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Revision 0

HANFORD BX-FARM LEAK ASSESSMENTS 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 past leaks in the 241-BX Tank Farm. This revision of the report will be distributed for public review as appropriate and comments will be incorporated in Revision 1.

Tank waste loss events were reassessed for single-shell tanks 241-BX-101, 241-BX-102, 241-BX-108, 241-BX-110 and 241-BX-111 which have previously been suspected of releasing waste to the ground. Table ES-1 summarizes the results of the tank waste loss reassessment for these single-shell tanks and provides a comparison to the waste loss estimates contained in HNF-EP-0182, Rev. 261, *Waste Tank Summary Report for Month Ending December 31, 2009*. Where known, the estimated volume of waste lost and the waste composition (type) was evaluated to update the estimated inventory of constituents released to the soil to update current estimates in RPP-26744, *Hanford Soil Inventory Model, Rev. 1*. In addition, tanks currently assumed as "sound" were reviewed to assess the potential for loss of waste containment. This review resulted in recommending further investigation of the source of activity near tank 241-BX-107.

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-BX Tank Farm was reviewed to determine if additional information exists for the unplanned releases within the 241-BX Tank Farm that are not associated with tank waste loss events. No significant new information was located for these unplanned releases. However, potential new unplanned releases as a result of pipeline failures were identified through review of the operational histories for the 241-BX Tank Farm, as summarized in Section 5.0. Insufficient information was available to estimate a volume or inventory of tank waste potentially discharged to the soil from most of the identified pipeline failures.

Table ES-1. Summary of Tank Waste Loss Events (2 sheets)

Tank	Description	HNF-EP-0182 (Rev. 261) Estimate	Revised Estimate[1]
241-BX-101	BX-101 was suspected of leaking based on high gamma-ray activity detected in drywell 21-01-01 in 1972. This activity was likely due to a leak from a riser in the sluicing pit and probably not due to a breach in the tank steel liner. SIM estimate of 4,000 gal should be revised to use 900 gal and 700 Ci of cesium-137 (^{137}Cs). Other analyte inventories use the HDW CSR waste type (B-Plant IX) divided by 2 based on ^{137}Cs measurements.	No estimate	<900 gal <700 Ci ^{137}Cs Re-assess tank leak classification per TFC-ENG-CHEM-D-42
241-BX-102	BX-102 was suspected of leaking based on high gamma-ray activity in drywell 21-02-04 in 1972. Two leaks from the spare inlet ports likely occurred. The first release occurred in 1951 of 91,600 gal of MW1 supernatant and 20,000 kg of uranium. The inventory estimates in SIM appear to be reasonable for the 1951 release. A second release occurred between 1962 and 1970. Based on available data a ^{137}Cs inventory of 4,000 to 40,000 Ci with a leak volume of 5,000 to <50,000 gal was estimated for the second release. The upper estimate for releases from BX-102 is ~140,000 gallons and 40,000 Ci of ^{137}Cs and 20,000 kg of uranium. The additional release after 1962 should be added to SIM. For other constituents for the later release multiply a leak volume of 5,000 gal by 1/2 the HDW concentration estimates for a IX(CSR) waste type.	70,000 gal	<140,000 gal 40,000 Ci ^{137}Cs Re-assess tank leak classification per TFC-ENG-CHEM-D-42
241-BX-108	BX-108 was declared a leaking tank in 1974 based on an increase in gross gamma activity in drywell 21-08-06 and declining liquid levels in the tank. However, liquid level decreases were suspect and two potential sources (tank overfill and transfer line leaks) for activity near tank BX-108 were identified in addition to a potential tank leak. There was no basis for an inventory estimate for this tank.	2,500 gal	No basis for estimate Re-assess tank leak classification per TFC-ENG-CHEM-D-42
241-BX-110	Tank 241-BX-110 was declared "questionable integrity" in 1976 based on an increase in drywell gross gamma activity in drywells 21-10-03 and 21-10-05. The increase may be due to an old transfer line leak, spare inlet overfills or a tank leak. Because the data suggests two potential leak sources (tank over flow and transfer line leaks) for activity near tank BX-110.	No estimate	No basis for estimate Re-assess tank leak classification per TFC-ENG-CHEM-D-42

Table ES-1. Summary of Tank Waste Loss Events (2 sheets)

Tank	Description	HNF-EP-0182 (Rev. 261) Estimate	Revised Estimate[1]
241-BX-111	Tank 241-BX-111 was declared "questionable integrity" in 1976 based on an increase in gross gamma activity in drywells 21-11-03, 21-11-04, 21-11-05, and 21-11-07 and a liquid level decrease in 1974. Liquid level decreases were attributed to stabilization of the crust surface after transfers. The increased activity may be due to an old transfer line leak, spare inlet overfills or a tank leak.	No estimate	No basis for estimate Re-assess tank leak classification per TFC-ENG-CHEM-D-42
Other BX Farm Single-Shell Tanks	Many of the tanks were overfilled and some show activity in nearby drywells that has previously been attributed to operations spills, line leaks or leaks from another tank. No evidence of a liner failure for any of these tanks was found. Additional investigation of the source of activity near tank BX-107 was recommended.	NA	NA

[1] Except as noted, ^{137}Ci inventories are decayed to January 1, 2001 consistent with values in SIM.

Reference: HNF-EP-0182, *Waste Tank Summary Report for Month Ending December 31, 2009*, Rev. 261.

HDW = Hanford Defined Waste
MW1 = Metal waste from the bismuth phosphate process, 1944 to 1951
IX = ion exchange (waste)
SIM = Hanford Soil Inventory Model

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Abbreviations and Acronyms

AEC-RL	Atomic Energy Commission-Richland Operations
ARHCO	Atlantic Richfield Hanford Company
bgs	below ground surface
CF	concentration factor
DCRT	double contained receiver tank
DE	diatomaceous earth
DOE	U.S. Department of Energy
DOE-ORP	DOE Office of River Protection
DST	double-shell tank
Ecology	Washington State Department of Ecology
FIC	Food Instrument Corporation
GPR	ground penetrating radar
HDW	Hanford Defined Waste
HGL	HydroGeologic, Inc.
HLM	Historical Leak Model
HLW	high-level waste
HTCE	Historical Tank Content Estimate
ILL	interstitial liquid level
KUT	potassium, uranium, thorium
LOW	liquid observation well
ORP	U.S. Department of Energy, Office of River Protection
PUREX	Plutonium Uranium Extraction (Plant)
R2	Reduction Oxidation high-level waste (1959-1966)
REDOX	Reduction Oxidation
SACS	Surveillance Analysis Computer System
SGE	Surface Geophysical Exploration
SGLS	spectral gamma logging system
SIM	Hanford Soil Inventory Model

SST	single-shell tank
TBP-UR	tributyl phosphate-uranium recovery
UPR	unplanned release
WIDS	Waste Information Data System
WMA	Waste Management Area
WRPS	Washington River Protection Solutions, LLC

Units

cps	counts per second
Ci	Curie
kgal	kilogallon (10^3 gallons)
rad	radiation adsorbed dose

Waste Type Abbreviations

1C	first cycle waste
1C-FeCN	treated 1C (ferrocyanide) waste
B	B Plant high level waste
BL	B Plant low level waste
CW	cladding (coating) waste
DW	decontamination waste
EB	Evaporator Bottoms
EVAP	Evaporator feed (waste)
IX	ion exchange waste
OWW	organic wash waste
P	PUREX waste
R	REDOX waste
RIX	ion exchange waste from supernatant
T2-SltCk(P2')	242-T Evaporator saltcake waste type (1965-1976)
TBP	tributyl phosphate waste
U	Uranium Waste also called TBP Waste

1.0 INTRODUCTION

Vadose zone inventories are estimated by multiplying the leak volume by the contaminant concentration in the solution leaked. Solution concentrations are based on process knowledge of the waste composition in the tank at the time the release occurred. For some major tank leaks and unplanned releases (UPRs), historical records confirm the waste loss event and provide a strong technical basis for leak volume and inventory estimates. However, for many tank leaks and UPRs little data is available.

Numerous studies and investigations have estimated the inventory of contaminants in the tank farms vadose zone. Document HNF-EP-0182, *Waste Status Summary Report for Month Ending December 31, 2009* provides the current official tank leak volume estimates, but it does not provide associated inventory estimates or UPR volumes. Tank leak volume estimates reported in HNF-EP-0182 have not been updated for many years. Document RPP-23405, *Tank Farm Vadose Zone Contamination Volume Estimates* summarizes vadose zone tank leak characterization and investigations. The information is consistent with many of the tank leak volume estimates listed in HNF-EP-0182 and provides UPR volume estimates. However, information in RPP-23405 shows large differences in estimated leak volumes, both higher and lower, compared to some tank leak volume estimates in HNF-EP-0182. The RPP-23405 volume estimates were used in RPP-26744, *Hanford Soil Inventory Model, Rev. 1* (SIM) to estimate leak inventories for DOE/ORP-2005-01, *Initial Single-Shell Tank System Performance Assessment for the Hanford Site*. RPP-23405 does not address volume uncertainties and some of the leak volume estimates, data interpretations, and conclusions presented in RPP-23405 required further review.

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-BX Tank Farm. Current SIM 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 Office of River Protection (DOE-ORP) and the Tank Farm Operations Contractor was assembled to review available information relating to waste loss events in the 241-BX Tank 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
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 in-tank (i.e., surface liquid level and liquid observation well) data 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 and Projects Division
Bob W. Lober	U.S. Department of Energy Office of River Protection	Tank Farms Programs and Projects Division
Beth Rochette	Washington State Department of Ecology	Regulatory oversight (primary focus: Near surface unplanned releases)
Marcus I. Wood	CH2M HILL Plateau Remediation Contract	Knowledge and experience in vadose zone and groundwater monitoring processes and data

In accordance with RPP-32681, the following steps were conducted in reassessing waste losses within the 241-BX Tank Farm.

- Collect information and data regarding past tank leaks in BX-Farm (see RPP-32681).
- Collect information and data regarding UPRs, including pipeline leaks, spills, and near surface contamination, in BX-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, Hanford Defined Waste (HDW) model, etc.

- Combine waste leak volume with waste composition to estimate radionuclide and chemical inventory of tank leaks and UPRs.

3.0 BACKGROUND

Approximately 57 million gal of radioactive waste from chemical and plutonium processing operations are stored in 177 underground storage tanks on the Hanford Site. Of these tanks, 149 are single-shell tanks (SST), which consist of a single steel liner inside a concrete shell. 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 (DST), with eventual transfer for treatment in the Waste Treatment and Immobilization Plant.

3.1 241-BX TANK FARM DESCRIPTION

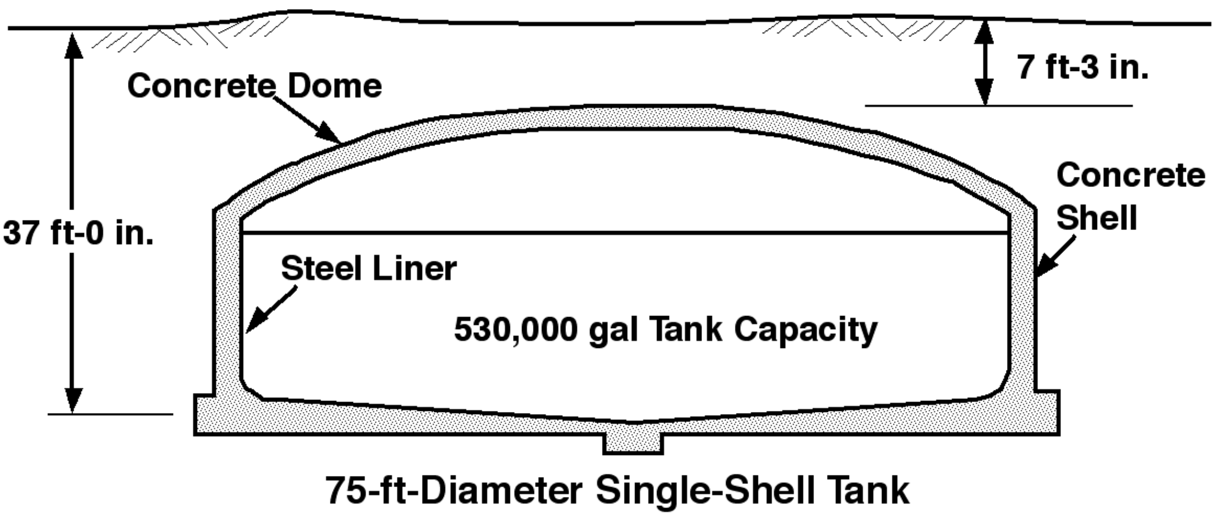
The 241-BX Tank Farm is located in the northwest portion of the 200 East Area, north of B Plant and south of the 241-BY Tank Farm and consists of twelve 100-series single-shell underground waste storage tanks. The BX-Farm tanks were constructed between 1946 and 1947 to store high-level radioactive waste generated by chemical processing of irradiated uranium fuel at the chemical separation plants.

The BX-Farm tanks are entirely below the ground surface and are covered with ~8 ft of backfill material. The base of the BX-Farm excavation is ~42 ft below ground surface (bgs), allowing space for footings and other construction requirements.

The BX-Farm tanks (Figure 3-1) are domed, steel-lined tanks, 75 ft in diameter, with a maximum operating height (cascade overflow level) of 188 in. above the center of the dished tank base; the center of the dished base is 1 ft lower than the base perimeter. Each tank is covered by a 1.25-ft.-thick reinforced concrete shell that extends ~14 ft above the maximum operating level of the tank. The storage portion of the tank is lined with a carbon-steel liner. The steel liner on the tank's side extends ~1.5 ft above cascade-line connections. The upper portion of the liner is constructed of 1/4-in.-thick steel plating, and the lower portion is constructed of 5/16-in.-thick plating. The 3/4-in.-thick bottom plating is joined to the side plating with several curved and mitered sections (knuckles) of 3/8-in.-thick plating. The knuckle sections allow for expansion of the bottom liner. The reinforced concrete shells are ~12 in. thick along the sides and in the domed portion of the shell. The inside of the top dome is unlined. Ten to twelve ft of backfill materials cover the tank top domes (WHC-SD-WM-ER-311, S*upporting Document for the Historical Tank Farm Content Estimate for BX-Tank Farm* and H-2-602, *Composite Tank Typical Details Concrete 241-BX*).

The BX-Farm tanks are connected in four three-tank cascade series. Cascade-overflow lines are connected in a series between the tanks at a depth of approximately 23 ft below the ground surface. These cascade series consist of tanks 241-BX-101 (BX-101), 241-BX-102 (BX-102), and 241-BX-103 (BX-103); 241-BX-104 (BX-104), 241-BX-105 (BX-105), and 241-BX-106 (BX-106); 241-BX-107 (BX-107), 241-BX-108 (BX-108), and 241-BX-109 (BX-109); and 241-BX-110 (BX-110), 241-BX-111 (BX-111), and 241-BX-112 (BX-112). The tanks in the cascade series are arranged with each successive tank sited at a lower elevation (with the receiving tank 1 ft lower than the feed tank), creating a gradient that allowed fluids to flow from one tank to another as the tanks were filled. The BX-Farm tanks overflow to the BY-Farm tanks, to tanks 241-BY-101 (BY-101), 241-BY-104 (BY-104), 241-BY-107 (BY-107), and 241-BY-110 (BY-110). The remaining liquid was cascaded to cribs when the last tank in the cascade series was filled (WHC-SD-WM-ER-311). Figure 3-2 shows the elevation of cascade lines (Nozzles A and B), spare inlet ports (Nozzle C) and risers for the 100-series BX-Farm tanks.

Figure 3-1. Simplified Sketch of 241-BX Farm Tank



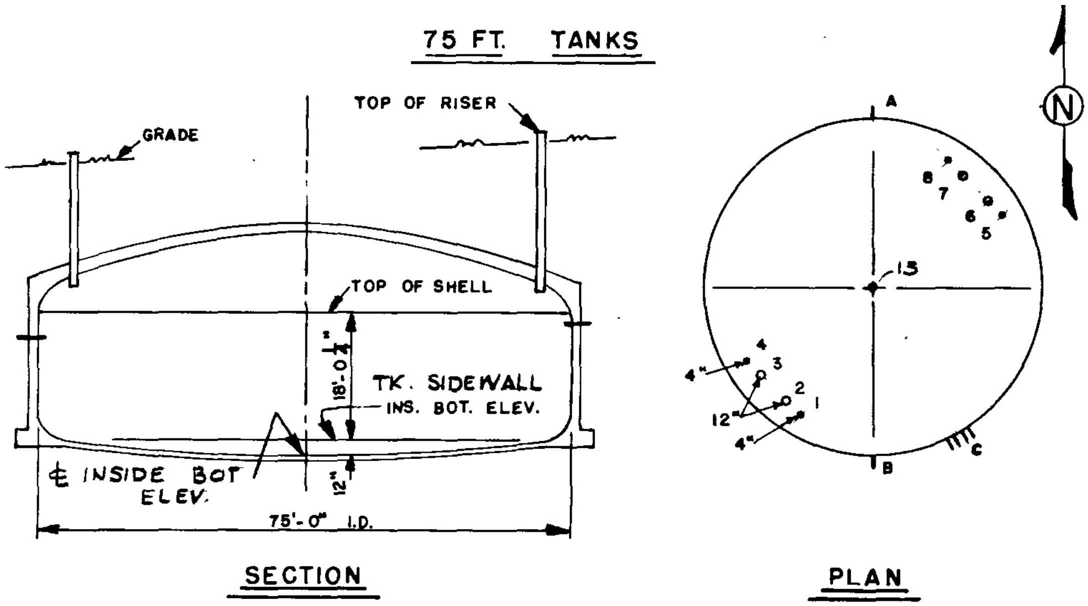
3.2 TANK LEAK DETECTION MONITORING

Historically, SSTs were monitored by two independent methods; in-tank and ex-tank monitoring. Monitoring was conducted both to identify liquid level decreases (indicating possible tank leaks or releases to the soil) and liquid level increases (indicating possible entry of liquids into the tanks or tank intrusions). 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. Routine monitoring of gross gamma activity in drywells near the SSTs provided the second leak detection method. A few drywells were constructed in BX-Farm as early as 1947, but most drywells were constructed in the 1970s. 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*).

3.2.1 In-Tank Monitoring

Originally liquid levels were measured using pneumatic dip tubes (HW-10475 C-DEL, *Hanford Technical Manual Section C*, page 908). This practice was later replaced and a manual tape with a conductivity electrode was used to detect the liquid surface (H-2-2257, *Conductor Reel for Liquid Level Measurement*). The biggest limitations of the manual tape measurements were failures of the electrodes, solids forming on the electrode and the surface of the waste within the tank as well as measurement precision. The statistical accuracy of the manual tape and electrode measurement technique was 0.75 in. (~2,060 gal), as determined in July 1955 (HW-51026, *Leak*

Figure 3-2. 241-BX Tank Farm Cascade Line, Spare Inlet Line and Riser Elevations



TANK NO.	TANK SIDEWALL INS. BOT. ELEV.	RISER NO.								
		1	2	3	4	5	6	7	8	13
241-BX-101	617.0	657.50	657.34					655.96	657.02	
241-BX-104	617.0		657.53					657.09	657.11	
241-BX-107	617.0	657.54	657.57	657.57	657.39	657.11	657.13	657.06	657.09	
241-BX-110	617.0	657.51	657.53	657.55	657.49	657.10	657.08	657.10	657.08	656.76
241-BX-102	616.0	656 52	656.35					656.10	656.04	
241-BX-105	616.0	656.47				656.01		656.05	656.07	655.95
241-BX-108	616.0	656.55	656.51	656.53	656.53	656.10		656.13	656.10	656.55
241-BX-111	616.0	656.55	656.57	656.57	656.48	656.09	656.10	656.10	656.05	655.78
241-BX-103	615.0	655.49	655.37					655.03	655.03	
241-BX-106	615.0	655.43				655.01		655.09	654.95	654.99
241-BX-109	615.0	655.52	655.53	655.48	655.48	654.97	655.04	655.06	655.06	
241-BX-112	615.0	655.51	655.60	655.54	655.55				655.09	655.35

TANK NO.	"A" NOZZLE	"B" NOZZLE	"C" NOZZLES
101,104,107,110	INV. 632.96	NONE	INV. 633.33
102,105,108,111	INV. 631.96	INV. 632 21	INV. 632.33
103,106,109,112	INV. 630.96	INV. 631 21	INV. 631.33

FOR AVAILABLE RISERS SEE H-2-37852

Reference: H-2-1745, *Tank Farm Riser & Nozzle Elev.*, Sheet 1, Rev. 6.

Detection -- Underground Storage Tanks, page 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 in the waste tanks that contained boiling wastes (e.g., 241-A, 241-AX and 241-SX Tank Farms), 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 leak, evaporation, barometric pressure changes or physical changes in waste surfaces (i.e., floating solids, surface collapse or gas release events). Liquid observation wells (LOWs) were installed in many of the tanks to measure interstitial liquid levels (ILLs) using gamma and neutron probe measurements.

All of the BX-Farm tanks were initially monitored using manual tape and or Food Instrument Corporation conductivity gauge (FIC) surface level measurements. In 1996 FIC gauges were removed and replaced by ENRAFs (see below) in all of the BX-Farm tanks. Liquid observation wells for neutron and gamma ILL measurements were installed in tank BX-110 in about 1985 and in tanks BX-109 and BX-111 in 2002. There are no LOWs in any other BX-Farm tanks.

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

ENRAF™. The ENRAF[1] 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 free liquid surface 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 inch 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 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 (MT). The manual tape 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.

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[1] ENRAF - Nonius Series 854 is a trademark of ENRAF-Nonius, N.V. Verenigde Instrumentenfabrieken, ENRAF Nonius Corporation Netherlands, Rontegenweg 1, Delft, Netherlands.

The FIC 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 gages.

Interstitial Liquid Level. Levels of waste phases can be measured by using geophysical techniques deployed inside a LOW placed in a tank. The LOWs were installed in tanks containing permeable waste (i.e., tanks containing salt cake 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 when the liquid level was moved between two waste layers with different permeability (e.g., saltcake and sludge). Updated methodologies have improved the accuracy of current LOW measurements.

3.2.2 Ex-Tank Monitoring

Seventy-four monitoring drywells were installed around the 12 tanks in BX-Farm for leak detection in the vadose zone (Table 3-1). Five "00" drywells located some distance from the tanks and drywell 27-01-11 were drilled in 1947 and 1948. No additional wells were drilled until 1967. Fifteen of the drywells drilled after 1967 were drilled to assess high activity near tank 241-BX-102. Most of the wells were drilled to depths of 100 ft or less (SD-WM-TI-356, *Waste Storage Tank Status and Leak Detection Criteria*). Figure 3-3 shows the relative positions of the BX-Farm tanks and vadose zone monitoring drywells installed around them between 1947 and 1973.

Table 3-1. 241-BX Tank Farm Drywells (3 sheets)

Well No.	Well ID	Well Name	Drill Date	Drill Depth (ft)
21-00-01	A6871	299-E33-63	30-Nov-47	150
21-00-02	A6950	299-E33-142	30-Jun-70	100
21-00-05	A6870	299-E33-62	30-Nov-47	150
21-00-07	A6885	299-E33-77	28-Feb-48	150
21-00-09	A6900	299-E33-92	30-Apr-67	75
21-00-11	A6873	299-E33-65	30-Nov-47	150
21-00-21	A6886	299-E33-78	28-Feb-48	150
21-00-22	A6901	299-E33-93	30-Apr-67	75
21-01-01	A6952	299-E33-144	31-Jul-70	100
21-01-02	A6943	299-E33-135	31-May-70	100
21-02-01	A6937	299-E33-129	30-Apr-70	100
21-02-03	A6953	299-E33-145	31-Aug-70	100
21-02-04	A4851	299-E33-27	31-Jul-70	255
21-02-06	A6951	299-E33-143	31-Jul-70	100

Table 3-1. 241-BX Tank Farm Drywells (3 sheets)

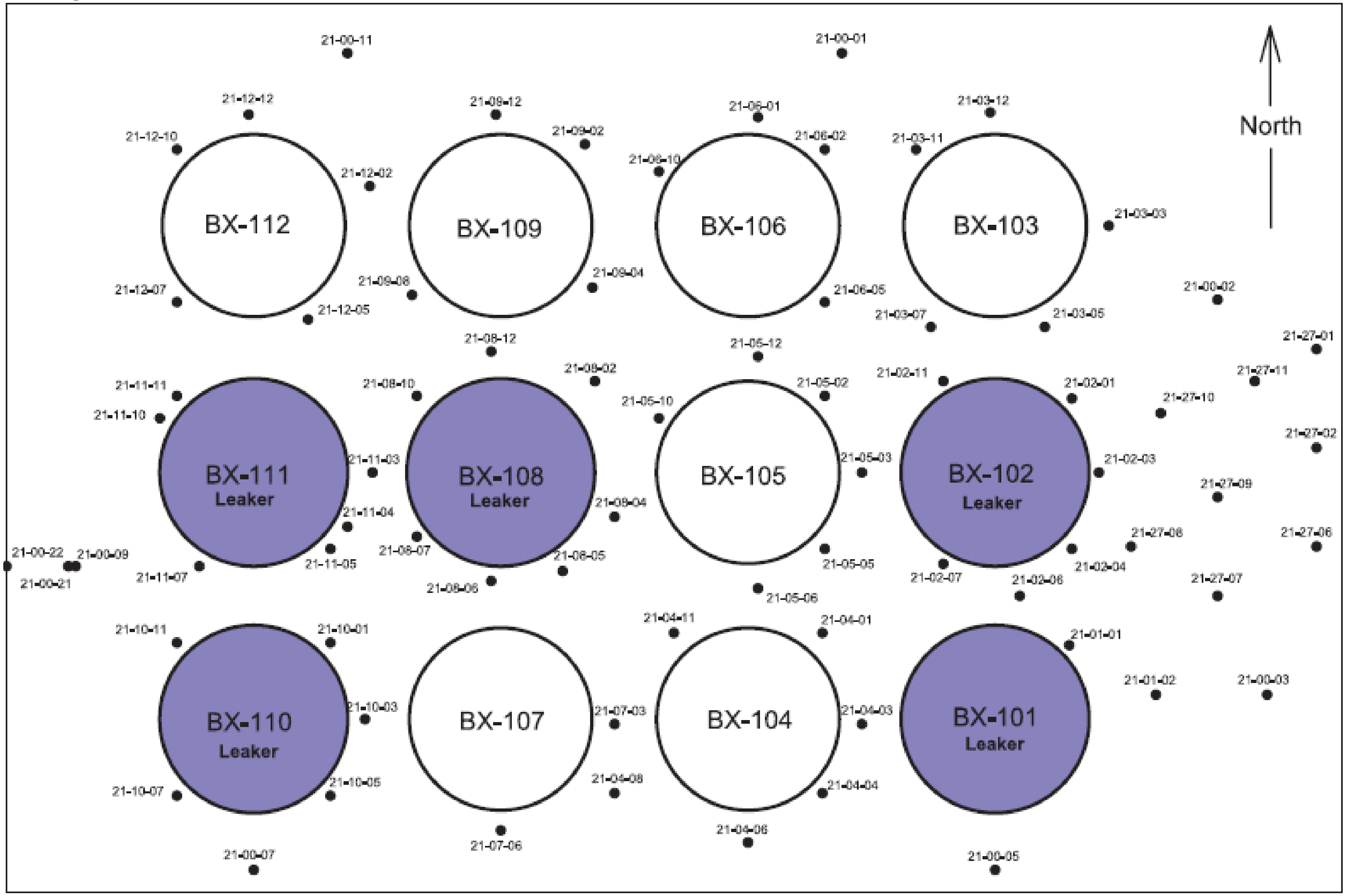
Well No.	Well ID	Well Name	Drill Date	Drill Depth (ft)
21-02-07	A6938	299-E33-130	30-Apr-70	100
21-02-11	A6939	299-E33-131	30-Apr-70	100
21-03-03	A7046	299-E33-239	1973	100
21-03-05	A7036	299-E33-229	30-Nov-73	100
21-03-07	A7081	299-E33-282	11-Apr-77	40
21-03-11	A7075	299-E33-275	1976	100
21-03-12	A7045	299-E33-238	1973	100
21-04-01	A7080	299-E33-281	01-Apr-77	20
21-04-03	A7033	299-E33-226	31-Oct-73	100
21-04-04	A7077	299-E33-278	25-Apr-77	9
21-04-06	A7031	299-E33-224	31-Oct-73	100
21-04-08	A7078	299-E33-279	15-Apr-77	40
21-04-11	A7079	299-E33-280	12-Apr-77	43
21-05-02	A6966	299-E33-158	30-Nov-71	100
21-05-03	A6967	299-E33-159	30-Nov-71	100
21-05-05	A6968	299-E33-160	30-Nov-71	100
21-05-06	A6969	299-E33-161	30-Nov-71	100
21-05-10	A6970	299-E33-162	31-Dec-71	100
21-05-12	A6965	299-E33-157	31-Dec-71	100
21-06-01	A6971	299-E33-163	31-Dec-71	100
21-06-02	A6972	299-E33-164	31-Dec-71	100
21-06-05	A6973	299-E33-165	31-Dec-71	100
21-06-10	A6974	299-E33-166	31-Dec-71	100
21-07-03	A7032	299-E33-225	31-Oct-73	100
21-07-06	A7029	299-E33-222	30-Sep-73	100
21-08-02	A6872	299-E33-64	30-Nov-47	150
21-08-04	A7041	299-E33-234	30-Sep-73	100
21-08-05	A7042	299-E33-235	30-Sep-73	100
21-08-06	A6959	299-E33-151	31-Jan-72	100
21-08-07	A6960	299-E33-152	31-Jan-72	100
21-08-10	A7043	299-E33-236	31-Oct-73	100

Table 3-1. 241-BX Tank Farm Drywells (3 sheets)

Well No.	Well ID	Well Name	Drill Date	Drill Depth (ft)
21-08-12	A6958	299-E33-150	31-Dec-71	100
21-09-02	A7064	299-E33-257	31-Dec-73	100
21-09-04	A7040	299-E33-233	31-Oct-73	100
21-09-08	A7065	299-E33-258	31-Dec-73	100
21-09-12	A7038	299-E33-231	31-Oct-73	100
21-10-01	A6975	299-E33-167	30-Sep-71	100
21-10-03	A7030	299-E33-223	30-Sep-73	100
21-10-05	A6976	299-E33-168	30-Sep-71	100
21-10-07	A6977	299-E33-169	30-Sep-71	100
21-10-11	A6978	299-E33-170	30-Sep-71	100
21-11-03	A7044	299-E33-237	31-Oct-73	100
21-11-04	A6981	299-E33-173	30-Sep-71	100
21-11-05	A6979	299-E33-171	30-Sep-71	100
21-11-07	A6980	299-E33-172	30-Sep-71	100
21-11-10	A6982	299-E33-174	30-Sep-71	100
21-11-11	A6983	299-E33-175	31-Aug-71	100
21-12-02	A6961	299-E33-153	31-Dec-71	100
21-12-05	A6962	299-E33-154	28-Dec-71	100
21-12-07	A6963	299-E33-155	31-Jan-72	100
21-12-10	A6964	299-E33-156	31-Dec-71	100
21-12-12	A7039	299-E33-232	31-Oct-73	100
21-27-01	A6949	299-E33-141	30-Jun-70	100
21-27-02	A6946	299-E33-138	31-May-70	100
21-27-06	A6947	299-E33-139	31-May-70	100
21-27-07	A6942	299-E33-134	31-May-70	100
21-27-08	A6954	299-E33-146	31-Aug-70	150
21-27-09	A6941	299-E33-133	31-May-70	100
21-27-10	A6940	299-E33-132	31-May-70	150
21-27-11	A6869	299-E33-61	30-Nov-47	150

Figure 3-3. 241-BX Farm Tanks and Drywells

Note: Tanks marked "**Leaker**" are confirmed or assumed leakers per HNF-EP-0182, *Waste Tank Summary Report for Month Ending December 31, 2009*, Rev. 261



Total gamma logging was initially performed in the drywells using NaI and Green and Red total gamma monitoring detectors (Figure 3-4). The total gamma logs were digitized starting in 1975, but much of the data before 1975 was not available. Between 1995 and 2000 all of the drywells were logged using a spectral gamma logging system (SGLS). The SGLS 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 cobalt-60 [^{60}Co], generally require an SGLS.

For areas of higher activity (> 2,000 pCi/g) a high rate logging system (HRLS) is used to quantify activity levels as high as 10E8 pCi/g. The SGLS uses a high-purity germanium (HPGe) detector. Figure 3-4 shows measurement ranges for SGLS and HRLS.

