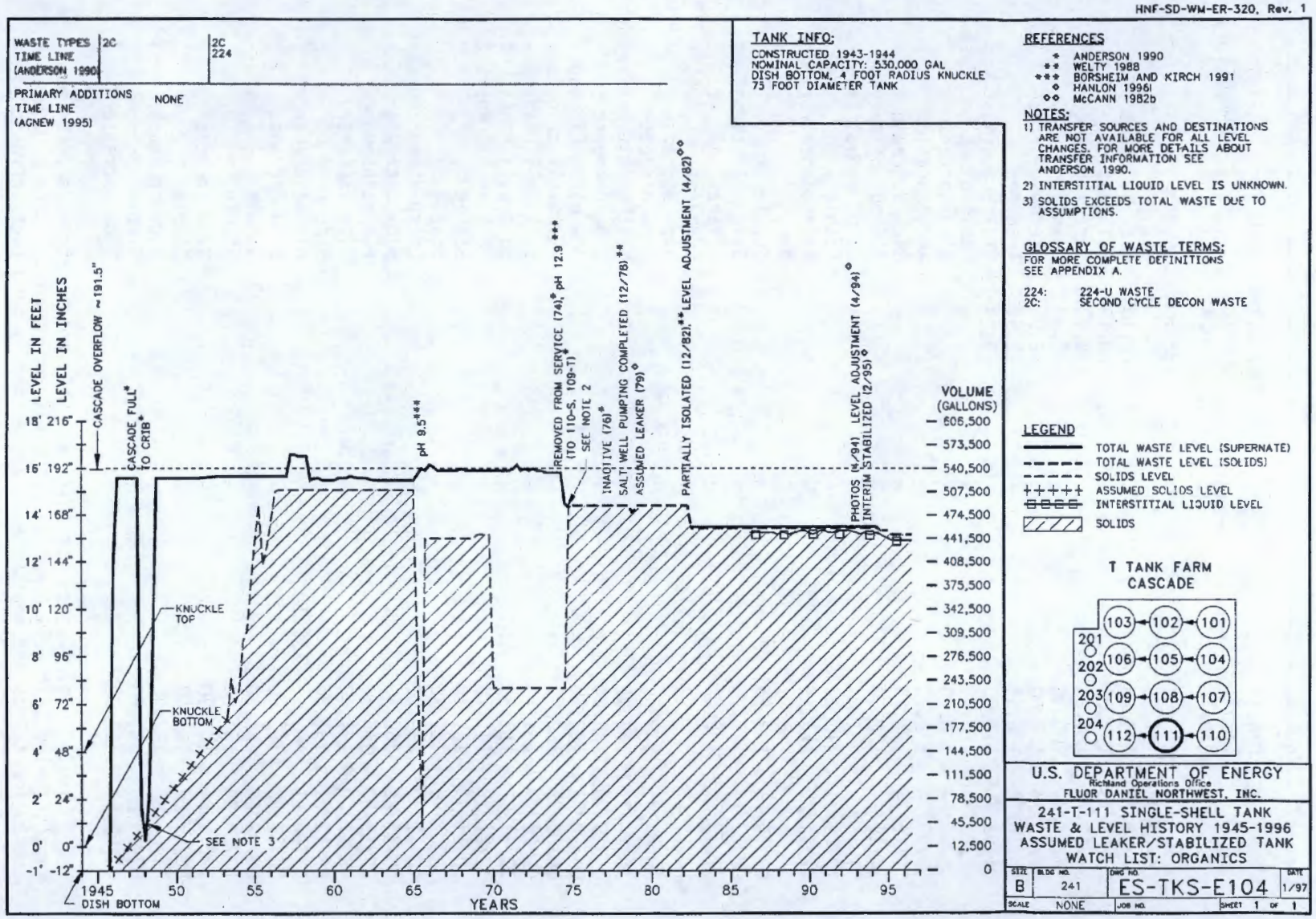
Tank liquid level measurements before 1973 were not available, other than from the transfer data in waste process reports (Figure B7-4). Figure B7-4 indicates that liquid waste may have been filled above the cascade/spare inlet level in tank T-111 between 1956 and 1958. Table B7-1 shows surface levels and surface level changes from 1973 to 1987. Figure B7-5 shows surface level measurements and LOW neutron and gamma interstitial liquid level measurements from 1975 to 2013. Figure B7-5 shows the pumping of the tank waste in 1995 and the readjustment of the baseline in 1996 correlates with the amount of waste transferred during jet pumping.

A 1994 occurrence report was issued for tank T-111 liquid level decreases (Occurrence Report RL--WHC-TANKFARM-1994-0009, *Apparent Liquid Level Decrease in Single Shell Underground Storage Tank 241-T-111; Declared an Assumed Re-Leaker*) documenting a 1.6-in. waste surface level decrease and that for 1984 to 1993 the waste surface level steadily increased. Following interim stabilization pumping in 1996, tank T-111 waste level began to slowly rise. The surface level increase rate was steady from late 1995 until around 2000 to 2002 when the increase rate began to decrease. From 2004 until 2007 the tank liquid level appeared constant with the exception of annual temperature fluctuations in the waste surface level.

The liquid level began to decrease in 2006. The highest LOW interstitial liquid reading was in November 2006. December 2007 the interstitial liquid level decreased 0.1 in. from July and is continuing to decrease. Efforts are underway to establish corrective measures and a basis for the determined waste release volume (RPP-RPT-54964). What has been concluded from the recent evaluation is the following:

- The waste surface level measurement in tank T-111 began to decrease sometime between 2002 and 2009, most likely 2002
- The rate of decrease in waste volume measured and calculated to be from tank T-111 as of April 1, 2013 is between 2.0 and 3.1 gal/day, estimated to be about 2.8 gal/day
- The post-1994 tank T-111 decreased tank volume was established to be between 1,000 and 3,900 gal, estimated to be 2,100 gal
- It could not be determined if the rate of water intrusion into tank T-111 did decrease following the grading in T-Farm in 2007 or decreased at a moderate rate to near zero over a five to six year period.

Figure B7-4. Tank 241-T-111 Quarterly Waste Fill History.



Reference: HNF-SD-WM-ER-320, *Supporting Document for the Historical Tank Content Estimate for T Tank Farm.*

Table B7-1. Tank 241-T-111 Liquid Level Measurements and Changes (1973 to 1987).

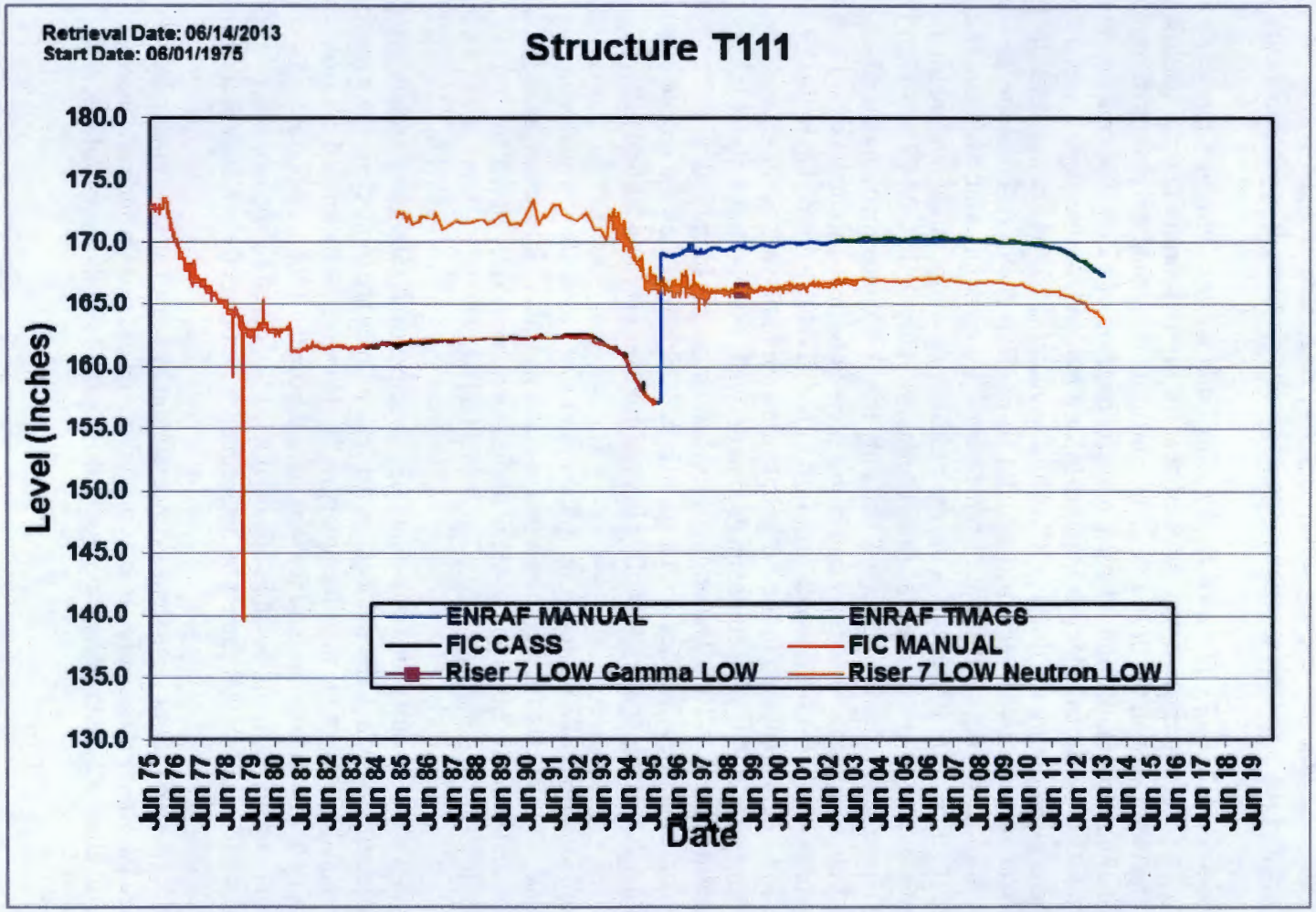
Liquid Level.

Date	Liquid level (in.)	Baseline ref.	Change from previous reading (in.)	Cumulative change (in.)	Comments
06/13/73	190.60		-	-	
07/25/73	190.50		-0.10	-0.10	Slow Decrease
07/26/73	190.00		-	-0.10	Calibration
04/13/74	189.70		-0.30	-0.40	Very slow decrease
04/14/74	180.15		-	-0.40	Transfer
05/13/74	177.60		-2.55	-2.95	Steady decrease
05/16/74	176.55		-	-2.95	Transfer
06/03/74*	174.90		-1.65	-4.60	Steady decrease
08/02/74	173.10		-		Unexplained increase
09/04/74	172.10		-		Slow decrease
09/05/74	172.70		-		Recalibration
10/15/74	171.75		-		Slow decrease
10/16/74	172.50		-		FIC out of service using manual tape
12/09/75	172.75		-		Stable
12/11/75	173.25		-		Maintenance work on tape
02/10/76	173.25		-		Stable
02/12/76	172.75		-		Salt well transfers
12/13/76	168.00		-		Several salt well pumpings per month slow decrease
08/03/77	167.00		-		Slow decrease
10/24/77	166.25		-		Salt well transfers
04/19/78	165.25		-		Slow decrease
04/20/78	162.80		-		Now using FIC gage
08/06/78	162.00		-		Salt well transfers
09/28/78	161.70		-		Salt well transfers
11/11/78	161.50		-		Salt well transfers
12/27/78	161.10		-		Salt well transfers
08/15/79	161.10		-		Stable
12/02/79	161.30		-		Stable
12/11/79	160.60		-		Unexplained decrease
05/13/80	160.30		-		Slow decrease
05/15/80	161.10		-		FIC maintenance
08/27/80	161.40		-		Slow increase
08/12/81	161.30		-		Stable
11/04/81		162.10	-		FIC maintenance
08/11/82	161.60		-		Slow decrease
08/22/83	161.50		-		Stable
07/16/84	161.60		-		Stable
08/19/84	161.90		-		Slow increase
08/05/85	161.80		-		Stable
01/06/86	162.00		-		Slow increase
07/14/86	161.90		-		Stable
09/08/87	162.20		-		Slow increase

*Liquid level changes for this tank will not be accumulated because the tank is being salt well pumped, or the FIC and/or manual tape plummet is contacting solids and measurements are primarily to detect intrusions.

Reference: SD-WM-TI-356, *Waste Storage Tank Status and Leak Detection Criteria.*

Figure B7-5. Tank 241-T-111 Waste Surface Level Measurements.



Note: Surface level measurement changed to bottom of tank (12-in. off-set) after October 1995 measurement.

CASS = Computer Automated Surveillance System
LOW = liquid observation well
FIC = Food Instrument Corporation (gauge)
TMACS = Tank Monitor and Control System

Honeywell Enraf is a product of Honeywell Process Solutions, Strahlenbergerstr. 110-112, 63067 Offenbach, Germany.

B7.5.2 Drywell Logging Data

Ten drywells surround tank T-111 (50-08-05, 50-10-10, 50-10-08, 50-00-06, 50-11-05, 50-11-07, 50-11-08, 50-11-10, 50-11-11, and 50-08-07). Figures B3-7, B7-6 and B7-7 show the 1999 reported SGLS results for these drywells (GJO-99-101-TARA/GJO-HAN-27). Figure B7-8 provides some historical gamma logging results for three drywells about tank T-111.

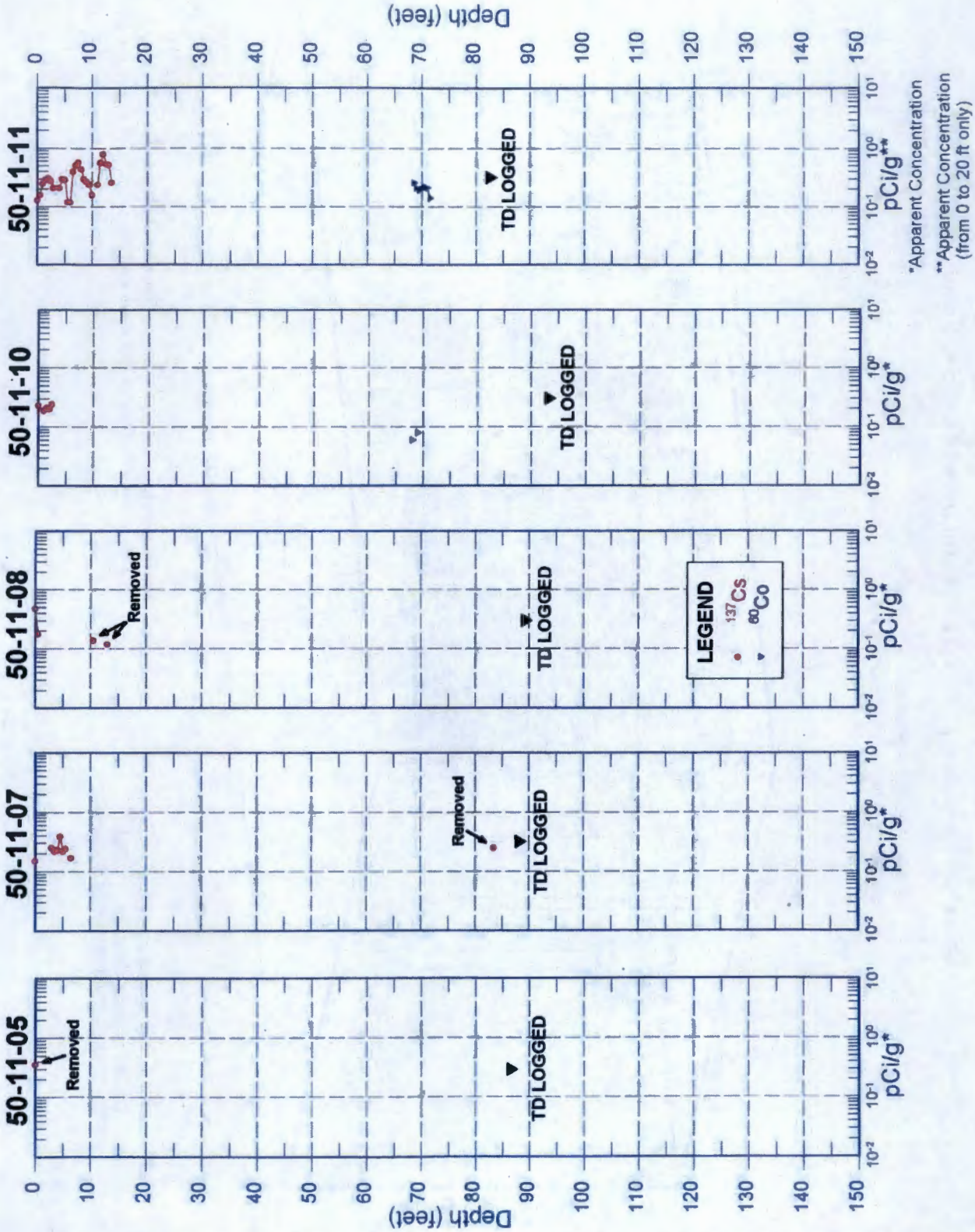
As documented in GJ-HAN-123, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank T-111*, ^{137}Cs contamination was detected near the ground surface and the shallow subsurface in the vicinity of all the drywells. This contamination could have resulted from surface spills, airborne contamination releases, or a combination of these. The contamination has migrated down into the sediments by precipitation infiltration, and, in some cases, was driven down along the drywell during the drilling. Cobalt-60 contamination was detected on the north side of the tank in drywells 50-11-10, 50-11-11, and 50-08-07 at depths that indicate the contamination originated from a subsurface source. The ^{60}Co contamination associated with drywells 50-10-11 and 50-08-07 appears to be the residual of a plume containing additional short-lived contaminants. This plume was first recognized in drywell 50-08-07 in 1978. These short half-life contaminants have all decayed, and only the ^{60}Co contamination remains. However, it is unlikely that the contamination in this plume originated from tank T-111. The contamination in drywell 50-11-11, which is closest to tank T-111, is limited in both concentration and extent compared to the ^{60}Co contamination in drywell 50-08-07, which is farther away from tank T-111. The contamination in drywells 50-11-11 and 50-08-07 most likely originated from tank T-108. The origin of the contamination identified in drywell 50-11-10 cannot be correlated with a specific tank, although the ^{60}Co contamination is coincident with a thin-bed boundary identified in drywells 50-11-11 and 50-08-07.

The absence of indications of contamination in the monitoring drywells is remarkable considering tank T-111 is classified both as a leaker and a re-leaker. However, because the tank leak volume estimate is only 2,000 gal, the leak designation is probably based only on very small decreases in liquid level that may not be the result of a tank leak.

No contamination plumes were found that could be indicative of a leak from this tank prior to 1998. Therefore, either the tank did not leak, or the leak plumes are limited in extent and have not been intercepted by any of the monitoring drywells. However, only limited data have been acquired since 1998 in boreholes around the tank near the depth of the tank bottom. Anomalous measurements at that depth would be an indicator of a leak. Therefore, the location of a leak or corroboration of a leak since 1998 cannot be determined from currently available information.

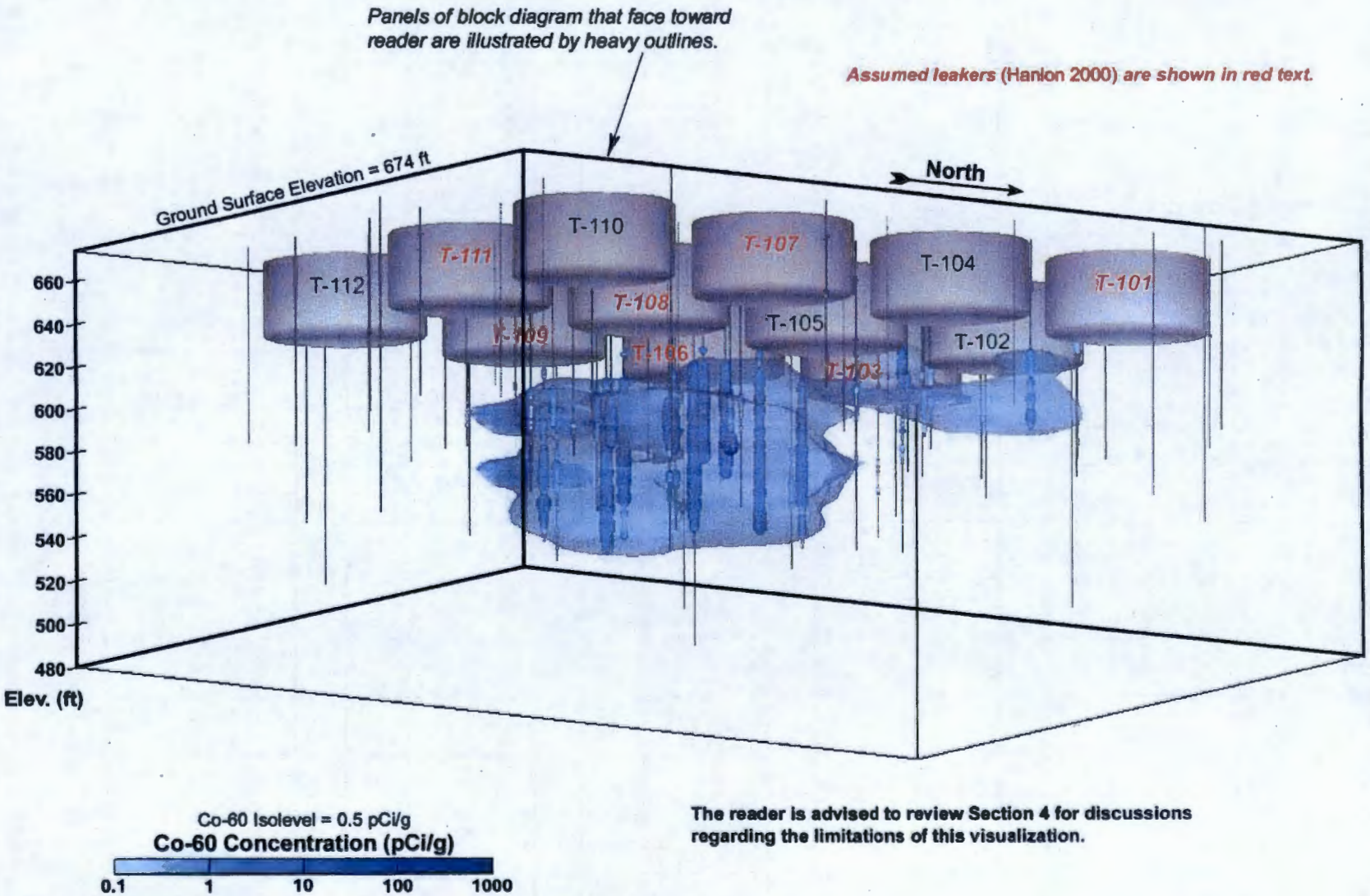
The ^{40}K log plots showed slight to moderate concentration increases at ~40 ft that most likely represent where the Hanford formation is in contact with the excavation surface. Increases in the ^{232}Th log plots at about 82 ft most likely represent the contact with the early Palouse soil.

Figure B7-6. 1998 Spectral Gamma Logging Results for Drywells near Tank 241-T-111.



Reference: GJO-99-101-TARA/GJO-HAN-27, *Hanford Tank Farms Vadose Zone: Addendum to the T Tank Farm Report.*

Figure B7-7. Cross Section Showing 241-T Tank Farm Drywell Logging Results for Cobalt-60.