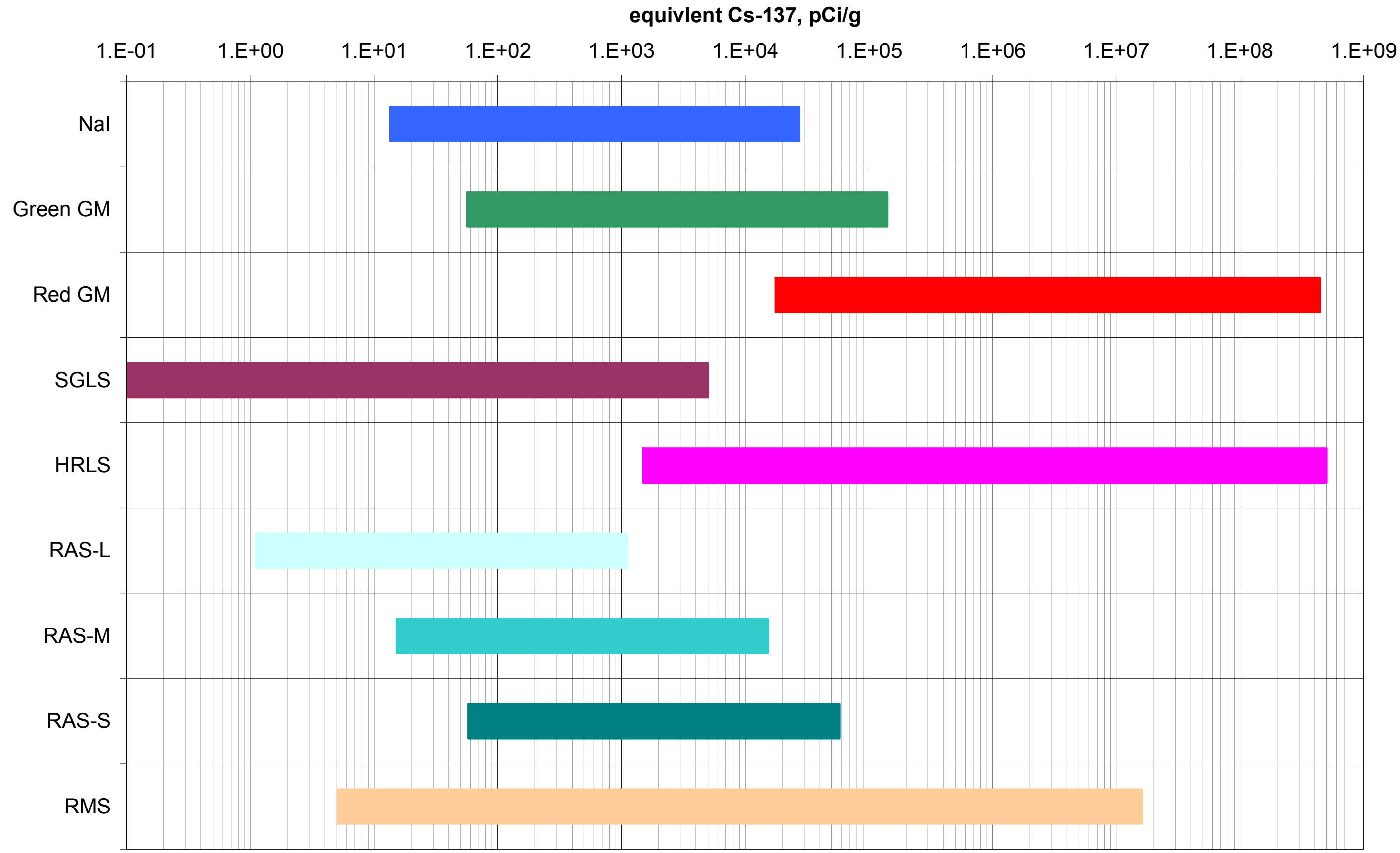
The RAS truck was designed for routine gamma monitoring against the baseline established from the spectral gamma logging system data. The RAS uses a series of three interchangeable NaI(Tl)-based scintillation detectors (RAS-L, RAS-M, and RAS-S) for measurement over the range from background levels to $\sim 10^5$ pCi/g cesium-137 (^{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 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. Leak detection approximations presented in Appendix B of RPP-10413, *Tank S-112 Saltcake Waste Retrieval Demonstration Project Leak Detection, Monitoring, and Mitigation Strategy* range from a mean of 100 gal for a leak located 10 ft from a drywell to a mean of 6,200 gal for a leak 45 ft from a drywell. However, 13,000 gal of saline solution injected for leak detection monitoring tests in S Farm was not detected by surrounding drywells (RPP-30121, *Tank 241-S-102 High-Resolution Resistivity Leak Detection and Monitoring Test Report*).

Approximate measurement ranges of different types of gamma radiation detectors are shown in Figure 3-4.

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

1. <u>Number and location of wells / laterals / leak detection pits</u>: There were rarely more than six drywells surrounding the 100-series SSTs (circumference ~235 ft) and often fewer. These drywells are generally 6-in.-diameter steel casings that extend vertically 75 to 125 ft bgs (groundwater is between 245 and 300 ft bgs) and allow access to geophysical probes. Because the holes had to be cased to prevent collapse and loss of the drywell, only gamma-emitting radionuclides within approximately a 12-in. radius of a drywell are detected. Alpha- and beta-emitting radionuclides, including daughter products, are not detected because alpha and beta particles will not penetrate through the steel casing, and most of the long-lived, mobile radionuclides do not emit gamma radiation during decay. Laterals provided a much more complete gamma monitoring system compared to drywells alone, however, the location and number of laterals did not represent full coverage beneath these SSTs and there are no laterals in BX-Farm. Consequently, the absence of gamma activity in

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 SGLS
RAS-L	=	Radionuclide Assessment System – large NaI detector
RAS-M	=	Radionuclide Assessment System – medium NaI detector
RAS-S	=	Radionuclide Assessment System – small NaI detector
RMS	=	radionuclide monitoring system (not used at Hanford)

a well, lateral, or leak detection pit does not necessarily indicate that a tank did not leak. Over the course of historical drywell logging, probe types changed several times, thus changing detection limits. The rate of withdrawal of any probe from a drywell and count times also affect the detection capability of any instrument and these too changed with time. Most drywells adjacent to tanks were not constructed until the 1970s and were subsequently logged for gamma radiation. There was very little ex-tank monitoring from ~1950 to ~1970 of tank farm operations when many of the releases likely occurred. Chemical contaminants are not detected during logging and can only be found through soil sampling and analyses.

2. <u>Waste type</u>: The overall effectiveness of gross gamma logging in drywells as a leak detection system depends on the waste type in the tank. 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 may have occurred. Consequently, the type of waste in the tank nearest a detected leak may not be the same as the waste that leaked. This contributes to uncertainty in inventory and leak volume estimates.

3. <u>Other contamination sources</u>: 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.

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 (TWRWPs). The accuracy of drywell logging count rate is roughly the square of the total number of counts (*Radiation Detection and Measurement* [Knoll 2000], pp. 94-96). The correlation between cps and radioactivity or moisture measurements varies by detector.

Leak detection monitoring for retrieval is conducted by observing changes in neutron readings (counts per second [cps]) 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 process control plans.

Ex-Tank High Resolution Resistivity (HRR). High Resolution Resistivity is used during retrieval operations and measures changes in resistivity against baseline conditions as specified in TWRWPs. 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 S-Farm, where 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).

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 approximately one foot 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 BX-Farm and HRR leak detection has not been used in BX-Farm.

3.3 TANK LEAKS

Sixty-seven of 149 SSTs have been designated as "confirmed or suspected leakers" over the SST operational timeline (1945 to 1980) (HNF-EP-0182). 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) 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 potential or known 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.

3.4 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 to remove pumpable liquid from the SSTs. This process was referred to as interim stabilization of the SSTs.

A consent decree (CT-99-5076-EFS, *Consent Decree for Stabilization of Single-Shell Tanks at Hanford Site*) was established that set a time table and specified criteria to complete interim stabilization, and by 2003 all of the SSTs were interim stabilized except a couple that went directly to retrieval without undergoing interim stabilization (HNF-EP-0182). A tank was considered interim stabilized when it contained less than 50 kgal of drainable interstitial liquid and less than 5 kgal 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).

3.5 SURFACE GEOPHYSICAL EXPLORATION IN 241-BX TANK FARM

Surface Geophysical Exploration (SGE) is an application of HRR (see Section 3.2), however, rather than measuring resistivity over time and looking for changes in resistivity, SGE consists of one-time measurements to identify resistivity anomalies or low resistivity areas. Because tank waste is high in nitrate and sodium, areas of low resistivity indicate locations where waste may have been released to the soil. Surface Geophysical Exploration is used to guide the selection of sampling locations and as a tool to assess resistivity anomalies (potential waste releases) across large areas.

Surface Geophysical Exploration was deployed in Waste Management Area (WMA) B-BX-BY in October 2006 (RPP-34690, *Surface Geophysical Exploration of the B, BX and BY Tank Farms at the Hanford Site*). Figure 3-5 shows 60 and 120 ohm-m three-dimensional resistivity results in B-, BX- and BY-Farm for surface electrodes and well-to-well resistivity surveys with electrical connections to and between surface electrodes, tank farm drywells and groundwater monitoring wells. It is difficult to identify a specific tank leak source within BX-Farm based on these results. However, consistent with tank farm leak histories presented in this report the results indicate low resistivity regions near tanks BX-101, BX-102, BX-108, BX-110 and BX-111. Resistivity is the opposite of conductivity; thus, highly conductive zones have low resistivity. Low resistivity regions are also observed near tanks BX-104 and BX-107 and to the north of tank BX-112 (probably from releases in BY-Farm). Infrastructure obstructions and other physical features appear to have impacted the ability to observe clearer well-to-well and three-dimensional resistivity anomalies in the soils around WMA B-BX-BY.

3.6 SUMMARY OF GROUNDWATER CONTAMINATION IN THE UNCONFINED AQUIFER UNDERLYING WASTE MANAGEMENT AREA B-BX-BY

Several contaminants are present in much of the unconfined aquifer underlying WMA B-BX-BY including uranium, technetium-99 (^{99}Tc), tritium and nitrate. Because wastes were released from several sources during the Hanford waste processing operations period that lasted more than two decades, these contaminants can have several sources. In addition to the waste leaks from tanks and transfer lines discussed in previous sections, several sets of cribs and trenches around the tank farms were intentional discharge sites some of which received tank supernate from the last tank in a cascade. The dominant facilities included the BY Cribs north of BY-Farm, the BX trenches west of BX-Farm, the 7A, and 7B and 8 Cribs, and the 11A and 11B French Drains north of B-Farm and east of BX-Farm (Figure 3-6).

Figure 3-5. 241-BX Tank Farm Surface Geophysics Exploration Results

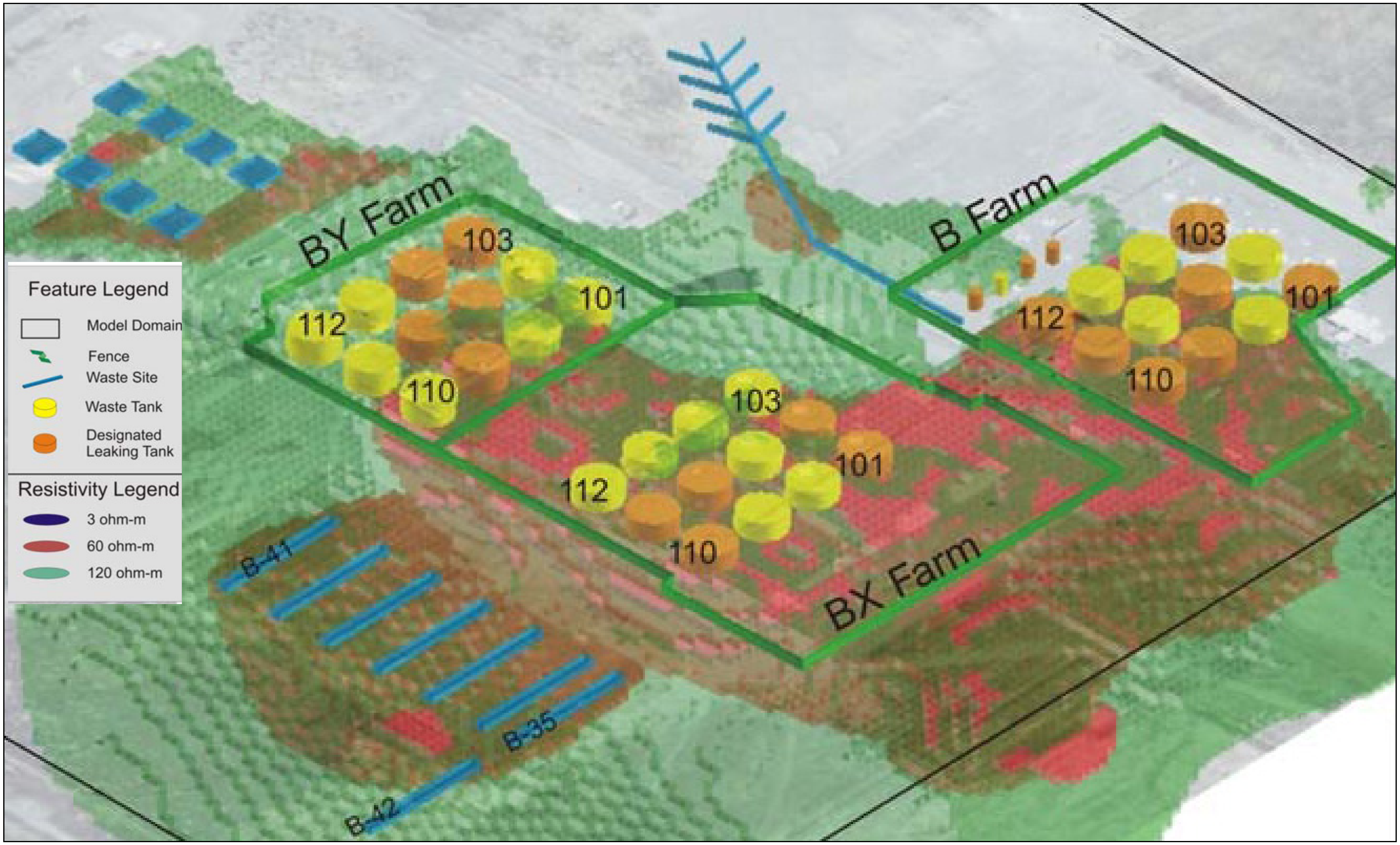
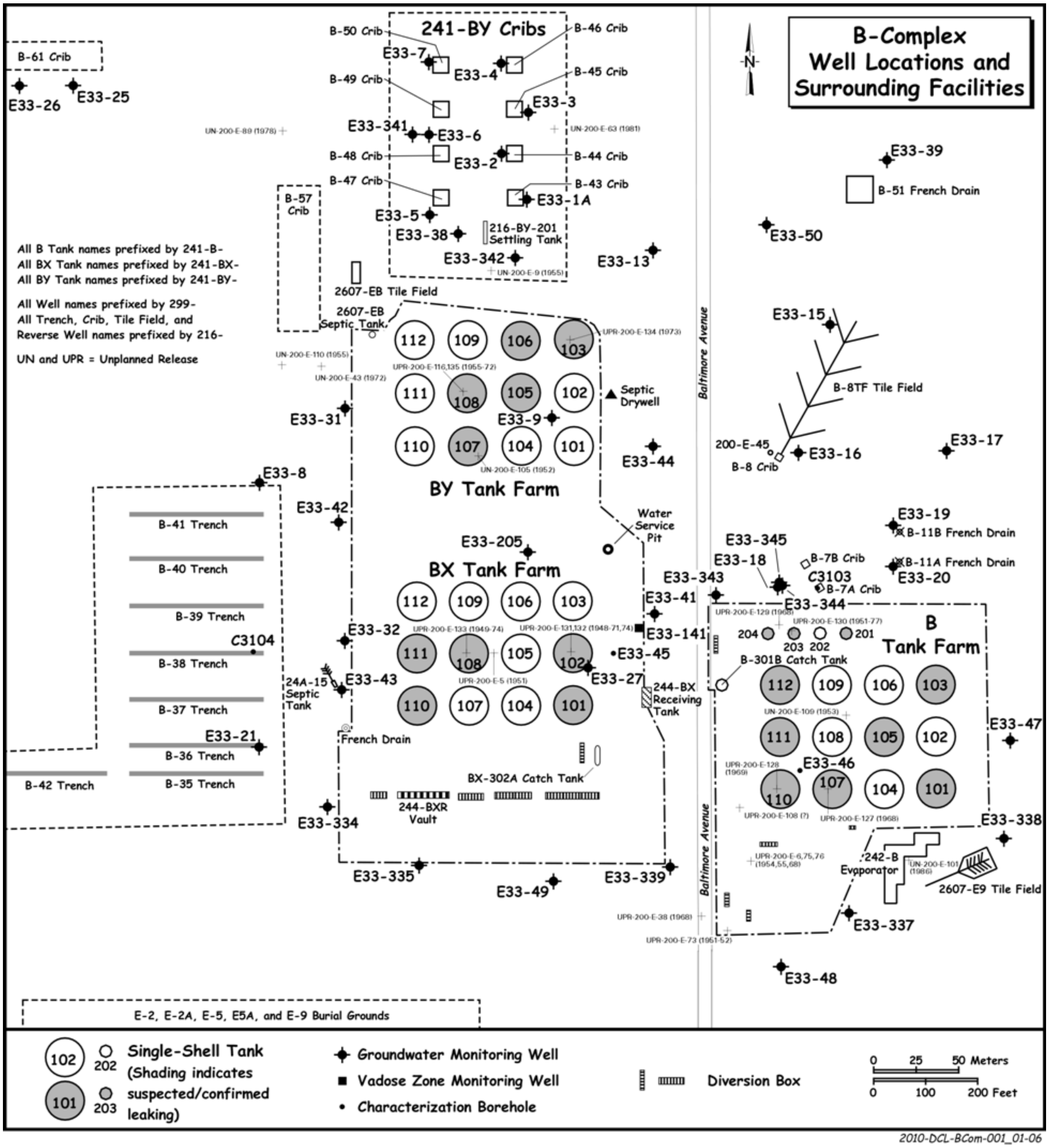


Figure 3-6. Map View of Waste Disposal Facilities in Waste Management Area B-BX-BY



Over the last 10 years substantial efforts have been made to characterize the nature and extent of contamination in the vadose zone and unconfined aquifer at WMA B-BX-BY (e.g., RPP-10098, *Field Investigation Report for Waste Management Area B-BX-BY*). Groundwater monitoring data were sparse during the operations period because there were fewer wells and less frequent sampling. The SSTs are *Resource Conservation and Recovery Act of 1976* temporary storage and disposal units that require groundwater monitoring. Many wells have been installed in the last two decades and routine sampling and analysis data have been collected since the early 1990s. A conceptual model describing the origin and evolution of uranium and ^{99}Tc has been developed (PNNL-19277, *Conceptual Models for Migration of Key Groundwater Risk Contaminants Through the Vadose Zone and Into the Unconfined Aquifer Below the B-Complex*) that incorporates most data that has been collected in the area. The report concludes that the majority of uranium in the subsurface came from the uranium-rich metal waste release that occurred in 1951 through a spare inlet port in tank 241-BX-102, and that the majority of ^{99}Tc came from scavenged uranium recovery waste discharged to the BY Cribs in the mid-1950s. Discussions of other prominent contaminants (e.g., nitrate, cyanide and chromium) were also provided, concluding that their primary sources were crib and trench discharges. A summary of this discussion is provided below.

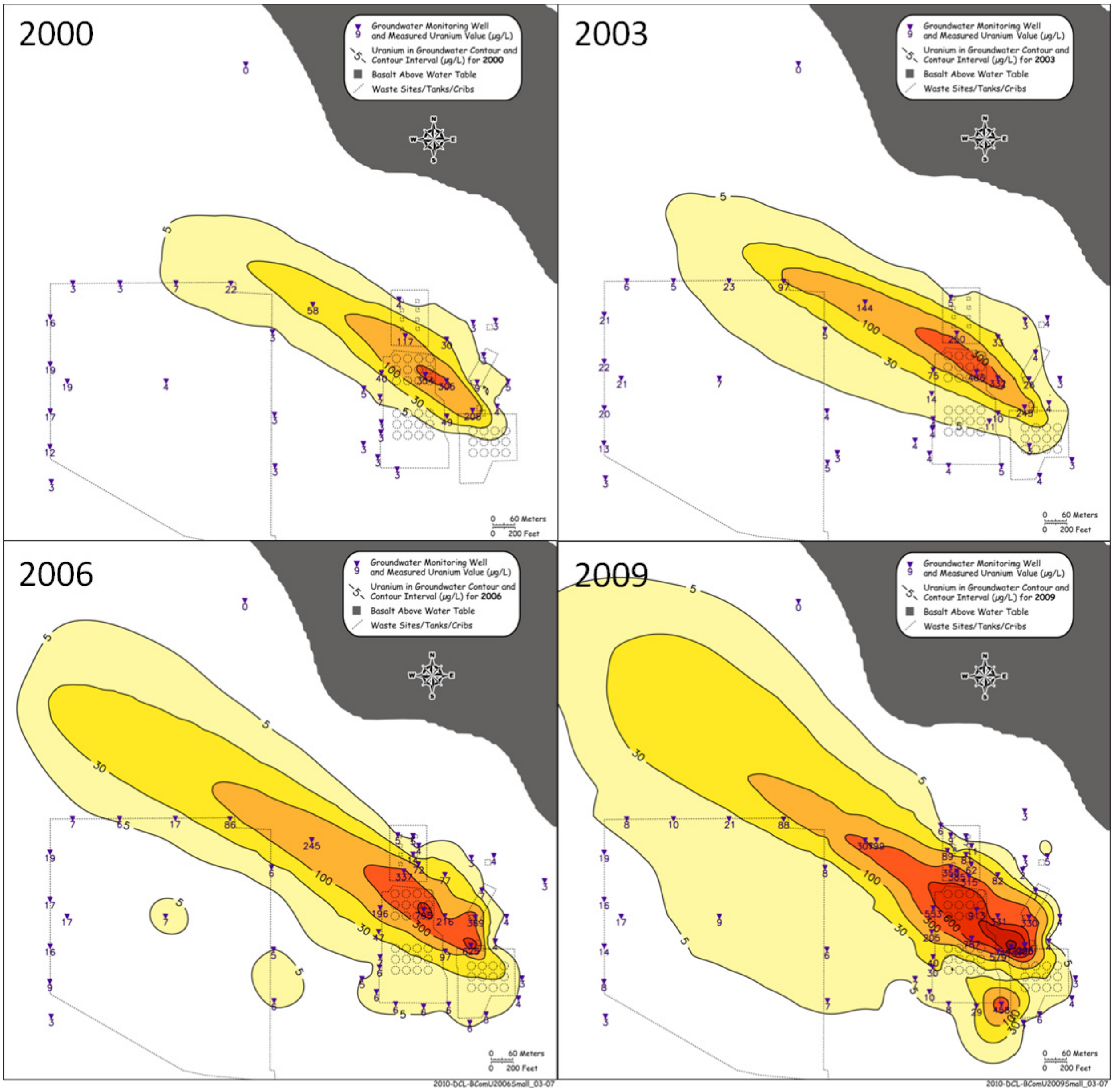
3.6.1 Uranium Aquifer Contamination

The nature and extent of uranium contamination in the aquifer underlying WMA B-BX-BY can only be discussed from the mid-1990s forward because of the lack of monitoring frequency in earlier years. However, it is known that groundwater was contaminated in 1956 with ^{137}Cs and ^{60}Co, and perhaps other radionuclides such as ^{99}Tc that were not measured at the time. This contamination is thought to have originated from the BY Cribs. In the mid-1990s low levels of uranium contamination (< 30 µg/L) were measured under much of WMA B-BX-BY. Since then, concentrations in the groundwater below WMA B-BX-BY have been increasing over the last decade, though the amount of uranium in the groundwater is thought to be small when compared to the mass of uranium estimated to be present in the vadose zone in this area. Snapshots of uranium groundwater plume evolution beginning in 2000 are shown in Figure 3-7. The snapshots show that the heart of the plume has been centered underneath the tank farms in the last decade. In 2003 the plume was centered at monitoring well 299-E33-9 in the eastern portion of BY-Farm. By 2006 a second maximum concentration area appeared at the northeast corner of B-Farm at monitoring well 299-E33-18. Finally, by 2009 this high concentration zone had grown and superseded the hot spot underneath BY-Farm. Currently, highest uranium concentrations are occurring at monitoring well 299-E33-343.

Generally, plume migration is oriented along a northwest to southeast axis with secondary migration to the south. Overall, the most consistent migration direction appears to be toward the northwest.

Unambiguous identification of the source term for the current plume has been complicated by the existence of numerous discharges of uranium at various locations in WMA B-BX-BY. These include the BY Cribs north of BY-Farm, the BX trenches east of the BX-Farm, liquid discharge facilities north of B-Farm and tank leaks, particularly the 1951 metal waste leak from tank BX-102. Major contributors of inventory are summarized in Table 3-2. Table 3-2 clearly indicates that the great majority of discharged uranium came from the metal waste leak from tank BX-102 in 1951 and various characterization efforts have shown that a large quantity of the leaked uranium is distributed at an intermediate vadose zone depth 120 to 150 ft bgs east of tank BX-102. These observations and the general observation that the heart of the uranium plume resides under the middle of the tank farms suggests that the tank BX-102 leak is the predominant source of the observed contamination. The isotopic composition of the uranium in groundwater more closely matches the composition of waste leaked from tank BX-102.

Figure 3-7. Uranium Plume Distribution in the Unconfined Aquifer Underlying Waste Management Area B-BX-BY in 2000, 2003, 2006, and 2009



Reference: PNNL-19277, *Conceptual Models for Migration of Key Groundwater Risk Contaminants Through the Vadose Zone and Into the Unconfined Aquifer Below the B-Complex.*

Two other types of characterization data also support this conclusion. First, an extensive silt-rich soil stratigraphic unit exists in the deep vadose zone under most of BX-Farm's footprint (see Figure 3-8). This unit, identified as the lower subunit of the Cold Creek Unit, is ~20 ft above the current water table, contains high levels of uranium contamination and is high in moisture content. Part of this unit contains a fully saturated perched water zone. Such units are known to store relatively large volumes of water and mobile contaminants, if present. The conceptual model then is that uranium was washed down from the shallower uranium mass existing in the intermediate vadose zone by repeated operational water discharges after 1951 and temporarily captured in the Cold Creek Silt Unit. Current aquifer contamination is now being fed by uranium in this unit.

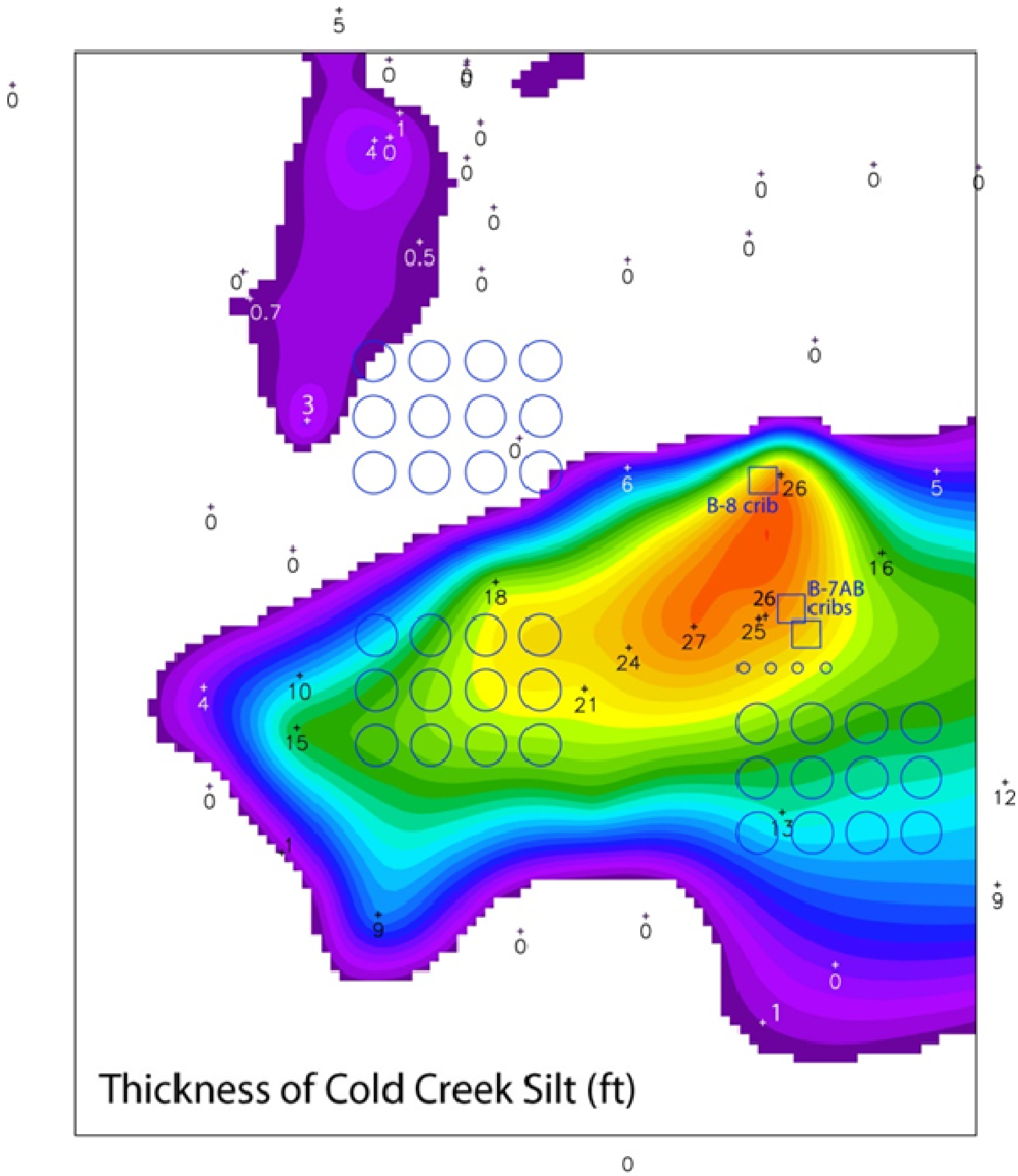
Table 3-2. Summary of Inventory Estimates at Major Potential Sources of Groundwater Contamination in Waste Management Area B-BX-BY

Facility	Uranium (kg)	Technetium-99 (Ci)	Chromium (kg)	Nitrate (kg)	Cyanide (kg)
216-B-7-A & -B	197	0.095	11,600	2,710,000	0
216-B-8	191	0.008	6,230	91.2	0
BY Cribs	1060	129	5,030	3,310	18,900
BX trenches	504	8.4	5,860	1,730,000	0
Tank BX-102	10,100	2.27	60.5	3,800	0

The second type of information that supports the concept of the tank BX-102 metal waste leak as the primary source of uranium is uranium isotopic data measured in a variety of subsurface water samples from the vadose zone and the unconfined aquifer. Collectively, these data indicate that a unique isotopic signature can be assigned to the metal waste fluid, a signature which is found in most of the analyzed samples. A summary diagram of these data is shown in Figure 3-9.

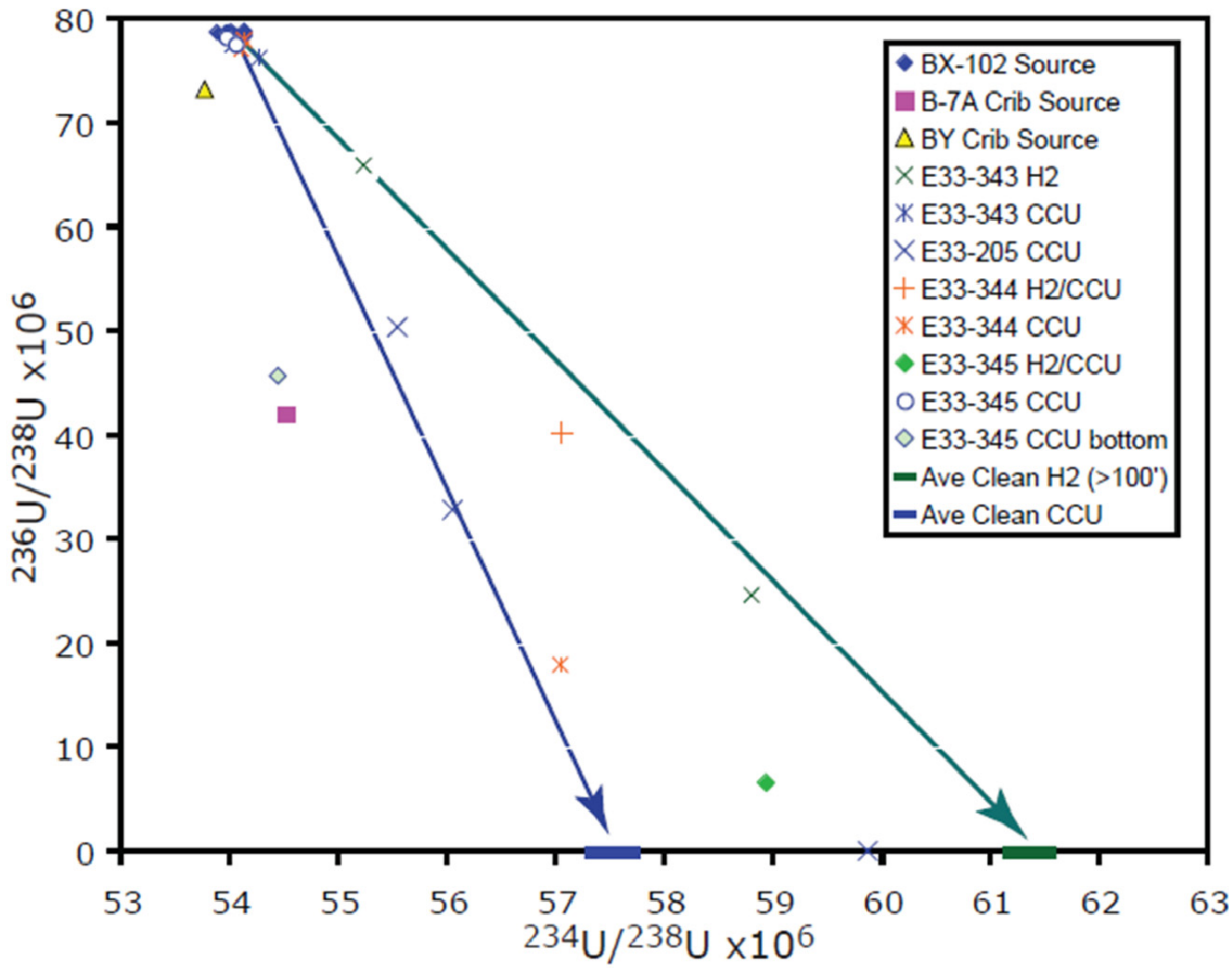
In Figure 3-9 ^{236}U to ^{238}U ratios are plotted against ^{234}U to ^{238}U for water samples taken in the vadose zone and unconfined aquifer. In the upper left hand corner are the porewater samples taken from the intermediate depth vadose zone soils containing high concentrations of metal waste uranium. On the x-axis are the ^{234}U to ^{238}U ratios of uncontaminated water in the Cold Creek Silt Unit and the unconfined aquifer. Note that the ^{236}U to ^{238}U ratio is zero because ^{236}U is not naturally occurring. The lines drawn between the tank BX-102 water samples and the groundwater ^{234}U to ^{238}U ratios are mixing lines which indicate the potential changes in these ratios as various proportions of contaminated and uncontaminated waters mix. If ratios fall outside of the triangle formed by the two mixing lines then another source term is indicated. Figure 3-9 shows that only a few samples fall outside the mixing triangle, notably those near the BY and 216-B-7A cribs. These results are used to conclude that the tank BX-102 isotopic signature is distinguishable from the other plausible uranium sources and the one that matches most of the aquifer water. Currently, between the intermediate vadose zone and the Cold Creek Silt Unit, there is more uranium in the vadose zone than in the aquifer. Given this condition, the uranium contamination in the unconfined aquifer underlying WMA B-BX-BY is likely to continue for an indeterminate time span.

Figure 3-8. Isopach Map of the Lower Cold Creek Silt Unit Underlying Waste Management Area B-BX-BY BY



Reference: PNNL-19277, *Conceptual Models for Migration of Key Groundwater Risk Contaminants Through the Vadose Zone and Into the Unconfined Aquifer Below the B-Complex*.

Figure 3-9. Uranium Isotopic Ratio Data for Subsurface Water Samples Taken at Waste Management Area B-BX-BY

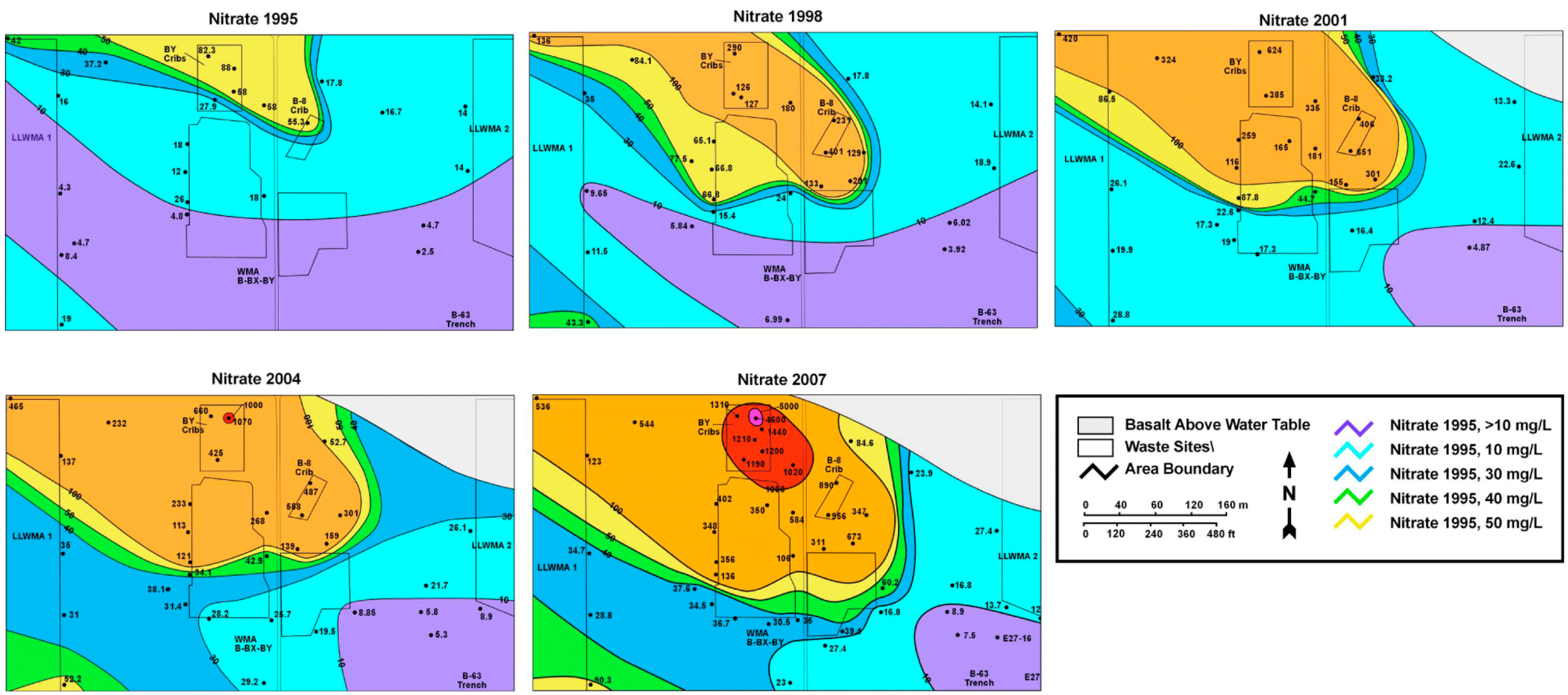


Reference: PNNL-19277, *Conceptual Models for Migration of Key Groundwater Risk Contaminants Through the Vadose Zone and Into the Unconfined Aquifer Below the B-Complex*.

3.6.2 Nitrate, Technetium-99 and Cyanide Aquifer Contamination

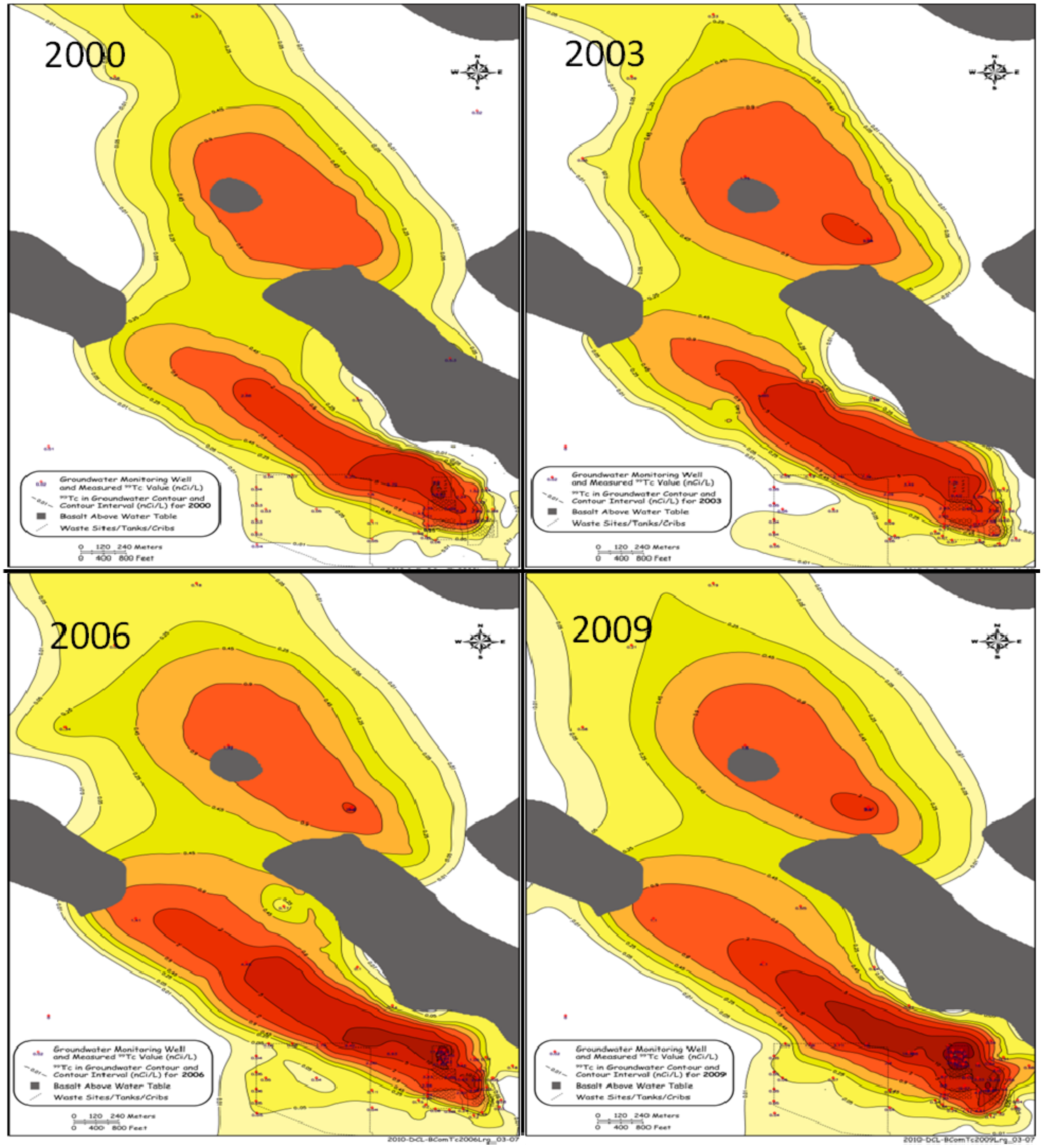
The combination of historical process knowledge and subsurface characterization data in both the vadose zone and aquifer strongly indicate that the dominant sources for these contaminants are the BY Cribs and/or the cribs north of B-Farm with some secondary contribution from the tank BX-102 leak. The early histories of flow and transport of these contaminants are not well known but more frequent and extensive groundwater monitoring that has occurred since the early to mid-1990s allows a more complete picture of plume evolution. Snapshots of recent plume distributions are shown in Figures 3-10, 3-11 and 3-12.

Figure 3-10. Nitrate Plume Distribution in the Unconfined Aquifer Underlying Waste Management Area B-BX-BY in 1995, 1998, 2001, 2004, and 2007



Reference: DOE/RL-2008-01, *Hanford Site Groundwater Monitoring for Fiscal Year 2007*.

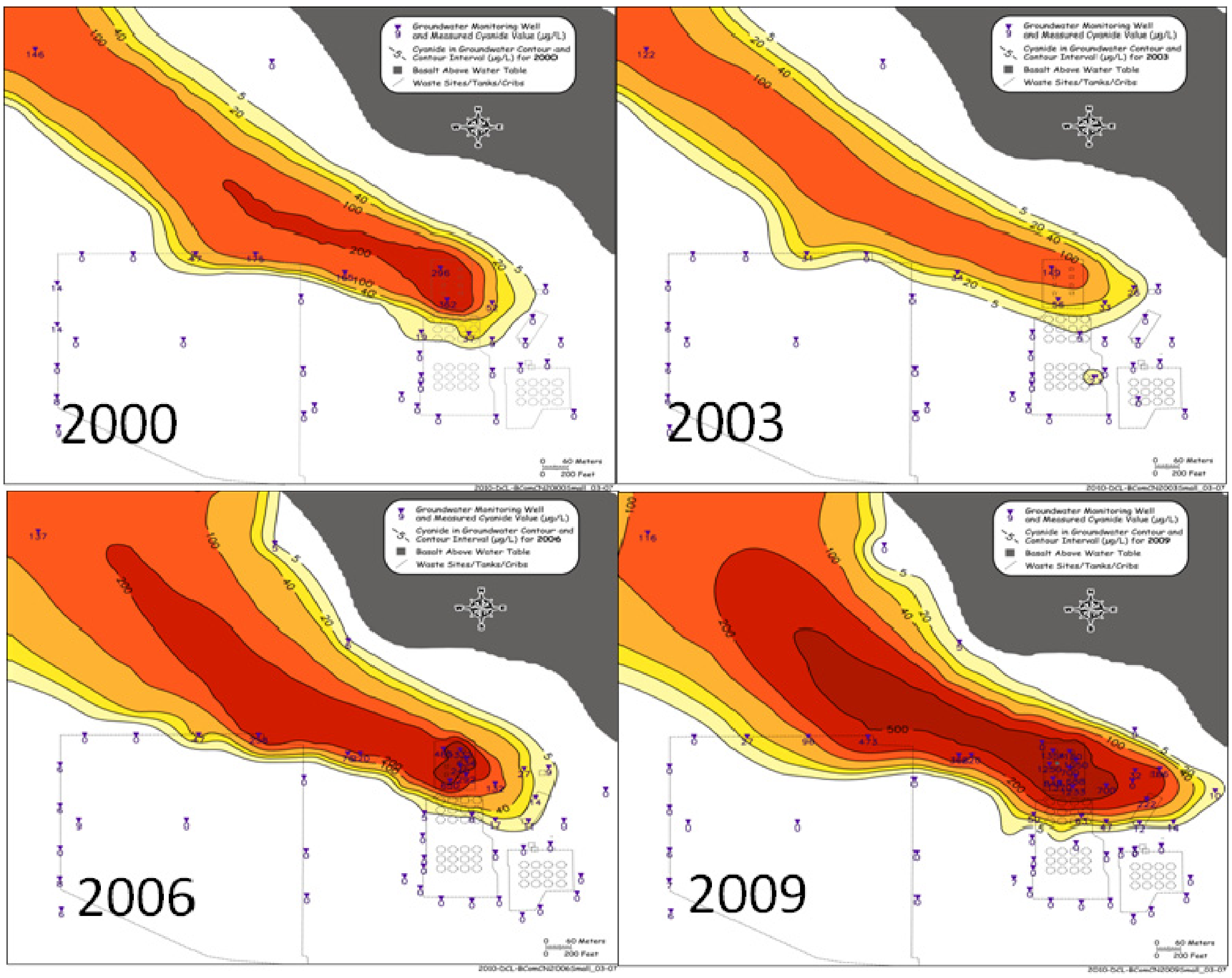
Figure 3-11. Technetium-99 Plume Distribution in the Unconfined Aquifer Underlying Waste Management Area B-BX-BY in 2000, 2003, 2006, and 2009



Reference: PNNL-19277, *Conceptual Models for Migration of Key Groundwater Risk Contaminants Through the Vadose Zone and Into the Unconfined Aquifer Below the B-Complex*.

Given the assumption of similar source terms and a common regional groundwater flow history, it is not surprising that current plume distributions of these contaminants are grossly similar. Furthermore, these contaminants share a similar chemical behavior in the soil-water environment being largely inert and therefore remaining dissolved in solution. The most contaminated parts of these plumes are found underneath the BY Cribs and/or cribs north of B-Farm and plume concentration contours extend along a northwest to southeast axis between the two sets of cribs. Also, extended migration has occurred northward through Gable Gap. Most of this northern extension is attributed to the large crib releases which occurred primarily in the mid-1950s. Because of these releases the overall water table was more than 10 m above its present level and this condition facilitated northward migration.

Figure 3-12. Cyanide Plume Distribution in the Unconfined Aquifer Underlying Waste Management Area B-BX-BY in 1995, 1998, 2001, 2004, and 2009



Reference: PNNL-19277, *Conceptual Models for Migration of Key Groundwater Risk Contaminants Through the Vadose Zone and Into the Unconfined Aquifer Below the B-Complex.*

The current migration rates are quite slow because of the low regional hydraulic gradient making it difficult to determine the preferred groundwater flow direction. It appears that movement to the northwest is most frequent with some apparent intermittent influence from the river stage effects to the north. At high river stage, there is an apparent southerly gradient that slows or stops northwesterly flow. Also, during these time periods, the contaminant concentrations increase as do the aquifer volumes exhibiting higher concentrations. Brief summaries of historical subsurface flow and transport processes for each of these contaminants are provided below.

Sporadic early measurements of nitrate contamination in the aquifer around WMA B-BX-BY suggest aquifer concentration levels of several thousand mg/L. In the early 1990s much lower contamination levels were observed (< 100 mg/L). Since then contamination levels have increased steadily, first in the vicinity of the cribs 216-B-7-A&B and 216-B-8 north of B-Farm and then underneath the northern BY Cribs (Figure 3-11) at well 299-E33-4 beginning in 2004. By 2007, contamination levels exceeded 5,000 mg/L at this well.

Early ^{99}Tc contamination levels in the mid 1950s appear to have been about 200,000 to 300,000 pCi/L using an approximate ratio to nitrate. In the early 1990s concentrations less than 1,000 pCi/L were measured and then began to increase. In the late 1990s concentrations in wells north of the BY Cribs steadily increased, ranging from 2,000 to 10,000 pCi/L. Snapshots of ^{99}Tc since 2000 (Figure 3-11) show continued maximum concentrations in the vicinity of the BY Cribs, and generally increasing along a northwest-southeast axis. A hotspot (~7,000 pCi/L) occurred at well 299-E33-44 (east of BY-Farm) in 2004 and by 2006 concentrations above 20,000 and 10,000 pCi/L were measured underneath and south of the BY Cribs, respectively. The high concentration zone has continued to extend southward but has apparently also been shaped by highly contaminated releases from a secondary source in the vicinity of well 299-E33-343 (drilled in 2008). In July 2008 concentrations reached a maximum of 100,000 pCi/L in well 299-E33-4 at the north end of the BY Cribs. Possible sources at this location, besides the BY Cribs, include the 216-B-7-A&B cribs and the tank BX-102 leak. Using the vadose zone characterization data collected underneath the BY Cribs, estimates are that 34 to 68% of the inventory (43 to 87 Ci, respectively) are still present in the vadose zone and 6 to 70 Ci of that are within 90 ft of the water table. If so, ^{99}Tc contamination will persist in the aquifer for many years.

Operations history clearly shows that the only facilities that received significant quantities of cyanide were the BY Cribs, which received waste fluids from the uranium recovery program in the 1950s. Sediments in the deep vadose zone underneath the BY Cribs area seem to be a major source of contaminants entering the WMA B-BX-BY groundwater plume. No cyanide measurements were taken before 1987, preventing development of cyanide groundwater plume maps prior to this date. More frequent measurements began in the early 1990s, and cyanide concentrations have generally increased mainly around the BY Cribs from 100 to 200 µg/L in the late 1990s to as much as 7,000 µg/L in 2009 beneath the northern BY Cribs. Cyanide has been measured in drywell soils underneath the BY Cribs, but data is insufficient to estimate the possible inventory that remains in the vadose zone. However, estimated groundwater cyanide masses (15 to 40 kg) are only ~0.3% of the total mass discharged to the BY Cribs. The fate of the missing cyanide mass has not been determined and it is not certain how long deep vadose zone contamination may support the present plume.

4.0 TANK LEAK ASSESSMENT RESULTS

Assessment results for each of the SSTs in the 241-BX Tank Farm are discussed in the following sections. Summary information for each tank and area assessed and for documented near surface releases in BX-Farm are included in Appendix B. Each tank summary includes: tank waste processes and history, in-tank level measurements and logging data, previous leak assessment observations and results, and current assessment conclusions and recommendations.

4.1 TANK 241-BX-101

4.1.1 Leak Status of Tank 241-BX-101

Tank BX-101 is suspected of leaking in the past based on high gamma-ray activity detected in drywell 21-01-01 in 1972. The tank was categorized as "questionable integrity" in 1973 (WHC-MR-0132, *A History of the 200 Area Tank Farms*; WHC-SD-WM-ER-311). In 1974 increased radioactivity was observed in drywell 21-01-02 and 21-02-06 and occurrence reports were issued (OR-74-104, *Symptoms Of Leakage As Indicated By Increasing Dry Well Radiation Levels At Waste Tank 101-BX*; OR-74-141, *Increasing Dry Well Radiation Adjacent to Tank 101-B*). There is no current estimate in the waste status report for a leak from tank BX-101 (HNF-EP-0182).

A saltwell pump system was installed in September 1974 and tank BX-101 was saltwell pumped in 1976 and declared interim stabilized in September 1978 (SD-WM-TI-356). As of January 2009 the tank is estimated to hold 48,000 gal of sludge and no supernate (HNF-EP-0182).

4.1.2 Leak Assessment Considerations

Based on the data reviewed and assessed (Appendix B.1) the 1972 activity at drywell 21-01-01 appears to have originated from a leak of a riser in the sluicing pit on the dome of the tank. It is unknown when the riser leak started. Uranium activity observed deeper in the profile in drywells 21-01-01 and 21-01-02 is attributed to a 1951 metal waste release from a cascade overflow at BX-101, BX-102, or both. The inventory associated with the 1951 overflow is discussed in section 5.2.

4.1.3 Conclusions and Recommendations

It was concluded that the activity near tank BX-101 was likely due to a leak from a riser in the sluicing pit and probably not due to a breach in the tank steel liner. The estimated inventory of the leak was <700 Ci of ^{137}Cs with a volume of <900 gal assuming the waste leaked was B Plant ion exchange (IX) waste. The leak volume is dependent on the composition and type of waste leaked from the tank. Based on the waste transfer history, gamma activity in drywell 21-01-01 and 1970 tank supernatant data it was assumed that the waste released was a diluted CSR (B Plant IX) supernate waste. The HDW composition estimates for CSR waste should be divided by 2 (based on differences between the HDW estimates and measured ^{137}Cs concentration 0.8 vs. 1.5 Ci/gal) and multiplied by 900 gal to estimate inventory values for other constituents.

Given the indications of a riser leak as the primary source of activity at drywell 21-01-02 a formal re-evaluation of the current leak classification for this tank is recommended and additional characterization is recommended (per procedure TFC-ENG-CHEM-D-42, "Tank Leak Assessment Process") to better quantify the inventory resulting from the losses near tank BX-101.

4.2 TANK 241-BX-102

4.2.1 Leak Status of Tank 241-BX-102

Tank BX-102 was suspected of leaking in the past based on high gamma-ray activity detected in drywell 21-02-04 in 1972 and a 1971 assessment (ARH-2035, *Investigation and Evaluation of 102-BX Tank Leak*). Additional drywells were drilled and logged to characterize the size and source of the plume released. The tank was categorized as "questionable integrity" in 1973 (WHC-MR-0132, WHC-SD-WM-ER-311) with a leak volume estimate of 70,000 gal (ARH-2035). In 1974 increased radioactivity was observed in drywells 21-01-02 and 21-02-06 and occurrence reports were issued (OR-74-104, OR-74-141). The current leak volume estimate shown in the waste status report for tank BX-102 is 70,000 gal (HNF-EP-0182).

Tank BX-102 was interim stabilized in 1978 (SD-WM-TI-356). As of January 2010, tank BX-102 contained an estimated 40 kgal of sludge and 39 kgal of diatomaceous earth (HNF-EP-0182).

4.2.2 Leak Assessment Considerations

The data reviewed and assessed (see Appendix B.2) showed that the cascade line between tanks BX-102 and BX-103 plugged in February 1951 (HW-28471, *Unconfined Underground Radioactive Waste and Contamination in the 200 Areas*). Activity observed in drywell 21-07-01 (drywell 61) was attributed to an overflow from the tank BX-102 spare inlets caused by the plugged cascade line. The leak was estimated to be 91,600 gal of metal waste supernate (high in uranium content and comparatively low in ^{137}Cs content). This overflow from tank BX-102 and possibly tank BX-101 appears to be the source of uranium that was observed deep in the vadose zone near and in tanks BX-102 and BX-101 and in drywells 21-27-1, 21-27-2, 21-27-6, 21-27-7, 21-27-8, 21-27-9, 21-27-10 and 21-27-11.

Increased activity in drywell 21-27-01 after 1962 and activity in drywell 21-02-04 observed in 1972 suggest a second release occurred. Given that the tank was overfilled and the activity increase was observed in drywell 21-02-04, starting at the depth of and located near the spare inlets, this increased activity could have been a result of spare inlet overflows after 1962 or from a leak in the BX-102 tank wall. The later release observed at drywell 21-02-04 showed high cesium activity and samples showed mixed fission products characteristic of CSR waste or other mixed fission product waste.

Based on drywell and direct push logging and sample results, an estimated inventory of 4,000 to 40,000 Ci of ^{137}Cs may have been released to the soil in 1951 and after 1962. The estimated ^{137}Cs inventory for 91,600 gal of metal waste is about 320 Ci. Therefore most of the ^{137}Cs inventory is attributed to releases after 1962. Assuming a waste composition of 0.8 Ci/gal for the waste based on 1970 BX-102 supernate measurements, the leak volume after 1962 ranged from 5,000 to 50,000 gal.

4.2.3 Conclusions and Recommendations

Two leaks from the spare inlet ports likely occurred. The first leak/overflow occurred in 1951 of 91,600 gal of bismuth phosphate process metal waste (1944 to 1951) (MW1). The inventory estimates in Hanford Soil Inventory Model (SIM) appear to be reasonable for the 1951 release. A second leak/overflow occurred sometime between 1962 and 1970. Based on available data a ^{137}Cs inventory of 4,000 to 40,000 Ci with a leak volume of 5,000 to <50,000 gal was estimated for the second event. The upper estimate for releases from tank BX-102 is ~140,000 gal and 40,000 Ci of ^{137}Cs and 20,000 kg of uranium.

The current SIM estimate is for the 92,600 gal metal waste release only; the additional release after 1962 should be added to this. For other constituents for the later release multiply a leak volume of 5,000 to 50,000 gal by 1/2 the HDW concentration estimates for a IX(CSR) waste type.

As noted in meeting summaries (Appendix A) the tank BX-102 leak losses in 1951 and after 1962 appear to be due to the tank being overfilled and waste leaking from the spare inlet lines. A tank leak for losses after 1962 cannot be ruled out. A formal leak classification assessment per procedure TFC-ENG-CHEM-D-42 is recommended for tank 241-BX-102.

4.3 TANK 241-BX-108

4.3.1 Leak Status of Tank 241-BX-108

The tank was declared a suspected leaker in the fourth quarter of 1973 and a confirmed leaker in 1974 with an estimated leak volume of 2,500 gal. The confirmed leaker classification was apparently based on an increase in gross gamma activity detected in drywell 21-08-06 and declining liquid levels in the tank (SD-WM-TI-356). No occurrence reports for liquid level decreases were identified for this tank.

Tank BX-108 was declared interim stabilized in July 1979 (HNF-SD-WM-TI-178, *Single-Shell Tank Interim Stabilization Record*). As of January 2010, tank BX-108 contained an estimated 31 kgal of sludge and no supernate (HNF-EP-0182).

4.3.2 Leak Assessment Considerations

The data reviewed and assessed (see Appendix B.3) showed that cumulative liquid level measurement decreases of 1.9 in. were observed between July 1973 and February 1983.

However, the liquid level system in use at the time was not a reliable indicator and no liquid level decrease criterion was assigned for this tank (SD-WM-TI-356).

Auger wells drilled in 1974 near drywell 21-07-06 indicated that the high activity near tanks BX-107 (21-07-06) and BX-110 (21-10-03 and 21-10-05) was associated with transfer line leaks (SD-WM-TI-356). Historical gamma logs, spectral gamma logs, and direct push logs show peak activity at ~12 ft bgs in some drywells extending to below the base of the tanks in other drywells. The logging data showing near surface contamination indicates multiple transfer line leaks or other near surface leaks likely occurred and the ^{137}Cs activity near the base of the tank likely migrated from these releases. The activity near the base of the tank may also be the result of a tank leak.

Although historical information and drywell data show the presence of contamination near tank BX-108, no inventory estimate could be determined from the information available. Based on the narrow peak and comparatively low gamma activity, the data suggests that if there was a tank leak, the tank leak inventory was likely small compared to the inventory of transfer line and or operations leaks.

4.3.3 Conclusions and Recommendations

Because the data suggests two potential sources (tank overfills and transfer line leaks) for activity near tank BX-108 in addition to a potential tank leak it is recommended that this tank be re-assessed per procedure TFC-ENG-CHEM-D-42. As noted above, there was no basis for an inventory estimate near tank BX-108.

4.4 TANK 241-BX-110

4.4.1 Leak Status of Tank 241-BX-110

Tank 241-BX-110 was declared “questionable integrity” in 1976 and in 1977 it was removed from service. A leak volume estimate could not be determined at the time. The questionable integrity classification was apparently based on an increase in gross gamma activity detected in drywells 21-10-03 and 21-10-05 (SD-WM-TI-356). SD-WM-TI-356 attributes this increase to an old transfer line leak. This explanation appears plausible given the high activity observed at 12 ft bgs but no information was found regarding a transfer line leak.

Interim stabilization was completed in August 1985 (HNF-SD-RE-TI-178). Additional supernate was removed in December 1993. As of December 2009 the tank contains an estimated 65 kgal of sludge 148 kgal of saltcake, and 1 kgal of supernate (HNF-EP-0182).

4.4.2 Leak Assessment Considerations

No previous leak assessments were found for this tank. The data reviewed and assessed (see Appendix B.4) showed no significant liquid level decreases were observed from 1973 to 1987. In-tank liquid level monitoring results indicate small decreases and increases for this tank.

Photos reviewed showed salt crystals on the tank BX-110 manual tape gauge in 1974 that likely contributed to changes in the manual tape readings. Historical transfer records show that tank BX-110 liquid levels were higher than spare inlet port levels at different periods and drywells near the spare inlet outlets show increased activity.

SD-WM-TI-356 states that early drywell gamma activity near tanks BX-107 (21-07-06) and BX-110 (21-10-03 and 21-10-05) was associated with transfer line leaks. SD-WM-TI-356 also states that auger wells drilled in 1974 near 21-07-06 indicated that the high activity was associated with a transfer line leak, but no additional information was found regarding transfer line leaks. Internal memo MEM-092672, "Gamma Energy Analysis of Dirt from Well E33-205" presents data for drywell 21-10-05. Based on the absence of cesium-134 (^{134}Cs) he concluded that the source of activity in the well was more than 10 years old. Historical gamma logs, spectral gamma logs, and direct push logs show peak activity at ~12 ft bgs in some drywells extending to below the base of the tanks in other drywells. The logging data indicates multiple transfer line leaks or other near surface leaks may have occurred.

4.4.3 Conclusions and Recommendations

Because the data suggests two potential leak sources (tank over flow and transfer line leaks) for activity near tank BX-110 in addition to a potential tank leak it is recommended that tank BX-110 be re-assessed per procedure TFC-ENG-CHEM-D-42.

4.5 TANK 241-BX-111

4.5.1 Leak Status of Tank 241-BX-110

Tank 241-BX-111 was declared "questionable integrity" in 1976, and in 1977 it was removed from service. The questionable integrity classification was apparently based on an increase in gross gamma activity detected in drywells 21-11-03, 21-11-04, 21-11-05, and 21-11-07 (Internal memo 13331-88-460, "Summary of Leaker or Questionable Integrity Tanks") and a liquid level decrease in 1974.

A supernatant pump (P-10) was installed in February 1977; pumping was completed in June 1977 and the tank was partially isolated in 1982 (SD-WM-TI-356). An off-normal occurrence report was issued in March 1993 due to a 1-in. liquid level decrease. Prior to the decrease the manual tape was showing a surface level increase (SD-WM-TI-356) and there were no observed changes in the LOW. The LOW was "considered accurate within 1.2 inches, and would not be expected to reflect a 1 inch drop." The tank was declared an "assumed re-leaker" in April 1993 and emergency jet pumping to remove supernatant liquid was performed from October 1993 to February 1995. In March 1995 the tank was administratively stabilized due to a major equipment failure. A total of 117 kgal of supernate was removed from the tank before the equipment failure (HNF-SD-RE-TI-178). No leak volume estimate is assigned for this tank (HNF-EP-0182).

As of December 2009 the tank contains an estimated 156 kgal of saltcake, 32 kgal of sludge, and no supernate (HNF-EP-0182).

4.5.2 Leak Assessment Considerations

Process information, in-tank monitoring data and associated drywell logging data for tank 241-BX-111 were reviewed (see Appendix B.5). In-tank liquid level monitoring results indicate both small decreases and small increases in the liquid levels for tank BX-111. Occurrence Report 74-37, *Significant Liquid Level Decrease – 241-111-BX* concluded that the liquid level decreases observed in the tank in 1974 were due to a stabilization of the crust surface after transfers.

Historical transfer records show that tank BX-111 liquid levels were higher than spare inlet port levels at different periods and drywells near the spare inlet ports for the tank show increased activity. Therefore, spare inlet overfills were identified as a potential source for the drywell activity.

Historical gamma logs, spectral gamma logs, and direct push logs were also reviewed and discussed. The logs show near surface activity and peak activity from about 30 to 40 ft bgs in drywells 20-11-03 and 20-11-04. The logging data and historical information (see Section 5.0 text) indicates that multiple transfer line leaks or other near surface leaks in lines that run between tanks BX-110 and BX-111 and lines between tanks BX-107 and BX-108 occurred that may account for deeper activity in the drywells (e.g., >1E7 pCi/g activity at ~12 ft bgs in drywell 21-10-03).

Although other potential sources are present, the high peak activity at 40 ft with lower near surface activity and little or no activity in drywells 20-11-03 and 20-11-04 indicates the potential for a tank leak.

4.5.3 Conclusions and Recommendations

Because the data suggests two potential sources (tank over flow and transfer line leaks) for activity near tank BX-111 in addition to a potential tank leak, it is recommended that this tank be re-assessed per procedure TFC-ENG-CHEM-D-42.

4.6 OTHER 241-BX FARM SINGLE-SHELL TANKS

In addition to reviewing tanks currently classified as “assumed leakers” (HNF-EP-0182), BX-Farm tanks currently classified as “sound” (HNF-EP-0182) were also reviewed. 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 operational spills, line leaks, or leaks from another tank. It was concluded that there was no conclusive evidence of a liner failure for any of these tanks.

The February 17 meeting minutes (Appendix A) noted that activity near tank BX-107 was attributed to a line leak and either additional verification of a transfer line leak should be provided or tank BX-107 should be reassessed per procedure TFC-ENG-CHEM-D-42. An earlier leak assessment for tank BX-106 (RPP-9752, *Leak Assessment for Tank 241-BX-106*) concluded that activity in drywell 21-06-05 was likely the result of several periods of overfilling the tank and tank overflows and spillage from the spare inlet ports located next to the drywell.

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5.0 POTENTIAL PIPELINE FAILURES AND OTHER UNPLANNED RELEASES

5.1 DOCUMENTED RELEASES

DOE/RL-88-30, *Hanford Site Waste Management Units Report*, contains the official listing of UPRs identified at the Hanford site. Unplanned releases, pipeline failures and near surface releases summarized in Table 5-1 were identified through review of operational histories for BX-Farm. Some of these releases are not currently included in the Waste Information Data System as UPRs. Figures 5-1 and 5-2 show BX-Farm pipeline diagrams. Some of these pipelines run near locations of UPRs designated as tank leaks. UPRs 200-E-5, 200-E-131, 200-E-132 and 200-E-133 are associated with tank leaks or overflows from tanks BX-101, BX-102 and BX-108 respectively and were discussed in Sections 4.1, 4.2, and 4.3. Figure 5-3 shows that the lines to the first tank in each cascade were supported by concrete beams. Figure 5-4 shows the plans for caps over the spare inlet ports.

Except as noted, information available was insufficient to estimate a leak volume or inventory for pipeline failures and surface releases. However, based on the available data, near-surface leaks appear to be at lower activity levels (< 100 pCi/g gamma) in general compared to the waste leaked from the tanks. Additional near surface data needs will be determined through data quality objective workshops in support of BX-Farm performance assessments and corrective management studies.