Hanlon 2000 = HNF-EP-0182-143, *Waste Tank Summary Report for Month Ending February 29, 2000.*

Source: GJO-99-101-TARA/GJO-HAN-27, *Hanford Tank Farms Vadose Zone: Addendum to the T Tank Farm Report.*

Figure B7-8. Tank 241-T-111 Historical Gamma Logging Results. (sheet 1 of 3)

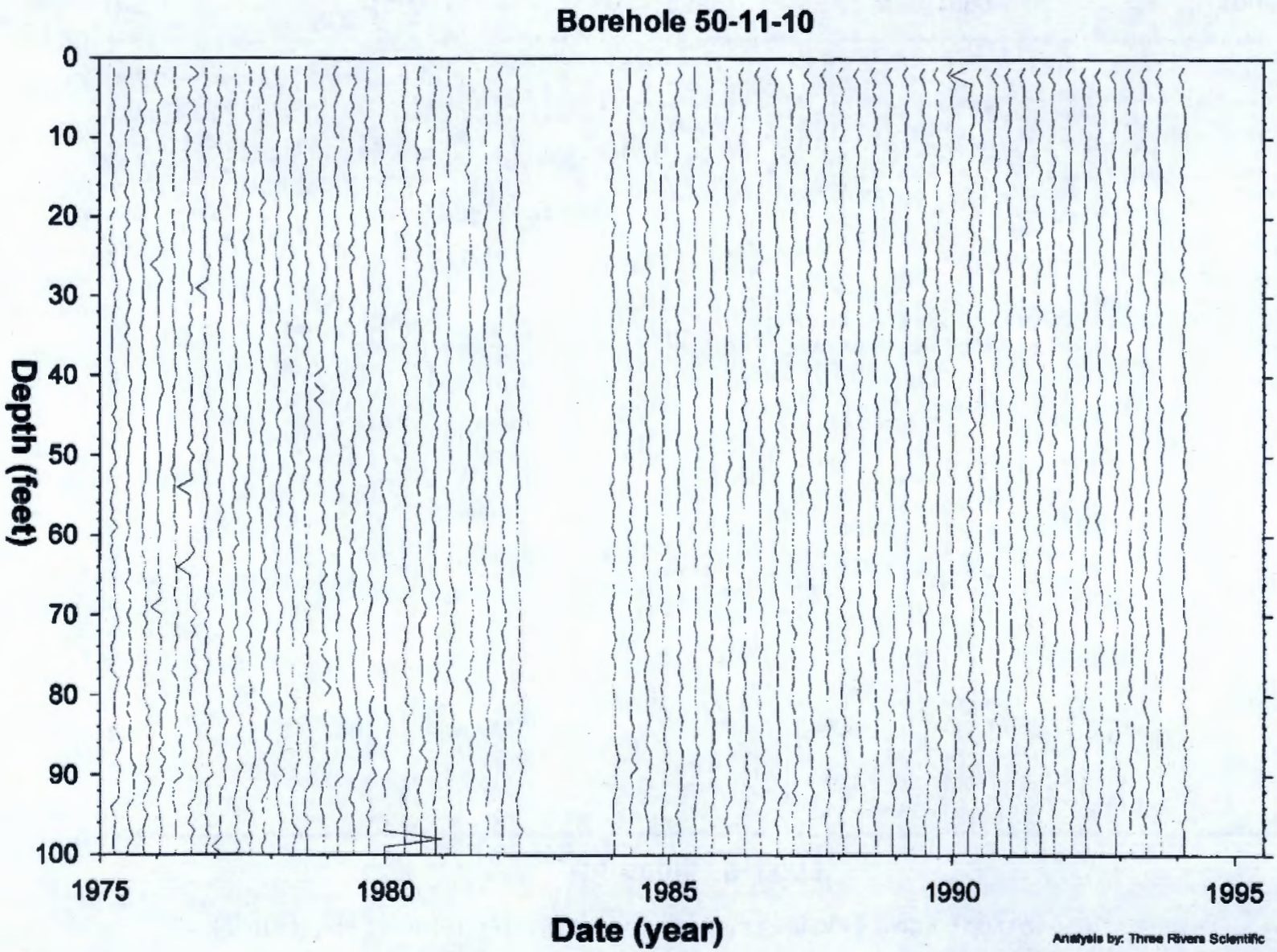


Figure B7-8. Tank 241-T-111 Historical Gamma Logging Results. (sheet 2 of 3)

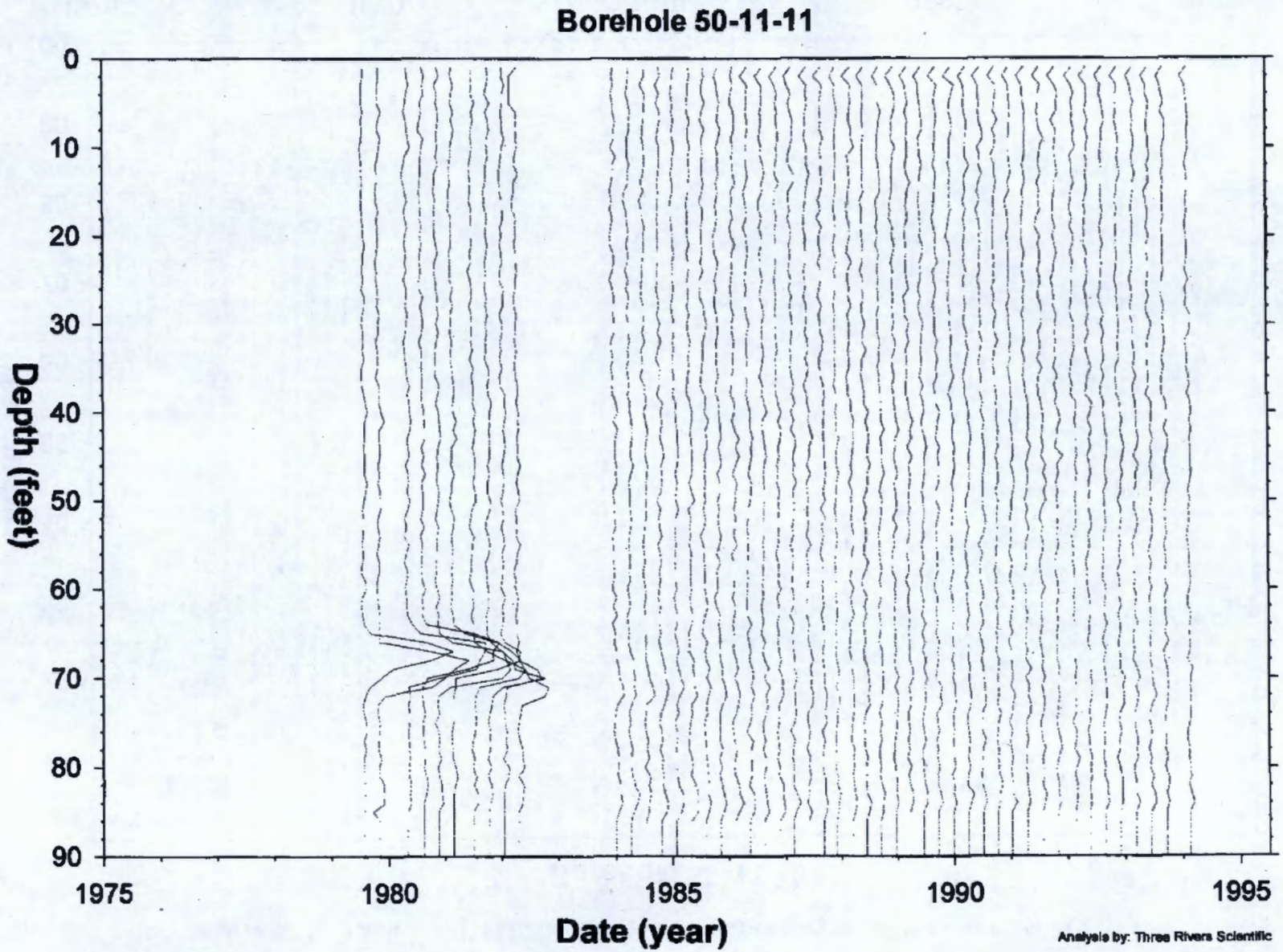
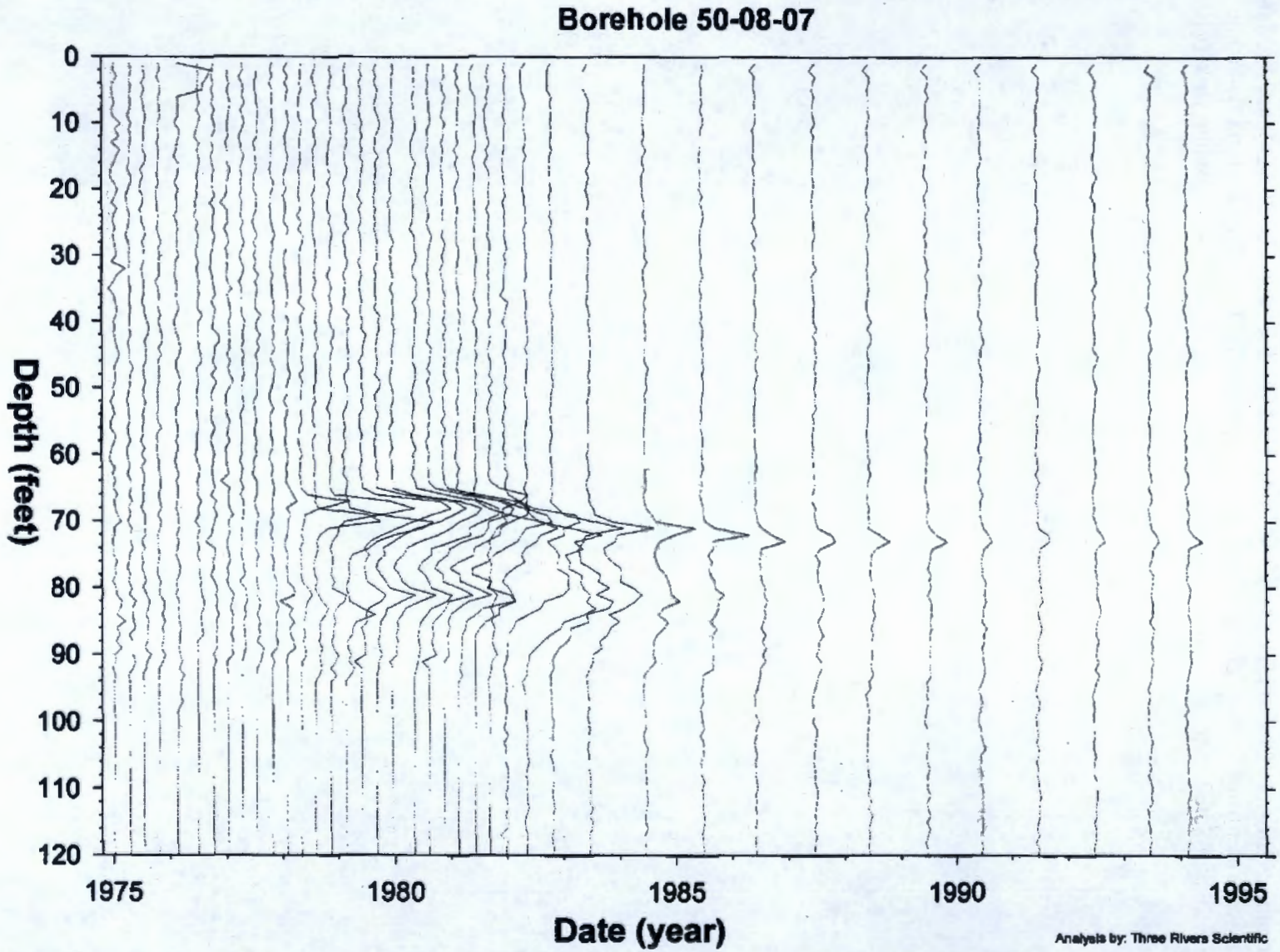


Figure B7-8. Tank 241-T-111 Historical Gamma Logging Results. (sheet 3 of 3)



Reference: RPP-6088, *Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-T Tank Farm – 200 West.*

Figure B7-6 presents a correlation plot of radionuclide concentration profiles for five drywells surrounding tank T-111 which indicate that surface spills have occurred, but do not indicate leakage from tank T-111. The information obtained from in-tank liquid-level observations remains as the only evidence that tank T-111 ever released waste. The contamination plumes that were identified in the vicinity of tank T-111 in drywells 50-11-11 and 50-08-07 can be directly correlated to contamination detected in monitoring drywells surrounding tank T-108.

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APPENDIX C

241-T TANK FARM INFORMATION SUMMARIES: FOR TANKS CLASSIFIED AS SOUND

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LIST OF TERMS

Abbreviations and Acronyms

FIC	Food Instrument Corporation (gauge)
LOW	liquid observation well
MW	metal waste
REDOX	Reduction-Oxidation

Units

Ci	Curie
kgal	kilogallon (10^3 gallons)

Waste Type Abbreviations

1C	$BiPO_4$ first cycle decontamination waste
CWR1	REDOX cladding waste, aluminum clad fuel (1952-1960)
CWR2	REDOX cladding waste, aluminum clad fuel (1961-1966)
MW	metal waste
R1	REDOX high-level waste (1952-1957)
S1	saltcake from the first 242-S Evaporator campaign using 241-S-102 feed tank (1973-1976)
S2	saltcake from the second 242-S Evaporator campaign using 241-SY-102 feed tank (1977-1980)
T1	saltcake from 242-B Evaporator operation (1951-1953) and the 242-T Evaporator operation (1951-1955)
T2	saltcake from the last 242 T Evaporator campaign (1965-1976)

C1.0 TANK 241-T-102

The Best-Basis Inventory (BBI) assessment for tank 241-T-102 (T-102) reports a total waste volume of 32 kgal of waste calculated from the Enraf[1] data. The waste consists of 13 kgal of cesium recovery by ion exchange supernate, 19 kgal of Plutonium Uranium Extraction Plant cladding waste, aluminum clad fuel (1961-1972) sludge, and 2 kgal of bismuth phosphate process metal waste (1950-1956) sludge (RPP-RPT-43160, *2009 Auto-TCR for Tank 241-T-102*). Tank T-102 was core sampled in 1993, and a Tank Characterization Report was prepared for this tank (HNF-SD-WM-ER-700, *Tank Characterization Report for Single-Shell Tank 241-T-102*). A process control grab sample of the supernatant liquid was obtained in 1994.

C1.1 HISTORY

Waste was initially added to tank T-102 in the second quarter of 1945 with the cascade from tank 241-T-101 (T-101) of metal waste initially from the bismuth phosphate process. The cascade was full in the first quarter of 1946. In the second quarter of 1953, all of the waste in tank T-102 was transferred to tank 241-T-103 (T-103). The tank was declared empty at the end of 1953.

In the second quarter of 1955, metal waste was again cascaded to tank T-102 from tank T-101. The tank was full again by the end of that quarter. From the second quarter of 1956 to the third quarter of 1957, the tank received flush water from miscellaneous sources, and most of the waste was sent to the uranium recovery process either directly or through tank T-103.

From the fourth quarter of 1964 to the second quarter of 1965, the tank received Plutonium Uranium Extraction Plant cladding waste from tank 241-C-102. In the third quarter of 1969, most of this waste was then sent to tank T-103 to be processed in the 242-T Evaporator. In the third quarter of 1972, the tank received supernatant waste from tank T-101. In the second quarter of 1974, most of this waste was sent to tank 241-S-110 (S-110) to be processed in the 242-S Evaporator.

In the first and second quarters of 1976, small amounts of supernatant waste were sent to tank T-101. Saltwell liquor was sent from the tank to tank 241-SY-102 in the third and fourth quarters of 1978. No additions or transfers have been made since that time (HNF-SD-WM-ER-351, *Historical Tank Content Estimate for the Northwest Quadrant of the Hanford 200 West Area*).

The tank was declared inactive in 1976. The tank was declared interim stabilized in March 1981 and intrusion prevention was completed in August 1981. Although tank T-102 was administratively stabilized in 1981, it is currently estimated to contain 13,000 gal of supernate,

[1] Honeywell Enraf is a product of Honeywell Process Solutions, Strahlenbergerstr. 110-112, 63067 Offenbach, Germany.

well in excess of the interim stabilization criteria of 5,000 gal. In 1996 it was recommended that this tank not be pumped for the following reasons (WHC-SD-WM-ER-622, *Recommendation for Interim Stabilization of SSTs B-104, BX-103, T-102, T-112*):

1. The tank liquid level appears to be stable and does not have any intrusion problems,
2. The tank is sound and is not experiencing any leakage,
3. It is not cost effective to pump this tank.

Figure C1-1 summarizes waste operations for this tank.

C1.2 SURFACE LEVEL DATA

Figure C1-2 shows historical quarterly waste levels for tank T–102 from 1945 to 1996 (HNF-SD-WM-ER-320, *Supporting Document for the Historical Tank Content Estimate for T Tank Farm*). Tank waste level histories (Figure C1-2) and in-tank photographs (Figure C1-3) indicate the tank was likely filled above the cascade level between 1965 and 1970. Figure C1-4 shows surface level measurements with little or no change between from 1996 and 2013.
“”

The following occurrence reports identify water intrusions into the tank in 1983 and 1989.

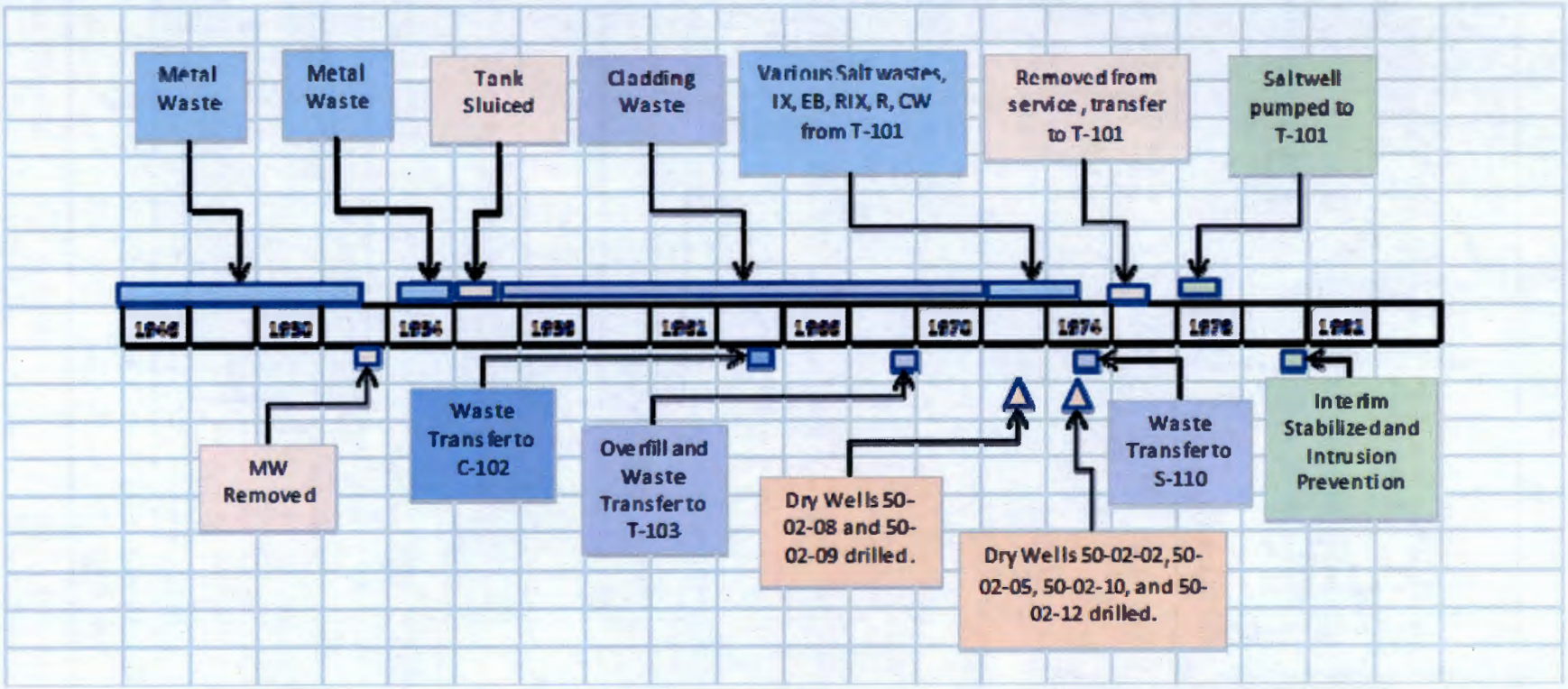
Unusual Occurrence Report 83-16, *Tank 241-T-102 Liquid Intrusion*:

“A surface level baseline of 5.2 inches was established for tank 102-T on January 12, 1979. Since March of 1981, there had been a gradual but relatively constant increase of 0.2 inches per quarter. Surface level increases were measured by Food Instrument Corporation (FIC) devices and confirmed by intank photographs. The December 21, 1984 surface level was 7.0 inches for an increase of 1.8 inches since the baseline was established. The 1.8 inch increase converts to 2,600 gallons.

There have been no surface level increases recorded since isolation work was completed in January of 1984.”

“The isolation of the 241-TR-153 booster pump pit was accomplished on November 8, 1984, thus sealing off all known piping pathways. This work was accomplished under Project B-231. The major causes of the liquid level changes were a direct result of higher than normal precipitation. The only conceivable pathway for intrusion is the leaching of precipitation into pipes and encasements between the tank and the point of isolation or blanking. This potential is recognized and at this time is considered an acceptable risk.”

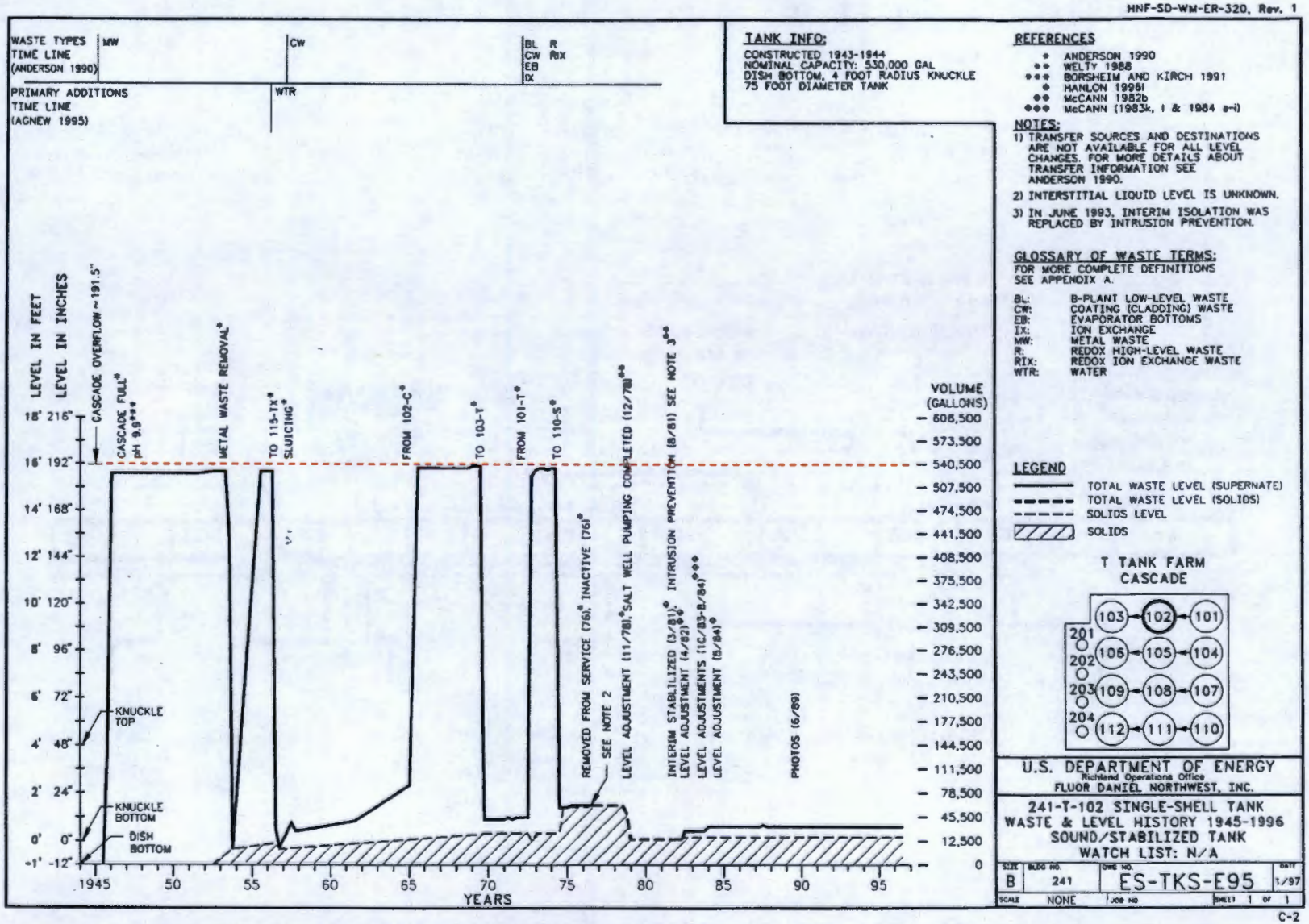
Figure C1-1. Tank 241-T-102 Waste Operations Summary.



Waste types:

CW = Cladding waste, aluminum clad fuel
EB = Evaporator bottoms waste
IX = Ion exchange waste
MW = Bismuth phosphate process metal waste
R = Reduction-Oxidation (S Plant) (REDOX) high-level waste
RIX = REDOX ion exchange waste produced at 221-B Plant by extracting cesium from REDOX supernate

Figure C1-2. Tank 241-T-102 Level History 1945 to 1996.