5.2 SPARE INLET NOZZLES

The SSTs in WMA BX are equipped with horizontal inlet nozzles. Process waste transfer pipelines were inserted through the inlet nozzle and protruded into the SST. A loose seal was installed around the process waste transfer pipeline at the nozzle. Tank waste may have been discharged from the SST inlet nozzles when the waste elevation in the tank exceeded the elevation of the inlet nozzles. Although the inlet nozzles on several SSTs were submerged, there is no record of the waste volume potentially lost to the soil surrounding the SST.

5.2.1 Spare Inlet Description

The SSTs in the 241-BX Tank Farm are each equipped with four horizontal inlet nozzles. The elevation of the four inlet nozzles for the 100-series SSTs is 17-ft 4-in. from the center of the tank bottom (H-2-1744, *Tank Farm Riser & Nozzle Elev.*). Inlet nozzles on the 100-series SSTs in 241-BX Farm are located at approximately the 7 o'clock position relative to north being 12 o'clock. Figure 5-4 shows inlet nozzle detail. Inlet nozzles consist 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-inches 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.

Table 5-1. Potential Pipeline Failures and Other Unplanned Waste Releases (2 sheets)

Date	Event	Reference	Comments
11-1950	In B Plant, a leak in a metal waste line between the canyon building and the 154-BX diversion box was detected by rising liquid level in the 154-BX catch tank. An alternative line was brought into service, necessitating a jumper change in the 154-BX box.	HW-19690, page 4	
9-15-1951	Late in August the first cycle waste was diverted from the 109-BY tank to the 112-BX tank since the former was filled to capacity. The new line which was placed in service leaked between the 221-B Building and the 154-BX diversion box, and it was necessary to reroute the waste through other lines.	HW-22304, page 39	
	The first cycle waste line which failed between 221-B and diversion box 154-BX on 9-15-51 was partially uncovered in an effort to determine the cause of the failure. However, radiation readings ranging to 120 R/hr were encountered at a depth of four feet and work was discontinued. About 18 inches of earth remained over the pipe	HW-22610, page 39	
10/6/1955	About 200 sq ft of ground near the 241-BX-155 Diversion Box (~900 ft S. of BX-Farm) was contaminated to maximum dose rate of 22.6 rads/hr at the surface as a result of pressure testing of lines and jumpers in the box. The Area was covered with clean soil.	East Tank Farm occurrence reports, RHO-HS-ST-10, HW-60807	The Area was covered with clean soil.
7-2-1970	103BX Repaired leaking pump discharge jumper and pumped to 109BY.	ARH-1526-3, page 2	
7-19-1972	On July 19, a routine radiation survey of the **R-13 electrical pit *[located adjacent to 221-B Plant on south side]*** gave an indication of contamination. In the investigation following the discovery, it was evident that the leakage came from the **V-342 line** which carries Cs-denuded waste from the 18-1 tank to 101-BX tank in the 241-BX Tank Farm; hydrostatic testing at 200 psi gave a leak indication. The direct buried line has now been removed from service with both ends blanked off. It was **estimated that 30 curies of Cs-137 are contained in the soil surrounding the leak**. The waste stream was rerouted through cell 24 while an alternate route was prepared.	ARH-2441 RD, page 34 PPD-493-7-DEL, page AIV-14	

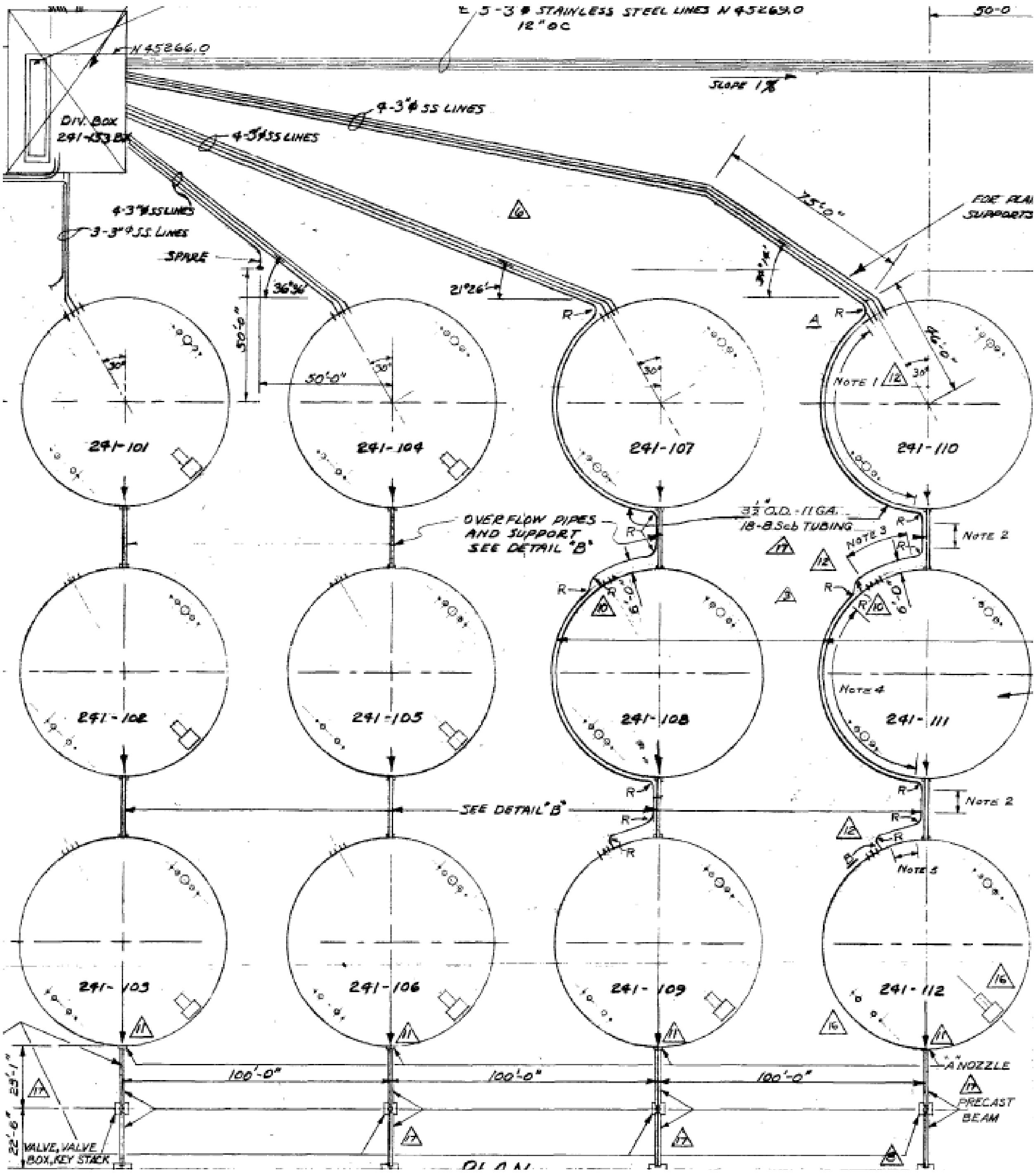
Table 5-1. Potential Pipeline Failures and Other Unplanned Waste Releases (2 sheets)

Date	Event	Reference	Comments
Before 11/1973	Tank 241-BX-103 was documented as having contaminated soil in the vicinity of dry wells 21-03-03 (75 ft), 21-03-05 (75 ft), and 21-03-12 (24 ft) and is believed to be from tank overflow and spillage some years ago. Believed to have been caused by tank overflow and spillage a number of years ago. Raw-water hose bibs and hydrant-type valving caused considerable water contamination in SE quadrant of farm.	BHI-00179 SD-WM-TI-356 GJ-HAN-96	First record of drywells logged 11/1973 shows activity ~50,000 cps in 21-03-12.
Before 1974	Some test drilling and augering was conducted in 1974 in an attempt to determine the source of high gamma ray activity in 21-07-06. It was concluded that the contamination was associated with a transfer line leak.	SD-WM-TI-356	Note: near BX-110 contamination
1978	Contaminated particulate matter was transported offsite creating an unplanned airborne release from the 241-BX tank farm. A radiation survey in 1978 revealed minute quantities of beta/gamma emitting particulate East of BX Farm. Wind spread the contamination to an area of 3 acres to N/NW of BY farm.	BHI-00179	Contaminated soils were consolidated on top of the 216-B Cribs and the cribs and area were covered with clean soil.
12-2-1978	During a cross-site transfer from 107-S to 105-BX, steam was noted coming from the 104-BX cover plate and condensate dripped from the vent filter to the cover plate. Smearable contamination was found on the 104-BX pit edge to 20 mRads/hr, and on the 105-BX cover plate to 100 mRads/hr. Direct readings of 300 mRads/hr on the 105-BX vent pipe. No ground contamination found.	East Tank Farm occurrence reports, RHO-HS-ST-10	A portable exhauster was hooked to the 104-BX Tank to decon 104-BX and 105-BX pit covers. The 105-BX vent filter was changed.

References:
ARH-1526 3 DEL, *Chemical Processing Division Daily Production Reports July 1970 Through September 1970.*
ARH-2441 RD, *Waste Processing Sec Monthly Reports January 1, 1972 Thru December 31, 1972.*
BHI-00179, *B Plant Aggregate Area Management Study Technical Baseline Report.*
GJ-HAN-96, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank BX-103.*
HW-19690, *#202 H.I. Divisions Monthly Report on 200 Areas and Associated Laboratories for Month of November 1950.*
HW-22304-DEL, *Hanford Works Monthly Report for September 1951.*
HW-22610-DEL, *Hanford Works Monthly Report for October 1951.*
HW-60807, *Unconfined Underground Radioactive Waste and Contamination in the 200 Areas–1959.*
PPD-493-7-DEL, *Monthly Status and Progress Report July 1972.*
RHO-HS-ST-10, *Historical Timelines of Hanford Operations.*
SD-WM-TI-356, *Waste Storage Tank Status and Leak Detection Criteria.*

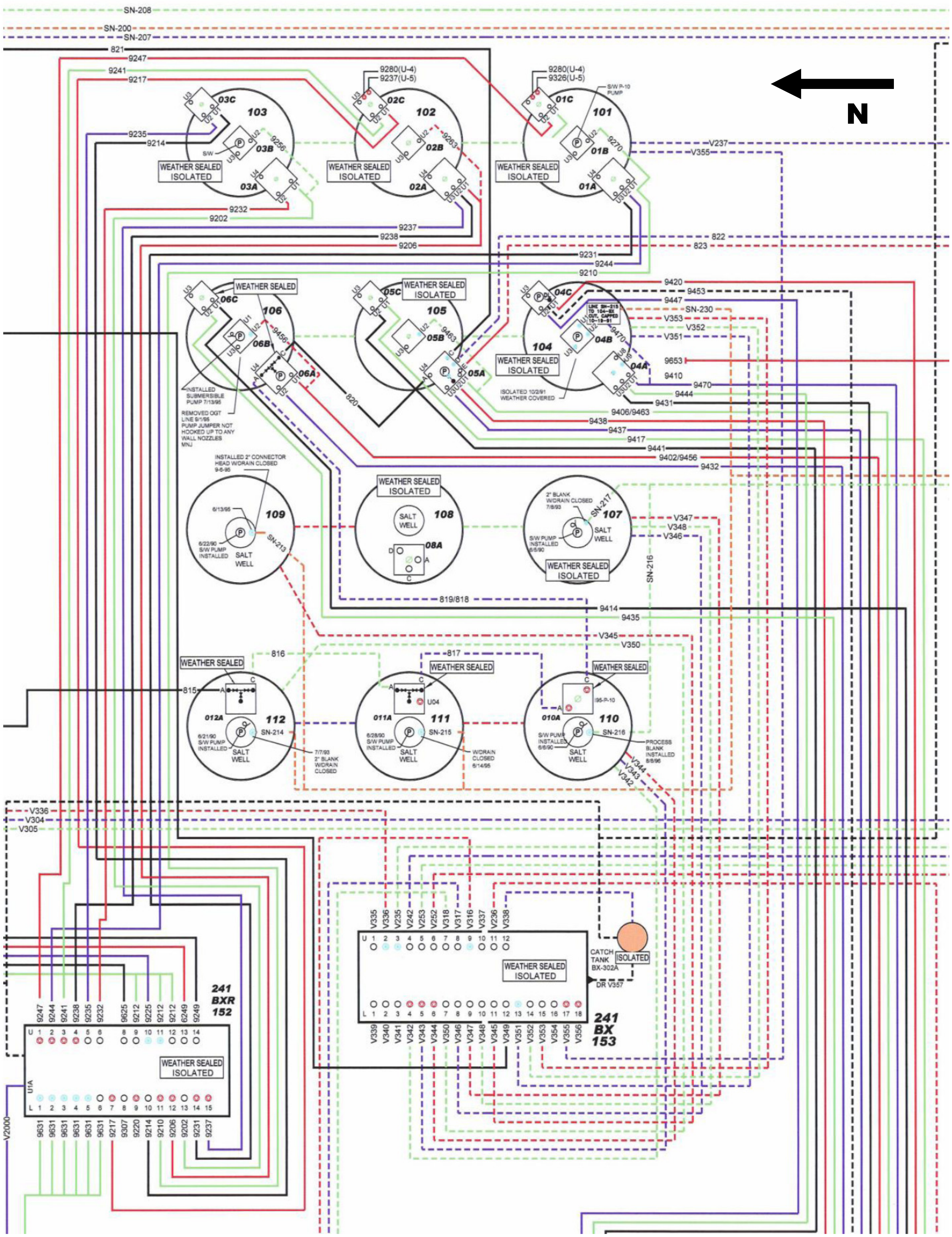
Three inch diameter process waste lines are inserted through the 4-inch diameter steel pipe and extend ~4-ft inside the SST. The process lines connecting to the inlet nozzles are supported by concrete beams to the first tank in each cascade (tanks BX-101, BX-104, BX-107 and BX-110). The concrete support beams are 30 in. tall and 32 in. wide, except for tank BX-101, which is only 26 in. wide. The concrete support beams have a 4-inch tall shoulder, resulting in a 24 in. (only 18 in. for tank 241-B-101) wide trough running down the center of the beam.

Figure 5-1. 241-BX Tank Farm Pipeline Diagram



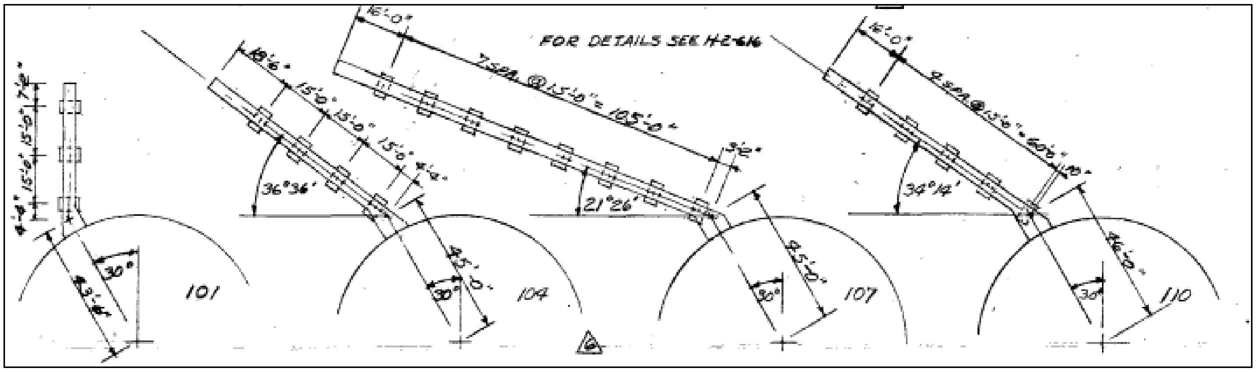
Reference: H-2-611, *Piping & Concrete 241-BX*, Sheet 1, Rev. 18.

Figure 5-2. 241-BX Tank Farm Transfer Lines



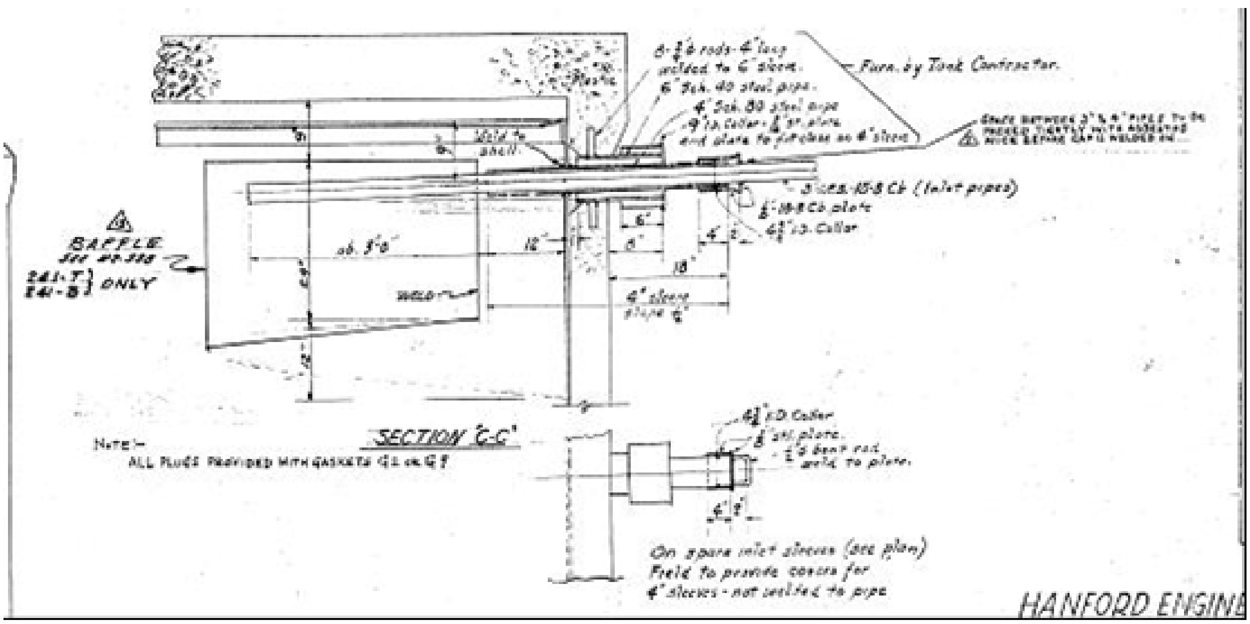
Reference: H-14-104175, *Waste Transfer Piping Diagram 200 East Area*, Sheet 1, Rev. 38.

Figure 5-3. 241-BX Tank Farm Concrete Beams and Supports



Reference: H-2-611, *Piping & Concrete 241-BX*, Sheet 1, Rev. 18.

Figure 5-4. 20-Foot Diameter Single-Shell Tank Detail Showing Inlet Nozzles



5.2.2 Potential Spare Inlet Overflows

Some of the inlet nozzles on the SSTs are spares and do not have installed process waste lines. A 4.5-in. diameter cover was to be placed over these 4-in. diameter spare inlet nozzles (Figure 5-4). However, some of the spare inlet nozzles are poorly sealed. Tank BX-102 was overfilled in February 1951 and waste was lost to the ground through the spare inlet nozzles (HW-20742, *Loss of Depleted Metal Waste Supernatant to Soil*). As part of the investigation into the waste loss from SST BX-102, spare inlet nozzles on several SSTs (specific tanks were not identified) were examined. This investigation revealed "… that 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, page 5).

Based on the SST BX-102 waste loss investigation, waste may have been similarly lost to the ground in other locations in the BX-Farm if SSTs were filled above the height of the spare inlet nozzles (17-ft 4-in. [~547,500 gal]). If waste losses occurred, small waste losses from the spare inlet nozzles for SSTs BX-101, BX-104, BX-107, and BX-110 may have been contained and channeled along the concrete beams that support the process waste lines connecting to the inlet nozzles (Figure 5-3).

The waste volumes for SSTs were reported monthly from January 1945 through December 1960 (except no data for August 1951 through March 1952), semi-annually from January 1961 through June 1965, quarterly from September 1965 through September 1976, and returned to monthly thereafter.

As shown in Table 5-2, all of the BX-Farm tanks were filled with waste above the elevation of the spare inlet nozzles on one or more occasions. Waste may have been lost to the ground from these SSTs during the periods shown. The volume of losses or whether losses actually occurred is unknown, except for a 91,600 gal loss from tank BX-102 (see Section 4.2).

5.3 OTHER POTENTIAL LOSSES

A 1984 Basalt Waste Isolation Project (BWIP) water balance study (Internal Letter 65633-128, "Status of the BWIP Water Balance Study") indicated that between 1977 and 1984, between 15% and 41% (24% average) of the 2.11 E9 gal (8E9 L) of water discharged to the 200 East Area general raw water lines was unaccounted for, suggesting either error in process measurements or significant losses in the water lines. While raw water losses do not increase the inventory of waste lost to the soil they provide a substantial driving force to move mobile contaminants toward groundwater and these raw water loss estimates give an indication of other potential losses from waste process lines.

Water was also released indiscriminately to "wash down" surface contamination and reduce surface radioactivity (mentioned in Table 5-1 for some events) and for fire hydrant testing. Flooding of the farms also occurred due to rapid snow melt and flooding and pipeline breaks or inadvertently leaving a valve open. The volume of waste or raw water released in these events is generally unknown.

Figures 5-5a to 5-5e are cross section visualizations based on SGLS drywell measurements. The figures show ^{137}Cs activity at <100 pCi/g throughout the upper 9 ft of BX-Farm and hot spots near tanks BX-101, BX-102, and BX-110. Europium-154 (^{154}Eu) is observed near tank BX-108. At 24 and 43 ft ^{154}Eu, ^{60}Co, and antimony-125 (^{125}Sb) are observed near tank BX-101 and at 43 ft a ^{60}Co plume is shown emanating from tank BX-108. At 80 ft and 104 ft the plume from the southeast edge of tank BX-102 is shown to migrate to the northeast and uranium is observed. These observations are consistent with previous discussion for tanks BX-101, BX-102, BX-108, BX-110 and BX-111.

Table 5-2. Potential Waste Losses through Spare Inlets on Waste Management Area BX Single-Shell Tanks

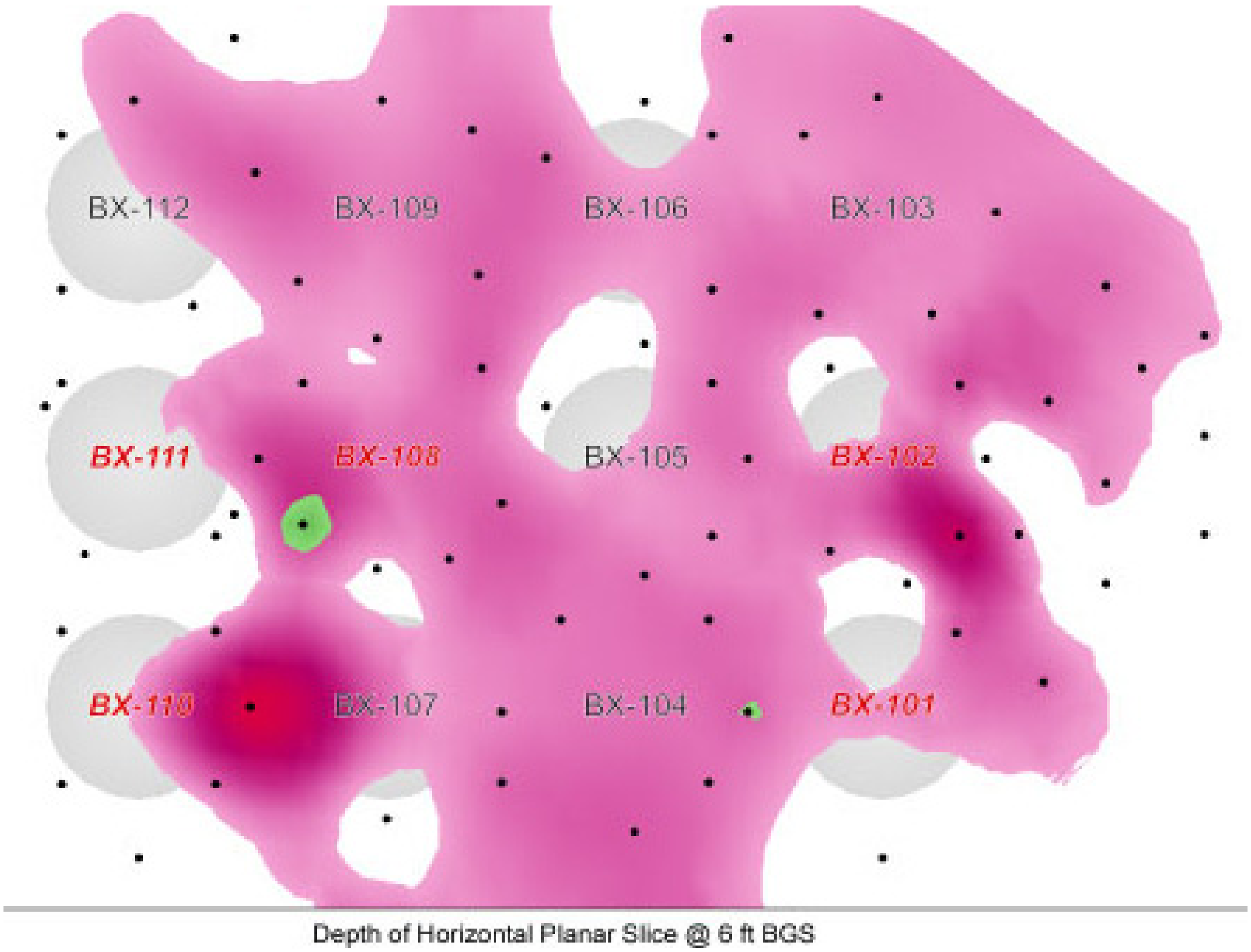
Tank	Dates Tank Waste static level exceeded 538 kgal (cascade level) (> 548 kgal, spare inlet level if no value is shown)
BX-101	February 1951 January 1962 to September 1967
BX-102	February 1951 January 1962 to December 1967 (538 kgal) October 1966 to September 1967 (546 kgal)
BX-103	October 1962 to December 1963 (538) October to December 1970 (542 kgal) April to June 1971 (541 kgal) April to June 1972 (542 kgal)
BX-104	April 1963 to September 1967
BX-105	January to December 1963 (546 kgal) July 1964 to September 1966 (538 kgal) April to June 1968 (538 kgal)
BX-106	January 1963 to Jun 1967 (541-543 kgal) January to June 1969
BX-107	April 1957 to September 1968 July 1969 to June 1974 (538-541 kgal)
BX-108	April to September 1957 January to December 1964 (544 kgal) April to June 1969 (539 kgal)
BX-109	April-September 1957 July 1964 to September 1967 (538-541 kgal) October 1967 to September 1968
BX-110	July 1964 to December 1967 (543-546 kgal) January to September 1968 January to June 1969 (542 kgal)
BX-111	April-September 1957 January 1964 to June 1968 (540-544 kgal)
BX-112	July 1964 to June 1968

5.4 OTHER FACILITIES IN 241-BX TANK FARM (BHI-00179)

216-B-35 through 216-B-42 (216-BX-1 through BX-8) Trenches

The 216-B-35 through 216-B-42 trenches are inactive waste sites located ~200 ft due west of the 241-BX Tank Farm (see Figure 3-6). The trenches received between 280 kgal (1,060,000 L) and 1,141 kgal (4,320,000 L) of first-cycle supernatant waste from the 221-B building between December 1953 and February 1955. Trench 216-B-37 (BX-3) received first-cycle bottom supernate from the 242-B waste evaporator in August 1954. Some inorganic liquids disposed at this site contained fluoride, nitrate, nitrite, phosphate, sodium aluminate, sodium hydroxide, sodium silicate, and sulfate based compounds. Radionuclides contained within the waste stream include: ^{137}C, ^{90}Sr, ^{106}Ru, plutonium, and uranium.

Figure 5-5a. Visual Based on Drywell Logging Activity @ 6 feet in 241-BX Tank Farm

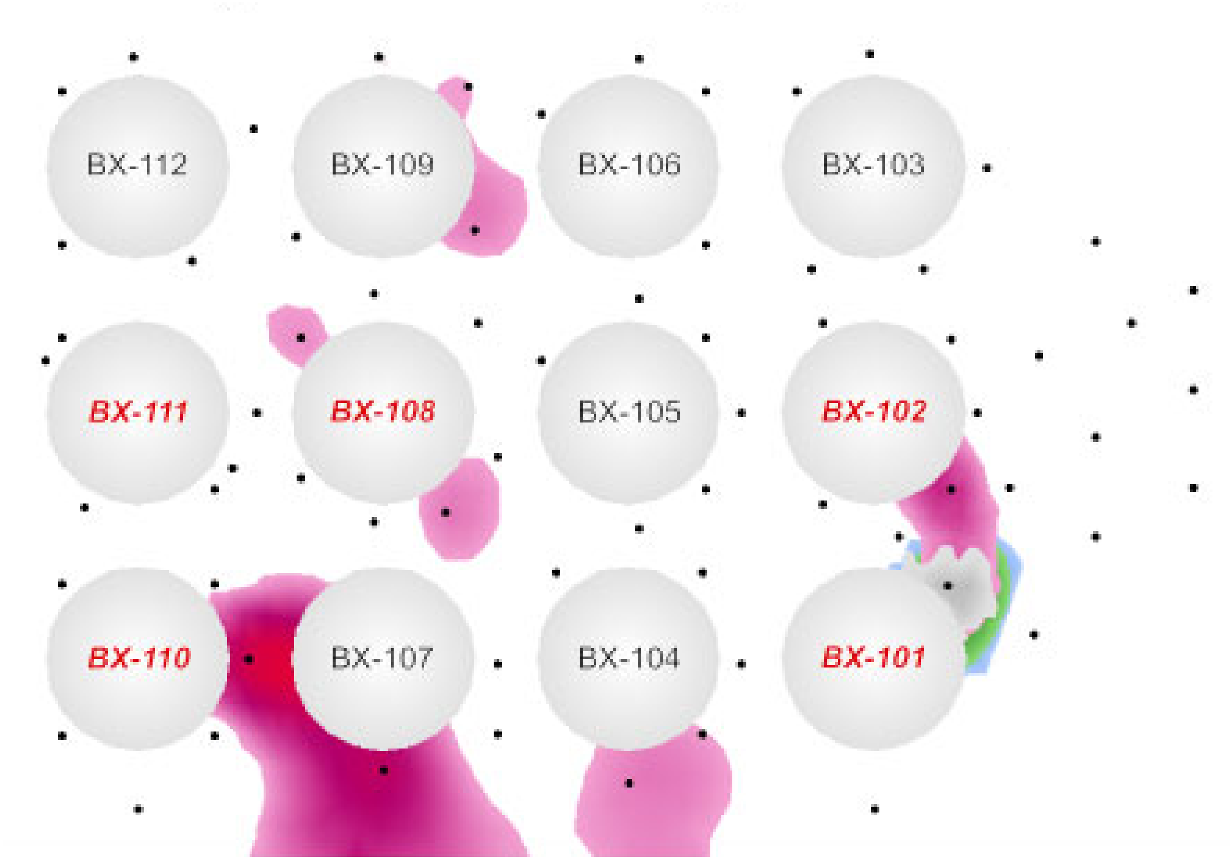


Reference: GJO-98-40-TARA/GJO-HAN-19, *Hanford Tank Farms Vadose Zone: Addendum to the BX Tank Farm Report.*

Trenches 216-B-35, 216-B-36 and 216-B-38 through 216-B-41 (BX-1, BX-2, BX-4, BX-5, BX-6 and BX-7) were used for the disposal of first-cycle supernate from tanks 241-B-110, BX-111, BX-112, 241-BY-106 and BY-110 from February through October 1954. The waste was covered with 10 ft of clean earth and "underground contamination" signs were posted on the east and south sides of the area.

Trench 216-B-37 (BX-3) was used for disposal of first-cycle waste from tanks B-107, B-108 and B-109 during August 1954. The waste was covered with approximately 10 ft of clean earth and an "underground contamination" sign was posted on the east side of the area.

Figure 5-5b. Visual Based on Drywell Logging Activity @ 24 feet in 241-BX Tank Farm



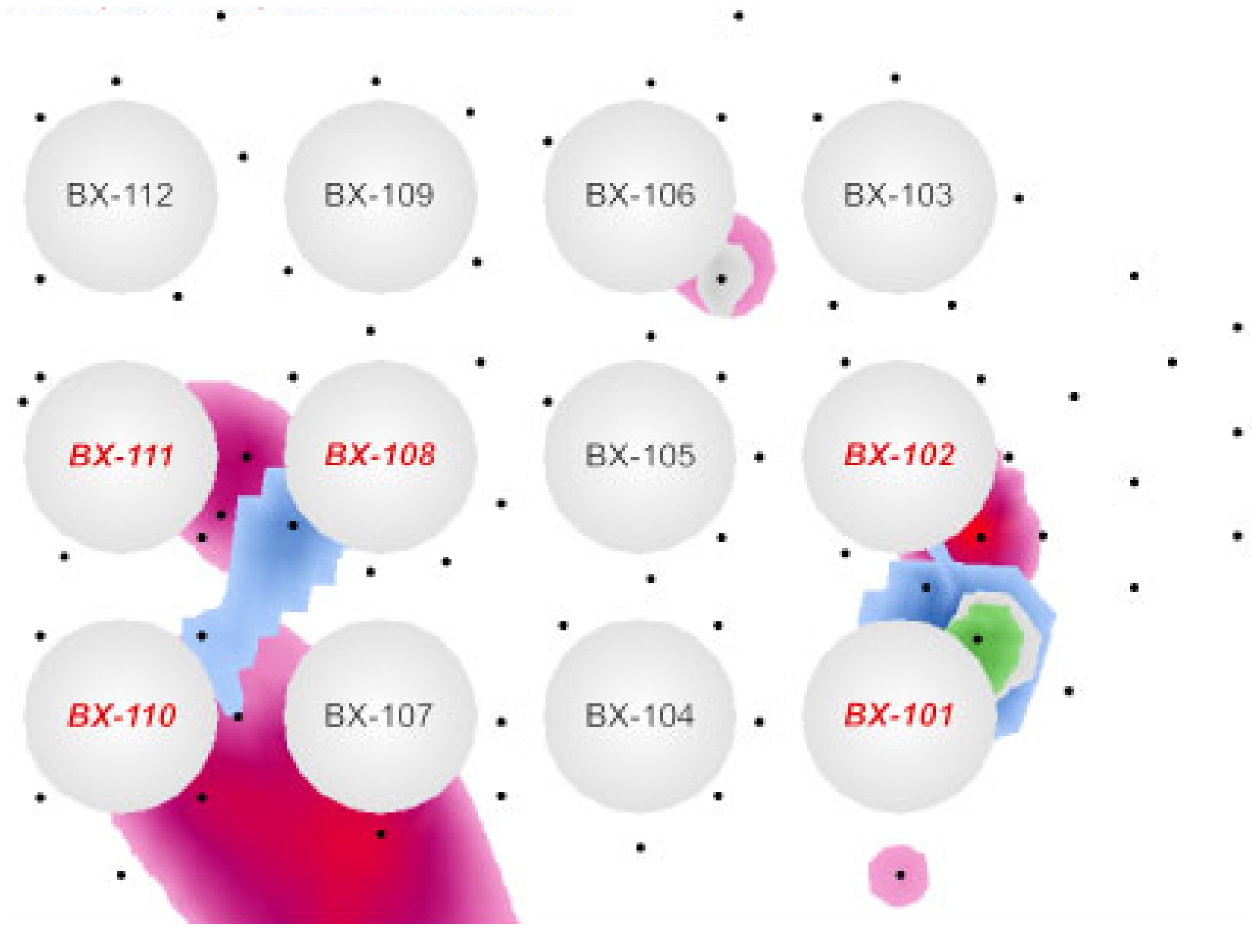
Reference: GJO-98-40-TARA/GJO-HAN-19, *Hanford Tank Farms Vadose Zone: Addendum to the BX Tank Farm Report.*

Trench 216-B-42 (BX-8) was used during January and February 1955 for disposal of TBP scavenged waste from tank BY-110. The waste was covered with approximately 10 ft of clean earth and an "underground contamination" sign was posted on the east side of the area.