Source: HNF-SD-WM-ER-320, *Supporting Document for the Historical Tank Content Estimate for T Tank Farm.*

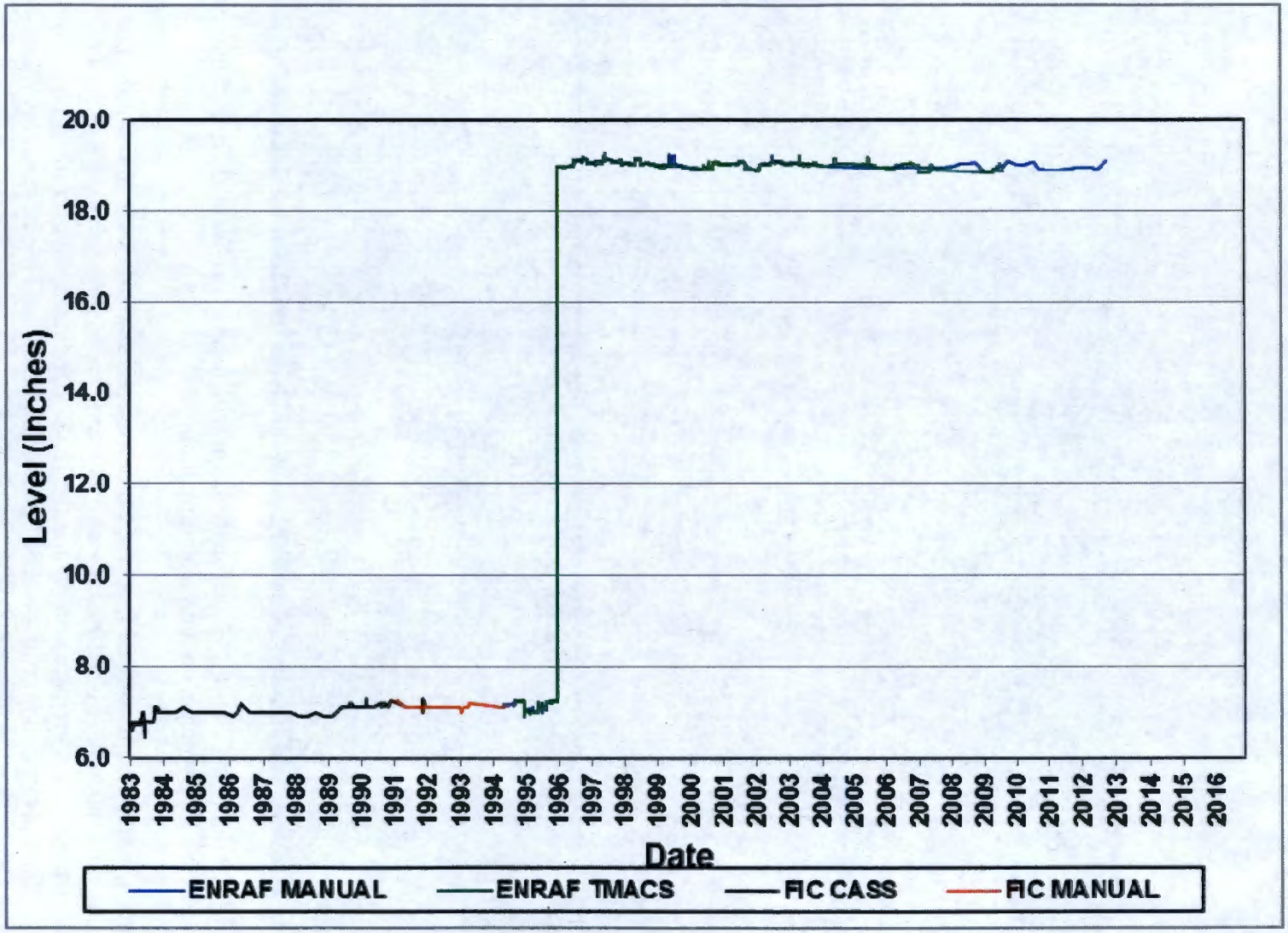
Figure C1-3. Tank 241-T-102 Liquid Level Photograph, June 1983.

TF-EFS-89-056, "Tank 241-T-102 surface level measurement exceeds the 0.50-inch increase criteria and the 12.00-inch maximum operating limit.":

"On June 3, 1989, the FIC surface level measurement for Tank 241-T-102 increased from 6.90 inches at 1100 hours to 21.10 inches at 1200 hours and alarmed on CASS as having exceeded the 0.50-inch increase criteria and the 12.00-inch maximum operating limit. Although the maximum operating limit was exceeded, the tank surface level measurement is within the 185.00-inch specification limit per OSD-T-151-00013."

"A work request was issued on June 5, 1989, by TFSO for 200 West Tank Farm Maintenance to perform a functional check and recalibrate the FIC."

Figure C1-4. Tank 241-T-102 Surface Level Measurements: 1983 to 2013.



CASS = Computer Automated Surveillance System FIC = Food Instrument Corporation (gauge) TMACS = Tank Monitor and Control System

Honeywell Enraf is a product of Honeywell Process Solutions, Strahlenbergerstr. 110-112, 63067 Offenbach, Germany.

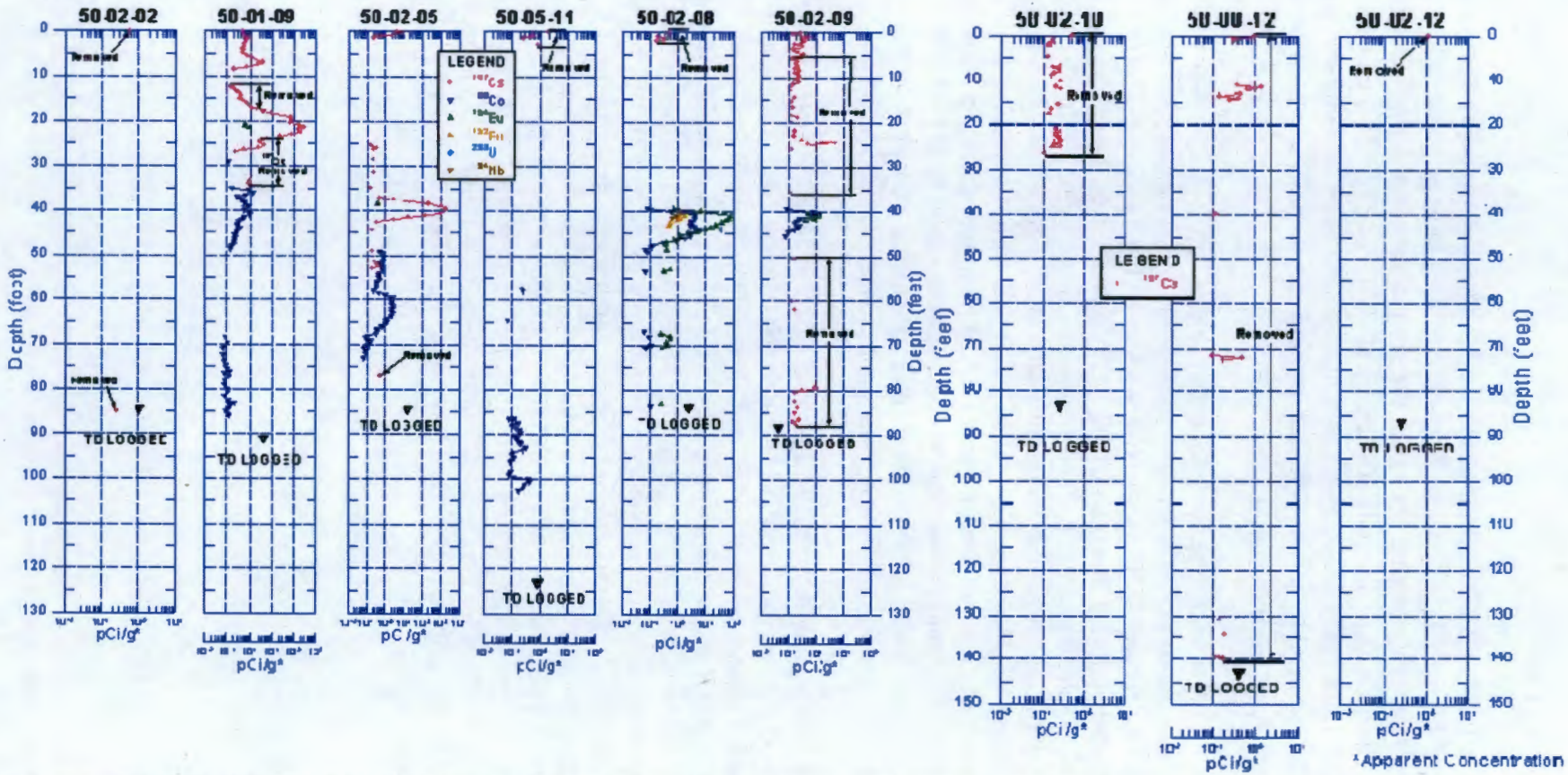
C1.3 DRYWELL DATA

Drywells 50-02-02, 50-01-09, 50-05-11, 50-02-08, 50-02-09, 50-02-10, 50-00-12 and 50-02-12 surround tank T-102. Figure C1-5 shows 1996 spectral gamma logging system (SGLS) results for these drywells. The SGLS detected ^{137}Cs near the ground surface and shallow subsurface around all of the drywells, except drywells 50-02-02 and 50-02-12. This contamination most likely resulted from surface spills and/or airborne contamination. The contamination has been carried down into the sediment by infiltration, and, in some cases, may have been driven down along with the casing as the drywell was drilled.

Cesium-137, ^{60}Co, and ^{154}Eu were detected on the east side of tank T-102 between 15 and 49 ft. This contamination was present in 1973 when drywell 50-01-09 was drilled and is attributed to migration from tanks T-101 and T-103, respectively and possibly 241-T-106 (T-106). Cobalt-60 was also detected below 69 ft in drywell 50-01-09. A ^{60}Co plume was detected along the south side of tank T-102 between 56 and 102 ft. This plume was first recognized in drywell 50-05-11 in 1973. The depth of the contamination suggests a subsurface source. The ^{60}Co contamination appears to be the residual of a plume that contained additional short-lived contaminants. These short half-life contaminants have all decayed to below the minimum detection limit, leaving only the ^{60}Co to be detected. It is unlikely that this plume originated from tank T-102; the contamination detected in drywell 50-05-11 most likely originated from tank T-106 (GJ-HAN-116, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank T-102*).

Drywell 50-02-05 was logged with the high-resolution SGLS in June 1998. Cesium-137 was detected at ~38 to 41 ft below ground surface (bgs), which corresponds to the base of the tanks. The maximum reported concentration was 1,850 pCi/g at 40 ft. However, the dead time at this depth was 85 to 90%, and it was acknowledged that ^{137}Cs concentrations were probably underestimated. Since the interval of high dead time in drywell 50-02-05 was thin and the detector did not appear to be completely saturated, no effort was made to run the high rate logging system. Cobalt-60 contamination was detected continuously from 49 to 73 ft at apparent concentrations ranging from 0.6 pCi/g to just over 2 pCi/g. The maximum apparent ^{60}Co concentration for this drywell was 2.4 pCi/g at 61.5 ft. Europium-154 contamination was detected at 38.5 ft at an apparent concentration of 0.36 pCi/g. In April 1999, drywell 50-02-05 was again logged with the SGLS. This log was run from 45 to 75 ft to assess changes in the ^{60}Co plume. Comparison of the 1998 and 1999 data showed no detectable change in the ^{60}Co profile after accounting for decay.

Figure C1-5. 1998 Spectral Gamma Logging System Results for Drywells Surrounding Tank 241-T-102.



Reference: GJO-99-101-TAR/GJO-HAN-27, *Vadose Zone Characterization Project at the Hanford Tank Farms T Tank Farm Report.*

Drywell 50-02-05 was drilled in March 1974 to a total depth of 91 ft using 6-in. diameter casing. Examination of the driller's log shows no indication that radiological contamination was encountered during drilling. Results of a 1977 in-situ gamma energy analysis with a lithium-drifted germanium detector are reported in RHO-ST-14, *High-Level Waste Leakage from the 241-T-106 Tank at Hanford.* Measurements were made at 5-ft intervals. With the exception of 12.3 m (40.4 ft), reported values are shown as less than detectable. Specific radionuclides identified in the gamma energy analysis at 40.4 ft are as follows:

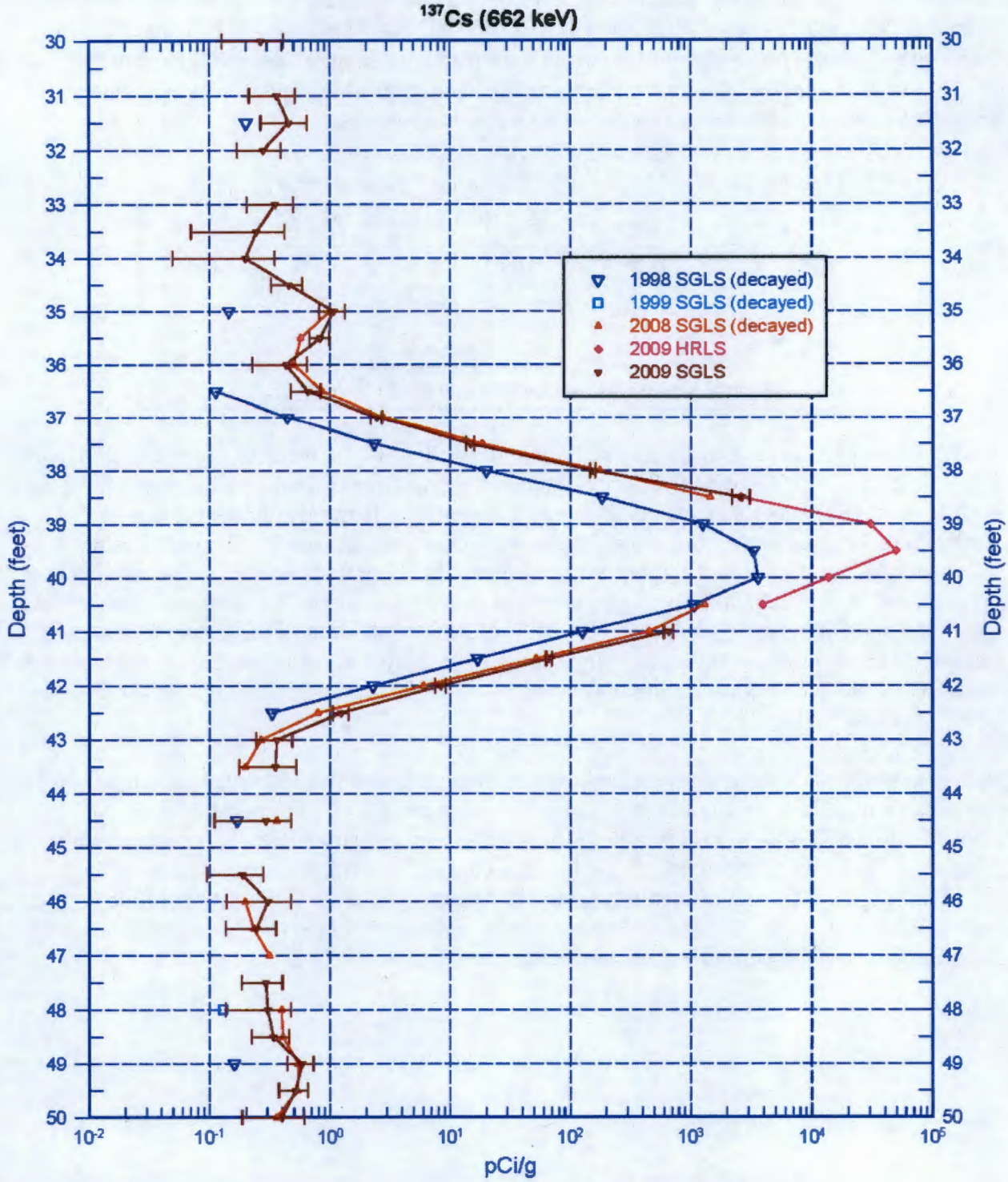
50-02-05 (299-W10-123 / A7213) Radionuclide Concentrations at 23 m (40.4 ft)

	Ru-106	Cs-137	Ce-144	Eu-154	Co-60
μCi/L	49	3.7	0.26	0.08	0.0013
pCi/g	26,000	1,946	137	42	0.684
pCi/g (2008)	non detect	947	non detect	3.4	0.01
μCi/L converted to pCi/g, assuming a bulk density of 1.9 g/cm^3					

Total gamma plots show that gamma activity in drywell 50-02-05 increased between 1990 and 1994, then gradually decreased. Spectral gamma logging system baseline measurements at the 40 ft level in 1998 reported a concentration of 1,850 pCi/g. However, dead time was high and it was acknowledged that the concentration may be higher than measured. The well was not re-logged using a High Rate Logging System at that time because the detector did not appear to be saturated. Four Radiation Assessment System gamma measurements were obtained between July 2001 and 2003. In September 2008 SGLS measurements showed higher dead time and indicated the detector was saturated. High Rate Logging System measurements obtained in 2009 showed that the ^{137}Cs concentration in drywell 50-02-05 increased from ~2,000 pCi/g to ~50,000 pCi/g (Figure C1-6).

As a result of the ^{137}Cs increase, the tank was further evaluated and additional investigations were recommended in an attempt to explain the increase in the ^{137}Cs concentration in drywell 50-02-05 (WRPS-091156, "Drywell 50-02-05 Investigation Plan"). Monthly gamma logging followed by quarterly logging was conducted in 50-02-05 and several surrounding drywells. Figure C1-7 shows results reported in Appendix B of the T Farm re-baseline logging report (RPP-RPT-44202, *Hanford Geophysical Logging Project Spectral Gamma Re-Baseline Logging for the T-Farm Interim Surface Barrier).*

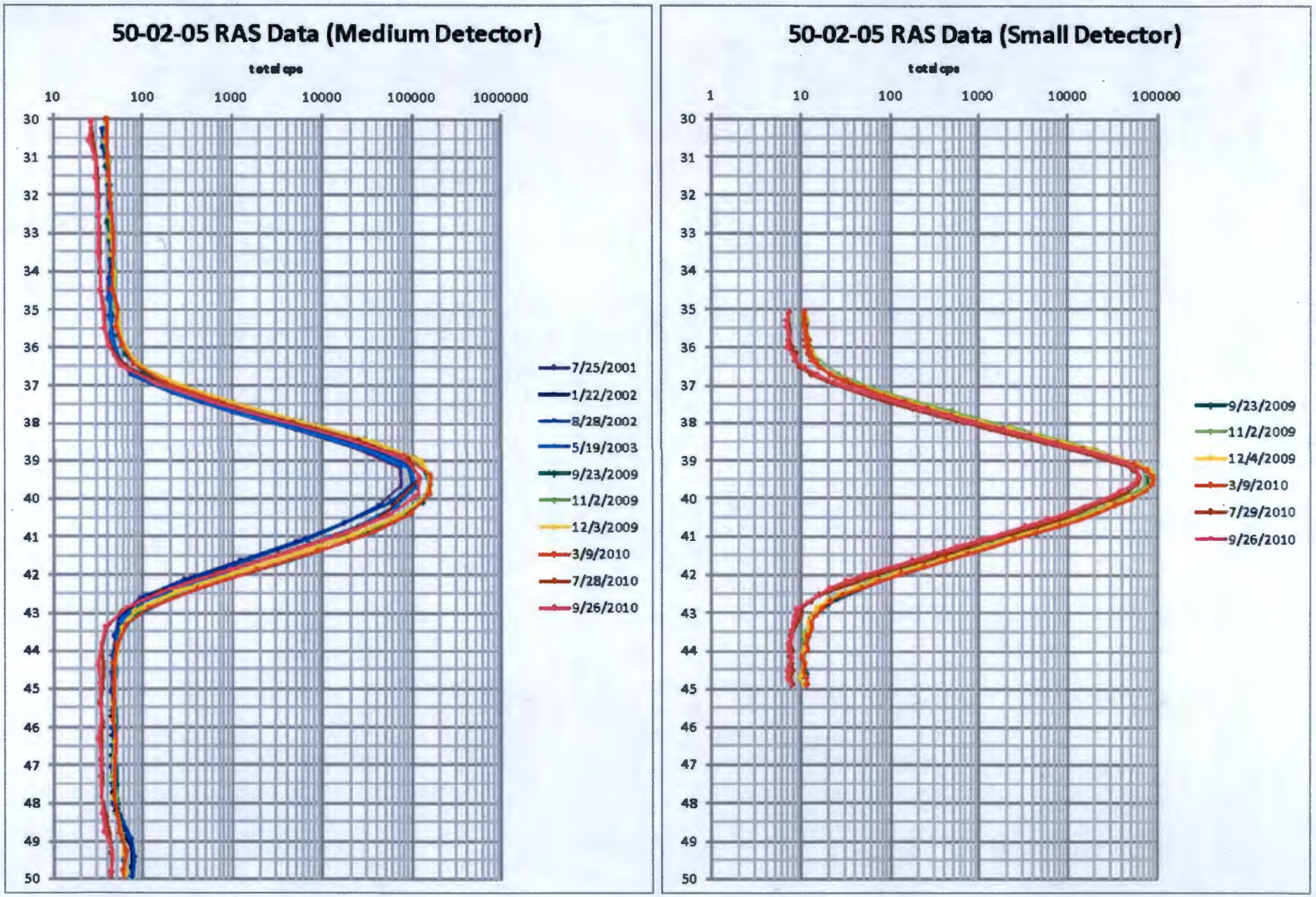
Figure C1-6. Drywell 50-02-05 Spectral Gamma Logging System Logging Results, 1998 to 2009.



HRLS = high rate logging system

SGLS = spectral gamma logging system

Figure C1-7. Drywell 50-02-05 Radiation Assessment System Total Gamma Logging Results, 1998 to 2009.



C2.0 TANK 241-T-104

The BBI assessment for tank T-102 reports a waste volume of 317 kgal of bismuth phosphate process first-cycle decontamination (1C) sludge calculated from the Enraf data (RPP-RPT-43162, *2009 Auto-TCR for Tank 241-T-104*). Tank 241-T-104 (T-104) was core sampled in 1992, and a Tank Characterization Report was prepared for this tank (HNF-SD-WM-ER-372, *Tank Characterization Report for Single-Shell Tank 241-T-104*).

C2.1 HISTORY

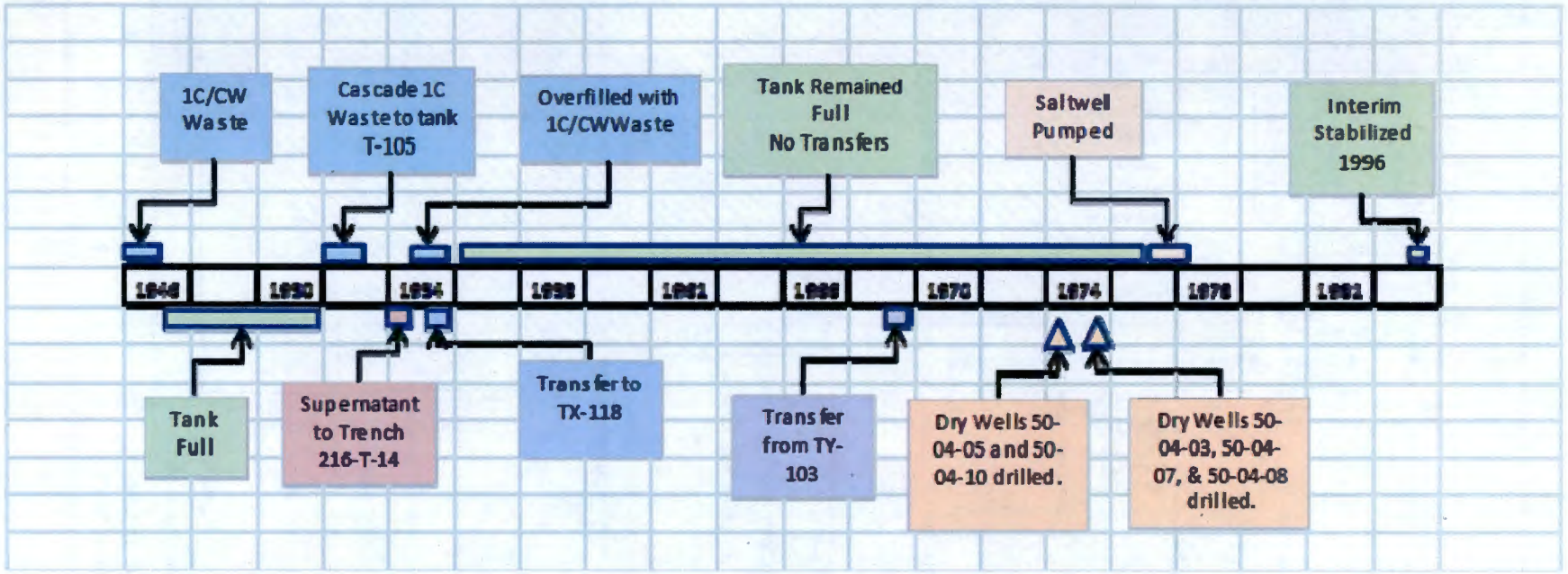
Waste was initially added to tank T-104 in March 1946 with the addition of first cycle decontamination waste from the 1944-1949 bismuth phosphate process (1C1) from the 221-T Plant (T Plant) following a plug in the transfer line to 241-U Tank Farm. The tank was filled by August 1946. Cascading had not begun at this time, but did begin in the second quarter of 1948 with the addition to the tank of more 1C1 waste from T Plant. Tanks T-104, 241-T-105 (T-105), and T-106 were originally designated as a spare set of tanks for receipt of bismuth phosphate process second decontamination cycle (2C) waste from T Plant. Collection of the combined 1C/cladding (coating) waste in tank T-104 was considered at the time to be a temporary measure. In order to allow the collection of 2C waste from T Plant in tanks T-105 and T-106, a separate transfer pipeline was established to the inlet of tank T-105 on July 17, 1946. With the exception of a transfer of 227 kL (60 kgal) of supernate to tank 241-TX-118 (TX-118) in the second quarter of 1951, the tank T-104 activity consisted of cascading first cycle decontamination waste from the 1950-1956 bismuth phosphate process (1C2) from T Plant to tank T-105 until the third quarter of 1954. Supernate contained in tank T-104 was discharged to the east section of trench 241-T-1 (later renamed to trench 216-T-14) on January 14, 1954. Tank 241-TY-103 received 182 kL (48 kgal) of supernate from tank T-104 in the third quarter of 1969, tank T-101 received 57 kL (15 kgal) in the first quarter of 1976, and tank 241-AW-102 received 144 kL (38 kgal) in the third quarter of 1992 (HNF-SD-WM-ER-351).

The tank was declared inactive in 1977 and was interim stabilized by jet pumping from March 1996 to November 1999. Photographs obtained in October 1999 show a collapsed surface, ~2 ft in diameter, around the saltwell screen with no visible bottom. Figure C2-1 summarizes waste operations for this tank.

C2.2 SURFACE LEVEL DATA

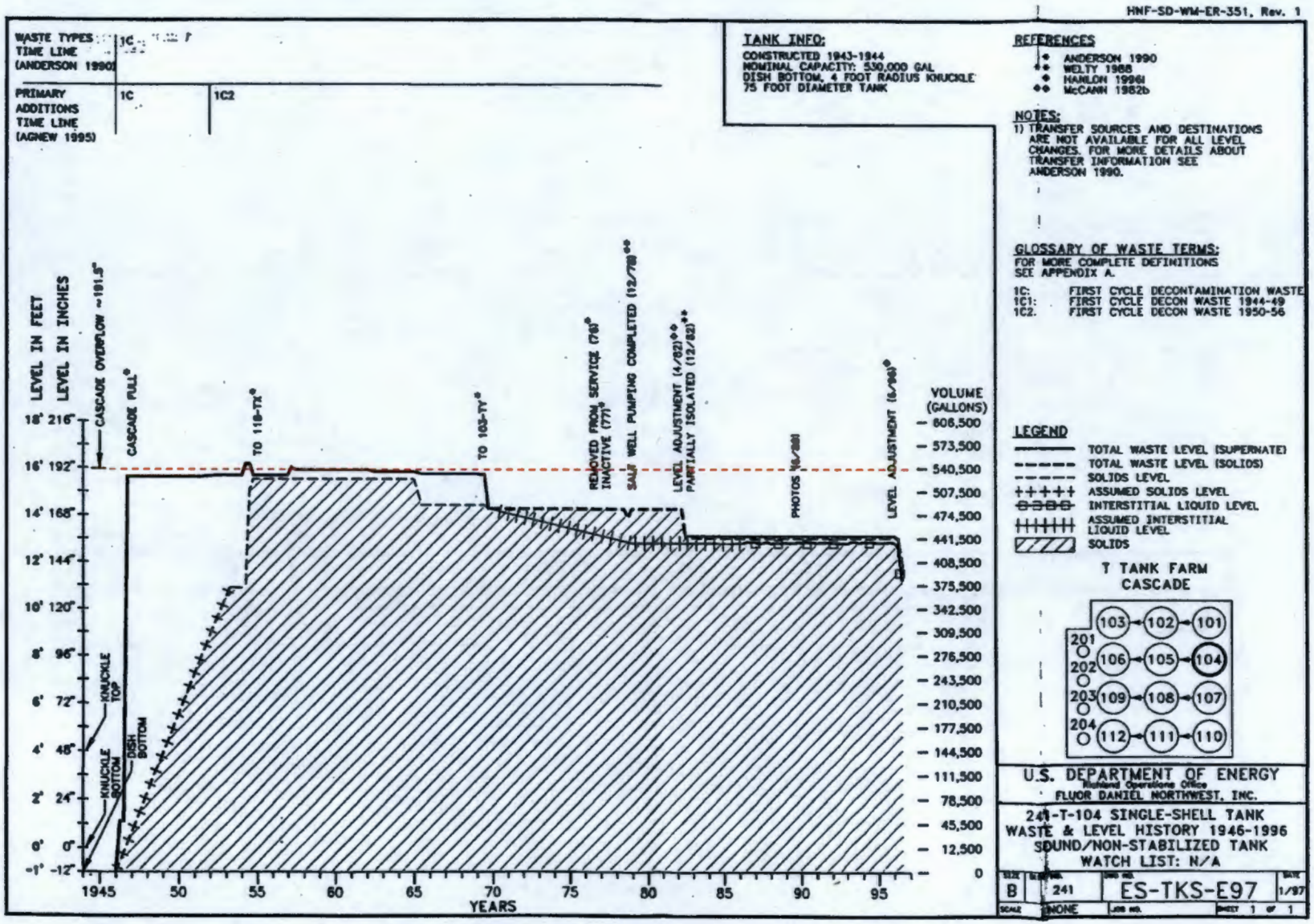
Figure C2-2 shows historical quarterly waste levels for tank T–104 from 1945 to 1993 (HNF-SD-WM-ER-351). Figure C2-3 shows liquid level measurements from 1980 to 2013. There were no occurrence reports associated with liquid level decreases or increases for this tank. The tank has a liquid observation well (LOW) to measure the interstitial liquid level (ILL). The ILL has slowly increased since jet pumping was completed in 1999.

Figure C2-1. Tank 241-T-104 Waste Operations Summary.



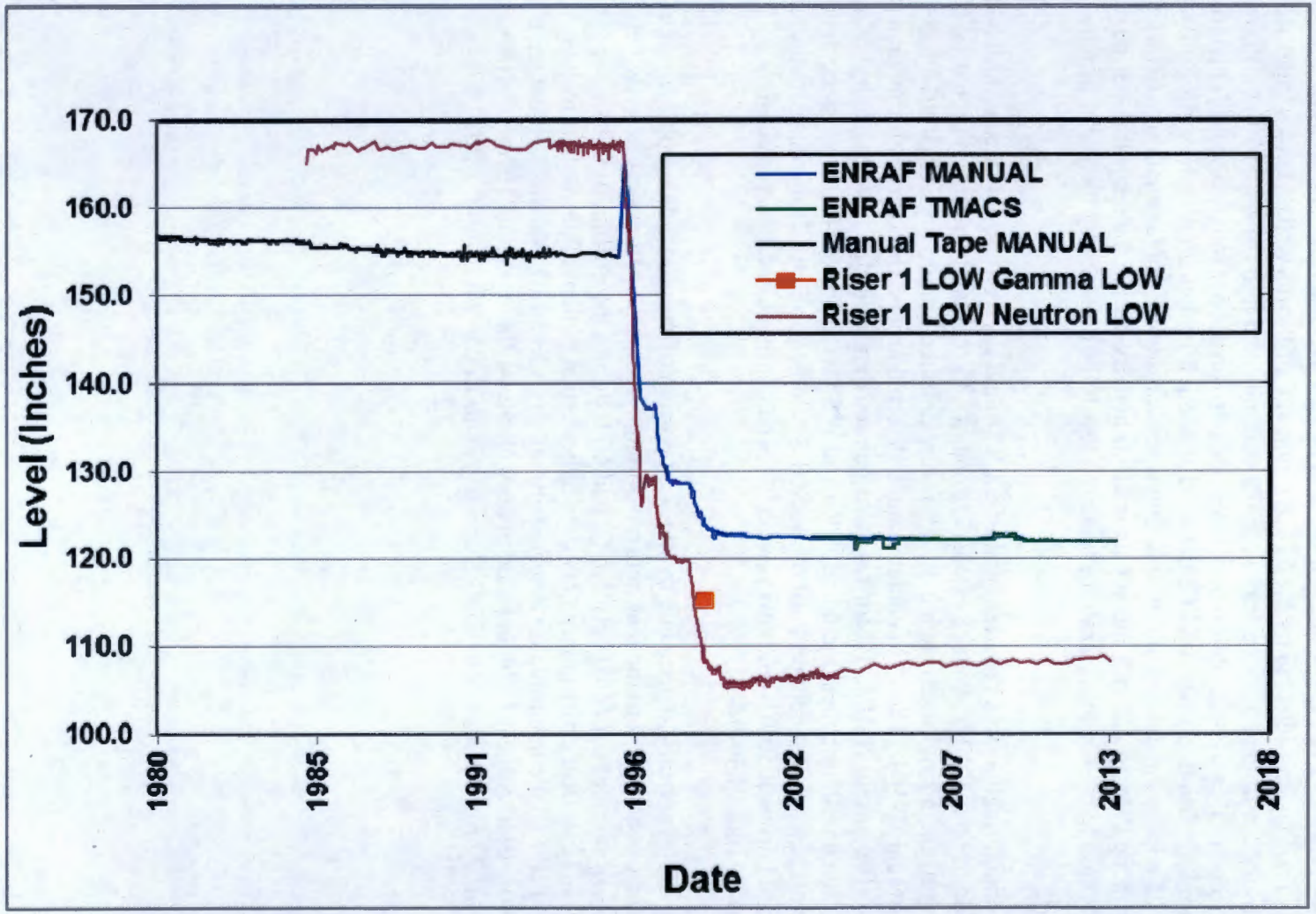
Waste types:
1C = First-cycle decontamination waste from the bismuth phosphate process
CW = Cladding waste, aluminum clad fuel

Figure C2-2. Tank 241-T-104 Level History 1945 to 1993.



Source: HNF-SD-WM-ER-351, *Historical Tank Content Estimate for the Northwest Quadrant of the Hanford 200 West Area.*

Figure C2-3. Tank 241-T-104 Surface Level Measurements: 1980 to 2013.



Note: Manual tape measurements are from the top of the dish (offset 12 in. from other measurements)

LOW = liquid observation well TMACS = Tank Monitor and Control System

Honeywell Enraf is a product of Honeywell Process Solutions, Strahlenbergerstr. 110-112, 63067 Offenbach, Germany.

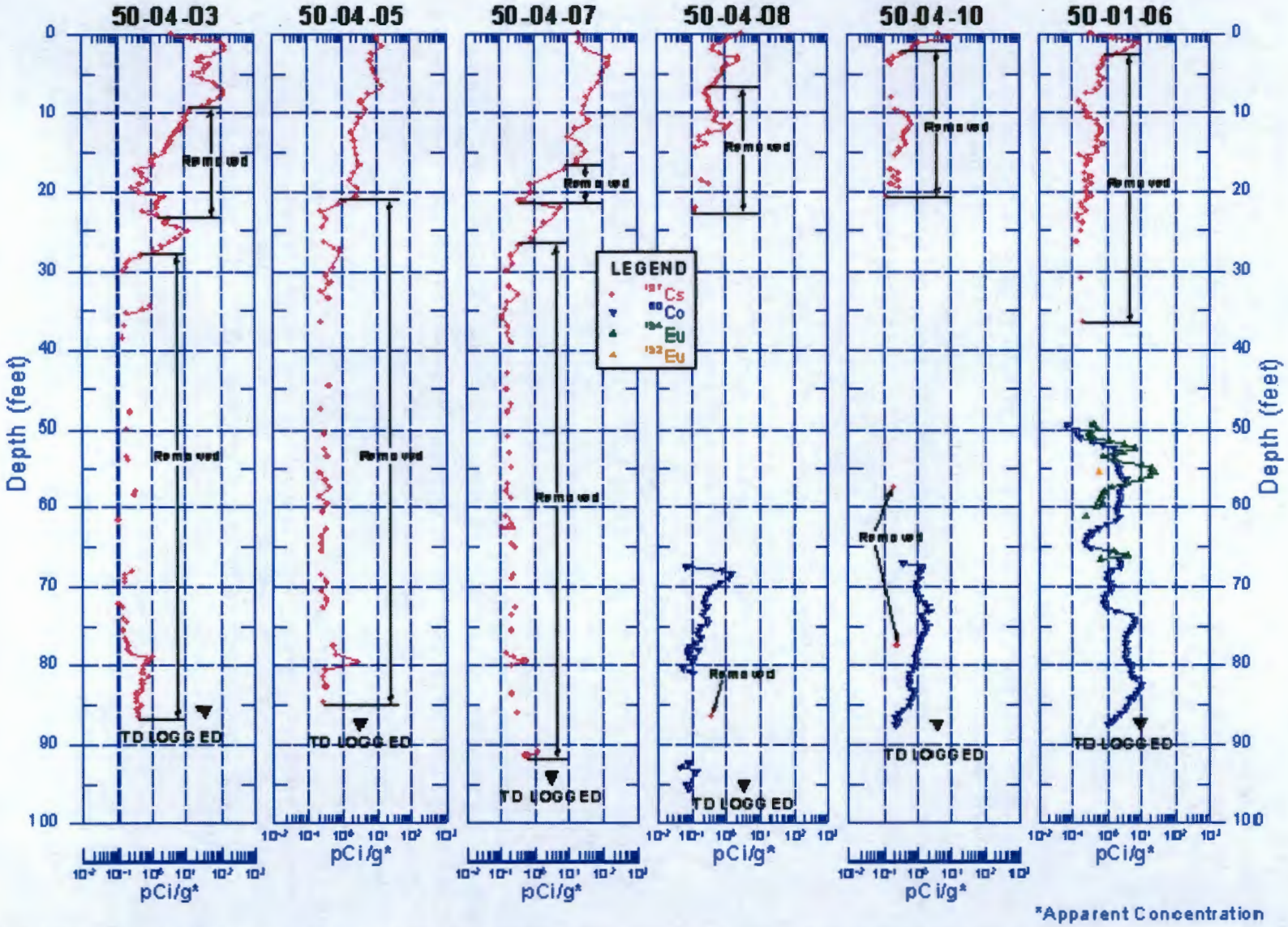
C2.3 DRYWELL DATA

Drywells 50-04-04, 50-04-05, 50-04-07, 50-04-08, 50-04-10 and 50-01-06 surround tank T-104. Figure C2-4 shows 1996 SGLS results for these drywells. Near-surface and shallow subsurface ^{137}Cs contamination was detected by the SGLS around all of the drywells. The contamination probably resulted from one or more surface spills that migrated into the shallow backfill material. Some of this contamination may have been driven deeper into the backfill material by precipitation infiltration. Zones of ^{137}Cs detected at about 80 ft bgs around drywells 50-04-03 and 50-04-05 appear to be the result of drag down of near-surface contamination. Historical gross gamma log data do not indicate any anomalous activity during the recording period, possibly because the ^{137}Cs concentrations were too low to be detected by the gross gamma system.

Cobalt-60 contamination was detected by the SGLS around drywells 50-04-08 and 50-04-10 near the west side of tank T-104. A more extensive zone of ^{60}Co contamination, a region of ^{154}Eu contamination, and a single occurrence of ^{152}Eu were detected around drywell 50-01-06 near the north side of tank T-104. The ^{60}Co contamination detected around these drywells appears to be from tank T-101 or tank T-106. Historical gross gamma data collected from these drywells show that shorter lived radionuclides, including ^{106}Ru and ^{125}Sb were present and have since decayed away to levels below the detection limit of the SGLS. Some residual ^{154}Eu contamination is present around drywell 50-01-06; however, no ^{154}Eu contamination was detected in drywells 50-04-08 and 50-04-10.

Drywell 50-01-06 appears to penetrate the thickest portion of the contaminant plume, suggesting that it is the closest drywell to the leak source. Anomalously high gamma-ray activity was detected in soil samples collected between 52 and 60 ft during the drilling of this drywell in August 1973. Historical gross gamma ray data indicate that radionuclide contamination, possibly related to the contamination detected around drywell 50-01-06, was first detected in drywell 50-04-10 in August 1974 and then in drywell 50-04-08 in August 1976 (GJ-HAN-118 , *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank T-104*).

Figure C2-4. Logging Results for Drywells Surrounding Tank 241-T-104.



Reference: GJO-99-101-TAR/GJO-HAN-27, *Vadose Zone Characterization Project at the Hanford Tank Farms T Tank Farm Report.*

C3.0 TANK 241-T-105

The BBI assessment for tank T-105 reports a waste volume of 98 kgal consisting of 24 kgal of Reduction-Oxidation (S Plant) cladding waste, aluminum clad fuel (CWR) sludge, 2 kgal of 1C sludge, and 72 kgal of 2C sludge (RPP-RPT-43163, *2009 Auto-TCR for Tank 241-T-105*). Tank T-105 was core sampled in 1993 and again in 1997.

C3.1 HISTORY

The first waste type introduced into tank T-105 was 2C waste in 1946. This waste consisted of effluent remaining after precipitation of plutonium product in the second decontamination cycle of the bismuth phosphate process at T Plant. The 2C waste filled the tank and cascaded to tank T-106 from 1947 to the first quarter of 1948. Because tank T-105 received waste directly from T Plant, 2C solids are expected to have been deposited in the lower portion of the tank. In the second quarter of 1948, much of the 2C supernate in tank T-105 was sent to the tank 241-T-107 crib.

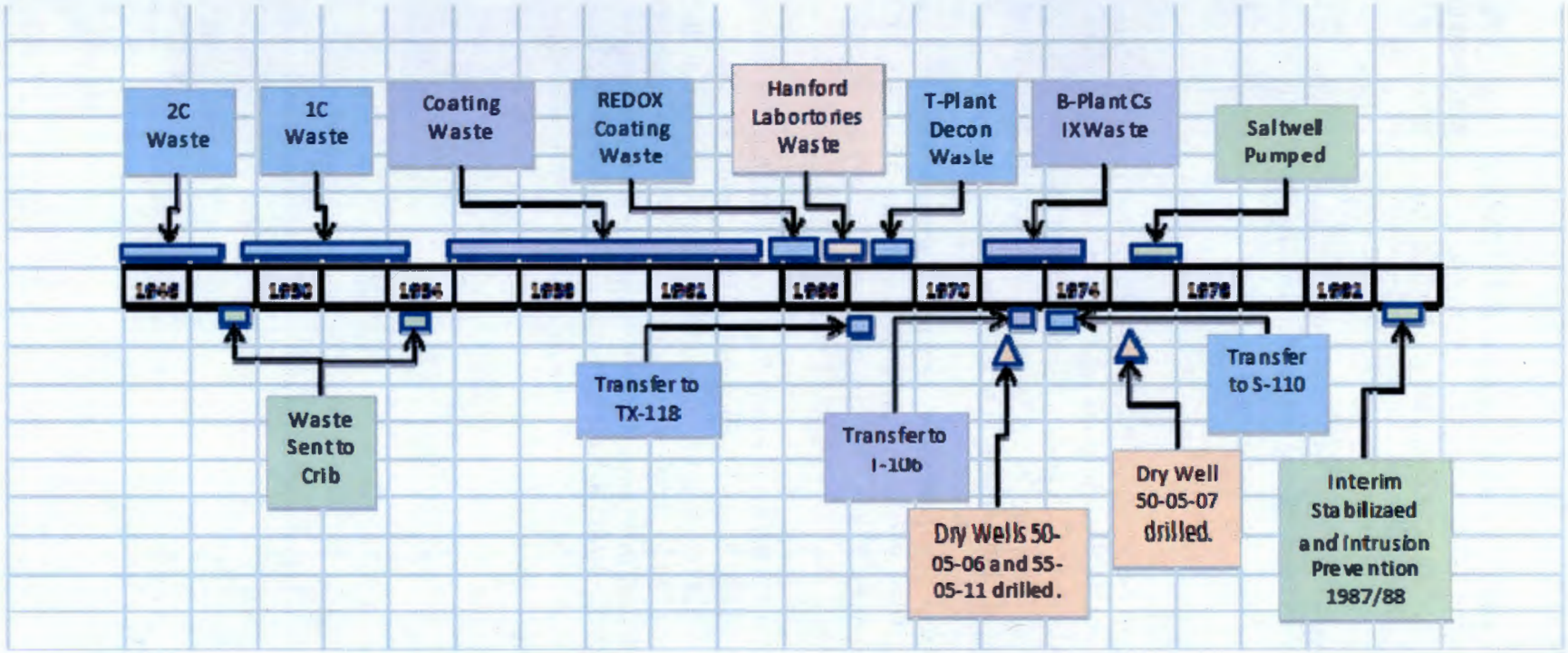
From the second quarter of 1948 to the first quarter of 1949, 1C waste cascaded into tank T-105 from tank T-104. Waste cascaded from tank T-105 to tank T-106 during this same period. The 1C waste is characterized by a relatively high concentration of bismuth and aluminum. During the second quarter of 1951, the waste was transferred from tank T-105 to tanks 241-TX-117 and TX-118. The 1C waste cascaded from tank T-104 to tank T-105 from the fourth quarter of 1951 to the third quarter of 1954. In 1954, the supernate in tank T-105 was pumped out and sent to a crib. Supernatant waste was also sent to tank TX-118 in the fourth quarter of 1954. The cascade system was not used after 1954.

The tank began receiving cladding waste at the beginning of 1955, and it was full by the end of 1956. Tank T-105 received supernate from tank 241-S-107 in 1965. From 1967 to 1968, supernate was transferred to tank TX-118 as feed to the 242-T Evaporator. In 1967, Hanford Site laboratory operations waste from the 300 Area was transferred to tank T-105. In 1968 and 1969, tank T-105 received decontamination waste, a wash solution from equipment decontamination at T Plant.

Tank T-105 received transfers from other single-shell tanks (SSTs) of liquid waste mixtures containing 221-B Plant low-level waste and ion exchange waste in 1973. Supernate was transferred to tank T-106 in the same year and to tank S-110 in 1974 (HNF-SD-WM-ER-351). Additional waste history and characterization detail for tank T-105 is presented in RPP-16764, *Origin of Waste in Single-Shell Tank 241-T-105*.

A supernate pump (P-10) was installed in February 1976 and the tank was pumped through April 1976 (WHC-MR-0132, *A History of the 200 Area Tank Farms*). The tank was declared inactive in 1976 and administratively interim stabilized in June 1987 (HNF-SD-RE-TI-178, *Single-Shell Tank Interim Stabilization Record*). Figure C3-1 summarizes waste operations for this tank.

Figure C3-1. Tank 241-T-105 Waste Operations Summary.



Waste types:
1C = First-cycle decontamination waste from the bismuth phosphate process
2C = Bismuth phosphate process second cycle decontamination waste
IX = Ion exchange waste
REDOX = Reduction-Oxidation (S Plant)

C3.2 SURFACE LEVEL DATA

Figure C3-2 shows historical quarterly waste levels for tank T–105 from 1946 to 1993 (HNF-SD-WM-ER-351). Figure C3-3 shows liquid level measurements from 1980 to 2013. The solid surface level appears to have has remained stable since about 1986. There is no LOW in this tank.

There were no occurrence reports associated with liquid level decreases or increases for this tank. However, several occurrence reports were issued for increased radioactivity in drywells.