Vadose wells 299-E8-10, 299-E8-21, 299-E8-286, 299-E8-287, 299-E8-288, 299-E8-289, and 299-E8-290 monitor the soil column beneath the trenches. Gamma logging profiles indicate the radioactive contaminant plume is currently contained in the soil above the groundwater.

241-BX-153 Diversion Box and 241-BX-302A Catch Tank
This is an inactive waste site located at the southern boundary in 241-BX Tank Farm. The site was in service from 1948 until June 1983 transferring waste solutions from processing and decontamination operations. Located adjacent to and below the diversion box is the 241-BX-302A catch tank that collects waste spilled in the box during transfers. Both units have been isolated and weather covered (HNF-EP-0182). The site interconnects the 241-B-152 and 241-13-155 diversion boxes and 241-BX and 241-BY Tank Farms. Radionuclide inventories were not available for this site.

Figure 5-5c. Visual Based on Drywell Logging Activity @ 43 feet in 241-BX Tank Farm



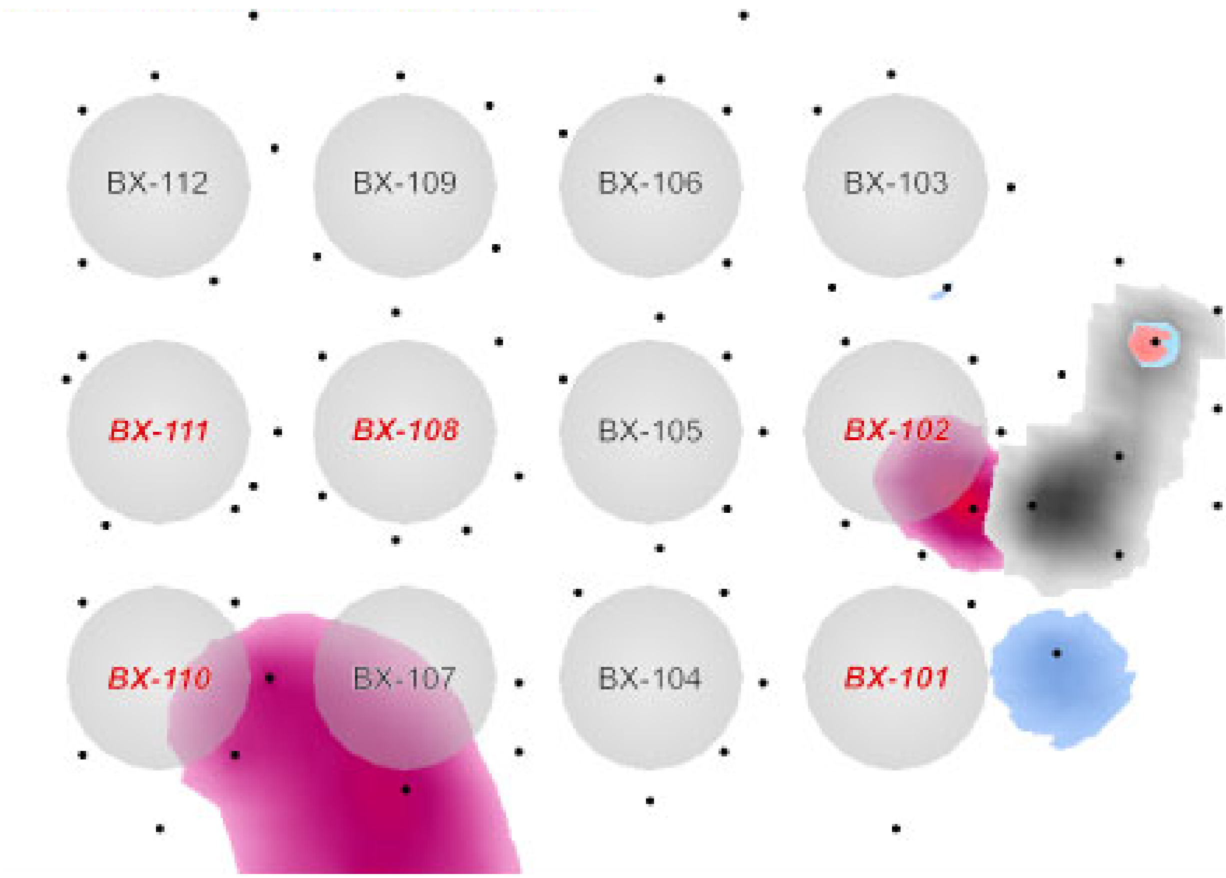
Reference: GJO-98-40-TARA/GJO-HAN-19, *Hanford Tank Farms Vadose Zone: Addendum to the BX Tank Farm Report.*

Located ~200 ft northeast of the diversion box in the 241-BX Tank Farm is the 241-BX-302-A catch tank, which collects waste spilled in the 241-BX-153 diversion box during waste transfers. The unit was in operation from 1948 until July 1985. This unit has been isolated and weather covered.

241-BXR-151 Diversion Box
The 241-BXR-151 diversion box is an inactive waste site located at the southern boundary in 241-BX Tank Farm. The site was in service from 1948 until June 1984 transferring waste solutions from processing and decontamination operations. Leak detection and air monitoring are performed continuously at 241-BX Tank Farm. The unit has been isolated and weather coated.

241-BXR-152 Diversion Box and 241-BX-302A Catch Tank
The 241-BXR-152 diversion box is an inactive waste site located at the southern boundary in the 241-BX Tank Farm. The site was in service from 1948 until June 1984 transferring waste solutions from processing and decontamination operations. The unit has been isolated and weather coated.

Figure 5-5d. Visual Based on Drywell Logging Activity @ 80 feet in 241-BX Tank Farm

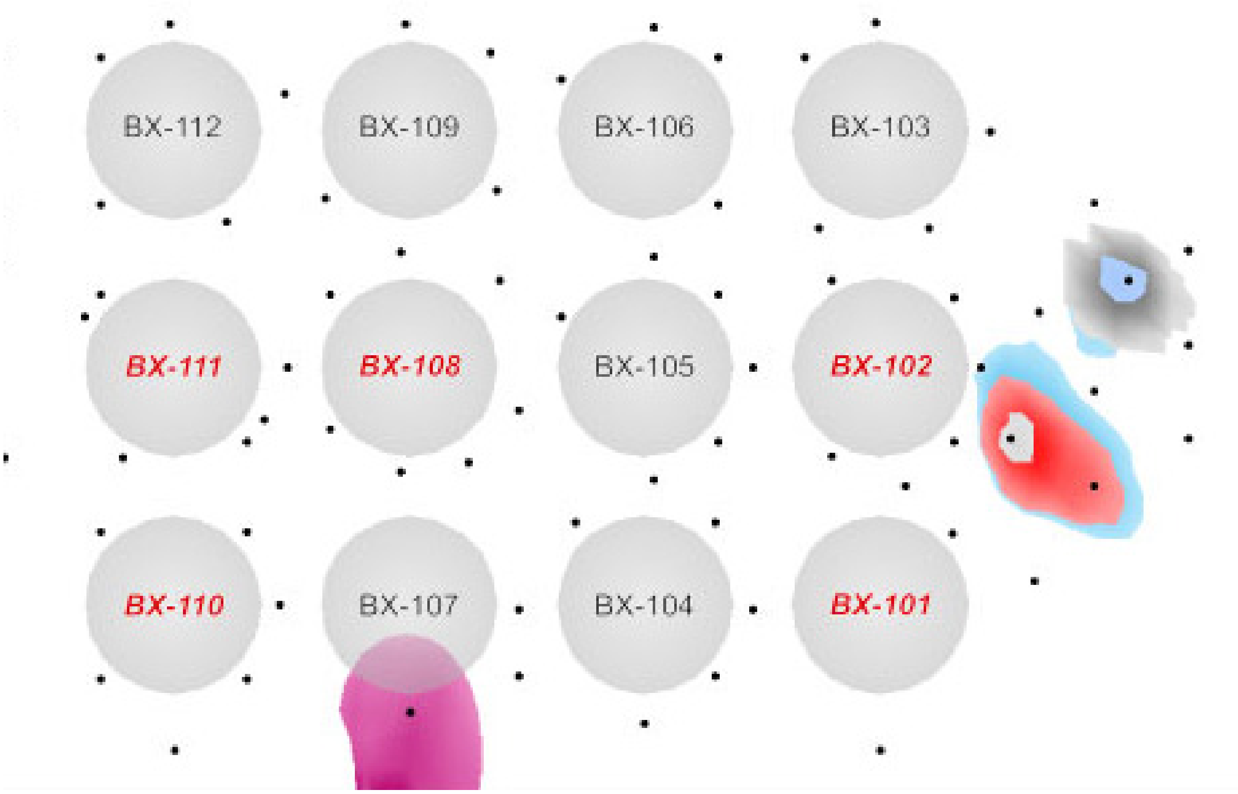


Reference: GJO-98-40-TARA/GJO-HAN-19, *Hanford Tank Farms Vadose Zone: Addendum to the BX Tank Farm Report*.

241-BXR-153 Diversion Box

The 241-BXR-153 diversion box is an inactive waste site located at the southern boundary in the 241-BX Tank Farm. The site was in service from 1948 until June 1984 transferring waste solutions from processing and decontamination operations. The diversion box interconnected the 241-B-152 and 241-B-155 diversion boxes and the 241-BX and 241-BY Tank Farms. The unit has been isolated and weather coated.

Figure 5-5e. Visual Based on Drywell Logging Activity @ 104 feet in 241-BX Tank Farm



Reference: GJO-98-40-TARA/GJO-HAN-19, *Hanford Tank Farms Vadose Zone: Addendum to the BX Tank Farm Report*.

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APPENDIX A

241-BX FARM TANK LEAK ASSESSMENT MEETING SUMMARIES

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MEETING SUMMARY

From:	J. G. Field
Phone:	376-3753
Location:	Ecology Office,
Date:	November 17, 2009
Subject:	Tank Farm Leak Evaluation
To:	Distribution/Attendees
Attendees:	Joe Caggiano, ECOLOGY Jim Field, WRPS Les Fort, ECOLOGY Paul Henwood, S.M. Stoller Jeremy Johnson, ORP Marc Wood, CHPRC

PURPOSE:
Assess tank BX-101 leak inventory estimate.

Review of Previous Meeting Summary:
The October 6, 2009 meeting summary was reviewed and approved.

Status of Assessment Reports
Reviews are in progress for the SX Farm leak assessment report and SX Heat load report. After review of these reports is completed, comments will be dispositioned with reviewers and incorporated accordingly and the SX Farm leak assessment report will be released for review by the tribes. The TY Farm leak assessment report is drafted and edited except for completion of the groundwater discussion. After this is completed, The TY report will be distributed for review by the assessment team. A draft of the BY Farm leak assessment report is being edited. A discussion of B-BX-BY groundwater will be prepared and included in the report before it is released for peer review.

Discussion and Review of Tank BX-101 Leak Inventory
Information about tank BX-101 to be included in the assessment report was presented. Tank BX-101 was suspected to be a leaking tank based on high activity observed in drywells 21-01-01 and 21-01-02. After discussing tank waste process information and past evaluations, four potential events contributing to the activity were identified.

1. 1951 Overflow: In 1951 the cascade overflow line between BX-102 and BX-103 plugged resulting in an estimated 91,600 gal loss based on a review of tank inventories for BX-101, 102 and 103 and the amount of depleted uranium discharged to the 101-BX

to 101-BY cascade series (HW-20742). A probable leak location based on drywell activity was the BX-102 spare inlet ports. This near the BX-101 drywells.

2. Potential overflows between 1962 and 1968: The liquid level in BX-101 was near or above the cascade line during this period. ISO and ARH reports show the level stayed below 543 kgal, but there are two conflicting drawings showing different cascade levels (See Table 1). Based on the drawings, the level was below spare inlet ports (551.4 gal).
3. Sudden increase in activity at drywell 61 (now 21-27-11) observed on 10/1969. This drywell is far from BX-101 and probably more related to losses near or from BX-102.
4. 1972 BX-101 leaking riser in the sluice pit. Excavated soil samples near where the riser enters the tank dome were "runny wet when received." (Sept. 26, 1972, Mem-092672, #D194037115).

Table 1. Level of Cascade Overflow lines and Spare Inlets (level above dish, 12" offset)

Location	Elev. above sea level (ft)	Depth bgs (ft)	Level (in)	Waste Vol (kgal)	Reference
Cascade BX-101 to BX-102 BX-102 to BX-103	 632.96 631.96	 23.4 23.4	 191.5 191.5	 539.1 539.1 (ht*2750+12500)	 Brevick DWG (H-2-1745)
Cascade BX-101 to BX-102 BX-102 to BX-103	 633.12 632.12	 23.2 23.2	 193.44 193.44	 544.5 (ht*2.75+12.5)	 H-2-611
Cascade BX-102 from BX-101	 632.37 632.21	 22.96 23.12	 196.44 194.52	 552.7 547.4	 H-2-611 H-2-1745
spare inlet nozzle (C) BX-101 BX-102	 633.33 632.33	 23 23	 195.96 195.96	 551.4 551.4	 H-2-1745
BX-101 sluice pit bottom (drain line)	647.25	9.1	363.0		H-2-41803
BX-101 above dish BX-102 above dish (12 " above tank bottom)	617.0 616.0	39.33 39.33		12.5 12.5	H-2-1745
Ground Surface BX-101 BX-102	 656.33 655.33				H-2-41803

There appears to be no indication of a breech in the tank BX-101 liner and several other sources for the activity observed in drywells.

The loss of 91,600 gal through 1951 appears to have a good technical basis. This loss was based on a uranium mass balance for the BX and BY cascade and is attributed to an overflow from BX-102.

The volume of waste lost to the soil after 1951 is less certain. A 1971 investigation of soil contamination near BX-101 and BX-102 estimated a total of 70,000 gal in the soil at that time (ARH-2035). This is the current estimate in HNF-EP-0182 for the BX-102 leak volume. However, this evaluation incorrectly assumed that the gamma activity measured was all Cs-137. Spectral gamma logging conducted in 1997 showed that some of the gamma contamination was uranium.

Another estimate for the BX-101 leaks after 1951 included a 4,000 gallon estimate based on unaccounted for differences between transfer volume measurements and tank BX-101 liquid level measurements in WSTRS (WHC-SD-WM-TI-615) between 1968 and 1972 (RPP-7389). Given the large volume of waste transferred in this period, this estimate is highly uncertain. Finally an estimate of 10,800 gal was developed based on assumed flow rates and time required to pump out the tank (35 days) after a riser leak was discovered near the sluice pit in 1972 (Internal memo 13331-88-460, R00781). Like the estimate from WSTRS, this estimate is questionable, particularly since the liquid level in the tank was high and overflows were possible for several years, not just the 35 days on which the estimate is based.

It was concluded that there is no evidence to indicate that the tank BX-101 liner failed and increased activity in the drywells can be explained by the leaking riser observed in the sluice pit in 1972. Therefore, tank BX-101 is a candidate for sluicing and a formal leak classification assessment is recommended.

The next meeting will look further at tanks BX-101, BX-102 and BX-103 (the full cascade) in an attempt to better quantify releases and estimate inventories of waste losses in the cascade.

ACTIONS:

1. All: Review meeting summary
2. J. Field: Prepare and distribute November 17, 2009 Meeting Summary
3. M. Wood: Complete TY and BY Farm groundwater write-up
4. ECOLGY: Complete review of SX farm leak assessment report
5. P. Henwood: Prepare logging information for BX-101, BX-102 and BX-103 cascade.
6. J. Field: Prepare summary for tank BX-102 and BX-101-103 cascade for next meeting

NEXT MEETING:

Assess tank overfills for BX-101, BX-102 and BX-103 (the full cascade) in an attempt to better quantify releases and estimate inventories of waste losses.

Date:	November 24, 2009
Time:	3:00-4:30
Location:	ECOLOGY Office

MEETING SUMMARY

From: J. G. Field
Phone: 376-3753
Location: Ecology Office,
Date: November 24, 2009
Subject: Tank Farm Leak Evaluation

To: Distribution/Attendees

Attendees: Joe Caggiano, ECOLOGY
Jim Field, WRPS
Les Fort, ECOLOGY
Paul Henwood, S.M. Stoller
Jeremy Johnson, ORP
Marc Wood, CHPRC

PURPOSE:
Assess tanks BX-101 and BX-102

Review of Previous Meeting Summary:
The November 17, 2009 meeting summary was reviewed and approved with changes.

Discussion and Review of Tank BX-101 and BX-102 Leak Inventory

Information for tank BX-101 was again reviewed along with waste process information for tank BX-102 and liquid level and tank cascade and spare inlet port elevations for the tanks BX-101, BX-102 and BX-103. This information will be included in the BX-Farm assessment report.

BX-101
A BX-101 sluice pit riser leak was observed in September 1972. This was previously determined to be the most likely source for increased activity in drywells near BX-101 (Sept. 26, 1972, Mem-092672, #D194037115). Larkin and Metz (Sept. 29, 1972 memo) shows analytical results for soil samples collected on the tank dome/riser interface (^{137}Cs = 8.46 uCi/g). Vadose zone data showed that increased and new activity observed in drywells 21-02-04 (drywell 27) and 21-27-11 (drywell 61) in 1970 was fission product supernate. The date the leak started could not be determined and previous leak estimates for this tank do not have a good technical basis. A formal re-evaluation of the current classification for this tank is recommended and additional characterization to better quantify inventory losses near tank BX-101.

BX-102
The high activity observed in drywell 21-27-11 near BX-102 in 1951 was attributed to an overflow caused by the plugged cascade line between BX-102 and BX-103. The estimated leak loss from this overflow was 91,600 gal loss of Metal Waste supernate. A probable leak location based on drywell activity was the BX-102 spare inlet ports (HW-20742). There was no evidence of overflows near tanks BX-101 or BX-103 in 1951.

Based on the data presented in ARH-2035, increased activity was observed in Drywell 21-27-11 in 1969. Data logs reviewed showed that the high activity may have been present earlier. Three possibilities for the increased activity in Drywell 21-27-11 in 1969 were discussed. These include: 1. The increased activity was due to the sluicing pit riser leak from tank BX-101, 2. The activity is the result of additional spare inlet overflows from Tank BX-102, 3. The activity was caused by a leak in Tank BX-102. All of these alternatives are possible. Drywell and surface level information related to increased activity in the 1960's will be further discussed in the next meeting.

ACTIONS:
1. All: Review meeting summary
2. J. Field: Prepare and distribute November 24, 2009 Meeting Summary
3. J. Field/P. Henwood: Prepare additional logging data for BX-102 and prepare summary and logging information for tank BX-108 for the next meeting

NEXT MEETING:
Assess tank BX-108

Date:	December 15, 2009
Time:	3:00-4:30
Location:	ECOLOGY Office

MEETING SUMMARY

From:	J. G. Field
Phone:	376-3753
Location:	Ecology Office,
Date:	December 15, 2009
Subject:	Tank Farm Leak Evaluation
To:	Distribution/Attendees
Attendees:	Joe Caggiano, ECOLOGY Jim Field, WRPS Les Fort, ECOLOGY Paul Henwood, S.M. Stoller Jeremy Johnson, ORP Marc Wood, CHPRC

PURPOSE:
Assess tanks BX-102 and BX-108

Review of Previous Meeting Summary:
The November 24, 2009 meeting summary was reviewed and approved with changes and a Draft TY-Farm Leak Assessment Report (RPP-RPT-42296) was provided to Ecology and team members for review.

Resistivity Tests in BX-Farm
The team discussed documentation showing that several hundred gallons of a 3M sodium nitrate solution was injected near BX-101 and BX-103 in November 1974 as part of electrical resistivity tests (ARH-LD-120). The report also states that during the test at well BX-103-05A "the nearby hydrant was turned on, only partially, allowing an unknown amount of water to be dumped into the nearby soil," and "the second addition of saltwater produced no observable consistent results, it is assumed that the soil at the base of the tank is too saturated with water and salt to allow significant reaction to further aqueous addition." This report was noted as one example of an event that likely contributed to mobilization and deeper migration of waste and that generally is not reflected in conceptual models.

Tank BX-102
Information for tank BX-102 was again reviewed to further assess the cause of several increases in activity in drywell 61 in 1951 and from 1962-1969. In February 1951, the drywell was "found to have a higher than background reading at the 40 foot depth and jammed the counter at 70 foot depth" (HW-20742) (It was assumed that "jammed the counter" means the reading went off-scale and exceeded the detection capacity for the detector). Between 1961 and 1964, evidence exists of increased activity in scintillation probe readings. Between 1969 and 1971 a rapid

decrease in activity in drywell 61 (21-27-11 or 299-E33-61) followed by a rapid increase back to near the original level is noted by Womack and Larkin (ARH-2035) and shown in Figure 1. Several inconsistencies and questions in the figure and the ARH-2035 assessment were discussed.

Liquid levels presented in the figure appear to be inconsistent with waste summary reports that show liquid levels did not exceed the level of the spare inlet ports in BX-102 through the 60's. However, liquid levels were above the cascade line and given measurement uncertainty, overflows from the spare inlet ports during this time are possible.

In contrast to Figure 1, at least one log reviewed showed that the activity level was > 10E6 c/m in 1963 roughly coincident with GM probe readings that suggest little or no activity. It is possible an influx of contamination to the drywell caused the GM detector to be paralyzed and erroneously indicating no activity. This leads to questions about other log data presented in the figure. The characteristics of the GM and scintillation detectors and the relationships between detectors presented in Figure 1 are unknown. However, the peak readings shown in the Three Rivers gross gamma historical data (HNF-3531) after 1980 and in SD-WM-TI-356 in 1972 appear to be consistent with scintillation readings in Figure 1.

Previous investigations concluded that the rapid increase in activity at drywell 21-27-11 (61) after 1962 was probably due to a second leak in the vicinity of the spare inlet line subsequent to the tank being reused in 1962 (M. E Johnson Memo, September 10, 2003). The wetted soil volume for both the 1951 leak and the later leak is described in ARH-2035. However, the ARH-2035 assessment incorrectly attributes the entire volume to the later leak, assumes the majority of the gamma activity in the drywells was Cs-137, assumes a Cs-137 composition of 0.726 Ci/gal based on the supernate in tank BX-102 in 1970 which was ion exchange waste (scavenged Cs-137), and does not consider the extensive low activity contamination generally below 100 ft; it is now known this low activity contamination is largely U-238/U-235 contamination from the 1951 leak event. As a consequence, the leak volume of 70,000 gallons (as of 1972) estimated in ARH-2035 is incorrect. As noted, an estimated 91,600 gallons of MW (depleted uranium and fission products) overflowed the spare inlets in 1951 with a very different waste composition than subsequent waste streams where fission products were dominant. SGLS logs show the gamma activity remaining in drywells near BX-102 is a combination of Cs-137, Sb-125, Co-60, Eu-154 and processed uranium. In general, the remnants of the 1951 leak are uranium from approximately 72 ft to 140 ft; it can be assumed gamma emitting fission products from 1951, with the exception of Cs-137, have decayed away. Remnants of fission and activation products such as Cs-137, Co-60, and Sb-125 are generally indicated from 40 to 100 ft. These likely originated from more recent leak events.

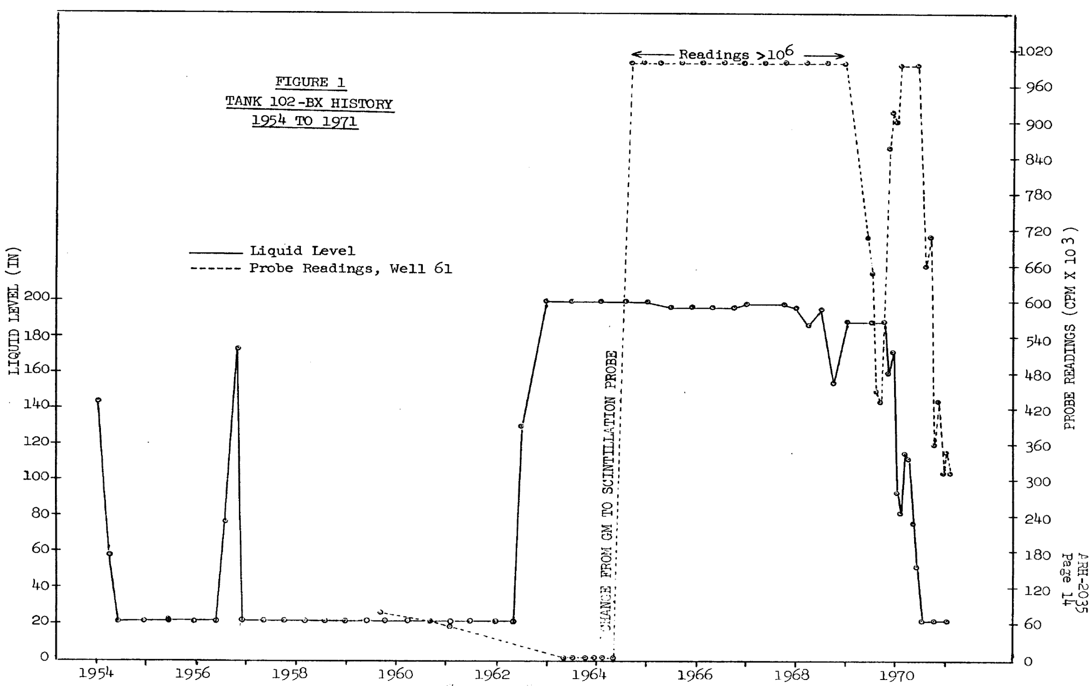
The volume of a second overflow or leak after 1962 appears small, but cannot be accurately determined from the available information. However, if the uranium is the primary remnant of the 1951 leak and the high activity zones in the 1970s drywell logs represent new influxes of contamination, an estimate of the subsequent leak may be made. A leak volume will be estimated using the proposed approach and results will be discussed in the next meeting. It was observed that extensive characterization has been performed near BX-102 and additional characterization may or may not help to estimate the size of the leak or overflow.

Given the probability that the tank overflowed and questions of whether it leaked, the team recommended revisiting the current leak classification for tank BX-102 per TFC-ENG-CHEM-D-42.

Tank BX-108

Information was presented to discuss leak volume estimates for tank BX-108. No previous assessments for this tank were identified. The tank was declared a suspected leaker in the fourth quarter of 1973 and a confirmed leaker in 1974 with an estimated leak volume of 2,500 gal (SD-WM-TI-356). The confirmed leaker classification was apparently based on an increase in gross gamma activity detected in drywell 21-08-06 and declining liquid levels in the tank (SD-WM-TI-356).

Figure 1. Drywell 61 (21-27-11) Measurements (ARH-2035)



Based on the information reviewed, there appears to be little or no technical basis for the current leak volume estimate. Liquid level measurement decreases of 0.9 in between July, 1973 and February, 1983 are within measurement uncertainty for manual tape measurements and activity in drywell 21-08-06 may have come from tank BX-111. Tanks BX-108, BX-110 and BX-111 will be reviewed together in the next meeting.

Tank BX-106

A February, 2003 assessment for tank BX-106 was distributed for information (RPP-9752). The assessment concludes that activity in one drywell near tank BX-106 was from a spare inlet overflow and that tank BX-106 did not leak. As a result, tank BX-106 is classified as sound (HNF-EP-0182).

ACTIONS:
1. All: Review meeting summary
2. J. Field: Prepare and distribute December 15, 2009 Meeting Summary
3. J. Field/P. Henwood: Prepare information and logging data for BX-110 and BX-111for the next meeting

NEXT MEETING:

Assess Tanks BX-108, BX-110 and BX-111

Date:	January 5, 2010
Time:	3:00-4:30
Location:	ECOLOGY Office

MEETING SUMMARY

From:	J. G. Field
Phone:	376-3753
Location:	Ecology Office,
Date:	January 12, 2010
Subject:	Tank Farm Leak Evaluation
To:	Distribution/Attendees
Attendees:	Mike Barnes, ECOLOGY Joe Caggiano, ECOLOGY Jim Field, WRPS Les Fort, WRPS Paul Henwood, S.M. Stoller Jeremy Johnson, ORP Bob Lober, ORP Jeff Lyon, ECOLOGY Marc Wood, CHPRC

PURPOSE:
Discuss the Tank Farm Leak Assessment Process and Consider Next Tanks to Assess

Review of Previous Meeting Summary:
The December 15, 2009 meeting summary was reviewed and approved with changes. An action was given to assess and re-estimate the total volume and activity of waste released to the soil near tank BX-102 based on current characterization data. The preliminary method outlined for this re-estimate of leak volume(s) is to subtract the total activity from the 1951 release and determine the ability to estimate the volume and activity of waste released after 1962.

Discussion of the Leak Inventory Assessment Process
The question was raised whether the leak assessment process should include additional members and potentially expand the scope of the effort. Pros and cons associated with this question were discussed. ECOLOGY indicated that the current process is working well. All those present agreed that any new members are expected to be regular and steady participants. It was recognized by the group that the leak assessment process (as represented in RPP-32681) includes the potential for an expert panel to review and assess the leak reports; the group determined that there is no current need for an expert panel. The process of issuing and sending assessment reports for review was deemed sufficient to invite feedback. Before any changes to the process are made, ECOLOGY requested a communications plan to inform the public of assessments and to outline protocol for stakeholder and tribal involvement. ORP is working with WRPS communications to develop a communications plan.

Next Tanks to Assess
As a result of additional data obtained for C-Farm, experience gained in the leak assessment process, and a December 17, 2009 letter relaying Nez Perce comments on the C-Farm assessment report, it was determined that C-Farm leak inventory estimates should be revisited. In particular, results for tanks C-101, C-105 and for UPR-82 should be revisited and an assessment for tank C-104 should be added to the current report. Prior to and as part of these reassessments, additional, more detailed transfer and logging information should be obtained, if possible.

In the mean time, B-Farm will be assessed following completion of the BX-Assessments. B-Farm assessments were requested by WRPS in support of retrieval life-cycle planning. B-Farm also has a number of tanks for which the current leak classification is questioned. The current baseline budget and schedule for FY2010 is to assess two farms (farms unspecified) and complete reports for two farms (unspecified) in FY 2010. The two farms to be assessed are BX and B and the two reports will be for BY and BX. Leak assessment reports for SX-Farm and TY-Farm are currently in final review. Assessment Reports for C and A/AX Tank Farms have been released.

Assess Tanks BX-108, 110 and 111
Discussions of the data and information for tanks BX-110, and BX-111 were deferred to the next meeting, set for January 19, 2010.

ACTIONS:
1. All: Review meeting summary
2. J. Field: Prepare and distribute January 12, 2009 Meeting Summary
3. J. Field/L. Fort: Prepare BX-102 leak estimates
4. J. Field/P. Henwood: Prepare tank summary information/logging data for next meeting

NEXT MEETING:
Assess Tanks BX-108, BX-110 and BX-111

Date:	January 19, 2010
Time:	3:00-4:30
Location:	ECOLOGY Office

MEETING SUMMARY

From: J. G. Field
Phone: 376-3753
Location: Ecology Office,
Date: February 2, 2010
Subject: Tank Farm Leak Evaluation

To: Distribution/Attendees

Attendees: Mike Barnes, ECOLOGY
Joe Caggiano, ECOLOGY
Jim Field, WRPS
Les Fort, WRPS
Paul Henwood, S.M. Stoller
Marc Wood, CHPRC

PURPOSE:
Discuss BX-102 leak inventory estimate and assess tanks BX-110 and BX-111.

Review of Previous Meeting Summary:
The January 12, 2010 meeting summary was reviewed and approved with changes.

Discussion and Review of Tank BX-102 Leak Inventory
An approach to estimate the 1951 leak and leaks after 1962 was presented and discussed. The approach is similar to the approach used for C-105 where an upper bound estimate of the distribution and mass of the ^{137}Cs was determined based on drywell and direct push logging after 1998. The approach resulted in an upper estimate of 40,000 Ci of ^{137}Cs attributed to overflows from BX-102. The 1951 leak of 91,600 gal of MW accounts for 320 Ci of ^{137}Cs and 20 tons of uranium based on standard inventory estimates. The Hanford Soil Inventory Model (SIM) (RPP-26744) indicated the ^{137}Cs inventory from the 1951 leak to be ~4,600 curies. The inventory of ^{137}Cs leaked after 1962 was estimated by subtracting the 1951 ^{137}Cs estimate from the the total estimated ^{137}Cs based on the drywell logging (40,000-320). Given the composition of first-cycle waste this equates to an upper leak volume after 1962 of ~30,000 gallons. The accumulated leak volume is ~120,000 gal. Additional discussion of this approach will be included in the assessment report.

As noted in previous meetings the BX-102 leak losses in 1951 and after 1962 appear to be due to the tank being overfilled above the spare inlet lines and overflows. Therefore, a formal leak classification assessment is recommended for tank 241-BX-102.