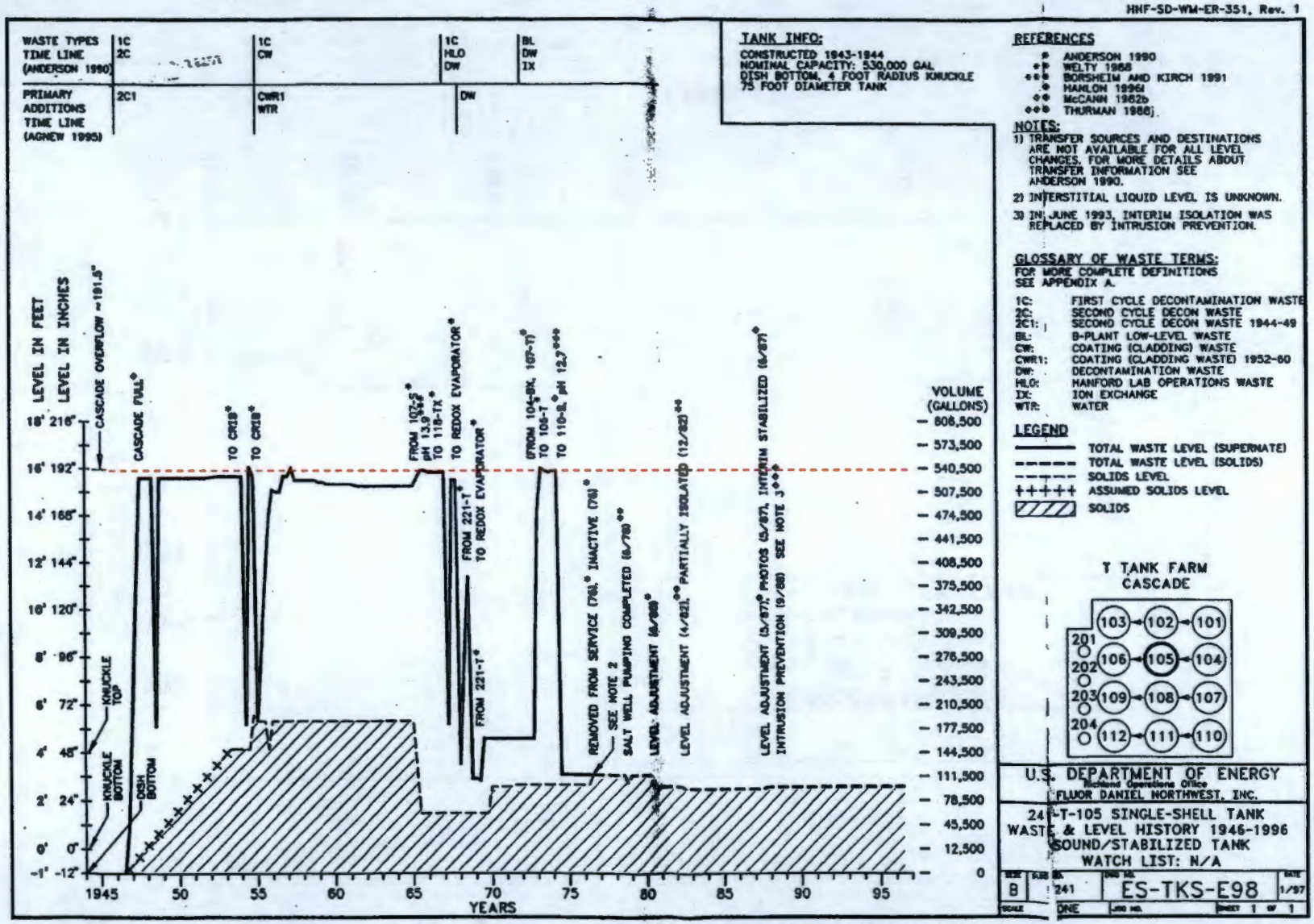
C3.3 DRYWELL DATA

Drywells 50-02-05, 50-04-10, 50-04-08, 50-05-06, 50-05-07, 50-06-03 and 50-05-11 surround tank T-105. Figure C3-4 shows 1996 SGLS results for these drywells. Near-surface and shallow subsurface ^{137}Cs was detected by the SGLS around all of the drywells. The ^{137}Cs detected between the ground surface and ~30 ft may be the result of surface spills and contamination that migrated downward into the backfill material around the tank.

The ^{137}Cs peak detected in drywell 50-02-05 from 37 to 42.5 ft was discussed in section C2.3. It appears to be from near tank T-102 and is under further investigation. The ^{137}Cs, ^{60}Co, ^{154}Eu, ^{152}Eu, and ^{126}Sn detected in drywell 50-06-03 are associated with contaminant plumes from tank T-106 (see Appendix B.4).

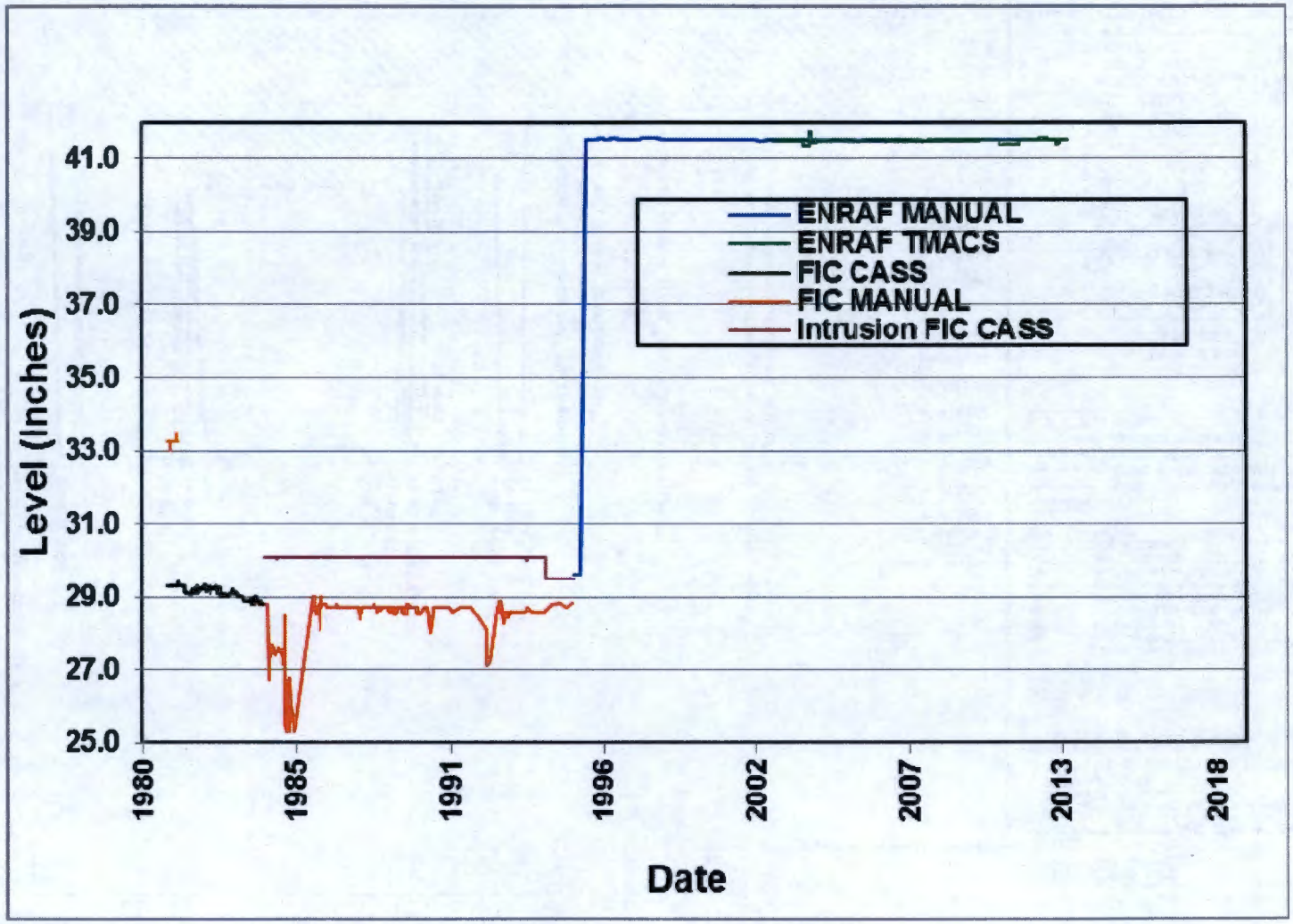
Cobalt-60 was detected by the SGLS between 49 and 74 ft in drywell 50-02-05, between 65 and 85 ft in drywells 50-04-10, 50-04-08, 50-05-06, and 50-05-07, and below 85 ft in drywell 50-05-11. The depth distribution of the ^{60}Co contamination suggests that the plume spread laterally. The ^{60}Co contamination in the vicinity of drywell 50-05-11 appears to have migrated downward. Data collected from these drywells define a contaminant plume extending under most of tank T-105. The source of the ^{60}Co contamination detected in this interval is probably the leak from tank T-106 (GJ-HAN-119, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank T-105*).

Figure C3-2. Tank 241-T-105 Level History 1946 to 1993.



Source: HNF-SD-WM-ER-351, *Historical Tank Content Estimate for the Northwest Quadrant of the Hanford 200 West Area.*

Figure C3-3. Tank 241-T-105 Surface Level Measurements: 1980 to 2013.

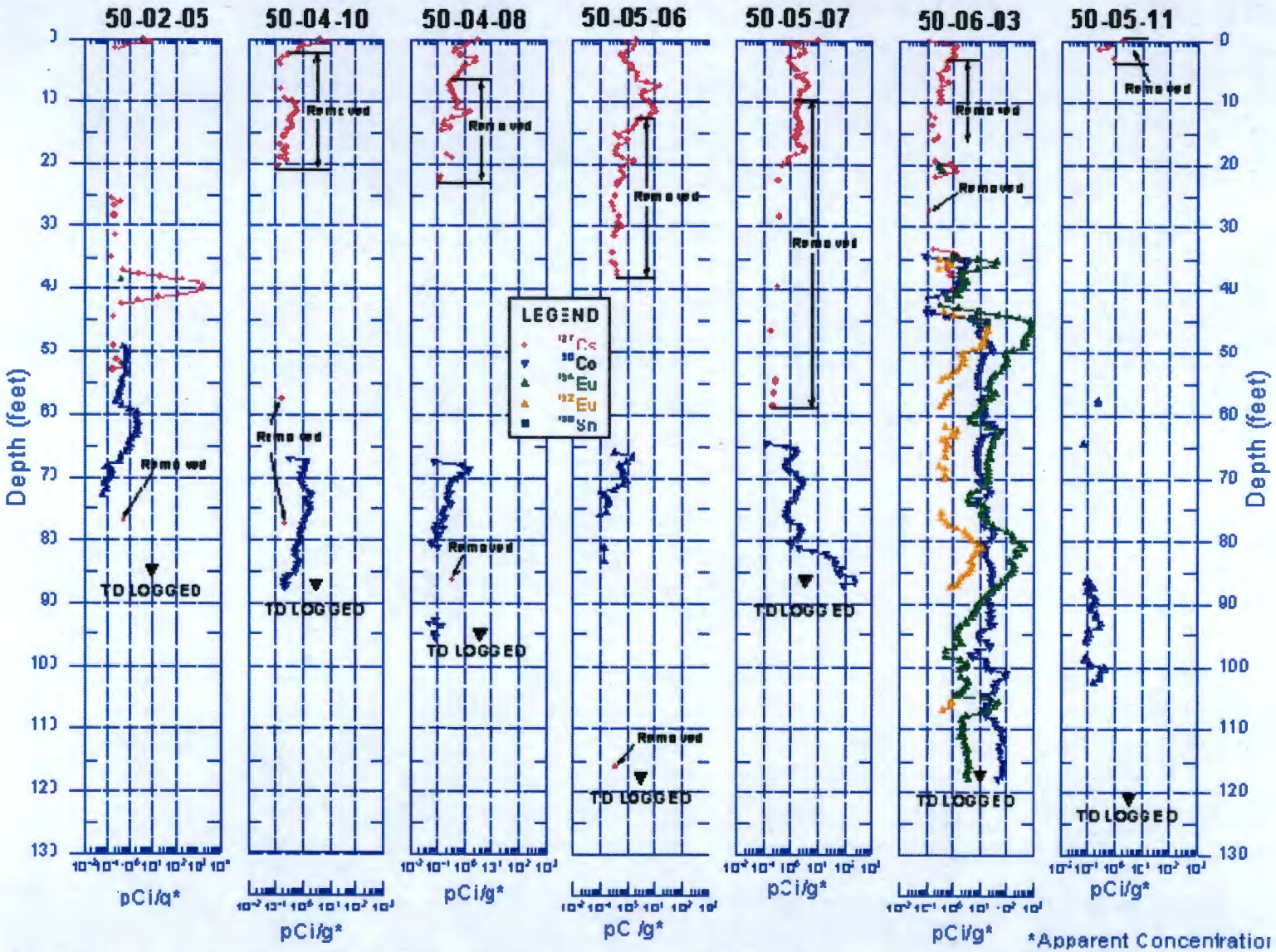


Note: Enraf measurements were reset to the bottom of the dish in 1995 (offset 12 in.).

CASS = Computer Automated Surveillance System FIC = Food Instrument Corporation (gauge) TMACS = Tank Monitor and Control System

Honeywell Enraf is a product of Honeywell Process Solutions, Strahlenbergerstr. 110-112, 63067 Offenbach, Germany.

Figure C3-4. Logging Results for Drywells Surrounding Tank 241-T-105.



Reference: GJO-99-101-TAR/GJO-HAN-27, *Vadose Zone Characterization Project at the Hanford Tank Farms T Tank Farm Report.*

C4.0 TANK 241-T-110

The BBI assessment for tank 241-T-110 (T-110) reports a waste volume of 370 kgal consisting of 3 kgal of supernate, 10 kgal of 224 Building lanthanum fluoride process (224) sludge, and 359 kgal of 2C sludge (RPP-RPT-43168, *2009 Auto-TCR for Tank 241-T-110*). Tank T-105 was core sampled in 1993 and again in 1997. The tank T-110 total waste volume was calculated from the waste phase volumes reported in HNF-SD-RE-TI-178. The surface level measurement was taken from an autoEnraf reading of 146.08 in., which corresponds to a waste volume of 381 kgal in the tank. The autoEnraf reading probably overestimates the tank volume because the surface of the waste slopes from the tank sidewall to a small pool of standing liquid in the center of the tank (surrounding the saltwell screen).

C4.1 HISTORY

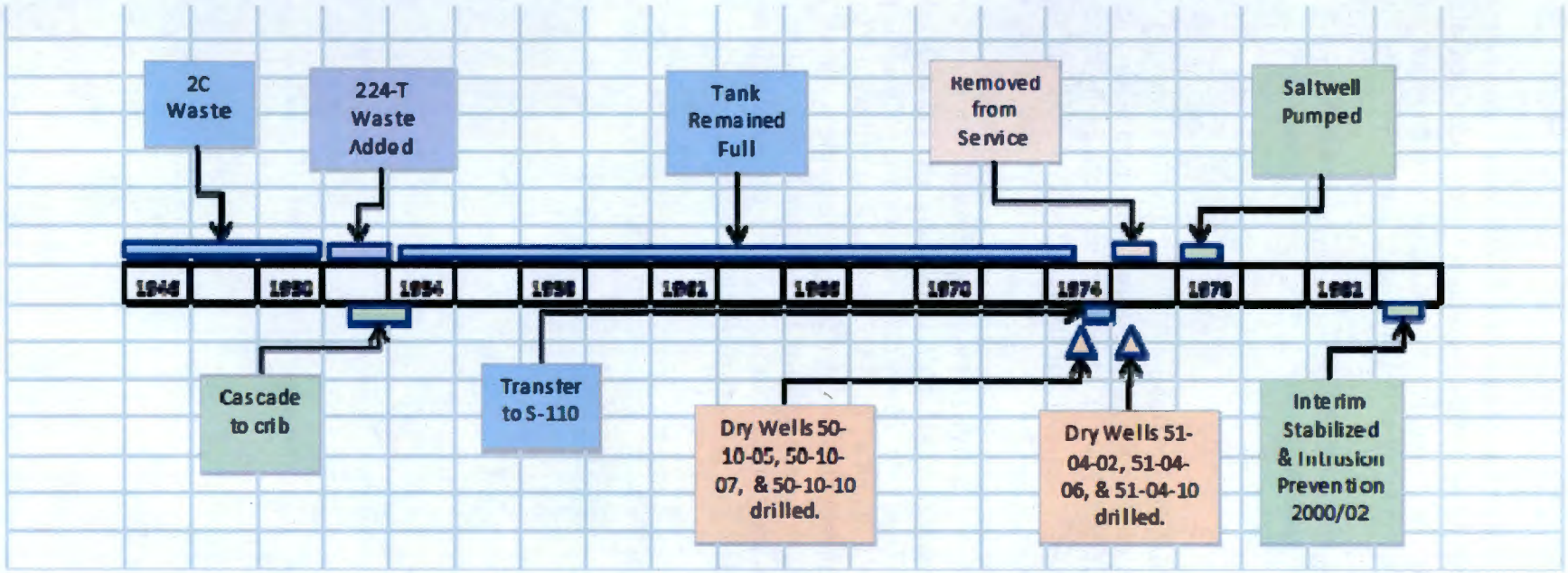
Tank T-110 first began receiving second-cycle waste from T Plant in December 1944. Additional second cycle waste was added from T Plant in the first quarter of 1948 until the third quarter of 1956. From the second quarter of 1952 to the first quarter of 1953, the tank also received lanthanum fluoride waste from the plutonium concentration facility. Flush water was added in the second and third quarters of 1956 before the tank was placed on standby. The tank was inactive and full until the second quarter of 1974 when waste was sent to tank S-110. Supernatant waste was sent to tank T-101 in the first and second quarters of 1976 and to tank TX-118 in the third quarter of 1978 (HNF-SD-WM-ER-351).

The tank was on the Watch List for Flammable Gas due to a seasonal fluctuation in waste level and was core sampled in 1996 and grab sampled in 1997. Additional waste history and characterization detail for tank T-110 is presented in RPP-13873, *Origin of Wastes in Single-Shell Tanks 241-T-110, 241-T-111 and 241-T-112.*

A jet pump was installed in 1977 and the last transfer from tank T-110 before a push mode core sample was taken was saltwell pumping to tank 241-AN-103 in the fourth quarter of 1983 (WHC-SD-WM-TI-669, *Waste Status and Transaction Record Summary for the Northwest Quadrant of the Hanford 200 West Area*). Saltwell jet pumping resumed in May 1997 and over 50 kgal of liquid was pumped from the tank before an equipment failure occurred on August 12, 1999 and the saltwell was shut down. The tank was declared administratively interim stabilized January 5, 2000 (HNF-SD-RE-TI-178).

Figure C4-1 summarizes waste operations for this tank.

Figure C4-1. Tank 241-T-110 Waste Operations Summary.



Waste types:
224 = 224 Building lanthanum fluoride process waste

2C = Bismuth phosphate process second cycle decontamination waste

C4.2 SURFACE LEVEL DATA

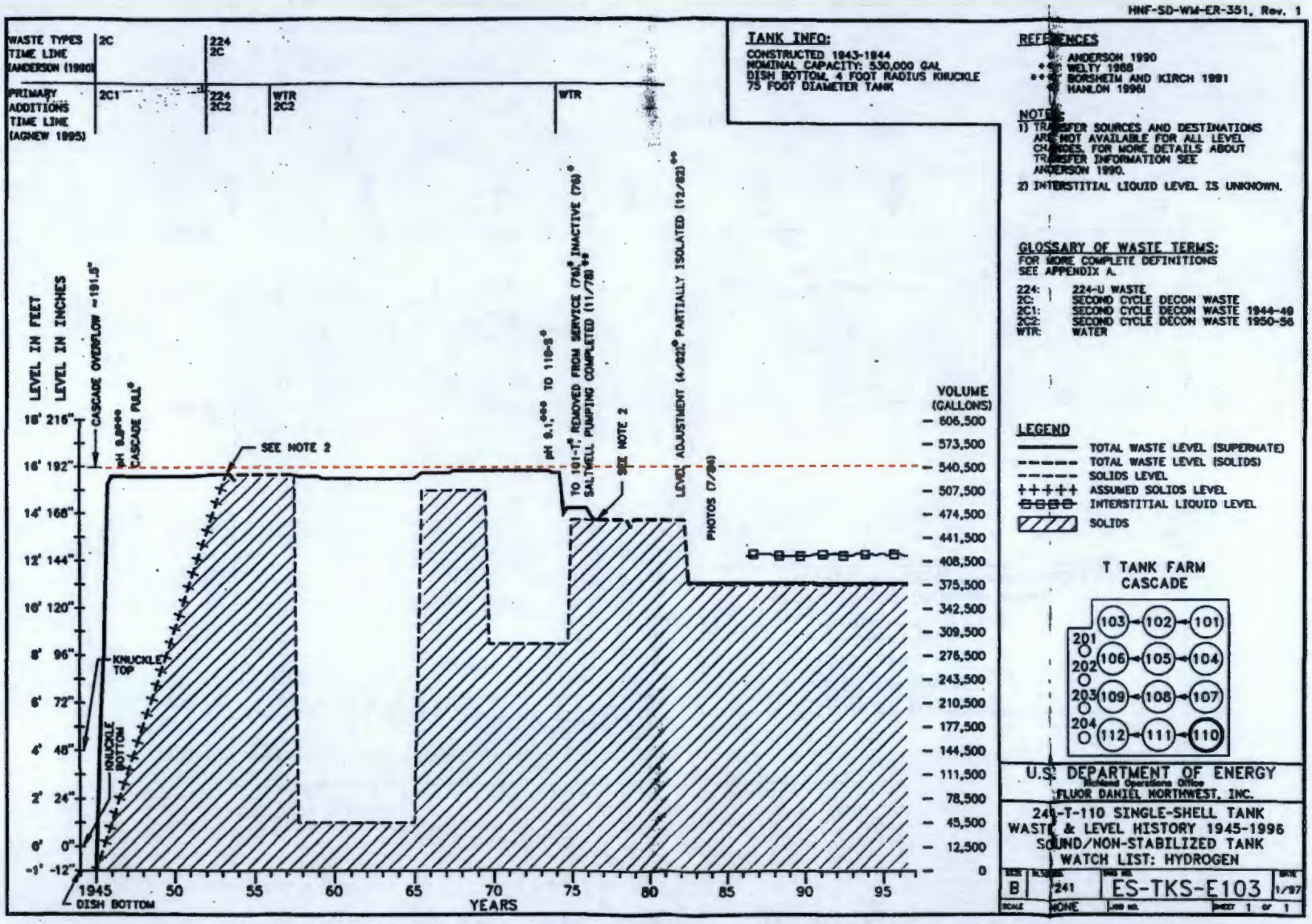
Figure C4-2 shows historical quarterly waste levels for tank T–110 from 1944 to 1993 (HNF-SD-WM-ER-351). Photographs show that the spare inlet nozzles are filled with solids and Figure C4-2 shows that the tank was filled above the cascade liquid level and spare inlet level from 1964 to 1974 when supernate was pumped out of the tank. Figure C4-3 shows liquid level measurements from 1980 to 2013, The liquid level decreases from 1996 to 1997 due to saltwell pumping. There is no LOW in this tank and there were no occurrence reports for this tank.

C4.3 DRYWELL DATA

Drywells 50-00-05, 50-10-05, 50-10-07, 50-10-08, 50-10-10 and 50-07-07 surround tank T-110. Figure C4-4 shows SGLS results for these drywells. Minor surface contamination was detected in all the drywells to a depth of ~30 ft bgs. The ^{137}Cs was detected sporadically at various depths from the surface to the bottom of drywell 50-10-10. In drywell 50–07–07 a 100 pCi/g spike of ^{137}Cs was detected at about 45 ft bgs.

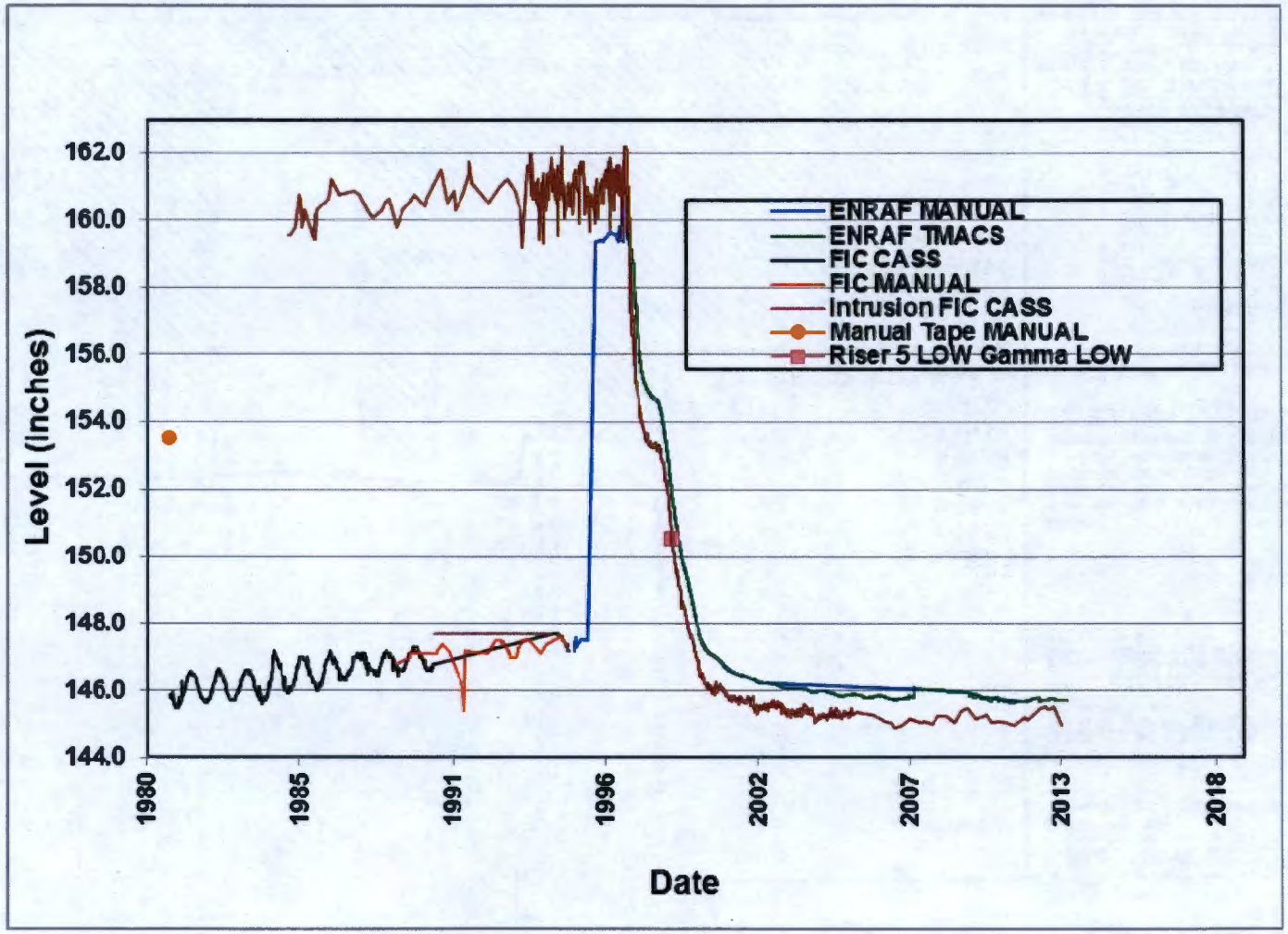
Low concentrations of ^{60}Co were detected in drywell 50-00-05 between 36.5 and 38.5 ft bgs. Gamma activity in drywell 50-00-05 was detected at 28 ft in September 1973 (SD-WM-TI-356, *Waste Storage Tank Status and Leak Detection Criteria*) and historical gross gamma plots show two anomalous activity peaks between 33 and 47 ft. The ^{60}Co detected below 70 ft in drywell 50-00-05 correlates with contamination detected in drywells to the north and northeast and appears to have migrated from a subsurface leak from another tank. Evaluation of the historical gross gamma data indicates the gamma anomaly has been present within this depth interval since at least mid-1981 (GJ-HAN-124, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank T-112*).

Figure C4-2. Tank 241-T-110 Level History 1944 to 1993.



Source: HNF-SD-WM-ER-351, *Historical Tank Content Estimate for the Northwest Quadrant of the Hanford 200 West Area.*

Figure C4-3. Tank 241-T-110 Surface Level Measurements: 1980 to 2013.

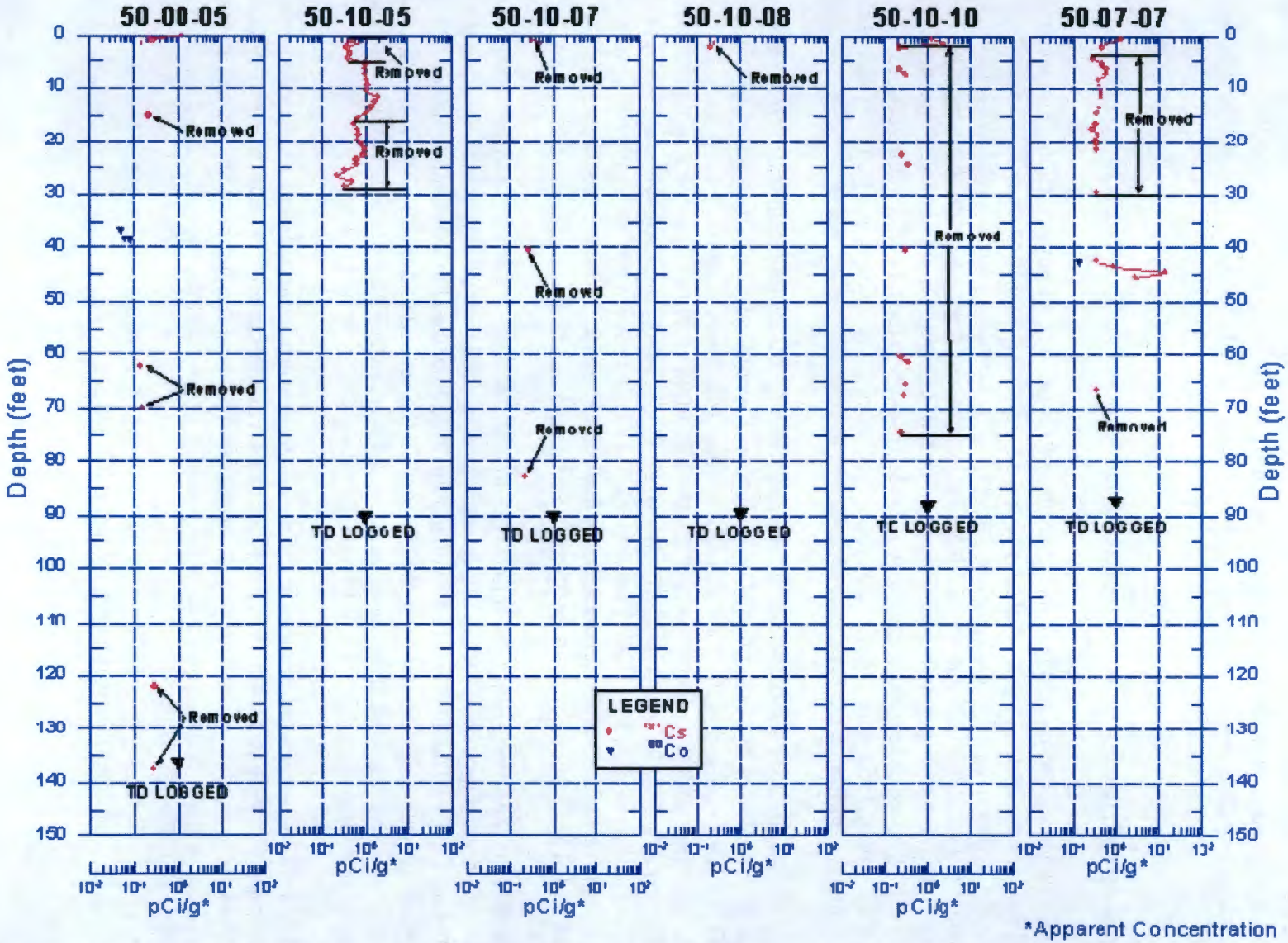


Note: FIC and Enraf measurements were from the top of the dish. The Enraf was reset to the bottom of the dish about 1996 (offset 12 in.).

CASS = Computer Automated Surveillance System
FIC = Food Instrument Corporation (gauge)
LOW = liquid observation well
TMACS = Tank Monitor and Control System

Honeywell Enraf is a product of Honeywell Process Solutions, Strahlenbergerstr. 110-112, 63067 Offenbach, Germany.

Figure C4-4. Logging Results for Drywells Surrounding Tank 241-T-110.



Reference: GJO-99-101-TAR/GJO-HAN-27, *Vadose Zone Characterization Project at the Hanford Tank Farms T Tank Farm Report.*

C5.0 TANK 241-T-112

The BBI assessment for tank 241-T-112 (T-112) reports a waste volume of 67 kgal consisting of of 7 kgal of supernate, 24 kgal of 224 sludge and 36 kgal of 2C sludge (RPP-RPT-47139, *Derivation of the Best-Basis Inventory for Tank 241-T-112*). Tank T-112 was core sampled in 1997.

C5.1 HISTORY

Waste began cascading into tank T-112 from tank 241-T-111 in January 1946. The waste was 2C waste from the bismuth phosphate process at T Plant. Waste from tank T-112 was deposited into the T-006 crib in the fourth quarter of 1947. The cascade again received 1944-1949 2C waste (2C1) in the fourth quarter of 1948 after supernatant waste was sent from tank T-112 to crib T-007. Supernatant waste was sent from tank T-112 to the T-007 crib until the third quarter of 1956. The cascade of waste from tank T-110 through to tank T-112 continued until the first quarter of 1952 with 2C and 224 waste from uranium recovery operations. Supernatant waste was sent from tank T-112 to crib T-005 in the second quarter of 1955.

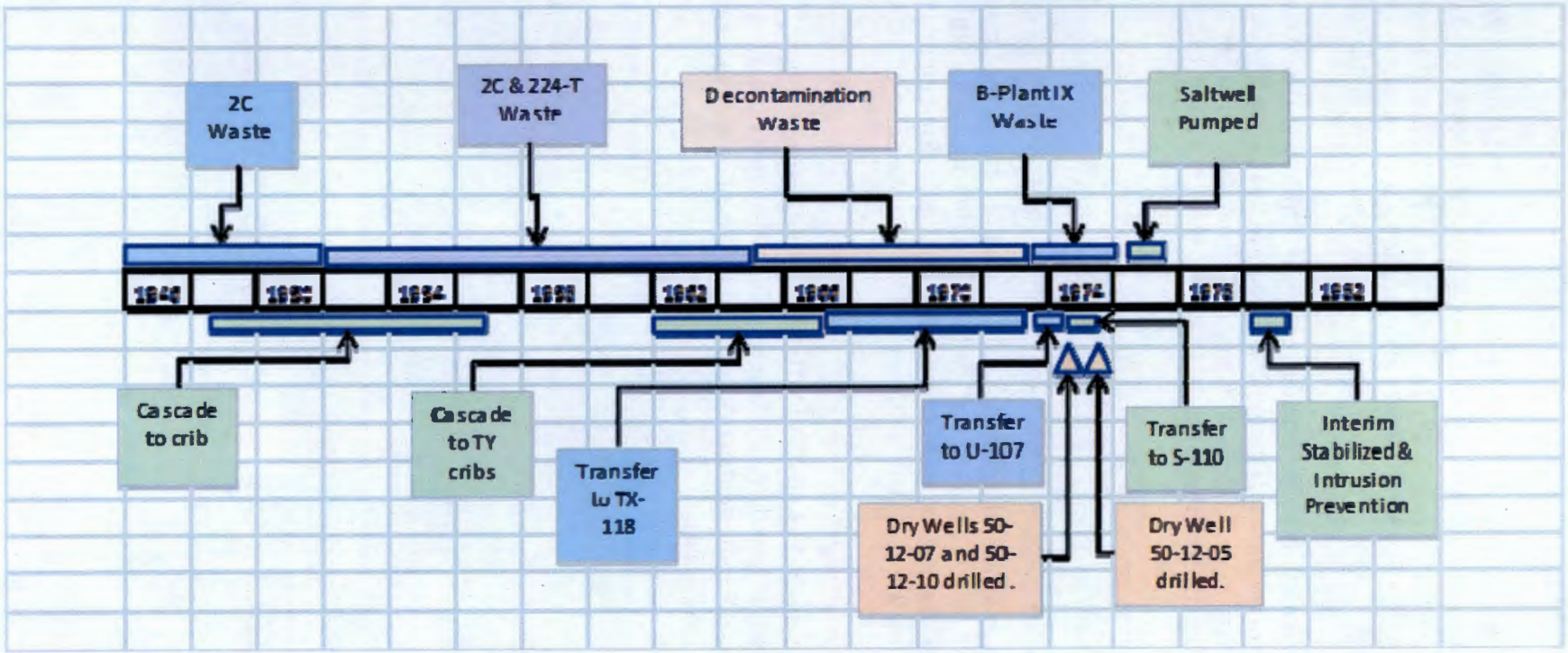
In the first quarter of 1960, tank T-112 began receiving decontamination waste from the 221-T Evaporator. Decontaminated waste was sent sporadically until the second quarter of 1973. Waste was sent to the TY crib in the second and fourth quarters of 1960, the fourth quarter of 1962, and the second and third quarters of 1966. Beginning in the second quarter of 1967, tank T-112 began exchanging evaporator waste with tank TX-118. Supernate was sent to tank TX-118 from tank T-112, and evaporator bottoms waste was returned to tank T-112. This continued until the second quarter of 1972. Waste was sent to tank 241-TY-103 in the second quarter of 1969.

Supernatant waste was sent from tank T-112 to tank 241-U-107 from the third quarter of 1972 until the second quarter of 1973. Flush water from miscellaneous sources was added in the first quarter of 1973. The last waste addition to tank T-112 occurred in the second quarter of 1973 when supernate was received from tank T-106. In the second and third quarters of 1974, tank T-112 sent supernatant waste to tank S-110 (WHC-SD-WM-ER-351). Additional waste history and characterization detail for tank 241-T-111 is presented in RPP-13873.

Tank T-112 was declared inactive in 1976. The tank was administratively stabilized after supernate pumping in March 1981. A supernate level adjustment was made in April 1982 to 7,000 gal, exceeding the interim stabilization criteria. There has not been any change in the liquid level since that time and additional pumping is not recommended (WHC-SD-WM-ER-622).

Figure C5-1 summarizes waste operations for this tank.

Figure C5-1. Tank 241-T-112 Waste Operations Summary.



Waste types:
224 = 224 Building lanthanum fluoride process waste 2C = Bismuth phosphate process second cycle decontamination waste IX = Ion exchange waste

C5.2 SURFACE LEVEL DATA

Figure C5-2 shows historical quarterly waste levels for tank T–112 from 1946 to 1993 (HNF-SD-WM-ER-351). The historical data and tank photographs show that tank T-112 was filled well above the cascade level in the early 1950s. Figure C5-3 shows liquid level measurements from 1981 to 2013. The figure shows a surface level increase about 1985. The surface level remained relatively stable after the increase. There is no LOW in this tank.

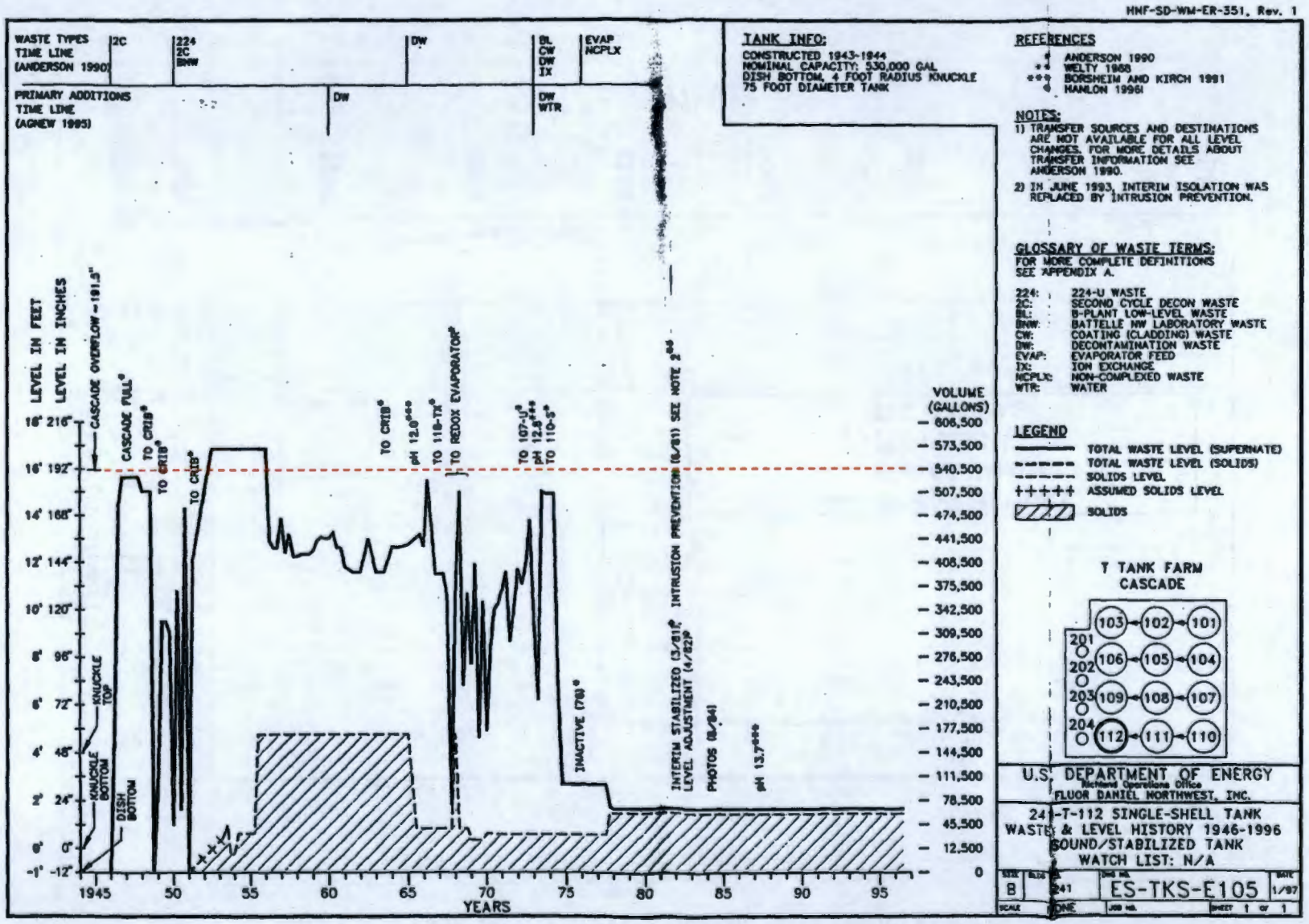
A liquid level decrease was reported in 1977. The decrease was attributed to "movement of the FIC *(Food Instrument Corporation [gauge])* plummet over an irregular surface" (Occurrence Report 77-201, *Tank 112-T Liquid Level Decrease Exceeding Criterion*). No other occurrences were reported for liquid level changes in this tank.

C5.3 DRYWELL DATA

Drywells 50-09-05, 50-11-10, 50-11-08, 50-12-05, 50-12-07, 50-12-10, 50-00-08 and 50-09-07 monitor tank T-112. Figure C5-4 shows 1997 SGLS results for these drywells. Cesium-137 was detected at isolated points at or near the ground surface in most of the drywells. With the exception of drywell 50-12-07, the ^{137}Cs concentrations were generally discontinuous. Continuous ^{137}Cs contamination was detected in the upper 24 ft of drywell 50-12-07 with a peak concentration of ~2 pCi/g.

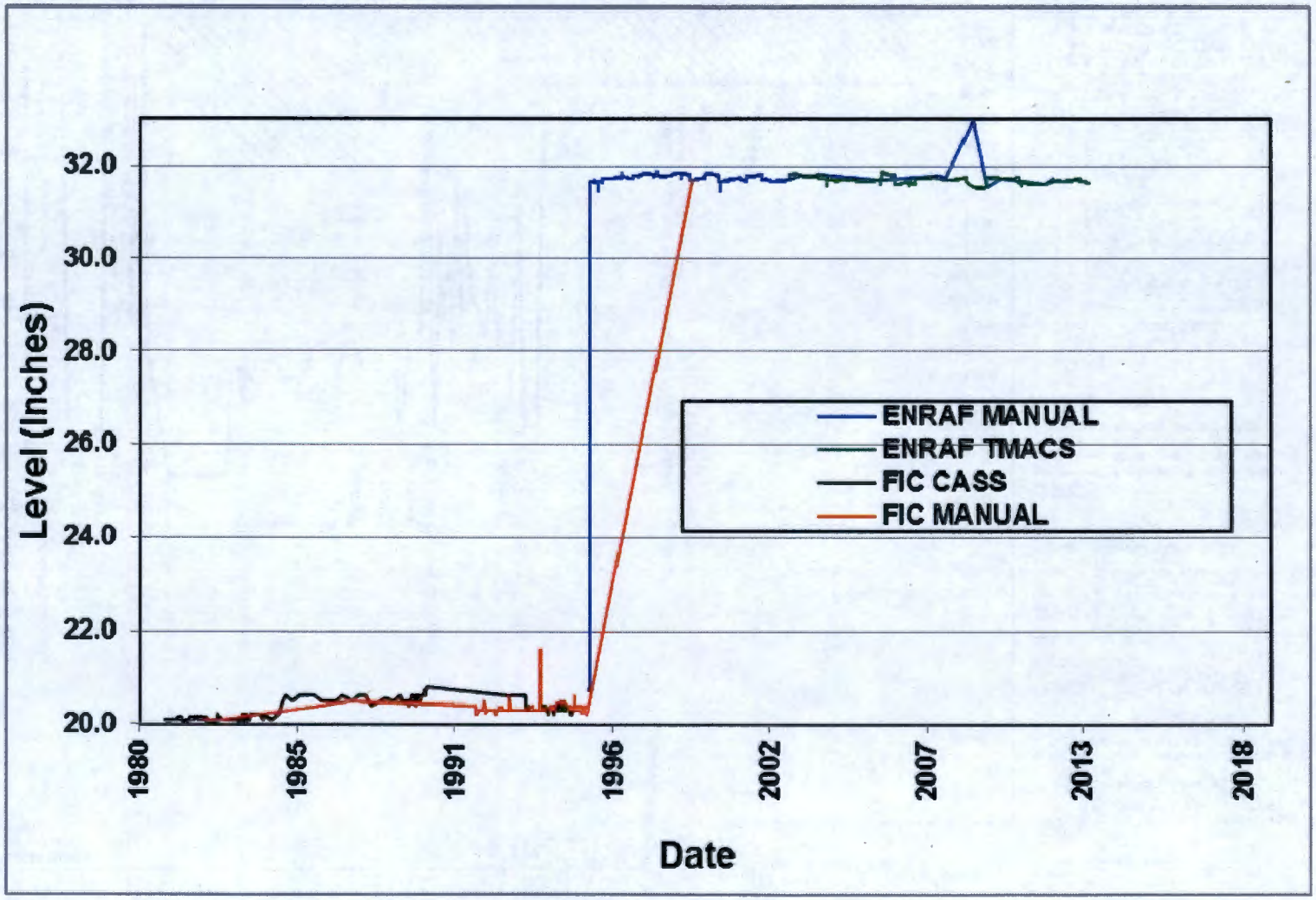
A trace of ^{60}Co was detected in both drywells 50-11-10 and 50-09-05 at ~70 ft bgs. The depth interval at which the contamination was detected corresponds to similar contamination intervals in drywells to the north. This may indicate that drywell 50-11-10 is at or near the southward extent of the ^{60}Co plume (GJ-HAN-124).

Figure C5-2. Tank 241-T-112 Level History 1946 to 1993.



Source: HNF-SD-WM-ER-351, *Historical Tank Content Estimate for the Northwest Quadrant of the Hanford 200 West Area.*

Figure C5-3. Tank 241-T-112 Surface Level Measurements: 1980 to 2013.