BX-110 and BX-111

Process information, in-tank monitoring data and associated drywell logging data for tanks 241-BX-110 and 241-BX-111 were reviewed. This information that was presented will be included in the assessment report. In-tank liquid level monitoring results indicate small decreases and increases for both tanks. Photos reviewed showed salt crystals on the BX-110 manual tape gauge in 1974 that likely contributed to changes in the manual tape readings. Historical transfer records show that both BX-110 and BX-111 liquid levels were higher than spare inlet port levels at different periods and drywells near the spare inlet outlets for both tanks show increased activity. Earlier assessments for tanks BX-102 (HW-20438 and HW-20742) and BX-106 (RPP-9752) concluded that activity near the tanks was due to spare inlet overflows. Welty (SD-WM-TI-356) states that early drywell gamma activity near BX-107 (21-07-06) and BX-110 (21-10-03 and 21-10-05) were associated with transfer line leaks. Welty (SD-WM-TI-356) also states that auger wells drilled in 1974 near 21-07-06 indicated that the high activity was associated with a transfer line leak, but no additional information was found regarding the auger wells. Historical gamma logs, spectral gamma logs, and direct push logs were reviewed and discussed. The logs show peak activity at about 12 ft bgs in some drywells extending to below the base of the tanks in other drywells. The logging data indicates multiple transfer line leaks or other near surface leaks occurred. Drywell data at 21-07-06 and additional historical records regarding transfer line or other leak events near BX-107, BX-108, BX-110 and BX-111 will be further investigated and discussed in the next meeting.

Because the data suggests two potential sources (tank over flow and transfer line leaks) for activity near tanks BX-108, BX-110 and BX-111 it is recommended that these tanks be re-assessed per TFC-ENG-CHEM-D-42.

ACTIONS:

1. All: Review meeting summary
2. J. Field: Prepare and distribute January 2, 2010 Meeting Summary
3. J. Field/P. Henwood: Review 21-07-06 and tank BX-107 information
4. J. Field: Prepare summary for UPRs and near surface leaks in BX farm

NEXT MEETING:

Assess tank BX-107, other tanks of potential interest in BX Farm and UPRs/near surface activity in BX Farm.

Date:	February 17, 2010
Time:	9:00-10:30
Location:	ECOLOGY Office

MEETING SUMMARY

From: J. G. Field
Phone: 376-3753
Location: Ecology Office,
Date: February 17, 2010
Subject: Tank Farm Leak Evaluation

To: Distribution/Attendees

Attendees: Mike Barnes, ECOLOGY
Joe Caggiano, ECOLOGY
Jim Field, WRPS
Les Fort, WRPS
Paul Henwood, S.M. Stoller
Beth, Rochette, ECOLOGY

PURPOSE:
Assess Tank BX-107, other tanks of potential interest in BX farm and UPRs/near surface activity in BX farm.

Review of Previous Meeting Summary:
The February 2, 2010 meeting summary was reviewed and approved with minor changes.

Tank BX-107 Discussion
As noted in the last meeting, Welty (SD-WM-TI-356) states that auger wells drilled in 1974 near 21-07-06 indicated that high activity measured in the well was associated with a transfer line leak. The activity was apparently present when Drywell 21-07-06 was drilled in 1973. No additional information was found regarding the auger well results or the basis for concluding that the drywell activity was the result of a transfer line leak. Drawing H-2-611 shows transfer lines near drywell 21-07-06 and a memo showed several transfer lines from B-Plant to tank farms failed pressure tests in 1974. For this reason it was determined that a transfer line leak appeared plausible and/or a tank leak. The team recommended that either additional verification of a transfer line leak should be provided or BX-107 should be reassessed per TFC-ENG-CHEM-D-42.

Other Tanks of Interest
Tank BX-106 is not designated as a leaking tank (HNF-EP-0182). However, high ^{137}Cs activity was measured near the base of the tank in drywell 21-06-05. An earlier leak assessment for tank BX-106 concluded that the activity was the result of several periods of overfilling the tank and tank overflows and spillage from the spare inlet ports located next to drywell 21-06-05. Tanks BX-106 and BX-107 will be discussed in detail in the assessment report.

Unplanned Releases
Table 1 lists documented unplanned releases that were discussed. There were no UPRs in WIDS for BX-Farm other than those associated with tanks BX-101, BX-102 and BX-108 discussed previously. Leak events identified as being near diversion boxes BX-154 and BX-155 are well South of BX-Farm. In addition to documented leaks, it was noted that other transfer line and raw water leaks likely occurred in the farms, but were not documented. For example, a 1985 water balance study showed that between 1977 and 1984 between 15% and 41% (24% average) of the 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.

As for other farms assessed, the data assembled is not sufficient to provide inventory estimates for near surface leaks and spills and additional characterization is recommended to provide a better technical basis for near surface releases in BX-Farm. Near surface characterization requirements will be part of future data quality objective workshops in support BX-Farm performance assessments and corrective management studies.

In the interim, drywell plots showing ^{137}Cs activity across the farm can be used for a rough calculation of the near surface (top 10 ft) ^{137}Cs inventory. The ^{137}Cs information can be used as a tracer or indicator to estimate inventories for other constituents based on waste type compositions in the soil inventory model (SIM).

ACTIONS:

1. All: Review meeting summary
2. J. Field: Prepare and distribute January 17, 2010 Meeting Summary
3. J. Field: Prepare summaries for tanks B-101, B-103 and B-105

NEXT MEETING:
Begin B-Farm assessments.

Date: March 2, 2010
Time: 9:00-10:30
Location: ECOLOGY Office

Table 1. Potential Pipeline Failures and Other Unplanned Waste Releases

Date	Event	Reference	Comments
11-1950	In B Plant, a leak in a metal waste line between the canyon building and the 154-BX diversion box was detected by rising liquid level in the 154-BX catch tank. An alternative line was brought into service, necessitating a jumper change in the 154-BX box.	HW-19690, page 4	The 154-BX diversion box is located over 2000 ft South of BX farm

Date	Event	Reference	Comments
9-15-1951	Late in August the first cycle waste was diverted from the 109-BY tank to the 112-BX tank since the former was filled to capacity. The new line which was placed in service leaked between the 221-B Building and the 154-BX diversion box, and it was necessary to reroute the waste through other lines. The first cycle waste line which failed between 221-B and diversion box 154-BX on 9-15-51 was partially uncovered in an effort to determine the cause of the failure. However, radiation readings ranging to 120 R/hr were encountered at a depth of four feet and work was discontinued. About 18 inches of earth remained over the pipe	HW-22304, page 39 HW-22610, page 39	The 154-BX diversion box is located S of B-Plant over 2000 ft South of BX farm
1951	"The contaminated soil in the vicinity of dry wells 21-03-03, 21-03-05, and 21-03-12 is believed to have been caused by tank overflow and spillage a number of years ago. 30,000 to 90,000 gal of waste spilled on the ground between 102- and 103-BX in 1951." Re. 21-03-12; "The zone of high dead time from 21.5 to 25.5 ft may be the result of a pipeline leak or may be associated with the tank overflow and spill that occurred in 1951. Considering that the borehole is adjacent to the cascade outflow line from this tank, the data suggest that this line may have leaked in the past. Welty (1988) notes that the contamination around this borehole was attributed to the 1951 spill."	SD-WM-TI-356 GJ-HAN-96	First record of drywells logged 11/1973 shows activity ~50,000 c/s in 21-03-12.
10/6/1955	About 200 sq ft of ground near the 241-BX-155 Diversion Box (~900 ft S. of BX-Farm) was contaminated to maximum dose rate of 22.6 rads/hr at the surface as a result of pressure testing of lines and jumpers in the box. The Area was covered with clean soil.	ETF report, RHO-HS-ST-10, HW-60807	BX-155 is located ~800 ft S of BX farm. The Area was covered with clean soil.
7-2-1970	103BX Repaired leaking pump discharge jumper and pumped to 109BY.	ARH-1526-3, page 2	
7-19-1972	On July 19, a routine radiation survey of the **R-13 electrical pit** ***[located adjacent to 221-B Plant on south side]*** gave an indication of contamination. In the investigation following the discovery, it was evident that the leakage came from the **V-342 line** which carries Cs-denuded waste from the 18-1 tank to 101-BX tank in the 241-BX Tank Farm; hydrostatic testing at 200 psi gave a leak indication. The direct buried line has now been removed from service with both ends blanked off. It was **estimated that 30 curies of Cs-137 are contained in the soil surrounding the leak**. The waste stream was rerouted through cell 24 while an alternate route was prepared.	ARH-2441 RD, page 34 PPD-493-7-DEL, page AIV-14	S of B-Plant
Before 1972	Raw-water hose bibs and hydrant-type valving caused considerable water contamination in SE quadrant of the tank farm prior to 1972.	SD-WM-TI-356	

Date	Event	Reference	Comments
Before 1974	Some test drilling and augering was conducted in 1974 in an attempt to determine the source of high gamma ray activity in 21-07-06. It was concluded that the contamination was associated with a transfer line leak.	SD-WM-TI-356	Note: near BX-110 contamination
1978	Contaminated particulate matter was transported offsite creating an unplanned airborne release from the 241-BX tank farm. A radiation survey in 1978 revealed minute quantities of beta/gamma emitting particulate East of BX Farm. Wind spread the contamination to an area of 3 acres to N/NW of BY farm.	BHI-00179	Contaminated soils were consolidated on top of the 216-B Cribs and the cribs and area were covered with clean soil.
12-2-1978	During a cross-site transfer from 107-S to 105-BX, steam was noted coming from the 104-BX cover plate and condensate dripped from the vent filter to the cover plate. Smearable contamination was found on the 104-BX pit edge to 20 mRads/hr, and on the 105-BX cover plate to 100 mRads/hr. Direct readings of 300 mRads/hr on the 105-BX vent pipe. No ground contamination found.	ETF report, RHO-HS-ST-10	A portable exhauster was hooked to the 104-BX Tank to decon 104-BX and 105-BX pit covers. The 105-BX vent filter was changed.

MEETING SUMMARY

washington river protection solutions

From: J. G. Field
Phone: 376-3753
Location: Ecology Office,
Date: July 13, 2010
Subject: Tank Farm Leak Evaluation

To: Distribution/Attendees

Attendees: Joe Caggiano, ECOLOGY
Jim Field, WRPS
Les Fort, WRPS
Paul Henwood, S.M. Stoller
Marc Wood, CHPRC

PURPOSE:
Discuss BX Farm tanks currently classified as Sound (HNF-EP-0182)

Review of Previous Meeting Summary
The June 29, 2010 meeting summary was reviewed and approved.

BY-Farm Assessment Report
The BY-Farm Assessment report draft was completed and distributed for review. Comments were requested by July 27, 2010.

Review of BX Farm Tanks Classified as Sound
Les Fort presented information for BX Farm tanks currently classified as sound. Although a general review of these tanks was conducted previously, a systematic tank by tank review had not been conducted. Many of the tanks were overfilled and some tanks show activity in nearby drywells that has previously been attributed to operations spills, line leaks or leaks from another tank. A question was raised regarding moisture samples from the SE quadrant of BX farm, near BX-101 and BX-102. No dry well moisture samples were available, but we have direct push moisture samples from groundsurface to 80 ft bgs (RPP-34623) that will be included in the BX-farm leak assessment report. Samples of perched water in the area at a depth of 225 ft bgs are discussed in the B-complex groundwater report (PNNL-19277). A summary of findings from the B-Complex report will be included in the BY and BX-Farm leak assessment reports. After reviewing the BX farm tanks that are currently classified as sound it was concluded that there was no evidence for any of these tanks of a liner integrity breech. It was recommended that drywell activity near tanks BX-106 and BX-107 be further investigated. The February 17 meeting minutes noted that activity near BX-107 was attributed to a line leak and either additional verification of a transfer line leak should be provided or BX-107 should be reassessed

per TFC-ENG-CHEM-D-42. An earlier leak assessment for tank BX-106 (RPP-9752) concluded that activity in drywell 21-06-05 was likely the result of several periods of overfilling the tank and tank overflows and spillage from the spare inlet ports located next to the drywell. The evaluation team concluded a BX-106 tank leak was unlikely.

ACTIONS:

1. All: Review meeting summary.
2. J. Field: Prepare meeting summary.
3. L. Fort: Prepare summary for C-200 series tanks.

NEXT MEETING:

Review C-200 series tanks. Next meeting postponed to August due to deep vadose zone and WMA C performance assessment workshops.

Date:	August 3, 2010
Time:	9:00-10:30
Location:	ECOLOGY Office

APPENDIX B

241-BX TANK FARM INFORMATION SUMMARIES: TANKS ASSUMED TO HAVE LEAKED

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Abbreviations and Acronyms

1C	first cycle waste
BiPO4	B Plant bismuth phosphate (process)
BL	B Plant low-level waste
CSR	B Plant ion exchange (waste)
CW	cladding (coating) removal waste
CWP	PUREX cladding (coating) removal waste (1961 to 1972)
EB	Evaporator Bottoms (waste)
FIC	Food Instrument Corporation (gauge)
HDW	Hanford Defined Waste
HLW	Thoria high level waste
HRLS	high rate logging system
ITS	in-tank solidification
IX	ion-exchange waste
MW	metal waste
OWW	organic solvent wash waste
PUREX	Plutonium Uranium Extraction (facility)
SGLS	spectral gamma logging system
SIM	Hanford Soil Inventory Model
SST	single-shell tank
TBP	tributyl phosphate
THL	Thoria low level waste

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B1.0 TANK 241-BX-101

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

B1.1 TANK 241-BX-101 WASTE HISTORY

B1.1.1 Metal Waste (1948 to 1952)

Single-shell tank (SST) 241-BX-101 was constructed during 1946 and 1947 and was placed into service in 1948 (SD-WM-TI-356, *Waste Storage Tank Status and Leak Detection Criteria*), receiving metal wastes (MW) from bismuth phosphate (produced in the bismuth phosphate process) from B Plant (WHC-SD-WM-ER-408, *Tank Characterization Report for Single Shell Tank 241-BX-101*, page 5).

From 1948 to 1952 the tank had received several transfers, with its greatest transfer recorded at ~1,101,000 gal (1,101 kgal) of MW sometime in 1950 (WHC-SD-WM-TI-615, *Waste Status and Transaction Record Summary for the Northeast Quadrant of the 200 Area,* p.189). Cascade transfers to tank 241-BX-102 (BX-102) were also performed throughout 1948 to 1952 allowing several MW transfers to be received and released during this time frame.

In June of 1948 the tank began to cascade into tank BX-102 (WHC-MR-0132, *A History of the 200 Area Tank Farms,* see Table B1-1). From the second quarter of 1953, supernatant liquid was pumped from the tank. Approximately 467,000 gal of sludge was transferred to tank 241-BX-103 (BX-103). From the second quarter of 1953 to the second quarter of 1954, the sludge remaining in the tank was sluiced to recover uranium. The tank was emptied on June 10, 1954.

B1.1.2 Tributyl Phosphate Waste (1956 to 1961)

In mid-1956, tank BX-101 was filled with tributyl phosphate (TBP) waste from tank 241-BY-106 (BY-106) (BY-Farm). During the fourth quarter of 1956, much of the waste was transferred to the BC-13 Ditch. Approximately 490,000 gal of TBP supernate was transferred to BC-13 Ditch. From 1957 to 1961 electrode readings showed ~145,000 gal of TBP waste remaining in the tank (HW-72625, *Chemical Processing Department Waste Status Summary July 1, 1961 Through July 31, 1961*).

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

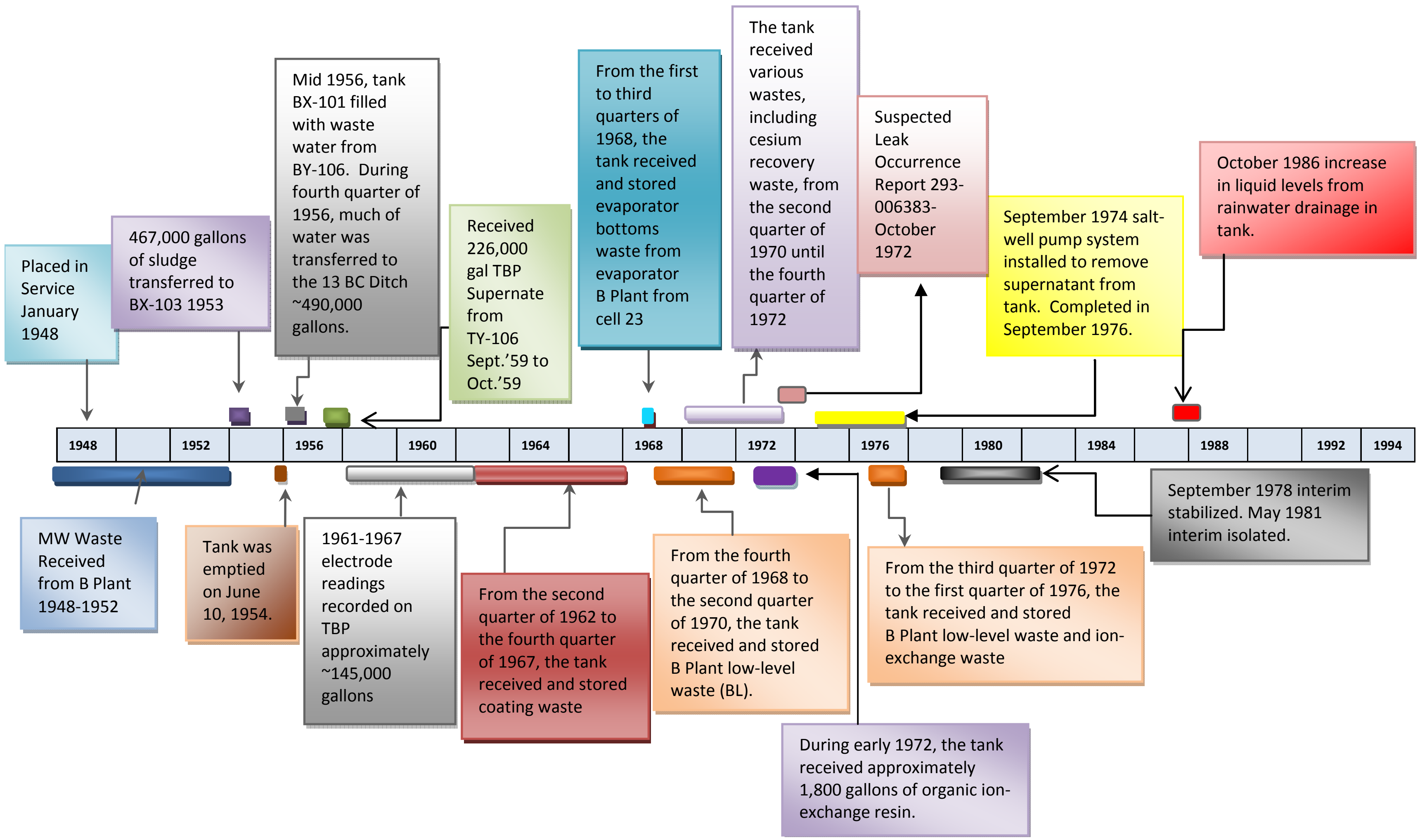
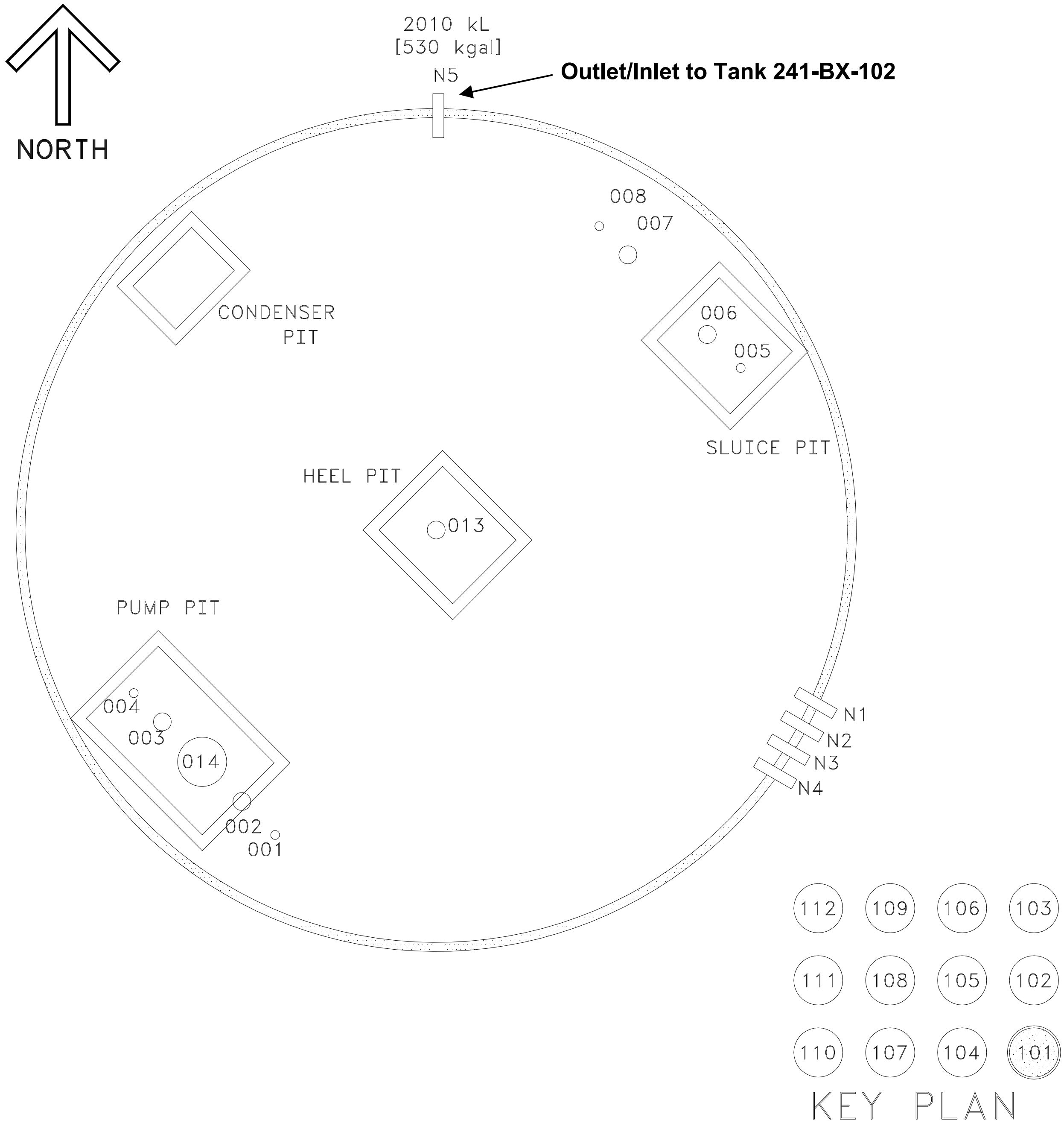


Figure B1-2. Tank 241-BX-101 Plan View



B1.1.3 Plutonium Uranium Extraction Facility Cladding (Coating) Removal Waste (1962 to 1967)

From the second quarter of 1962 to the fourth quarter of 1967, the tank received and stored coating waste. Approximately 546,000 gal of TBP and cladding (coating) removal waste (CW) were received in the second quarter of 1962 with ~565,000 gal remaining in 1967 (HW-74647, *Chemical Processing Department Waste Status Summary January 1, 1962 Through June 30, 1962*).

B1.1.4 Evaporator Bottoms (1968 to 1968)

From the first to third quarters of 1968, the tank received and stored evaporator bottoms waste from B Plant cell 23 concentrator (ARH-534, *Chemical Processing Division Waste Status Summary, January 1, 1968 Through March 31, 1968*). An estimated 251,000 gal of B Plant bottoms, TBP, and CW waste were received from cell 23 in 1968 (ARH-534, ARH-721, *Chemical Processing Division Waste Status Summary, April 1, 1968 Through June 30, 1968* and ARH-871, *Chemical Processing Division Waste Status Summary July 1, 1968 Through September 30, 1968*).

B1.1.5 Organic Ion-Exchange/B Plant Low-Level Waste (1968 to 1972)

From the fourth quarter of 1968 to the second quarter of 1970, the tank received and stored B Plant low-level waste (BL). In the fourth quarter of 1968 tank BX-101 began receiving BL from 221-B and transferring to tanks BX-102, BX-103, and 241-BX-106 (BX-106). The BL was waste that had been processed for the removal of cesium in preparation for in-tank solidification (WHC-SD-WM-TI-615). Tank BX-101 also received the spent Norton Zeolon 900 ion exchange material from the B Plant cesium ion exchange column (August 1970) and Duolite ARC-359 ion exchange resin (December 1971) (RPP-RPT-29191, *Supplemental Information Hanford Tank Waste Leaks*). Tank BX-101 received an inadvertent transfer of 1,800 gal (~6,813 L) of ARC-359 organic ion exchange resin in early 1972.

B1.1.6 Miscellaneous Waste (1972 to 1976)

From the third quarter of 1972 to the first quarter of 1976, the tank received and stored B Plant low-level waste and ion-exchange waste as listed in Table B1-1.

- B Plant Low-Level (BL)
- Ion-Exchange (IX)
- Organic solvent wash waste (OWW)
- Plutonium Uranium Extraction (PUREX) facility cladding removal waste (CWP)
- Thoria high level waste (HLW)
- Thoria low level waste (THL).

Table B1-1 and Figure B1-3 show tank BX-101 tank waste surface levels and transfers between 1948 and 1975.

B1.2 INTEGRITY OF TANK 241-BX-101

In 1972, high gamma-ray activity was detected in drywell 21-01-01 from about 16 to 30 ft. An investigation was conducted to determine if the source of the contamination was the 241-BXR-01C Sluice Pit, located above the tank in the vicinity of drywells 21-01-01 and 21-01-02. A test hole was hand dug to a depth of 16.5 ft (approximately 1 ft above the outer edge of the tank's domed top) near the sluice pit before high activity forced a halt to the digging. A soil analysis from the 16.5-ft depth of the test hole showed the presence of cesium-137 (^{137}Cs), cesium-134 (^{134}Cs), praseodymium-144 (^{144}Pr), cerium-144 (^{144}Ce), zirconium-95 (^{95}Zr), niobium-95 (^{95}Nb), europium-154 (^{154}Eu) (Internal memo MEM-092672, "Gamma Energy Analysis of Dirt from Well E33-205"). Results of this investigation led to the conclusion that the contamination detected in drywell 21-01-01 emanated from the 241-BXR-01C Sluice Pit, rather than a leak in the tank structure (Internal letter LET-092572, "Leak Investigation – 101-BX" and Letter Metz 1972, "Additional Information on Leak Investigation at 241-BX-101"). However, an additional high-activity peak detected in drywell 21-01-01 led to the conclusion that the contamination might be from a tank leak, and it was recommended that the tank be designated as a suspected leaker (Internal letter LET-113172, "Suspected Leak at TK-101-BX-Recommendations"). The tank was categorized as "questionable integrity" in 1973 (WHC-MR-0132, WHC-SD-WM-ER-311, *Supporting Document for the Historical Tank Farm Content Estimate for BX Tank Farm*).

In 1974 drywell 21-01-02 showed an increase in radioactivity at a depth of 56 to 60 ft and drywell 21-02-06 showed an increase at 41 ft. OR-74-104, *Symptoms Of Leakage As Indicated By Increasing Dry Well Radiation Levels At Waste Tank 101-BX* states, "These increases may be related to extensive excavation and work which was in progress for a number of months during which this drywell was stable. The backfilling operations introduced considerable volumes of water which over the past few months have moved through an old contamination source and caused some of this material to move. The radiation occurrences might also be due to an actual tank leak."

B1.3 INTERIM STABILIZATION

In April 1974, a new zone of anomalously high gamma-ray activity was detected in drywell 21-01-02 between ~56 and 60 ft (SD-WM-TI-356). An investigation into this activity increase concluded that interstitial liquid may be leaking from tank BX-101 (OR-74-141, *Increasing Dry Well Radiation Adjacent to Tank 101-B*). As a result, a saltwell pump system was installed in September 1974 to remove the supernate from the tank. Tank BX-101 was saltwell pumped in 1976 and declared interim stabilized in September 1978 (SD-WM-TI-356). Because of the solids in the tank, the primary means of liquid-level measurement at that time was a comparison of in-tank photographs. Based on a Tank Farm Process Engineering Evaluation of tank photographs and liquid or solid level data, BX-101 status was changed to primary interim stabilization (HNF-SD-RE-TI-178, *Single-Shell Tank Interim Stabilization Record*). As of January 2009 the tank is estimated to include 48,000 gal of sludge and no supernate (HNF-EP-0182, *Waste Tank Summary Report for Month Ending December 31, 2009*). Figure B1-4 shows a photo mosaic of the tank waste surface in 1988.

B1.4 TANK 241-BX-101 TEMPERATURE HISTORY

The thermal history for tank BX-101 is available starting in 1974 and continuing to the present (Figure B1-5). During this period the waste temperature varied between about 50 and 85°F indicating that the tank is a low heat tank. The tank temperature is monitored by a single thermocouple tree located in riser 2.

Table B1-1. Tank 241-BX-101 Transfers 1948 to 1975 (4 sheets)

Date/Date Range	Transfer Type[1]	Transfer Volume (gal*1000)	Total Vol. In Tank (gal*1000)[2]	Discrepancy with previous reading[3] (gal*1000)	Waste type	Transfer tank from/to	Document Number (see Section B6.0 for full reference)
Jan. to Mar. 1948	REC	303	303		MW	B Plant	WHC-SD-WM-TI-615 WHC-MR-0132
Apr. to June 1948	REC	332			MW	B Plant	WHC-SD-WM-TI-615
Apr. to June 1948	SEND	-112	523		MW	BX-102	WHC-SD-WM-TI-615 WHC-MR-0132
July to Sep. 1948	REC	426			MW	B Plant	WHC-SD-WM-TI-615
July to Sep. 1948	SEND	-426	523		MW	BX-102	WHC-MR-0132
Oct. to Dec. 1948	REC	489			MW	B Plant	WHC-SD-WM-TI-615
Oct. to Dec. 1948	SEND	-489	523		MW	BX-102	WHC-MR-0132
Jan. to Mar. 1949	REC	33			MW	B Plant	WHC-SD-WM-TI-615
Jan. to Mar. 1949	SEND	-33	523		MW	BX-102	WHC-MR-0132
Apr. to Dec. 1949	STAT		523		MW		WHC-MR-0132
Jan. to Mar. 1950	REC	285			MW	B Plant	WHC-SD-WM-TI-615
Jan. to Mar. 1950	SEND	-285	523		MW	BX-102	WHC-MR-0132
Apr. to June 1950	REC	377			MW	B Plant	WHC-SD-WM-TI-615
Apr. to June 1950	SEND	-377	523		MW	BX-102	WHC-MR-0132
July to Sep. 1950	REC	571			MW	B Plant	WHC-SD-WM-TI-615
July to Sep. 1950	SEND	-571	523		MW	BX-102	WHC-MR-0132
Oct. to Dec. 1950	REC	428			MW	B Plant	WHC-SD-WM-TI-615
Oct. to Dec. 1950	SEND	-428	523		MW	BX-102	WHC-MR-0132
Jan. to Mar. 1951	REC	530			MW	B Plant	WHC-SD-WM-TI-615
Feb. 19, 1951	STAT		548.8		MW	16'3" level, BX-102 cascade line plugged	HW-20742
Feb. 23, 1951	STAT		544.6				HW-20742
Feb. 26, 1951	STAT		540.5				HW-20742
Mar. 1951	SEND	-530	523		MW	BX-102	WHC-MR-0132
April 1952 to June 1952	STAT		530		MW	Cascade Full	HW-27838
July 1952 to Sep. 1952	STAT		530		MW	Cascade Full	HW-27839
Oct. 1952 to Dec. 1952	STAT		530		MW	Cascade Full	HW-27840
Jan. 1953 to Mar. 1953	STAT		530		MW	Cascade Full	HW-27841/HW-27841/HW-27842/ HW-27775
Apr. 1953 to June 1953	SEND	-319	211		MW	UR	HW-28043/HW-28377/HW-28712
July 1953 to Sep. 1953	SEND	-46	165		MW	UR	HW-29054/HW-29242/HW-29624
Oct. 1953 to Dec. 1953	REC	35	200		MW	WTR	HW-29905/HW-30250/HW-30498
Jan. 1954	REC	357			MW	WTR	HW-30851
Jan. 1954 to Mar. 1954	SEND	-467	90		MW	BX-103	HW-30851/HW-31126/HW-31374

Table B1-1. Tank 241-BX-101 Transfers 1948 to 1975 (4 sheets)