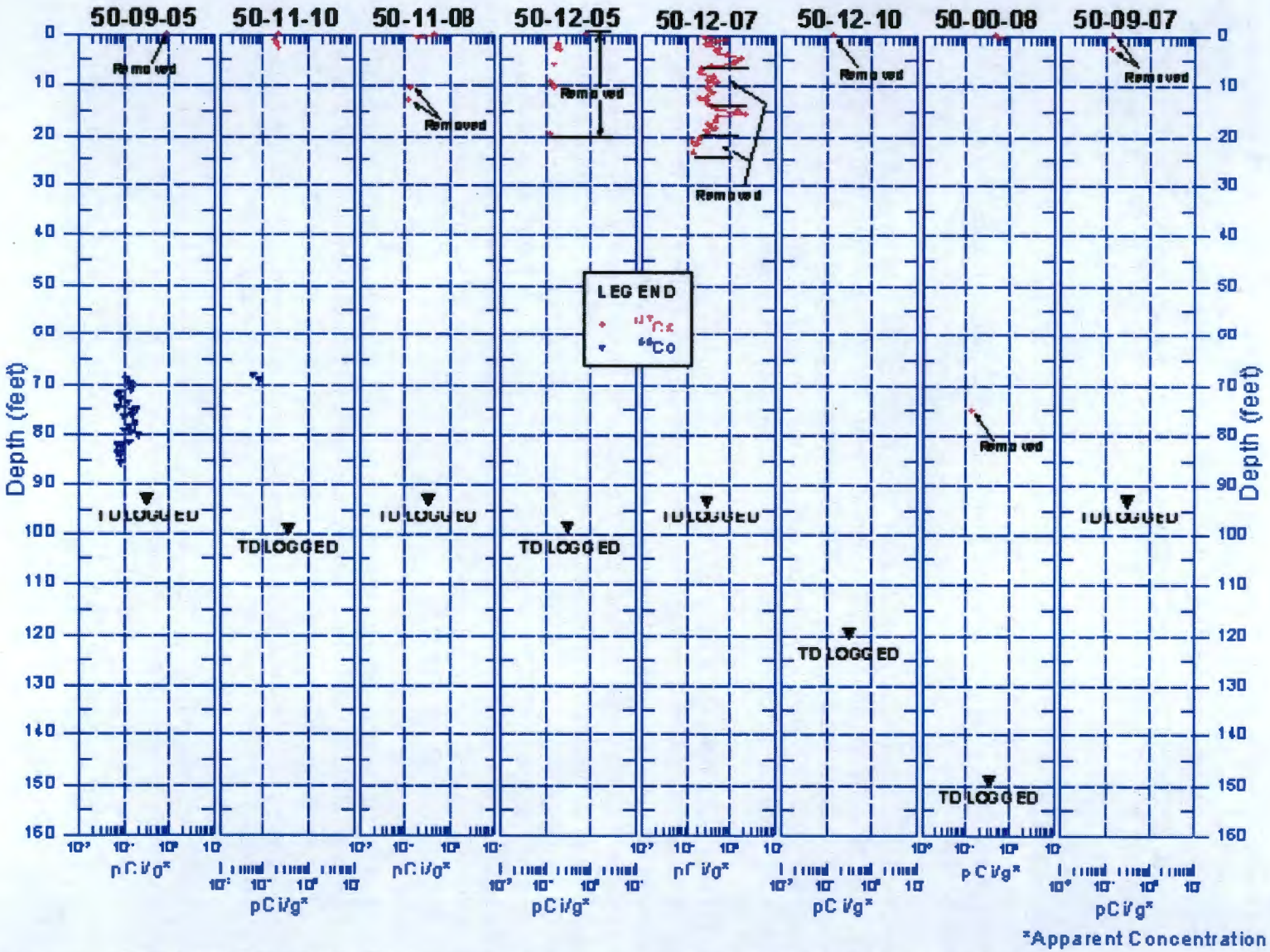


Note: Enraf measurements were reset to the bottom of the dish in 1995 (offset 12 in.).

CASS = Computer Automated Surveillance System FIC = Food Instrument Corporation (gauge) TMACS = Tank Monitor and Control System

Honeywell Enraf is a product of Honeywell Process Solutions, Strahlenbergerstr. 110-112, 63067 Offenbach, Germany.

Figure C5-4. Logging Results for Drywells Surrounding Tank 241-T-112.



Reference: GJO-99-101-TAR/GJO-HAN-27, *Vadose Zone Characterization Project at the Hanford Tank Farms T Tank Farm Report.*

C6.0 T-200-SERIES TANKS

The BBI assessments report that tanks 241-T-201 (T-201), 241-T-202 (T-202), 241-T-203 (T-203) and 241-T-204 (T-204) contain 30, 20, 36 and 36 kgal of waste respectively. The waste volume for tank T-201 consists of 2 kgal of supernate and 28 kgal of 224 sludge. The waste is entirely 224 sludge for tanks T-202, T-203 and T-204 (RPP-RPT-43171, *2009 Auto-TCR for Tank 241-T-201*; RPP-RPT-43172, *2009 Auto-TCR for Tank 241-T-202*; RPP-RPT-43173, *2009 Auto-TCR for Tank 241-T-203*; and RPP-RPT-43174, *2009 Auto-TCR for Tank 241-T-204*).

C6.1 HISTORY

The operations history is similar for the four T-200-series tanks. Figure C6-1 summarizes operations for these tanks.

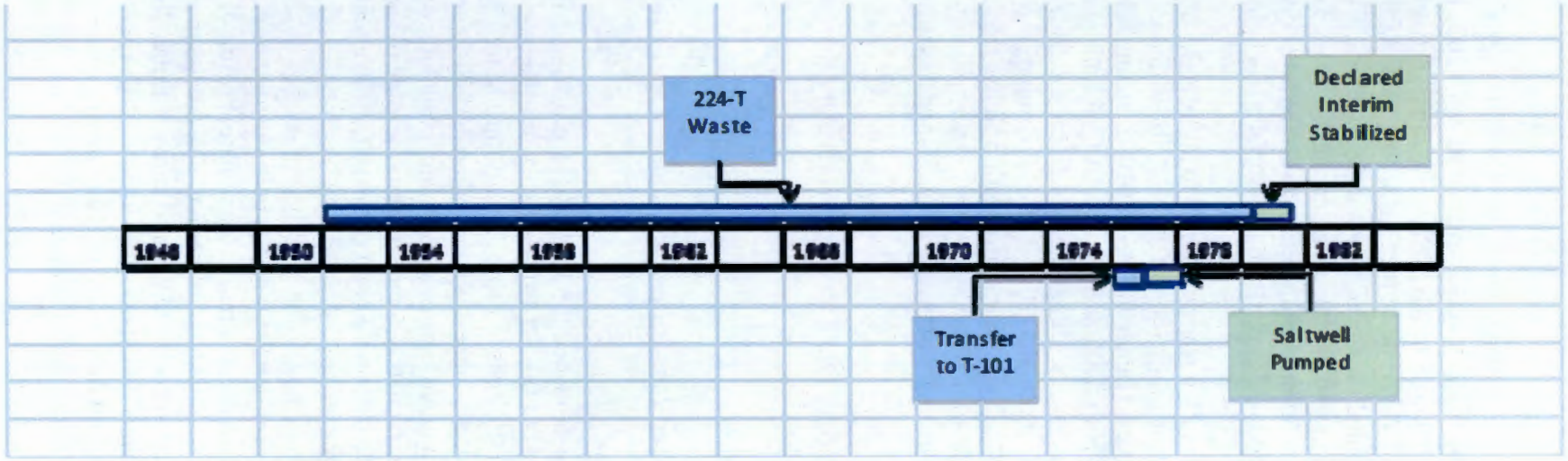
Tank T-201 is not part of any tank cascade. The tank went into service in 1952, receiving 224 waste from T Plant and was filled later that year. No other transfers into the tank occurred. Tank T-201 was declared inactive in 1976. Supernate pumping using a P-10 pump to remove liquids started in 1977 and the tank was declared interim stabilized in April 1981 (SD-WM-TI-356).

Tank T-204 was connected in a cascade to tanks T-203 and T-202. The tanks are connected by a 3-in. diameter line that enables waste transfers from one tank to the other. Because there is no vertical offset in the connection from one tank to the others, the tanks are not cascaded but rather tied together. Solids contained in the 224-T Concentration building waste from the lanthanum fluoride finishing process were allowed to settle in tanks T-204 through T-202. Liquid was gravity discharged from the last tank in the cascade (tank T-202) to cribs (RPP-13300, *Origin of Wastes in the B-200 and T-200 Series Single-Shell Tanks*). Tank T-204 went into service in 1952, receiving 224 waste from T Plant. The tank was filled later that year and transferred supernate to tank T-203. Tank T-204 was declared inactive in 1976, and interim stabilized August 10, 1981 (SD-WM-TI-356).

Tank T-203 first began receiving lanthanum fluoride finishing waste in 1952 from tank T-204. The tank was filled later that year. Supernatant waste was cascaded to tank T-202 during mid-1952. Supernate from tank T-203 was sent to tank 241-T-101 in 1976. Tank T-203 was declared inactive in 1976 and reported as interim stabilized in April 1981 (SD-WM-TI-356). HNF-SD-RE-TI-178 shows an interim stabilization evaluation dated July 1991.

Tank T-202 went into service in 1952, receiving 224 waste from tank T-203. Tank T-202 was filled later that year and transferred supernate to the cribs. Supernate was transferred to tank T-101 from 1976 through May 1979 when supernate was saltwell pumped in support of stabilization efforts. Tank T-202 was declared inactive in 1976 and was interim stabilized in August 1981.

Figure C6-1. T-200-Series Tanks Waste Operations Summary.



224 = 224 Building lanthanum fluoride process waste

C6.2 SURFACE LEVEL DATA

Figures C6-2 through C6-5 show historical quarterly waste levels for the T-200-series tanks from 1945 to 1993 (HNF-SD-WM-ER-351). The historical levels show that tanks T-202, T-203 and T-204 were filled above the overflow level in the mid- to late 1950s. Figures C6-6 through C6-9 show liquid level measurements from 1981 to 2013. The figures show that the liquid level in tank T-201 has gradually increased since 1996 and the liquid levels in tanks T-202, T-203 and T-204 have gradually decreased. Liquid level measurements show annual cycling. The gradual decrease in liquid level is accounted for by evaporation estimates and surface level cycling indicates the presence of retained gas, which could also contribute to surface level changes.

A Single-Shell Tank Level Decrease Evaluation Plan was developed to address the investigation of unexplained surface level and ILL decreases for the group of 20 SSTs identified in the plan with level decreases greater than -0.07 in. per year (Letter WRPS-1301005, "Contract No. DE-AC27-08RV14800 – Washington River Protection Solutions LLC Submittal of Single-Shell Tank Level Decrease Evaluation Plan to the U.S. Department of Energy, Office of River Protection"). This evaluation includes tanks T-203 and T-204. The evaluation of the 20 SSTs is scheduled to be completed by January 31, 2014. Preliminary information shows that surface level decreases in tanks T-203 and T-204 are accounted for by evaporation estimates. As shown in occurrence report evaluations, liquid level decreases may also be attributed to settling of the waste.

The following occurrence reports were prepared for liquid level increases and decreases in tanks T-201, T-202, T-203 and T-204.

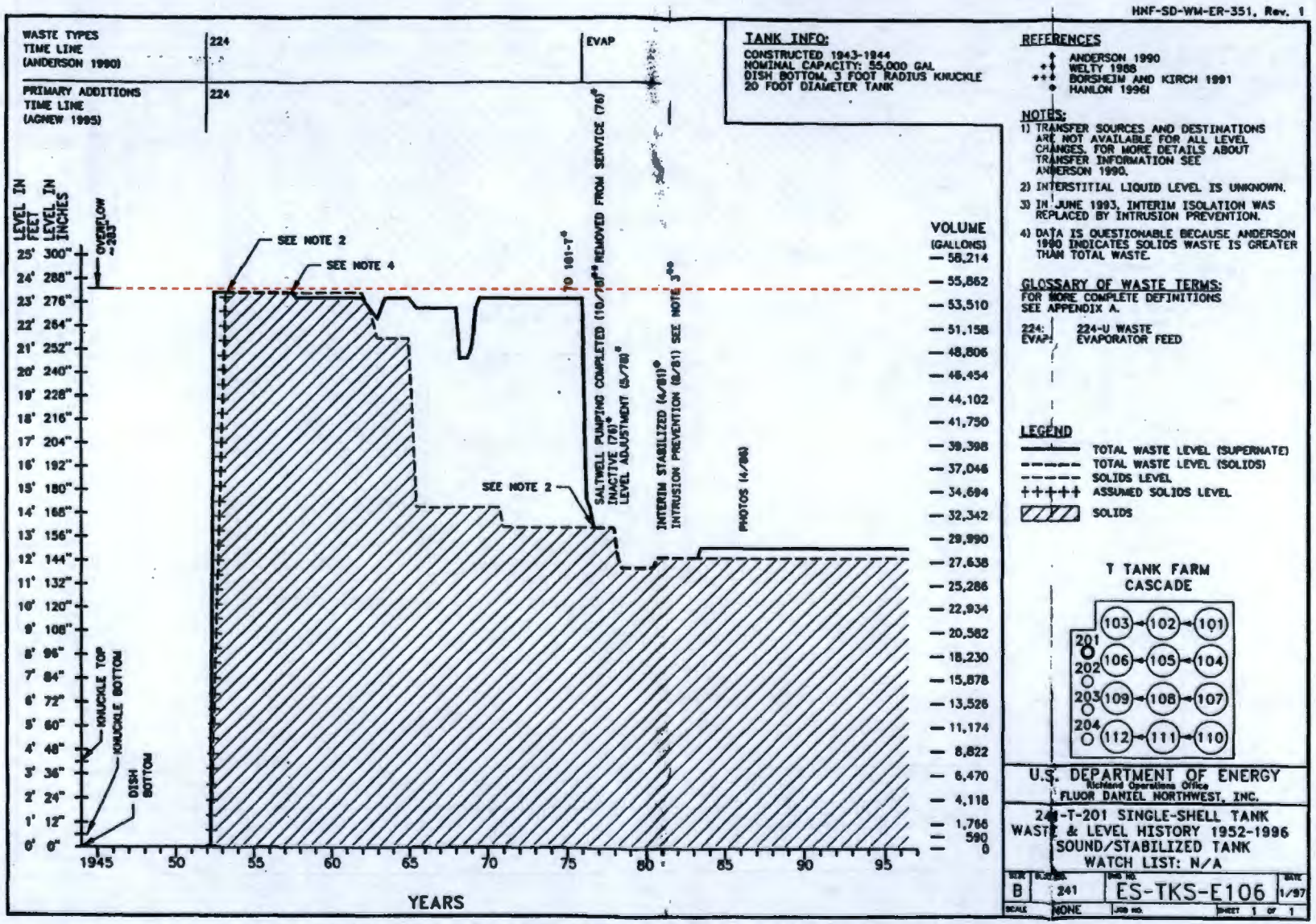
C6.2.1 Tank 241-T-201 Occurrence Reports

Occurrence Report 80-53, *Tank 201-T Liquid Level Measurement (Manual Tape) Exceeding the Increase Criterion*:

"A liquid level baseline of 144.00 inches was established for Tank 201-T on August 11, 1978. Liquid level measurements fluctuated between 144.00 and 145.50 inches until January 11, 1979 when readings stabilized at approximately 144.00 inches. From January thru March 1980 the liquid level increased from 144.00 inches to 145.75 inches. Photos taken 3/19/80 revealed a liquid pool around the saltwell casing and the manual tape pencil plummet touching down in damp sludge (sloping toward the saltwell) approximately 6 inches from the edge of the pool. On April 10, 1980, the liquid level reading increased .25 inches and on June 7, 1980 an additional .25 inches which exceeded the 2 inch increase criterion."

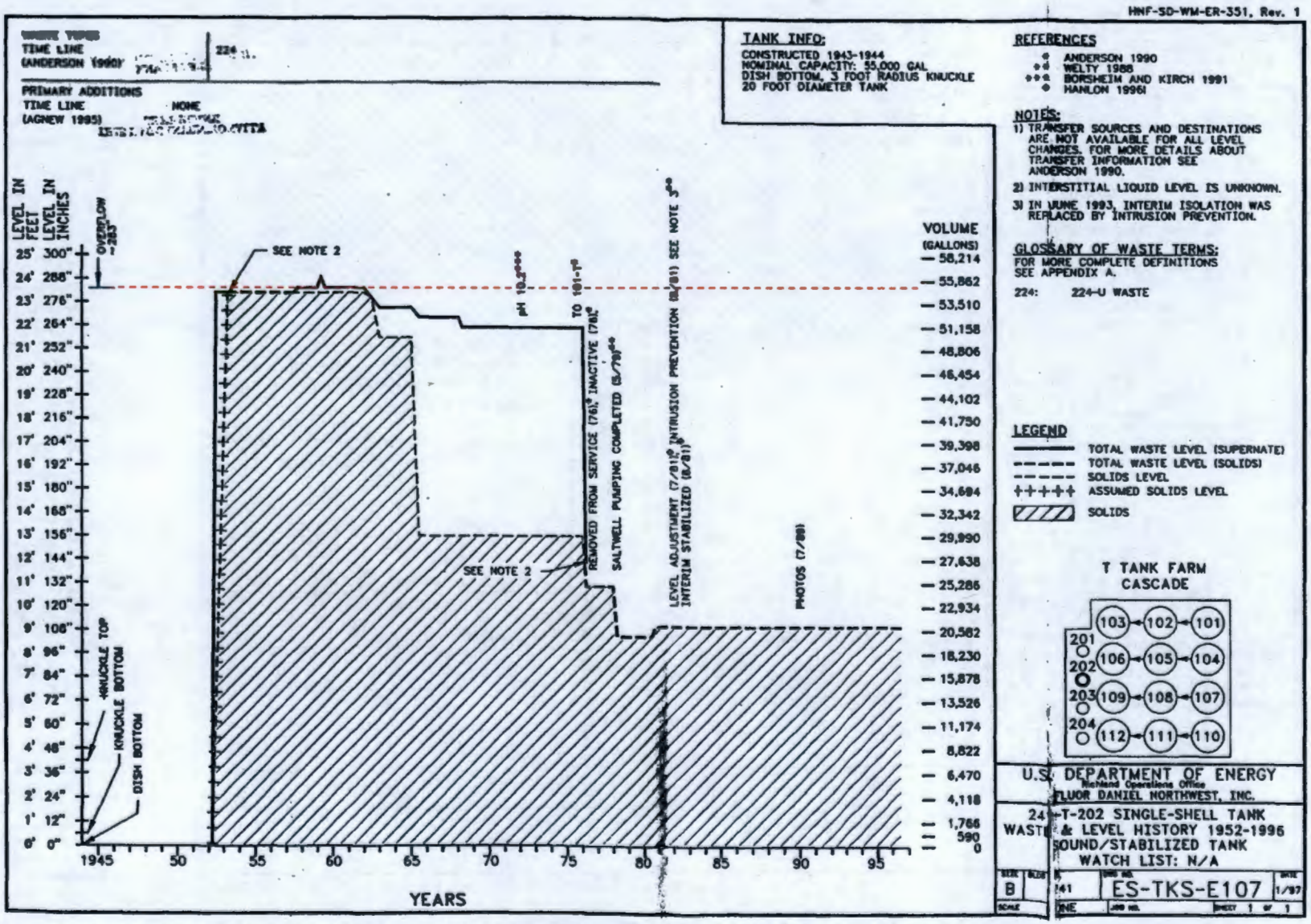
"In-tank photographs were taken on 6/11/80. Comparison with the previous photos revealed no real increase in the liquid pool size. The cause of the increase is the apparent result of the movement of sludge located directly below the manual tape plummet. The sludge in the plummet contact area has been moved or shifted in such a manner to cause a higher "liquid level" reading. The increase in the surface level readings which occurred in Tank 201-T, could be the result of surface water intrusion and the subsequent movement of the exposed solids. The volume of the intruding liquid is estimated to be less than 100 gallons."

Figure C6-2. Tank 241-T-201 Level History 1952 to 1993.



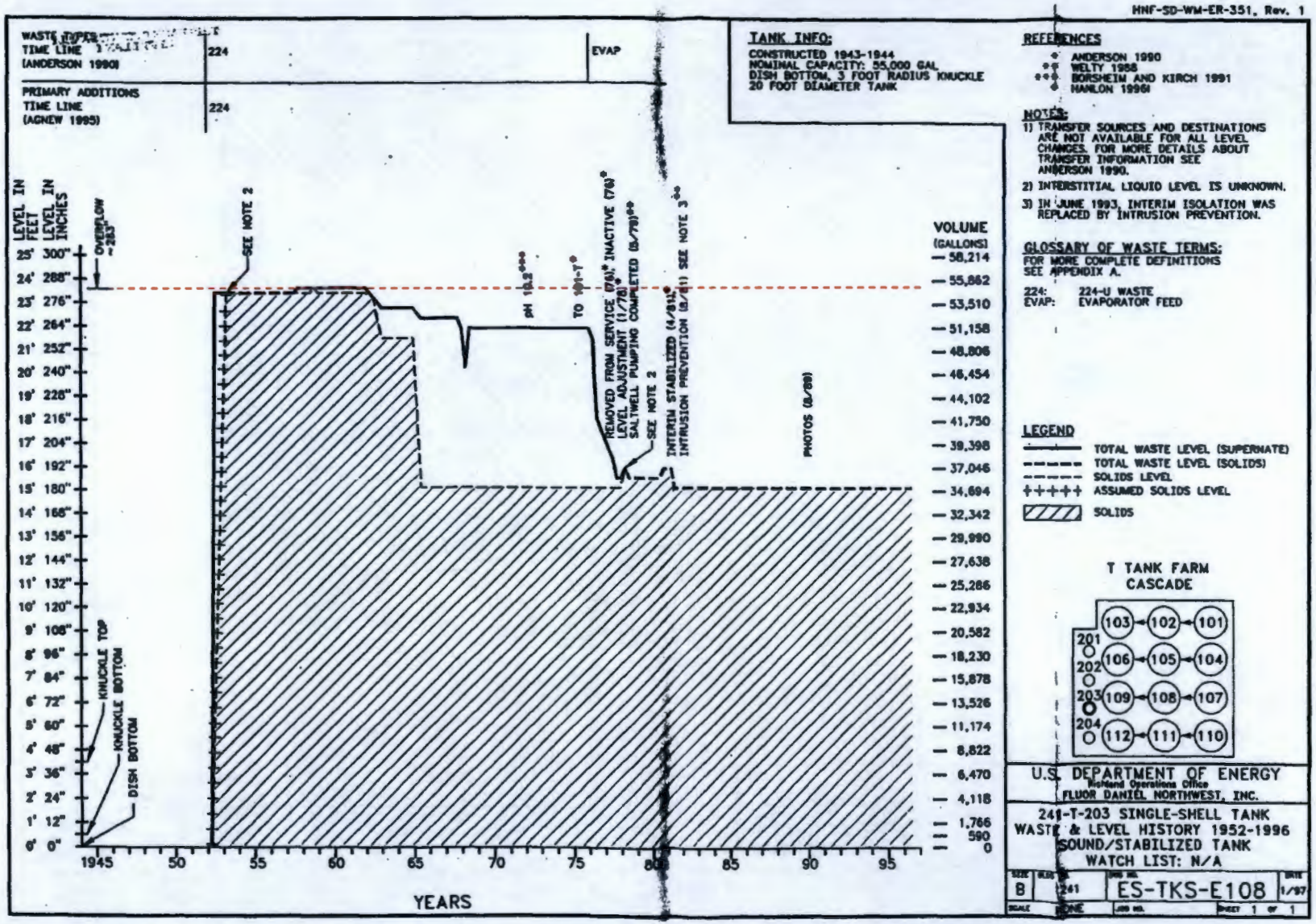
Source: HNF-SD-WM-ER-351, *Historical Tank Content Estimate for the Northwest Quadrant of the Hanford 200 West Area.*

Figure C6-3. Tank 241-T-202 Level History 1952 to 1993.