Date/Date Range	Transfer Type[1]	Transfer Volume (gal*1000)	Total Vol. In Tank (gal*1000)[2]	Discrepancy with previous reading[3] (gal*1000)	Waste type	Transfer tank from/to	Document Number (see Section B6.0 for full reference)
Apr. 1954 to June 1954	SEND	-90	0			UR	HW-31811/HW-32110/HW-32389
June 1954 to Sep. 1956	STAT		0				HW-32389/WHC-MR-0132
July 1956	REC	254	524		TBP		HW-44860
Aug. to Nov. 1956	STAT		524		TBP		HW-45140/HW-47052
Dec. 1956	SEND	-490	34		TBP	CRIB, #13 BC ditch	HW-47640
Jan. to Feb. 1957	REC	67	112	11	TBP	WTR, line drainage	HW-48144/HW-48846
Mar. to Nov. 1957	STAT		114	13	TBP		HW-49523/HW-54067
Dec. 1957 to Feb. 1958	STAT		120		TBP	Latest electrode reading	HW-54519/HW-55264
Mar. to June 1958	STAT		123	3	TBP	Latest electrode reading	HW-55630/HW-56761
July 1958 to Feb. 1959	STAT		125	2	TBP	Latest electrode reading	HW-57122/HW-59586
Mar. 1959	STAT		128	3	TBP		HW-60065
Apr. to Oct. 1959	STAT		130	2	TBP		HW-60419/HW-62723
Nov. 1959 to Dec. 1960	STAT		131	1	TBP		HW-62723/HW-68292
Jan. 1961 to June 1961	STAT		145	14	TBP		HW-71610
July 1961 to Dec. 1961	STAT		147	2	TBP		HW-72625
Jan. 1962 to June 1962	REC	399	546		TBP-CW	C-102 & C-103	HW-74647/HW-83906 E RD
July to Dec. 1962	STAT		552	6	TBP-CW	New electrode	HW-76223
Jan 1963 to June 1964	STAT		554	2	TBP-CW		HW-78279/HW-83308
July 1964 to Dec. 1964	STAT		557	3	TBP-CW		RL-SEP-260
Jan. to Sep. 1965	STAT		560	3	TBP-CW		RL-SEP-659/RL-SEP-821
Oct. 1965 to Dec. 1966	STAT		563	3	TBP-CW		RL-SEP-923/ISO-674
Jan. to Sep. 1967	STAT		565	2	TBP-CW		ISO-806/ARH-95
Oct. 1967 to Dec. 1967	SEND	-392	173		TBP-CW	B-112	ARH-326
Jan. 1968 to Mar. 1968	REC	73	246		TBP-CW-EB	Cell 23, BY-112	ARH-534
Apr. 1968 to June 1968	REC	102	348		TBP-CW-EB	BY-112	ARH-721
July 1968 to Sep. 1968	SEND	-274	74		TBP-CW-EB	BX-102	ARH-871
July 1968 to Sep. 1968	REC	76	150		EB	BY-112	ARH-871
Oct. 1968 to Dec. 1968	REC	144			BL	BL 221-B(23-1)	ARH-1061
Oct. 1968 to Dec. 1968	SEND	-94	200		BL	BX-102	ARH-1061
Jan. 1969 to Mar. 1969	REC	330	530		BL	BL 221-B (23-1)	ARH-1200 A
Apr. to June 1969	REC	4	534		BL	BL 221-B (TK 23-1)	ARH-1200 B
July to Sep. 1969	STAT		501	-33	BL	Solids volume reduced	ARH-1200 C
Oct. to Dec. 1969	STAT		499	-2	BL		ARH-1200 D
Jan. to Mar. 1970	SEND	-385	114		BL	C-103	ARH-1666 A
Apr. to June 1970	REC	877			OWW-CW-IWW	B Plant IX	ARH-1666 B
Apr. to June 1970	SEND	-403			OWW-CW-IWW	BX-103	ARH-1666 B

Table B1-1. Tank 241-BX-101 Transfers 1948 to 1975 (4 sheets)

Date/Date Range	Transfer Type[1]	Transfer Volume (gal*1000)	Total Vol. In Tank (gal*1000)[2]	Discrepancy with previous reading[3] (gal*1000)	Waste type	Transfer tank from/to	Document Number (see Section B6.0 for full reference)
Apr. to June 1970	SEND	-299	290	1	OWW-CW-IWW	BX-106	ARH-1666 B
July to Sep. 1970	REC	550			OWW-CW-IWW	B Plant IX	ARH-1666 C
July to Sep. 1970	REC	437			OWW-CW-IWW	B-101	ARH-1666 C
July to Sep. 1970	REC	849			OWW-CW-IWW	C-104	ARH-1666 C
July to Sep. 1970	SEND	-1877	249		OWW-CW-IWW	BX-103	ARH-1666 C
Oct. to Dec. 1970	REC	1796			CW-OWW-RIX	B Plant IX	ARH-1666 D
Oct. to Dec. 1970	REC	1614			CW-OWW-RIX	C-104	ARH-1666 D
Oct. to Dec. 1970	SEND	-2495			CW-OWW-RIX	BX-103	
Oct. to Dec. 1970	REC	448			CW-OWW-RIX	B-101	ARH-1666 D
Oct. to Dec. 1970	SEND	-1251	360	-1	CW-OWW-RIX	BX-106	ARH-1666 D
Jan. to Mar. 1971	REC	1833			EB-SIX-RIX	B Plant IX	ARH-2074 A
Jan. to Mar. 1971	REC	348			EB-SIX-RIX	C-104	ARH-2074 A
Jan. to Mar. 1971	SEND	-1830			EB-SIX-RIX	BX-103	ARH-2074 A
Jan. to Mar. 1971	REC	529			EB-SIX-RIX	B-101	ARH-2074 A
Jan. to Mar. 1971	SEND	-1027	213		EB-SIX-RIX	BX-106	ARH-2074 A
Apr. to June 1971	REC	1489			EB-SIX-RIX	CSR B-101	ARH-2074 B
Apr. to June 1971	REC	12			EB-SIX-RIX	WTR A-302	ARH-2074 B
Apr. to June 1971	REC	782			EB-SIX-RIX	BY-101	ARH-2074 B
Apr. to June 1971	REC	1092			EB-SIX-RIX	C-104	ARH-2074 B
Apr. to June 1971	SEND	-1196			EB-SIX-RIX	BX-103	ARH-2074 B
Apr. to June 1971	SEND	-2297			EB-SIX-RIX	BX-106	ARH-2074 B
Apr. to June 1971	REC	454			EB-SIX-RIX	B-101	ARH-2074 B
Apr. to June 1971	SEND	-85	466	2	EB-SIX-RIX	BX-104	ARH-2074 B
July to Sep. 1971	REC	1523			RIX	B Plant IX	ARH-2074 C
July to Sep. 1971	REC	89			RIX	C-104	ARH-2074 C
July to Sep. 1971	SEND	-360			RIX	SX-103	ARH-2074 C
July to Sep. 1971	SEND	-1375			RIX	SX-105	ARH-2074 C
July to Sep. 1971	SEND	-200	143		RIX	TX-101	ARH-2074 C
Oct. to Dec. 1971	REC	1430			BL-CW-OWW-RIX	B Plant IX	ARH-2074 D
Oct. to Dec. 1971	REC	102			BL-CW-OWW-RIX	C-104	ARH-2074 D
Oct. to Dec. 1971	SEND	-424			BL-CW-OWW-RIX	SX-101	ARH-2074 D
Oct. to Dec. 1971	SEND	-1196			BL-CW-OWW-RIX	SX-105	ARH-2074 D
Oct. to Dec. 1971	REC	190	245		BL-CW-OWW-RIX	B-101	
Jan. to Mar. 1972	REC	1010			BL-RIX	CSR B Plant IX	ARH-2456 A
Jan. to Mar. 1972	SEND	-1125			BL-RIX	SX-105	ARH-2456 A
Jan. to Mar. 1972	REC	208	337	-1	BL-RIX	B-101	ARH-2456 A

Table B1-1. Tank 241-BX-101 Transfers 1948 to 1975 (4 sheets)

Date/Date Range	Transfer Type[1]	Transfer Volume (gal*1000)	Total Vol. In Tank (gal*1000)[2]	Discrepancy with previous reading[3] (gal*1000)	Waste type	Transfer tank from/to	Document Number (see Section B6.0 for full reference)
Apr. to June 1972	REC	1414			BL-SIX	CSR B Plant IX	ARH-2456 B
Apr. to June 1972	SEND	-443			BL-SIX	BX-103	ARH-2456 B
Apr. to June 1972	SEND	-742			BL-SIX	SX-102	ARH-2456 B
Apr. to June 1972	SEND	-390			BL-SIX	SX-105	ARH-2456 B
Apr. to June 1972	SEND	-165			BL-SIX	TX-101	ARH-2456 B
Apr. to June 1972	REC	520	531		BL-SIX	B-101	ARH-2456 B
July to Sep. 1972	REC	1100			BL-IX	B Plant IX	ARH-2456 C
July to Sep. 1972	SEND	-498			BL-IX	T-101	ARH-2456 C
July to Sep. 1972	SEND	-907			BL-IX	TX-101	ARH-2456 C
July to Sep. 1972	REC	254	475	-5	BL-IX	B-101	ARH-2456 C
Oct. to Dec. 1972	REC	368			BL-IX	B Plant IX	ARH-2456 D
Oct. to Dec. 1972	SEND	-686			BL-IX	TX-101	ARH-2456 D
Oct. to Dec. 1972	REC	192			BL-IX	B-101	ARH-2456 D
Oct. to Dec. 1972	SEND	-205	146	2	BL-IX	BX-104	ARH-2456 D
Jan. to Mar. 1973	STAT		142	-4	BL-IX		ARH-2794 A
Apr. to June 1973	STAT		149	7	BL-IX		ARH-2794 B
July to Sep. 1973	STAT		151	2	BL-IX		ARH-2794 C
Oct. to Dec. 1973	STAT		157	6	BL-IX	*(Suspect leaker)*	ARH-2794 D
Jan. to Mar. 1974	STAT		160	3	BL-IX	*(Suspect leaker)*	ARH-CD-133A
Apr. to June 1974	SEND	-115	46	1	BL-IX	BX-104	ARH-CD-133B
July to Sep. 1974	SEND	-1	45		BL-IX	BX-104	ARH-CD-133C
Oct. to Dec. 1974	STAT		46		BL-IX	*(Suspect leaker)*	ARH-CD-133D
Jan. to Mar. 1975	STAT		46		BL-IX		ARH-CD-336 A
Apr. to June 1975	STAT		46		BL-IX	BX-104; *(Removed from srvc)*	ARH-CD-336 B
1975	STAT		47		SU	BX-104	*(No reference)*
July to Sep. 1975	STAT		46		SU	BX-104	ARH-CD-336 C
Oct. to Dec. 1975	STAT		46		BL,IX	Removed from srvc	ARH-CD-336 D

[1] IN defines a transfer into the tank, OUT defines a transfer out of the tank, STAT refers to a volume reading where no transfer occurred.
[2] "Total Volume In Tank" refers to measured STAT values following the transfers shown.
[3] Except as noted, discrepancies are attributed to effects such as-evaporation, questionable surface level measurements, and/or undocumented water additions.

BL = B Plant low-level waste
CW = cladding (coating) removal waste
EB = Evaporator Bottoms (waste)
IWW = sulfate free waste
UR = uranium recovery (waste)
IX = ion-exchange (waste)
MW = metal waste
OWW = organic solvent wash waste
RIX = ion exchange waste from Reduction-Oxidation (S Plant) supernate
WTR = Water
SIX = ion exchange waste from sludge wash waste supernate
SU = supernate
TBP = tributyl phosphate (waste)

Figure B1-3. Tank 241-BX-101 Waste Fill History

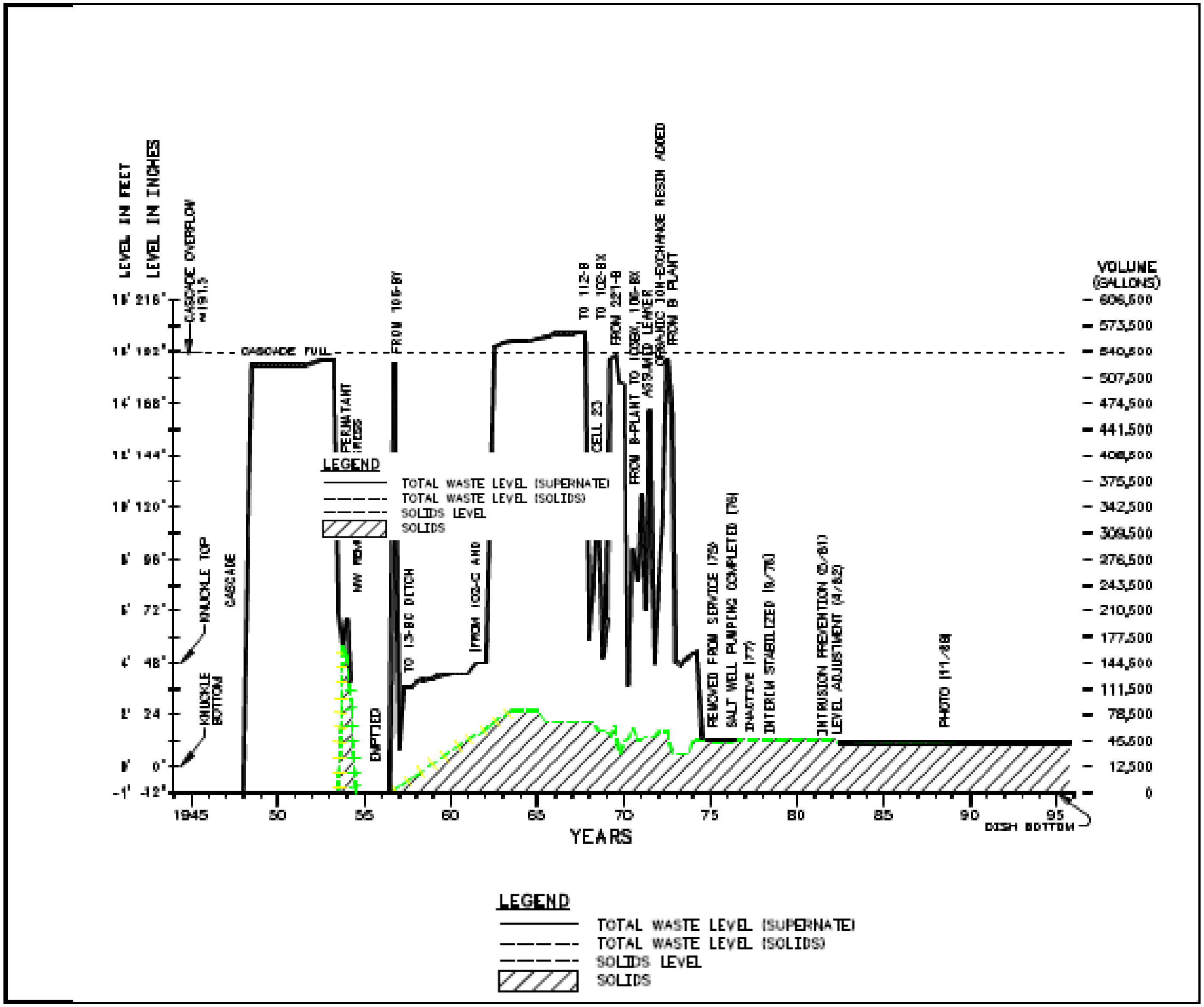


Figure B1-4. Tank 241-BX-101 Waste Surface Photo Mosaic

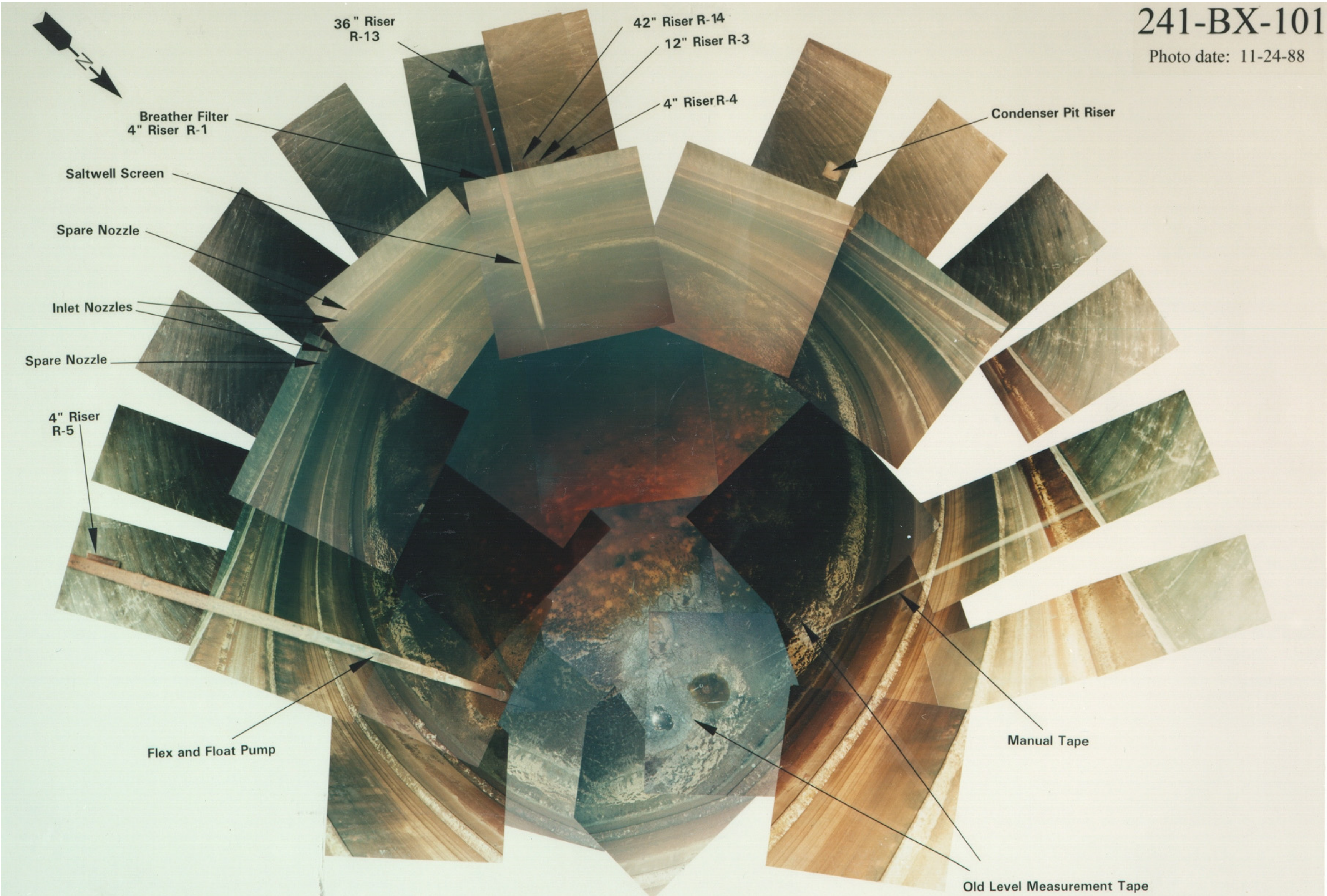
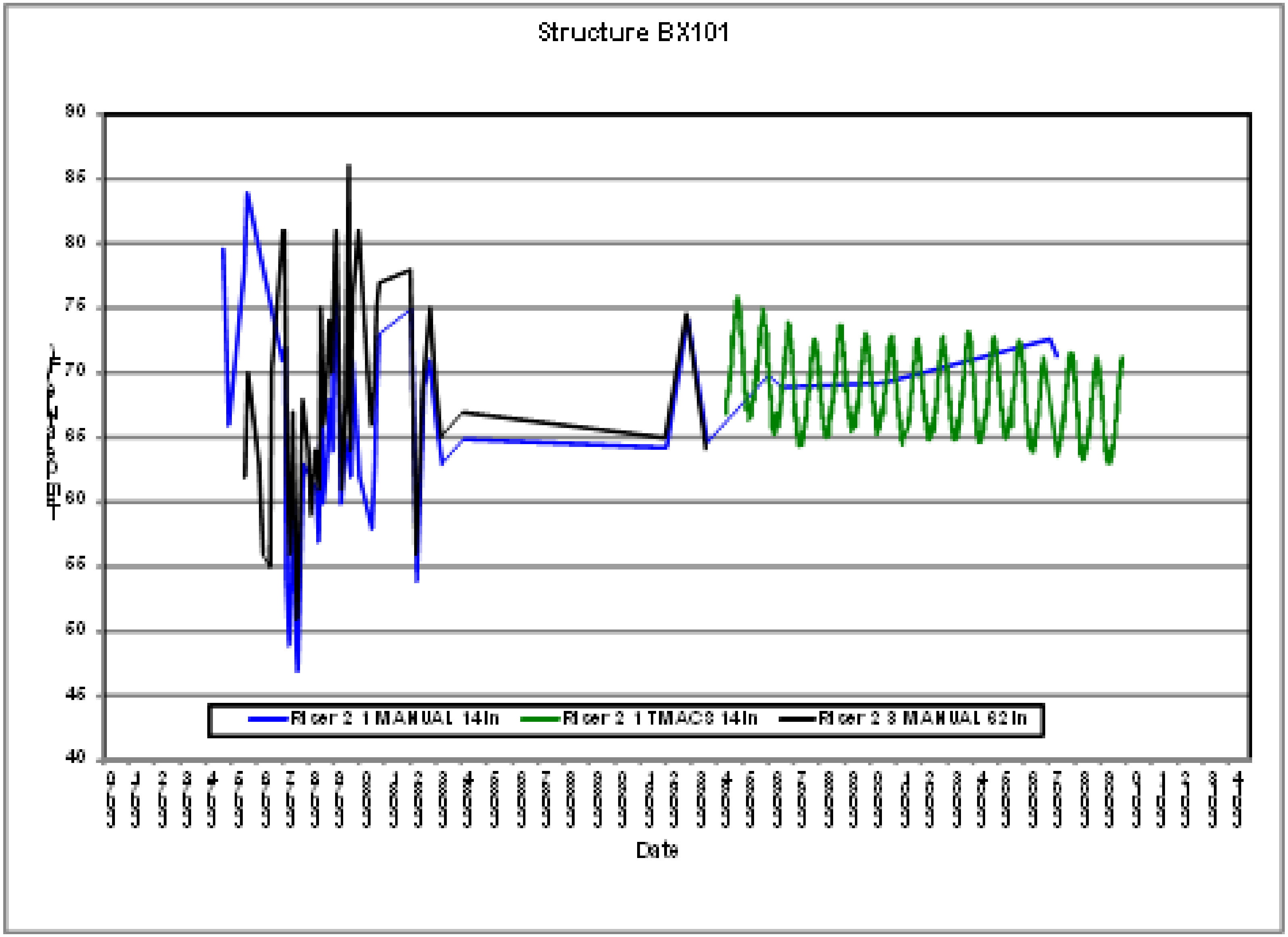


Figure B1-5. Tank 241-BX-101 Waste Temperature Measurements



B1.5 DATA REVIEW AND OBSERVATIONS

The following sections contain tank discussions of the surface level and drywell logging data reviewed, a summary of previous assessments, if any, and observations and results for the 2009 assessments.

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 (Table B1-1). Table B1-2 shows liquid level measurements between 1973 and 1987 (SD-WM-TI-356). Liquid level increases and decreases were observed during this period. The FIC gauge used from 1973 through 1974 was recalibrated a couple of times, gave erratic readings and was replaced with a manual tape in November 1974. After saltwell pumping in 1976 liquid level measurements were primarily to detect intrusions. The manual tape was replaced in 1979 and moved to another riser in 1981. Consequently, the liquid surface level measurements after 1973 appear to have been unreliable.

Table B1-2. Tank 241-BX-101 Liquid Level Measurements and Changes (1973 to 1987)

Date	Liquid level (in.)	Baseline ref.	Change from previous reading (in.)	Cumulative change (in.)	Comments
06/15/73	60.70				FIC gage
06/23/73	61.80				FIC recalibrated
07/13/73	61.80				Stable
07/14/73	50.20				Recalibration
10/19/73	50.20				Stable
03/03/74	53.50				Diversion box drainage
05/17/74	53.85		+0.35	+0.35	Slow increase
10/12/74	9.60			+0.35	Transfers
11/19/74	9.50		-0.10	+0.25	Slow decrease
11/20/74	10.50	10.50		+0.25	FIC erratic and o/s; now using manual tape
01/15/76	11.00		+0.50	+0.75	Slow erratic increase
02/27/77	11.00			+0.75	Reading varies from 10.50 to 11.25 in.
02/05/79	11.00			+0.75	Stable
03/13/79	10.75		-0.25	+0.50	Slow decrease
03/14/79	14.50	14.50		+0.50	New tape installed
03/03/80	14.50			+0.50	Stable
02/13/81	10.25			+0.50	Manual tape removed to riser 8
02/15/81		11.00	+0.75	+1.25	Unexplained increase
02/22/82*	10.75				Stable
02/14/83	10.75				Stable
01/03/84	10.50				Slow decrease
02/15/85	10.00				Slow decrease
01/01/86	10.00				Stable
10/03/86	11.00				Unexplained increase
01/02/87	11.00				Stable

*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*.

Diversion box drainage caused liquid level increases observed between March and May 1974, and the drain was subsequently relocated. A comparison of in-tank photographs from February 1982 and October 1986 revealed an increase in liquid levels in tank BX-101. However, an evaluation of the isolation process revealed that a 3-in. utility drain line might have been overlooked during isolation activities and was allowing rainwater to drain to the tank (Internal memo 13240-88-30, "Surveillance Weekly Report for Week Ending 4/22/1988"). The drain line was sealed, and the tank waste level continued to be monitored.

The surface level continued to increase from 10 to 12 in. (25 to 30 cm) in September 1993, exceeding the 1.00-in. increase criteria. In-tank photographs taken May 31, 1996 show the manual tape donut plummet contacting liquid in a shallow pool. The tank waste level was re-baselined to 12 in. from the side dish of the tank. An ENRAF™[1] was installed and the surface level measurement was 23.73 in. from the bottom of the tank (11.73 in. above the side of the dish) on April 30, 1996. (Note: The surface level measurement taken by the ENRAF gauge is referenced from the bottom of the tank and differs by about 12 in. from the reading shown by the prior gauge referenced from the top of the side dish). Figure B1-6 shows the ENRAF waste level for tank BX-101 has continued to gradually increase.

Comparison of November 1988 photos with November 1994 video and surface level measurements show evidence of ongoing intrusions in tanks BX-101 and BX-103. In-tank videos of BX-103 taken in 2006 show dripping down the outside of riser 014. No liquid has been observed in tank pits or open pipelines to the pits. As of 2008, the intrusions were believed to be due to leaking seals between the riser and tank dome.

B1.5.2 Drywell Logging Data

Two wells drilled near tank BX-101 showing activity were 21-01-01 and 21-01-02. Figure 3-3 shows the location of drywells in BX Farm. Figure B1-7 shows 1997 spectral gamma logging system (SGLS) results for drywells near tank BX-101 (GJ-HAN-95, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank BX-101*). Drywells 21-01-01 and 21-01-02 showed the greatest activity. A discussion of historical gross gamma results (HNF-3531, *Analysis of Historical Gross Gamma Logging Data from BX Tank Farm*) and spectral gamma logging results for these wells follows.

Drywell 21-01-01 was installed in July 1970 and the earliest logging record found was July 1972 in which anomalous high gamma-ray activity was observed (SD-WM-TI-356). Historical gross gamma log data from 1975 to 1994 (Figures B1-7 and B1-8) show gamma activity starting at about 20 ft bgs and extending below the bottom of the tank. The activity gradually decayed over time following a ^{137}Cs decay curve.

Spectral gamma logging in 1997 detected ^{137}Cs, cobalt-60 (^{60}Co), antimony-125 (^{125}Sb), processed uranium, and ^{154}Eu around drywell 21-01-01. Cesium-137 was measured continuously from the ground surface to a depth of 25 ft, with a peak of about 500 pCi/g at 20 ft.

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[1] ENRAF - Nonius Series 854 is a trademark of ENRAF-Nonius, N.V. Verenigde Instrumentenfabrieken, ENRAF Nonius Corporation Netherlands, Rontegenweg 1, Delft, Netherlands.

Figure B1-6. Tank 241-BX-101 Waste Surface Level Measurements

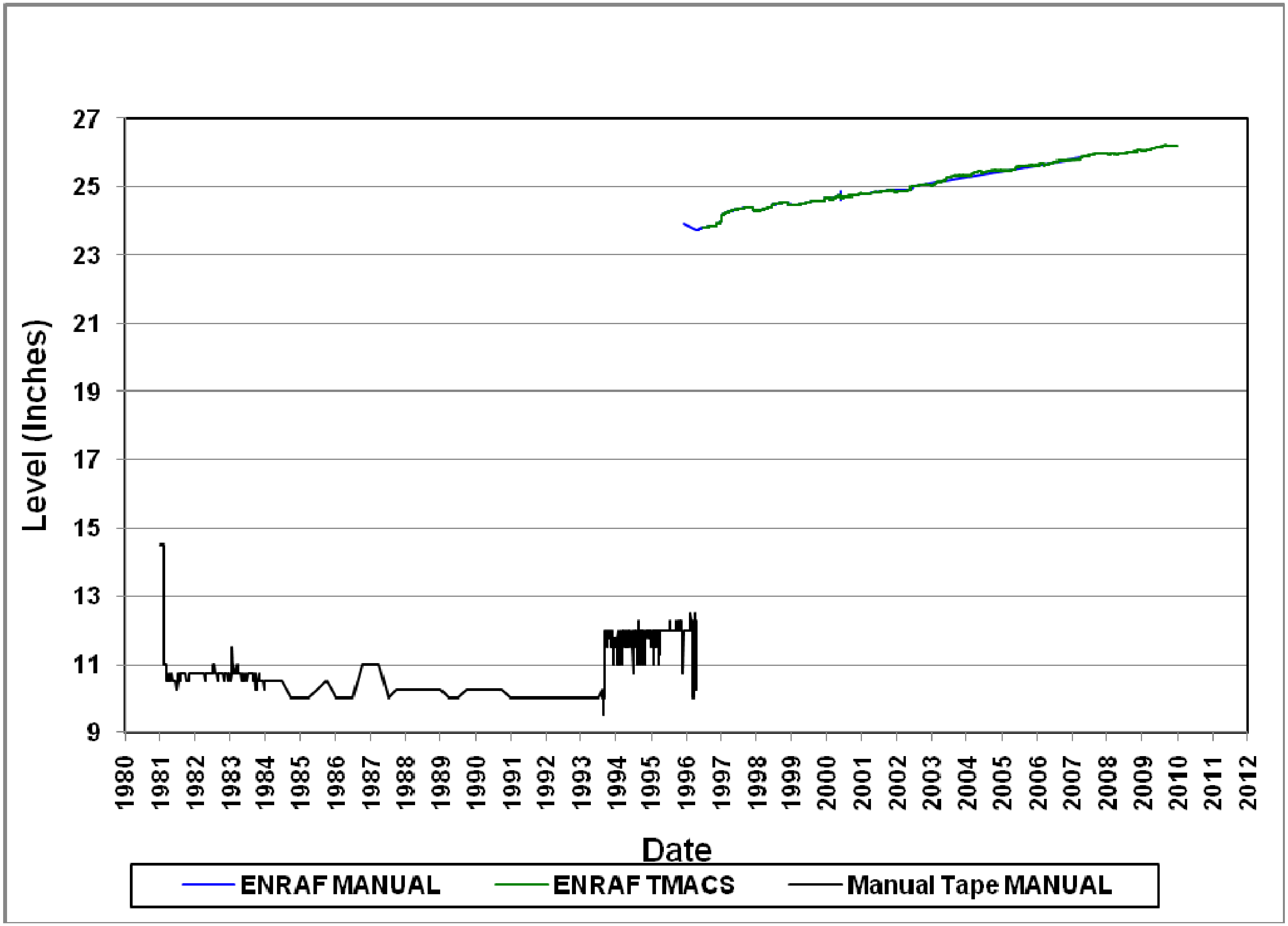
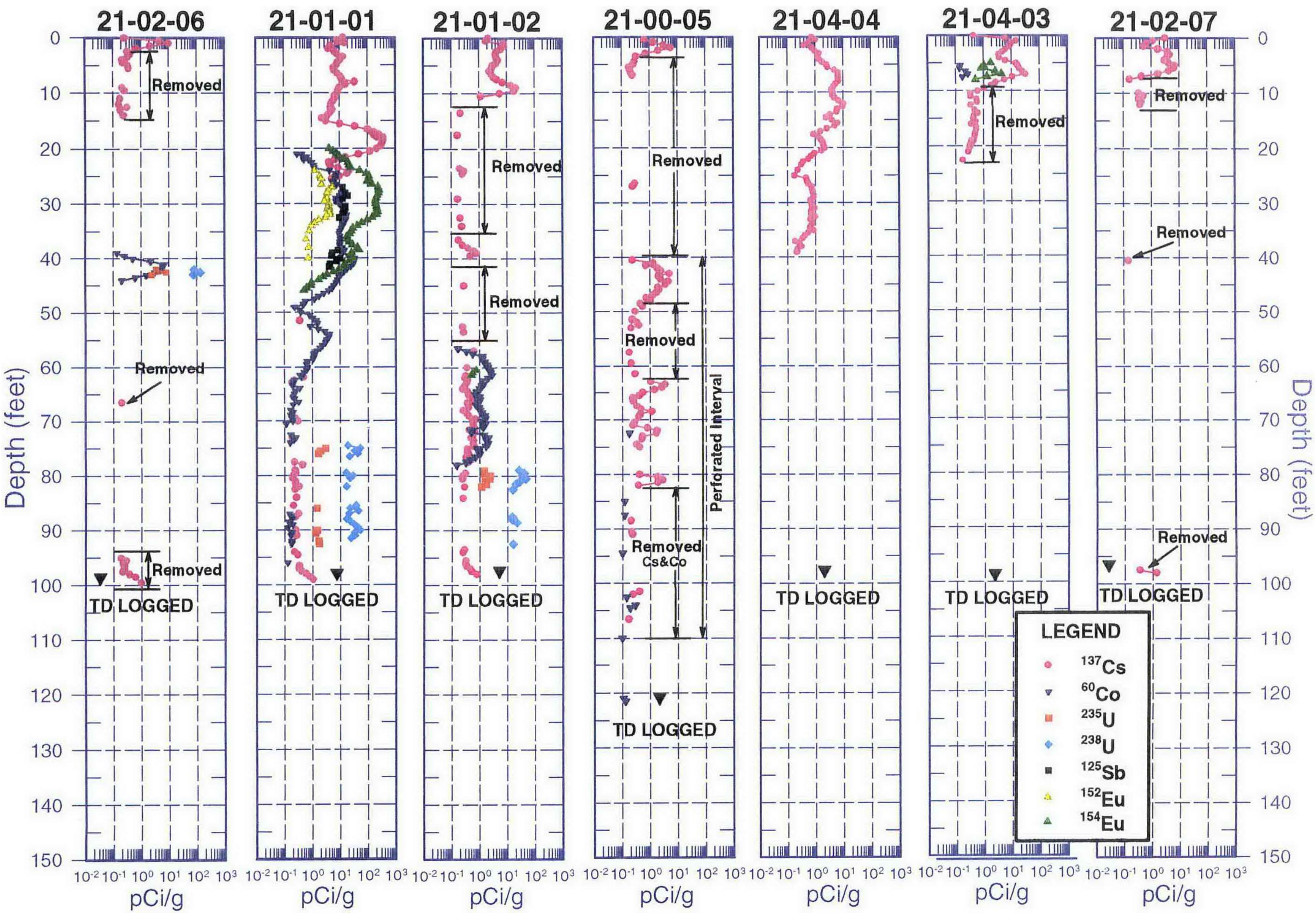
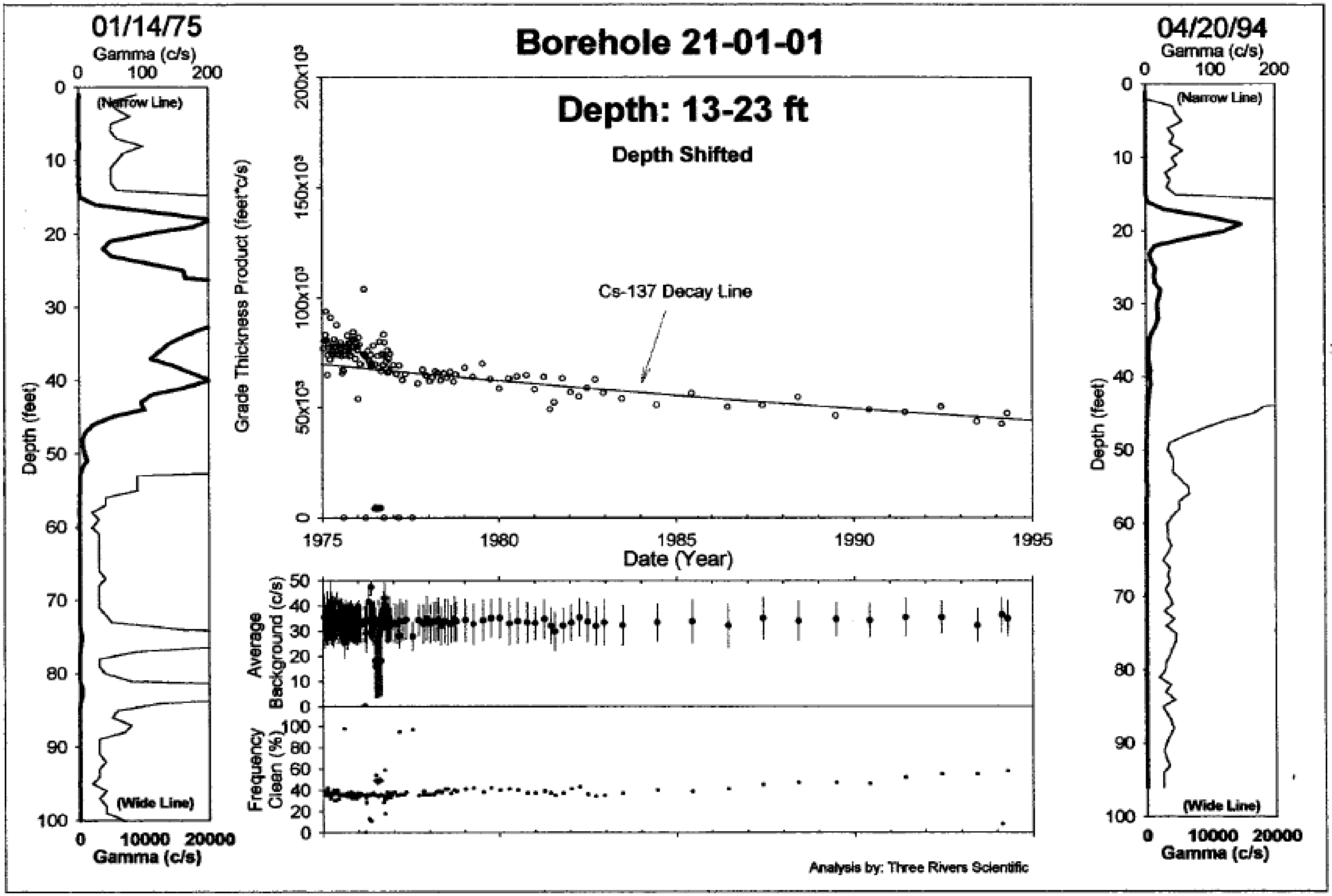


Figure B1-7. 1997 Spectral Gamma Logging Results for Drywells near Tank 241-BX-101



Reference: GJO-98-40-TAR/GJO-HAN-19, *Hanford Tank Farms Vadose Zone: BX Tank Farm Report*.