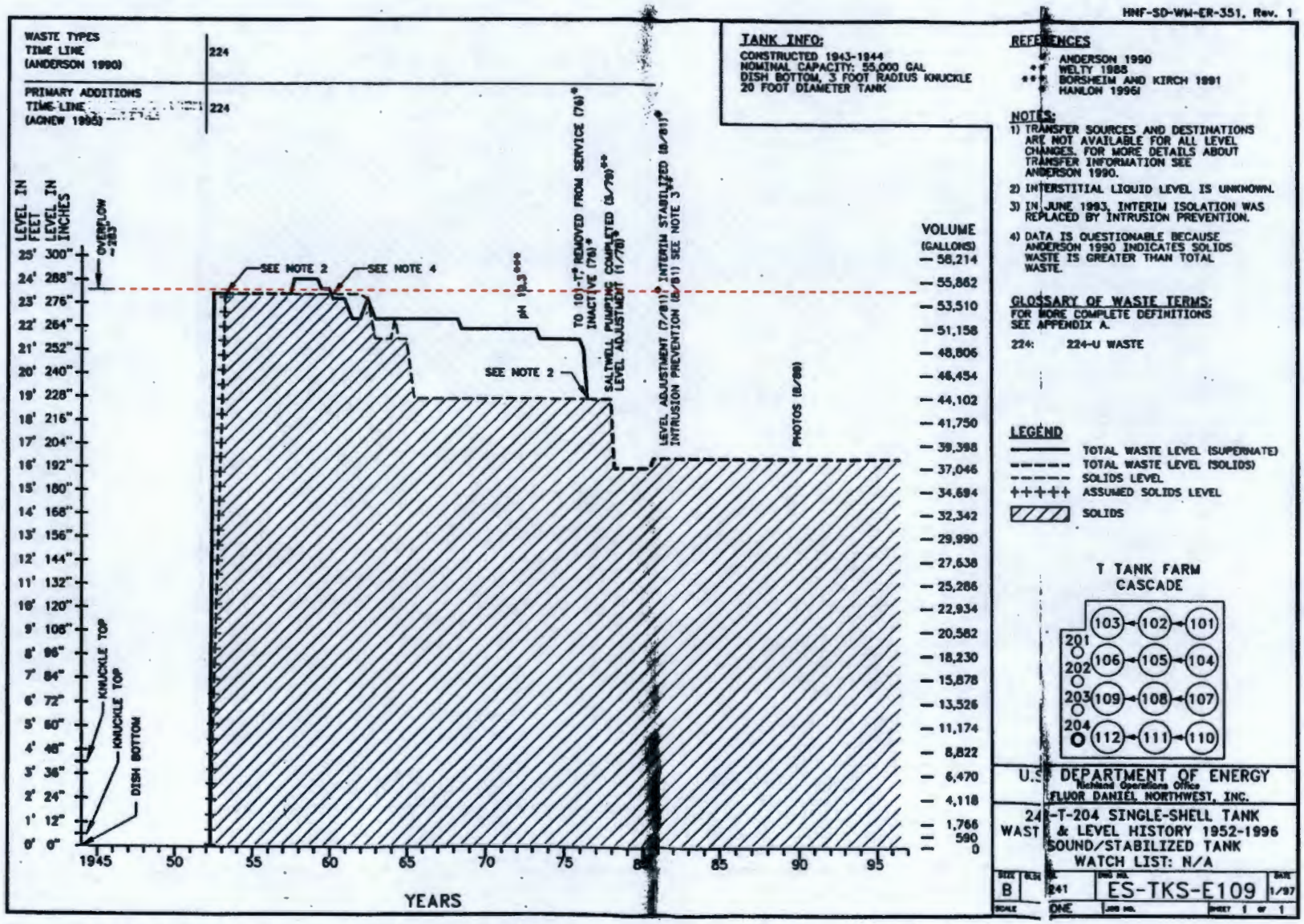
Source: HNF-SD-WM-ER-351, *Historical Tank Content Estimate for the Northwest Quadrant of the Hanford 200 West Area.*

Figure C6-4. Tank 241-T-203 Level History 1952 to 1993.



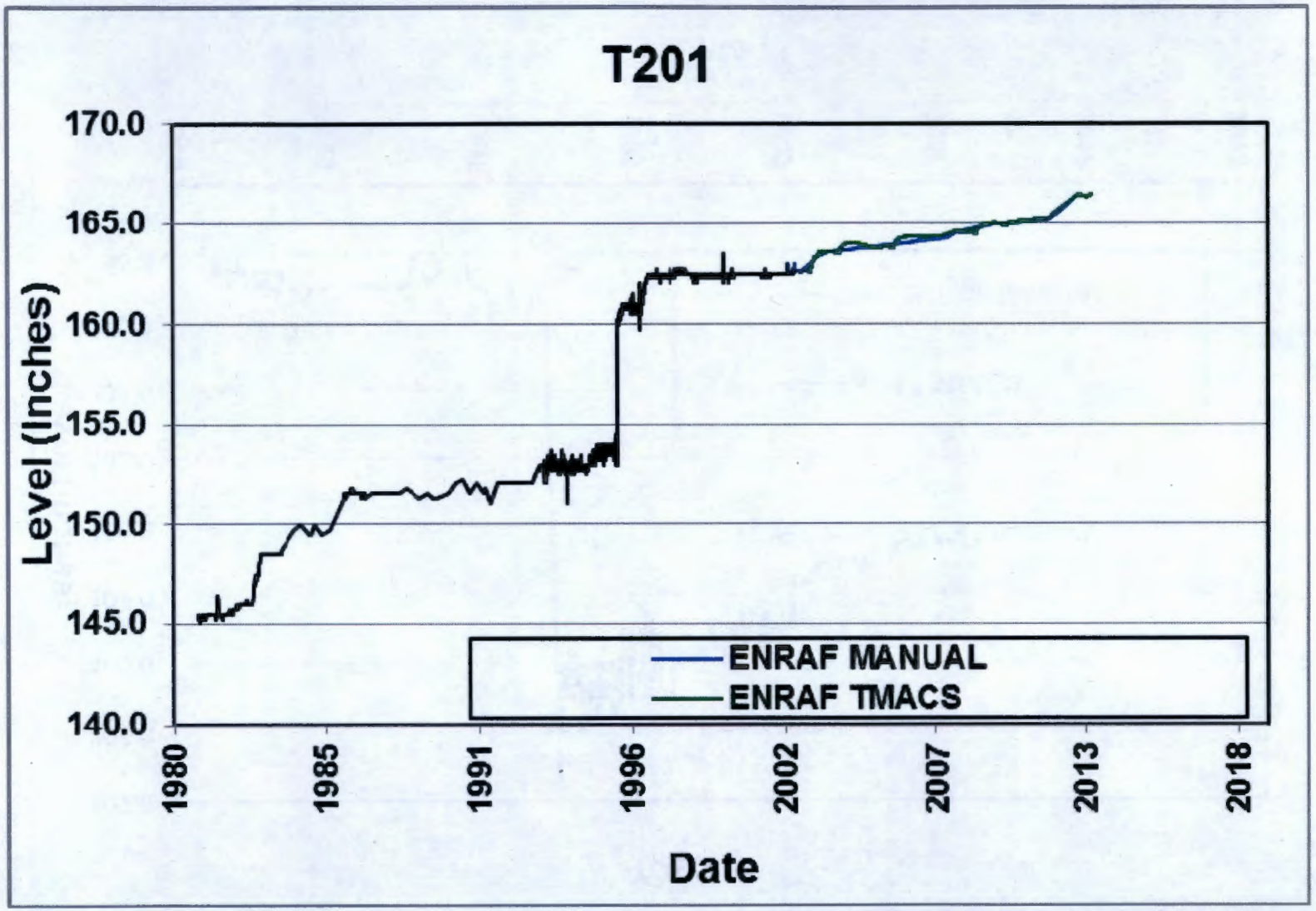
Source: HNF-SD-WM-ER-351, *Historical Tank Content Estimate for the Northwest Quadrant of the Hanford 200 West Area.*

Figure C6-5. Tank 241-T-204 Level History 1952 to 1993.



Source: HNF-SD-WM-ER-351, *Historical Tank Content Estimate for the Northwest Quadrant of the Hanford 200 West Area.*

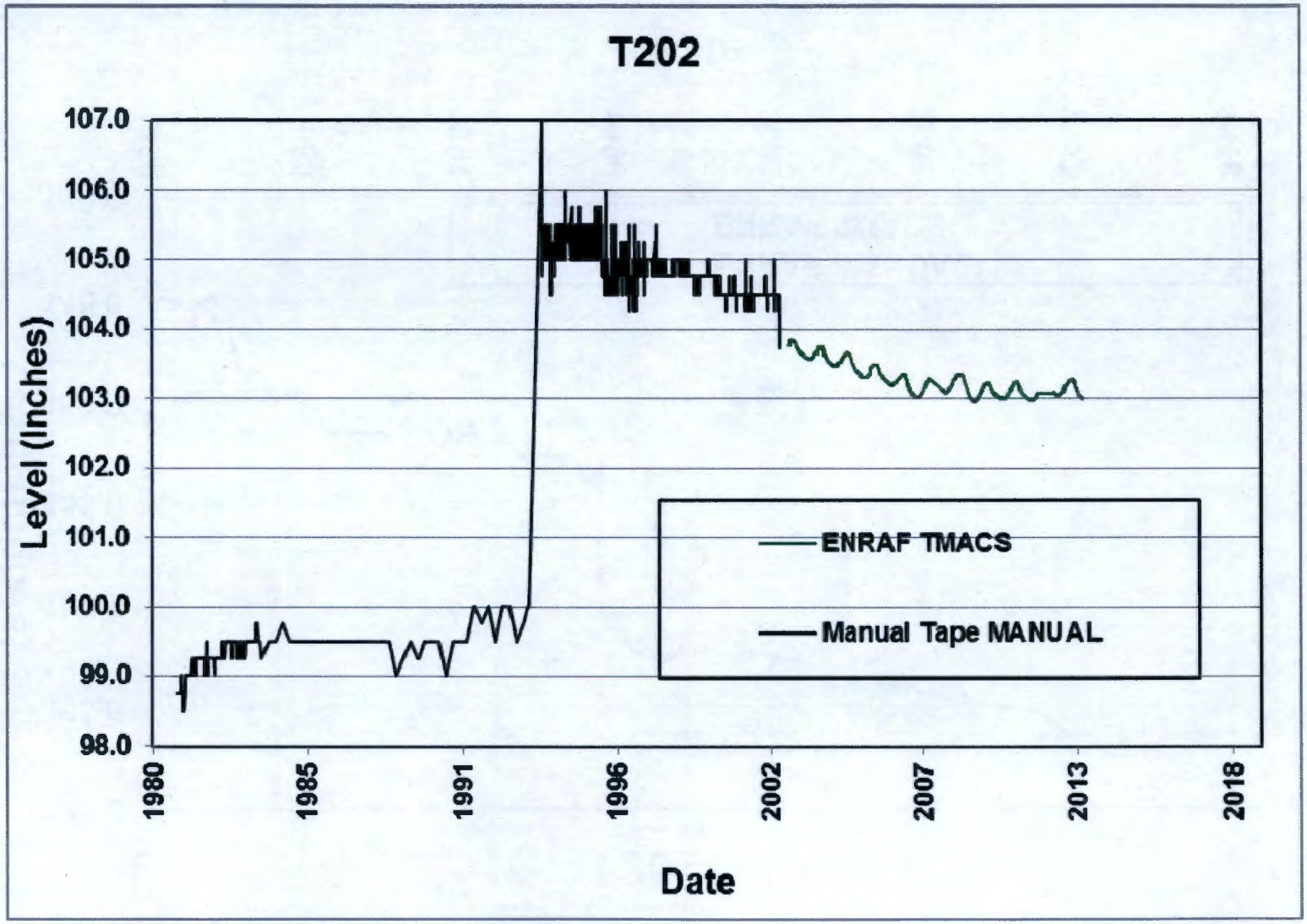
Figure C6-6. Tank 241-T-201 Surface Level Measurements: 1980 to 2013.



TMACS = Tank Monitor and Control System

Honeywell Enraf is a product of Honeywell Process Solutions, Strahlenbergerstr. 110-112, 63067 Offenbach, Germany.

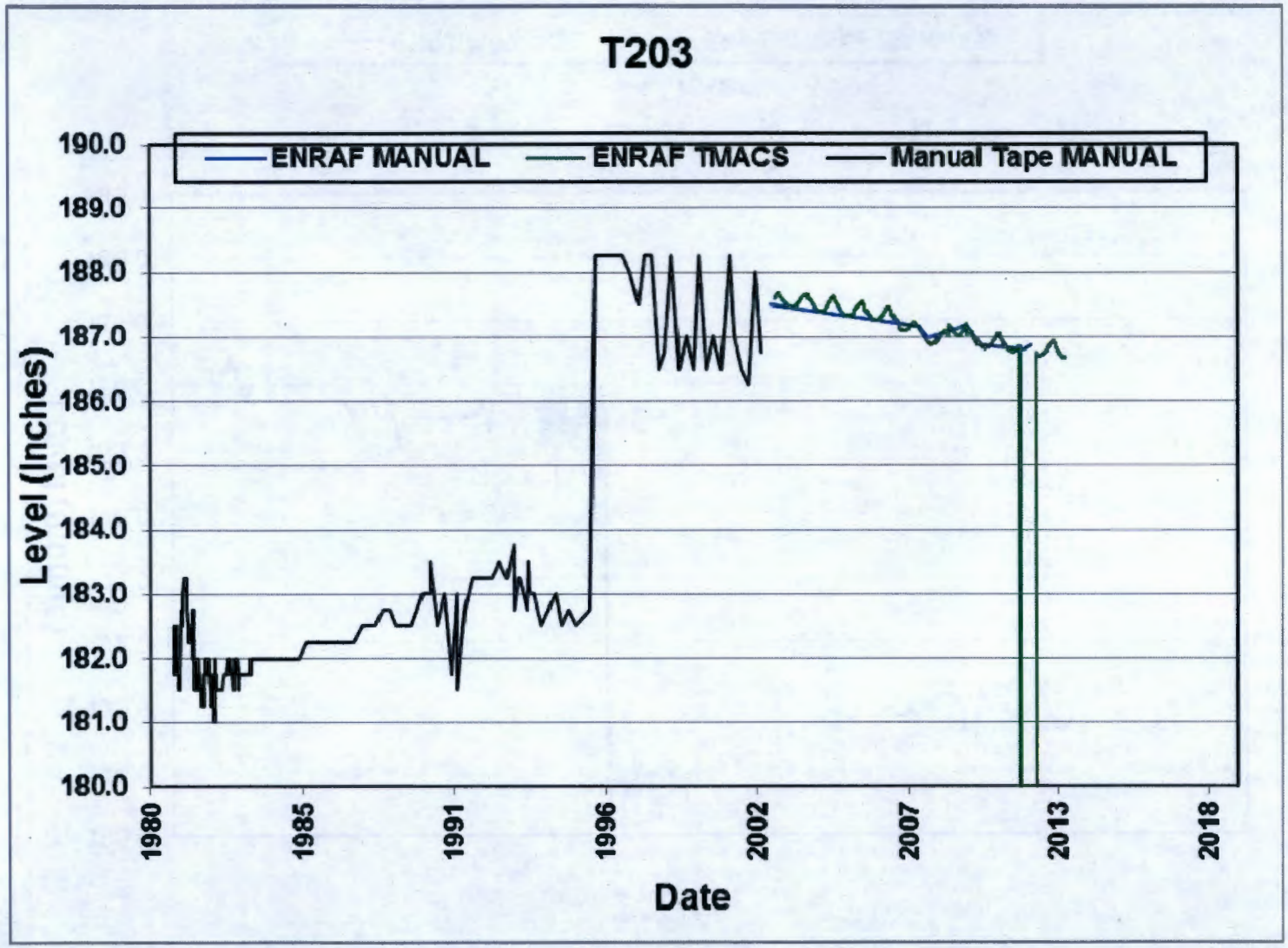
Figure C6-7. Tank 241-T-202 Surface Level Measurements: 1980 to 2013.



TMACS = Tank Monitor and Control System

Honeywell Enraf is a product of Honeywell Process Solutions, Strahlenbergerstr. 110-112, 63067 Offenbach, Germany.

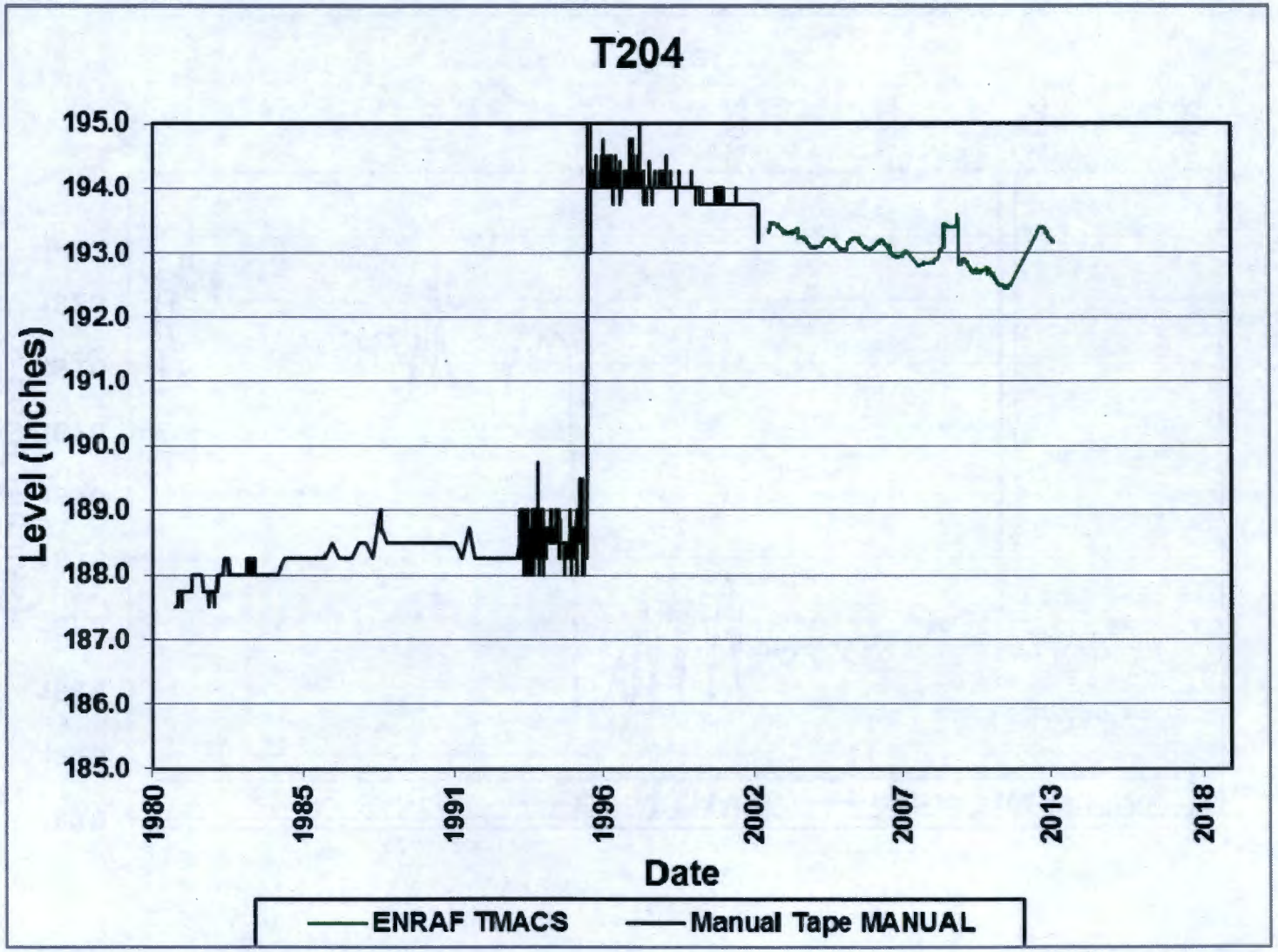
Figure C6-8. Tank 241-T-203 Surface Level Measurements: 1980 to 2013.



TMACS = Tank Monitor and Control System

Honeywell Enraf is a product of Honeywell Process Solutions, Strahlenbergerstr. 110-112, 63067 Offenbach, Germany.

Figure C6-9. Tank 241-T-204 Surface Level Measurements: 1980 to 2013.



TMACS = Tank Monitor and Control System

Honeywell Enraf is a product of Honeywell Process Solutions, Strahlenbergerstr. 110-112, 63067 Offenbach, Germany.

Unusual Occurrence Report 83-11, *Tank Farm Surveillance & Operations*:

"A surface level baseline of 146.00 inches was established for Tank 201-T on July 7, 1980. On March 19, 1983 a surface level measurement of 148.25 inches was obtained, exceeding the two inch increase criterion. Measurement fluctuations (145.00 to 146.00 inches) had been experienced until January 1983, when the slow surface level increase was first observed.

Photographs taken of Tank 201-T on 6-11-80 (because of surface measurement anomalies-OR 80-53) reveal a surface of soft sludge and a pool of liquid around the salt well. The manual tape pencil plummet was replaced with a donut plummet in 1980."

"In-tank photographs were requested to determine if the surface level increase was associated with surface solids or possible intrusions. In-tank photographs were taken on 04-01-83. Comparing these photos with those taken 06-11-80 confirmed a liquid level increase. The pool of liquid has increased in size and the manual tape donut plummet is now directly over liquid. The current liquid level is 148.50 inches."

EPDR 86-01, *Tank 201-T surface level measurement (M-Tape) exceeding the two inch increase criterion*:

"A liquid level baseline of 148.50 inches was established for Tank 201-T on October 4, 1983. On April 1, 1986 a quarterly liquid level measurement of 151.25 inches was obtained, thus exceeding the two inch increase criterion."

"Photographs of the 201-T Tank were taken on April 15, 1986. Views of the photographs revealed an intrusion.

This tank is on a quarterly liquid level monitoring frequency. The manual tape on January 3rd. was 146.25 inches, the next reading on April 1st. was 151.25 inches. At this time the tank was put on a daily monitoring routine, for a period of three weeks the level did not change.
A contributing factor towards this liquid intrusion is snow melt during the period from January to April.

Inspection of the grade area around the tank caisson appears that liquid could have seeped below the caisson and into the tank thru a drain. On May 15, 1986 a plastic membrane was laid down around the caisson and covered with approximately 4 inches of a sand and gravel mixture, sloping away from the tank and caisson."

C6.2.2 Tank 241-T-202 Occurrence Reports

No occurrence reports were found for this tank.

C6.2.3 Tank 241-T-203 Occurrence Reports

The following occurrence reports were issued for liquid level increases and decreases.

Occurrence Report 76-71, *Liquid Level Increase Exceeding Criteria for Tank 203-T*:

"A liquid level increase of 1.25 inches exceeds the action criteria of 1 inch. The baseline was established the day after completing a salt well transfer and the ensuing increase suggests a slow drain down from the outlying waste surfaces.

The liquid level stability during the period following the initial report indicates that the increase was a temporary phenomenon which followed a salt well transfer."

Occurrence Report 77-210, *Tank 203-T Liquid Level Decrease Exceeding Criterion*:

"A liquid level baseline of 192.25" was established for Tank 203-T on 10/17/77 following a salt well pumping on 10/15/77. On 12/19/77 the liquid level measurement was 190.50", exceeding the allowed 1.0" decrease beneath the baseline. The current liquid level measurement is 189.75" (02/16/78).

The cause of the decrease is attributed to settling of the sludge following salt well pumping."

OLDR 80-11, *Apparent Surface Level Decrease in Tank 203-T*:

"On 6/16/80 the Tank 203-T manual tape reading decreased to 182.50 inches (.25 inches from the previous day's reading of 182.75 inches) and exceeded the one inch decrease criterion from an established baseline. The baseline value for the tank is 183.75 inches and was established on 12/18/79. The manual tape pencil plummet was flushed and the reading increased 1.0 inch (or to .25 inches below the baseline value). On the following day (6/17/80) the manual tape reading returned to the previous day's reading of 182.50 inches, exceeding the one inch decrease criterion."

C6.2.4 Tank 241-T-204 Occurrence Reports

The following occurrence reports were issued for liquid level increases.

Occurrence Report 76-76, *Liquid Level Increase Exceeding Criteria for Tank 204-T*:

"A liquid level increase of 1.25 inches exceeds the action criteria of 1 inch. The baseline was established the day after completing a salt well transfer and the ensuing increase suggests a slow drain down from the outlying waste surfaces.

The liquid level has stabilized over the past month and the initial evaluation appears to be justified."

Occurrence Report 80-53:

"A liquid level baseline of 144.00 inches was established for Tank 201-T on August 11, 1978. Liquid level measurements fluctuated between 144.00 and 145.50 inches until January 11, 1979 when readings stabilized at approximately 144.00 inches. From January thru March 1980 the liquid level increased from 144.00 inches to 145.75 inches. Photos taken 3/19/80 revealed a liquid pool around the saltwell casing and the manual tape pencil plummet touching down in damp sludge (sloping toward the saltwell) approximately 6 inches from the edge of the pool. On April 10, 1980, the liquid level reading increased .25 inches and on June 7, 1980 an additional .25 inches which exceeded the 2 inch increase criterion."

In-tank photographs taken on 6/11/80 indicate no liquid level increase and verify the increase was the result of solids movement in the vicinity of the measurement plummet."

C6.3 DRYWELL DATA

No drywells monitor the 200-Series tanks. Several drywells were installed and monitored around the T-7 and T-32 cribs in T Farm near the T-200-series tanks. These drywells show no sign of waste releases from the T-200-series tanks. However, given the distance of the drywells from the tanks and the low level of gamma activity for 224 waste in the tanks, it is unlikely that anything would be detected from the 200-series tanks even if leaks occurred.

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