Figure B1-8. Drywell 21-01-01 Total Gamma Measurements



Reference: HNF-3531, *Analysis of Historical Gross Gamma Logging Data from BX Tank Farm*.

Alternating zones of intermittent and continuous ^{137}Cs contamination were detected from 26 ft to the bottom of the logged interval (99 ft). Cobalt-60 was detected from 20 to 74 ft and 87 to 96 ft. Europium-152 (^{152}Eu), ^{154}Eu and ^{125}Sb were measured from 20 to 40 ft.

Drywell 21-01-02 was installed in May 1970 and the earliest logging record found was July 1972 (SD-WM-TI-356). Figures B1-9, B1-10 and B1-11 show gamma logs from January 1975 to April 1994. The activity peaks are at ~10 ft and 60 ft. The peak at 10 ft gradually decays over time following a ^{137}Cs decay curve. The peak at 60 ft decays more rapidly following a ^{60}Co decay curve.

Spectral gamma logging in 1997 detected ^{137}Cs, ^{60}Co, ^{154}Eu, and processed uranium around this drywell. Measurable ^{137}Cs contamination was detected continuously from the ground surface to a depth of 10 ft and intermittently to the bottom of the drywell. The maximum ^{137}Cs concentration was ~20 pCi/g at 9 ft. Cobalt-60 was measured continuously from 56 to 78 ft with a maximum concentration of 3 pCi/g at 61 ft. Alternating intermittent and continuous zones of uranium were detected from 79 to 92 ft. The presence of ^{154}Eu was detected from 60 to 62 ft.

2003 Direct Push Logging Results
In 2003, additional holes were pushed using a hydraulic hammer and logged to further investigate the extent of contamination near tanks BX-101 and BX-102 (RPP-34623, *Small Diameter Geophysical Logging In the 241-BX Tank Farm*). Figure B1-12 shows the location of the holes that were logged and Table B1-3 summarizes results. Holes C5125, C5123 and C5133 are located near drywells 21-01-01 and 21-01-02. Uranium was encountered in these holes between 39 and 78 ft, but no ^{137}Cs was measured in these holes.

B1.6 TANK 241-BX-101 ASSESSMENT

Four indications of leaks or migration of past leaks were discussed.

1. 1951 Overflow: In 1951 the cascade overflow line between tanks BX-102 and BX-103 plugged resulting in an estimated 92,600 gal loss (see Section 5.2). A probable leak location based on high activity in drywell 20-02-04 was the tank BX-102 spare inlet ports. Some of the 1951 loss could have originated at tank BX-101 or the loss from tank BX-102 could have spread to near tank BX-101. Either of these scenarios could account for the uranium observed in drywells near tanks BX-101 and BX-102. Table B1-4 shows cascade line elevations for the BX-Farm tanks.

2. Potential overflows between 1962 and 1968: The liquid level in tank BX-101 was near or above the cascade line during this period. ISOCHEM Inc. and Atlantic Richfield Hanford Company reports show the supernate level stayed below 543 kgal, but there are two conflicting drawings showing different cascade levels (see Table B1-4). Both drawings indicate the supernate level was below the spare inlet ports (551.4 gal). Therefore, if the losses were from the spare inlet ports and not the cascade line (HW-20742, *Loss of Depleted Metal Waste Supernatant to Soil*) there would have been no additional liquid losses to the soil between 1962 and 1968.

Figure B1-9. Historical Gross Gamma Logs for Drywell 21-01-01

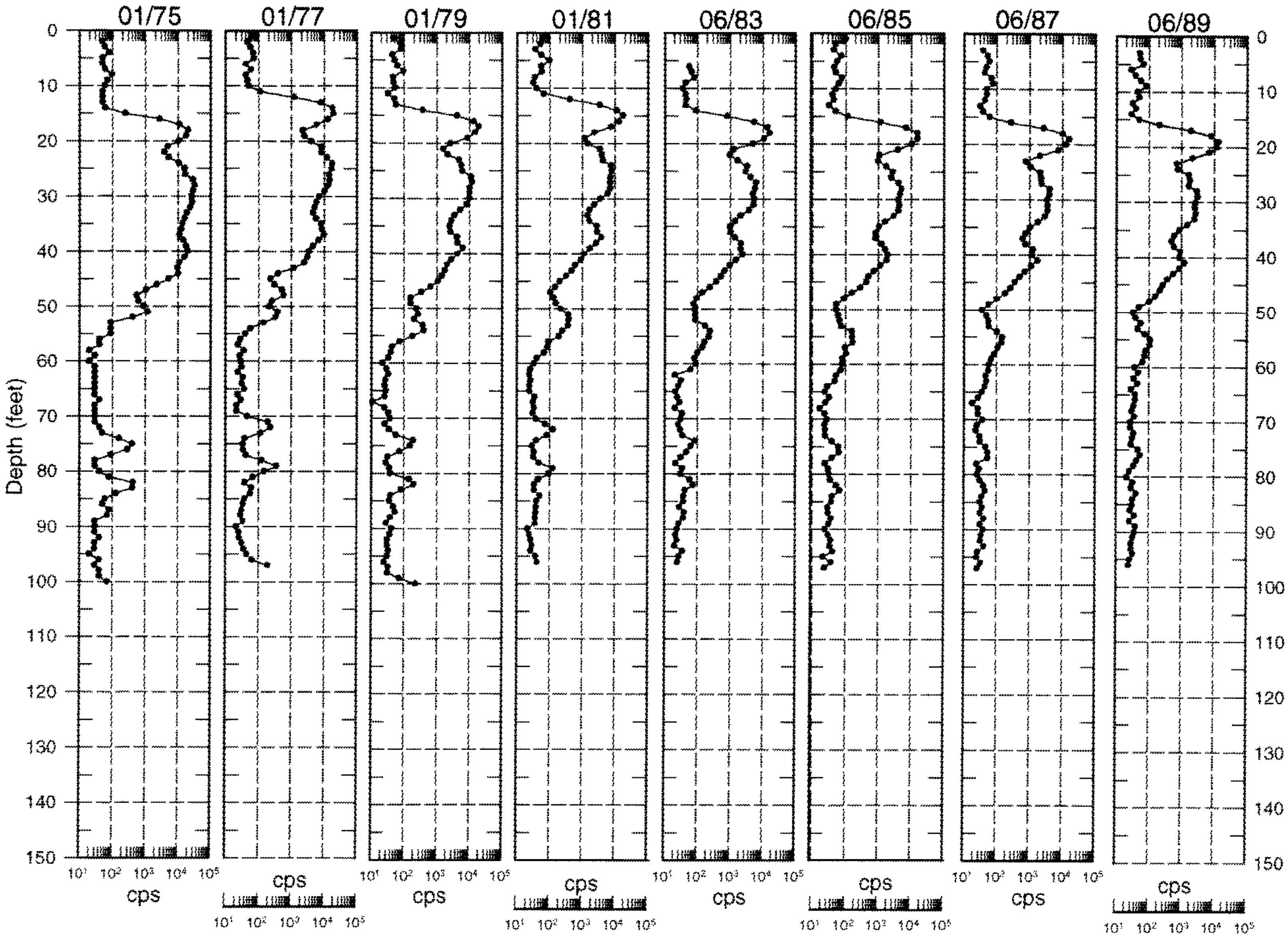


Figure B1-10. 21-01-02 Total Gamma Measurements

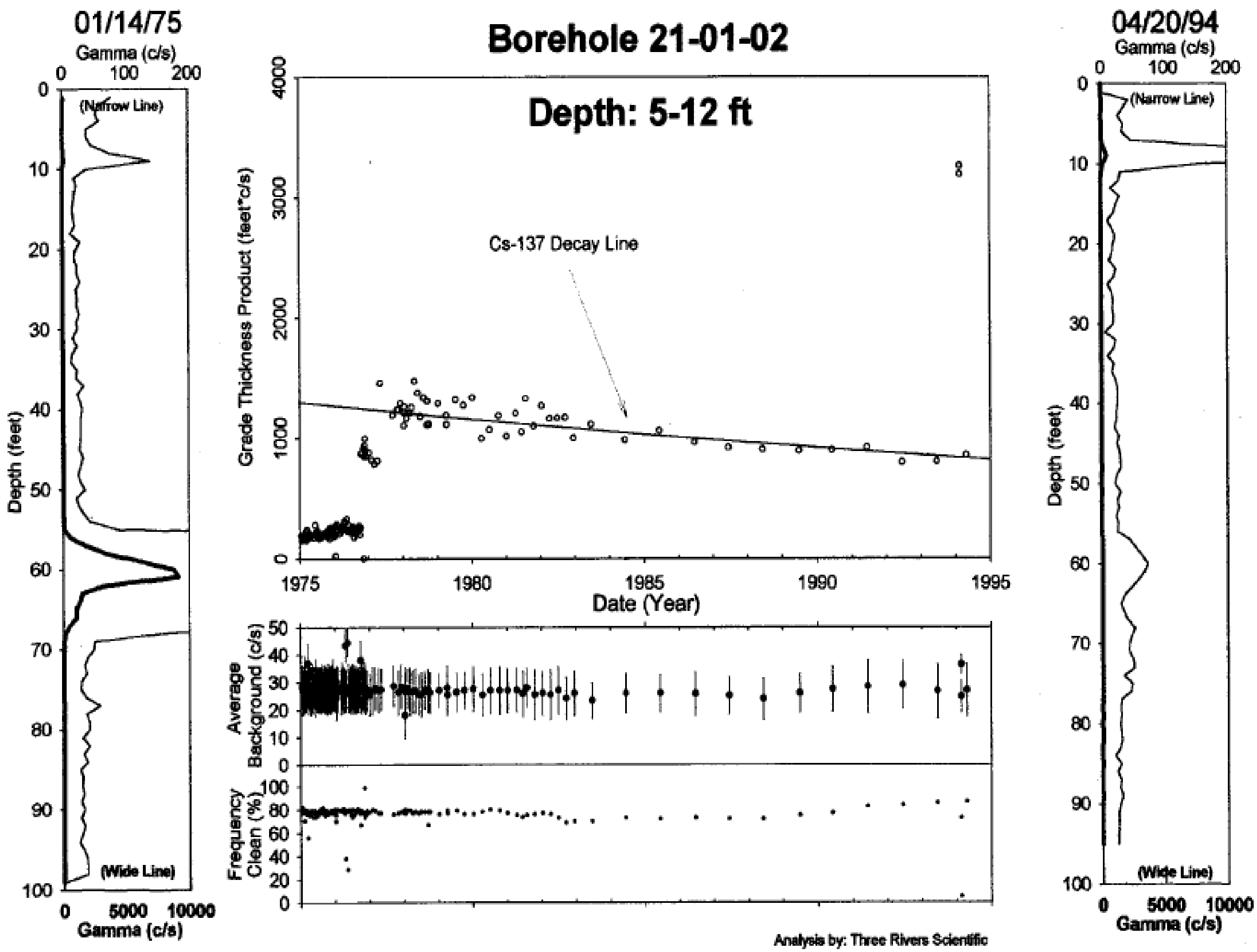


Figure B1-11. Historical Gross Gamma Logs for Drywell 21-01-02

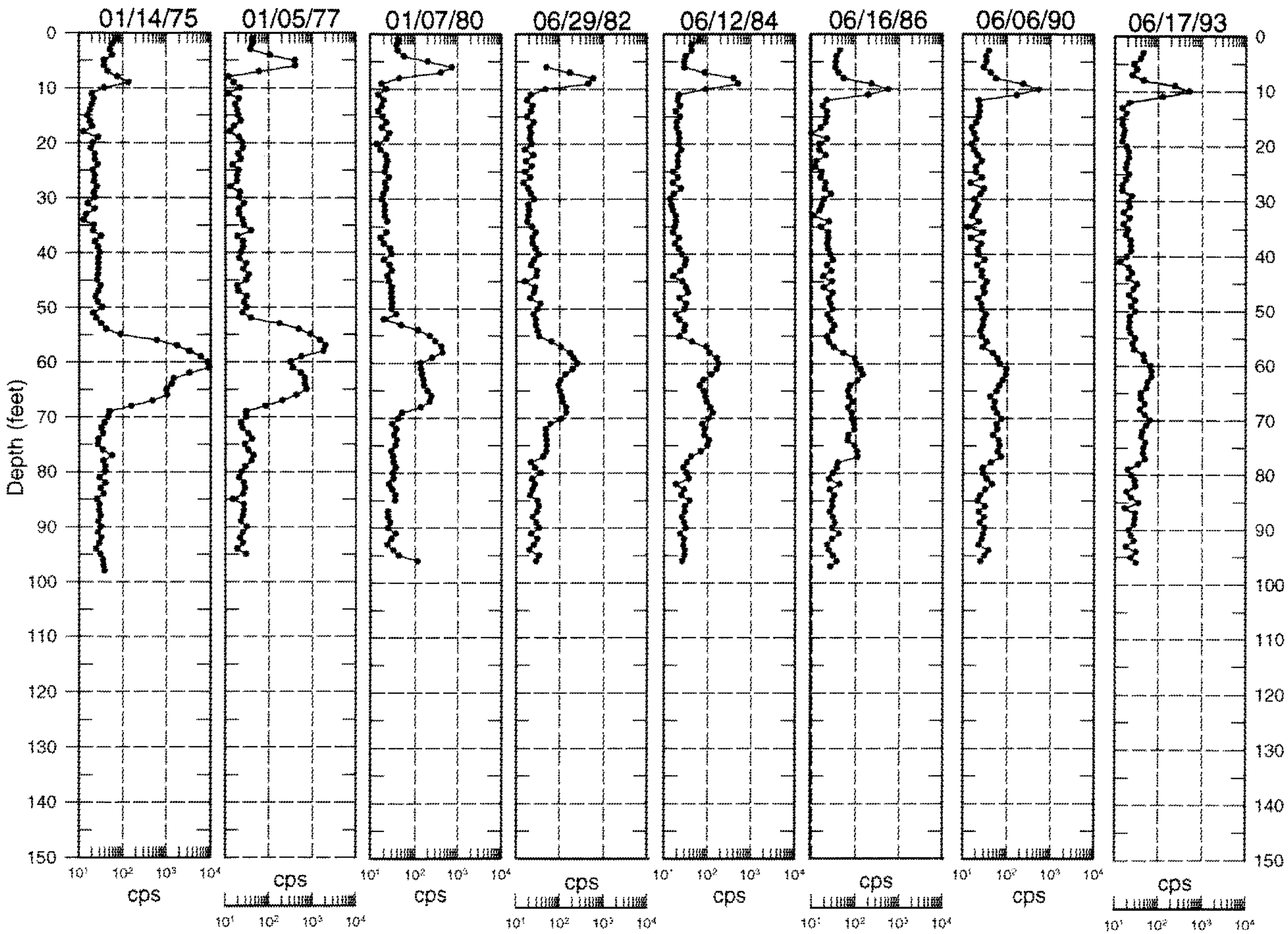


Figure B1-12. Location of Direct Push Holes near Tanks 241-BX-101 and 241-BX-102

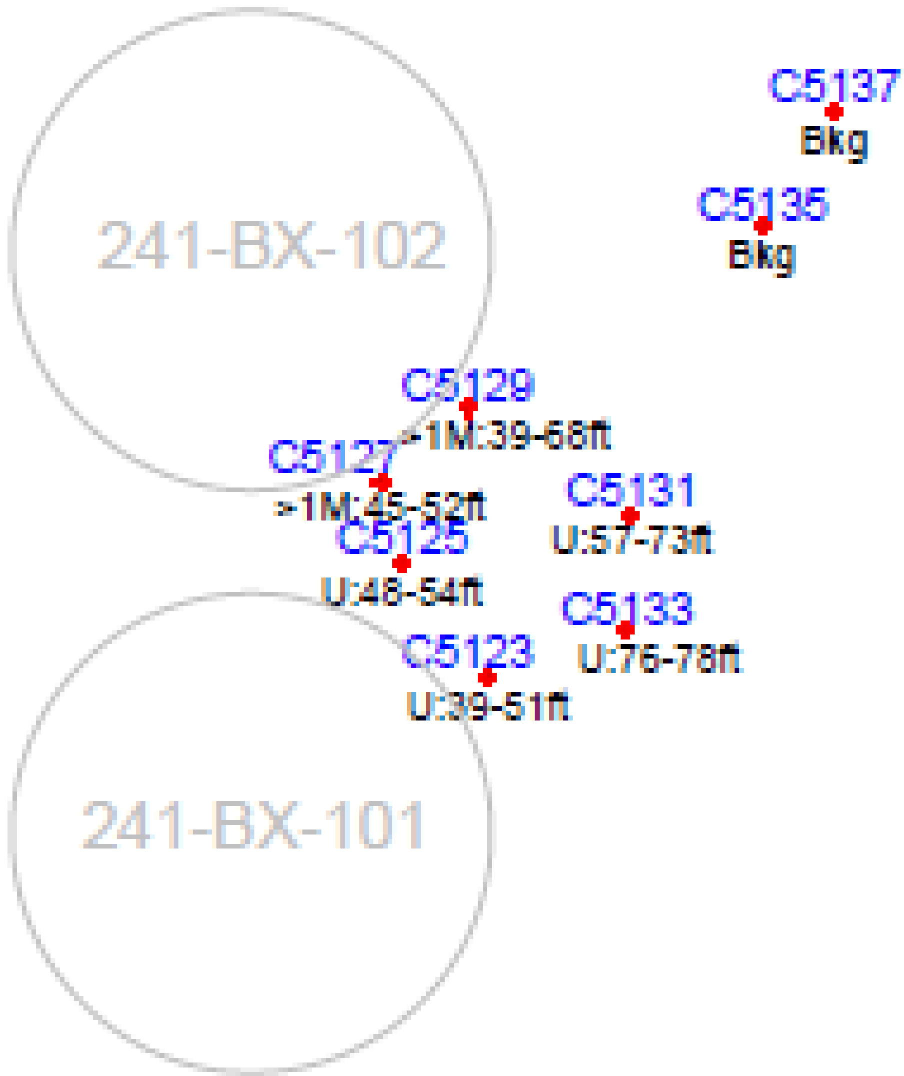


Table B1-3. Direct Push Results

Probe Hole	Gross Gamma	Spectral Gamma	Hole Depth	Depth Max Activity	Max eCs-137 (pCi/g)	Comment
C5123	X	Spectra	80.5 ft	39-51 ft	U-238 (1001 keV)	Spectra 37-54 ft
C5125	X	Spectra	80.5 ft	48-54 ft	U-238 (1001 keV)	Spectra 47-56 ft
C5133	X	Spectra	80.5 ft	76-78 ft	U-238 (1001 keV)	Spectra 74-79 ft

Reference: RPP-34623, *Small Diameter Geophysical Logging In the 241-BX Tank Farm*.

3. Sudden increase in activity at drywell 61 (now 21-27-11) observed in October 1969. This drywell is far from tank BX-101 and probably more related to losses near or from

tank BX-102. However, the large increase may be attributed to migration of earlier contaminants released from tank BX-101 or tank BX-102.

4. 1972 – tank BX-101 leaking riser in the sluice pit.

Table B1-4. Level of Cascade Overflow lines and Spare Inlets (level above dish, 12-inch offset)

Location	Elev. above sea level (ft)	Depth bgs (ft)	Level (in)	Waste Vol (kgal)	Reference
Cascade BX-101 to BX-102 BX-102 to BX-103	 632.96 631.96	 23.4 23.4	 191.5 191.5	 539.1 539.1 (ht*2750+12500)	 H-2-1745
Cascade BX-101 to BX-102 BX-102 to BX-103	 633.12 632.12	 23.2 23.2	 193.44 193.44	 544.5 (ht*2.75+12.5)	 H-2-611
Cascade BX-102 from BX-101	 632.37 632.21	 22.96 23.12	 196.44 194.52	 552.7 547.4	 H-2-611 H-2-1745
spare inlet nozzle (C) BX-101 BX-102	 633.33 632.33	 23 23	 195.96 195.96	 551.4 551.4	 H-2-1745
BX-101 sluice pit bottom (drain line)	647.25	9.1	363.0		H-2-41803
BX-101 above dish BX-102 above dish (12 in. above tank bottom)	617.0 616.0	39.33 39.33		12.5 12.5	H-2-1745
Ground Surface BX-101 BX-102	 656.33 655.33				H-2-41803

References:
H-2-611, *Piping & Concrete 241-BX*, Sheet 1, Rev. 18.
H-2-1745, *Tank Farm Riser & Nozzle Elev.*, Sheet 1, Rev. 6.
H-2-41803, *Piping – Cascade Sluice Pit Plan & Sections – 101 Cascade*, Sheet 1, Rev. 2.

The 1972 increased activity in drywell 21-01-01 appears to have originated from a sluicing pit on the dome of the tank (RPP-10098, *Field Investigation Report for Waste Management Area B-BX-BY*). Large volumes (about 25 Mgal) of waste moved through this tank from 1968 until the end of 1972. RPP-10098 suggests that there may have been an active leak from the SST BX-101 pump pit over this 4-year period and that the suspected increase in activity in drywell 21-27-11 (attributed to a leak from SST BX-102 in the early 1970s [ARH-2035, *Investigation and Evaluation of 102-BX Tank Leak*]) may have been caused by migrating contaminants from the SST BX-101 pump pit. This would indicate that the tank BX-101 pump pit leak may have been very large. (Note: The pump pit is located on the southwest edge of tank BX-101, more than 100 ft from the tank BX-102 spare inlets and drywell 21-27-11 [see

Figure B1-2]. RPP-10098 was likely referring to the sluice pit on the northeast edge of the farm. This is the pit where the riser leak was discovered in August 1972 not the pump pit.)

Large volumes of water were used to excavate a hole to assess the riser leak theory. Excavated soil samples near where the riser enters the tank dome were hot and "runny wet when received." (Internal memo MEM-092672). This confirmed that the activity observed was likely from the riser. The samples taken showed fission products and appear to be from 2d cycle waste but show little uranium. The sluice pit riser leak appears to be the best explanation for the peak activity between 20 and 40 ft first discovered in 1972, but the deeper uranium identified in spectral gamma logs had to be from a different source. It was postulated to be from either migration of MW from a tank BX-102 overflow or a tank BX-101 overflow.

Table B1-5 documents additional information from process records related to the leak from tank BX-101.

Table B1-5. Tank 241-BX-101 Leak Information

Date	Event as Described in Reference	Reference
8-1972	Investigations are underway to determine the origin of radioactivity which was found in a dry well at the 241-101-BX tank. Since the peak of the activity was above the maximum tank liquid level, other sources are being checked for the cause of the radioactivity, such as valves piping, pits and encasements. The pump was lifted and visual observation showed significant leakage through the upper column holes which have been striking the riser walls between the pit and the tank. As of June 30, 1972, the 101-BX tank contained 474,000 gallons of liquid and 57,000 gallons of solids from ion exchange (sludge supernate waste) and B-Plant low-level waste. A jumper was installed in the 155-TX diversion box to receive waste from 101-BX to 101-T enroute to the 242-T evaporator. Pumping was switched to another pit. Sampling of the soil between the pump pit and the subject drywell was in process at month end.	PPD-493-8-DEL, page AIV-17
9-1972	The investigation was completed to determine the origin of the radioactivity (1,000,000 cpm) which was found in a dry well at the 241-101-BX tank. The peak of the activity was above the maximum tank liquid level and was traced to a leaky pump riser. A full report is currently being written. As of June 30, 1972, the 101-BX tank contained 474,000 gallons of liquid and 57,000 gallons of solids from ion exchange (sludge supernate waste) and B-Plant low-level waste.	PPD-493-9-DEL, page AIV-18
11-1972	Underground storage tank 104-BX was prepared for receiving ion-exchange bottoms waste from B-Plant. This vessel replaces **101-BX tank, a suspect leaker** which has been emptied to a sludge level where it will be held pending examination of dry well activity.	PPD-493-11-DEL, page AIV-17
11-1972	High activity in adjacent dry wells has led to the decision to **designate the 101-BX and 114-SX Tanks as leakers**. Tank 114 was emptied and placed in sludge cooling system at SX farm.	ARH-2348 RD, page 25

References:
ARH-2348 RD-DEL, *Manufacturing Department Monthly Management Reports January 1972 – December 1972*.
PPD-493-8-DEL, *Monthly Status and Progress Report August 1972*.
PPD-493-9-DEL, *Monthly Status and Progress Report September 1972*.
PPD-493-11-DEL, *Monthly Status and Progress Report November 1972*.

Estimated Inventory Released to the Soil from Tank 241-BX-101
The basis for changing from a "Questionable Integrity" classification to "leaker" for tank BX-101 is unknown except for a statement in ARH-2348 RD-DEL, *Manufacturing Department Monthly Management Reports January 1972 – December 1972* (Table B1-3) "High activity in adjacent dry wells has led to the decision to designate the 101-BX and 114-SX Tanks as leakers." No previous assessments were found other than the estimates and information presented. There appears to be no indication of a breech in the tank BX-101 liner and several other sources are identified for the activity observed in drywells.

A leak volume estimate for SST BX-101 of 4,000 gal was previously assumed based on discrepancies between transfer volumes and liquid level measurements in waste transfer records between 1968 and 1972 (RPP-7389, *Preliminary Inventory Estimates for Single-Shell Tank Leaks in B, BX, and BY Tank Farms*, see Table B1-1). Given the large volume of waste transferred in this period, uncertainty in surface level measurements and when the riser leak started and incomplete transfer records, this estimate is highly uncertain.

A 10,800-gal leak was also estimated based on assumed flow rates and time required to pump out the tank (35 days) after an increase in activity was observed at drywell 21-01-02 in April 1974 (Internal memo 13331-88-460, "Summary of Leaker or Questionable Integrity Tanks"). This estimate is also a rough approximation. It assumes the 1974 activity is from a new leak and ignores any potential leaks before the increased activity was observed in 1974. Consequently, neither of the previous leak estimates for tank BX-101 have a good technical basis.

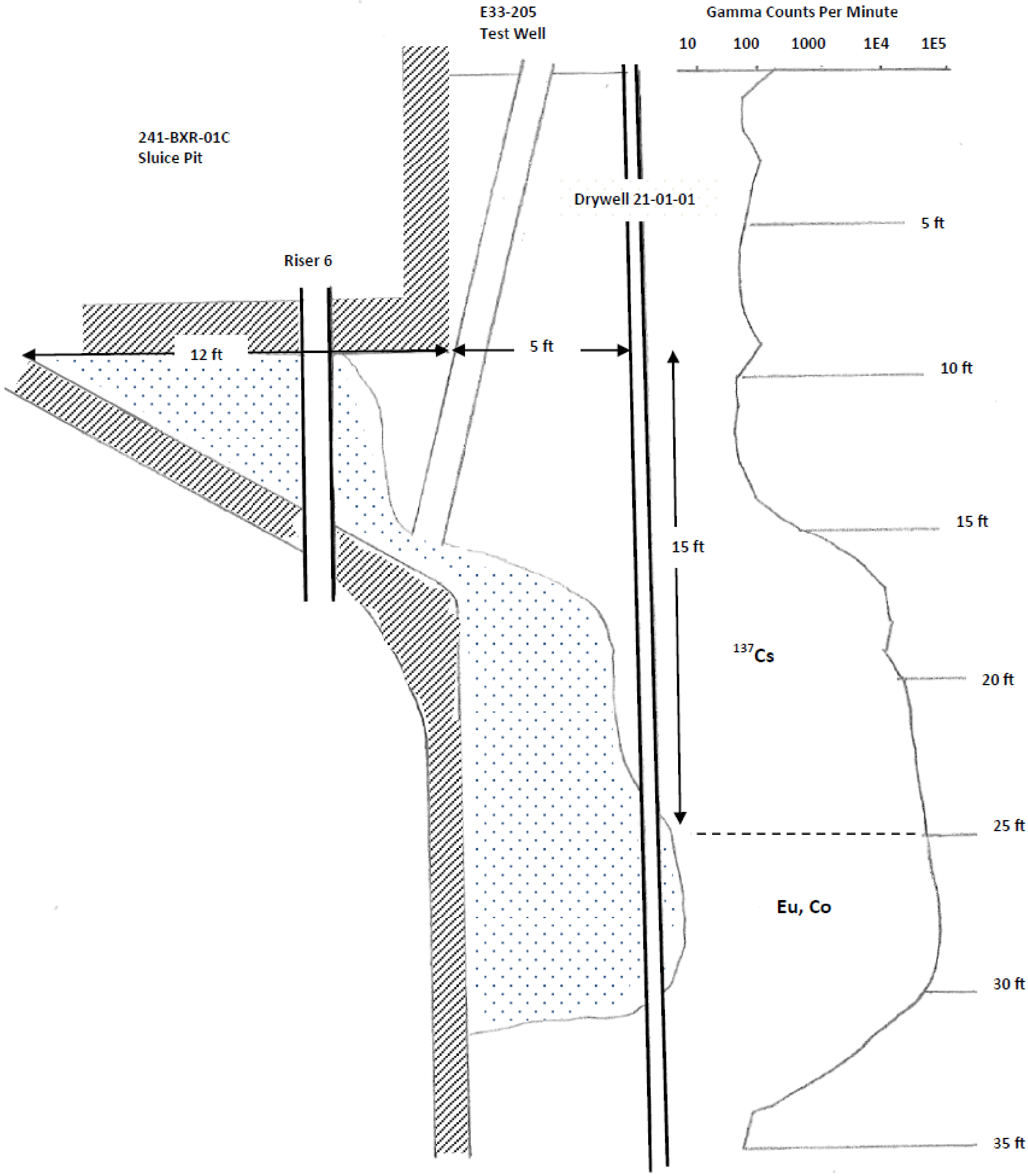
The loss of 92,600 gal from the BX-BY cascade through 1951 appears to have a good technical basis. This loss was based on a uranium mass balance for the BX and BY cascade and may have been an overflow in tank BX-102, tank BX-101, or both. This loss is currently attributed to an overflow from the spare inlets at tank BX-102 due to the higher activity observed near that tank and early activity measured in drywell 20-00-27 east of tank BX-102. The total inventory for the release is discussed in Section 5.2.

The volume of waste lost to the soil from tank BX-101 after 1951 is less certain. Fission products, including ^{137}Cs, apparently from the riser leak prior to 1972, appear to be contained between the tank dome and near drywell 21-01-01 (Figure B1-13), except for a near surface ^{137}Cs peak of ~200 pC/g in 20-01-02. Based on drywell and direct push measurements and conservative assumptions an inventory was estimated as follows:

Equation Assumptions:

1. Leak originated from pump pit riser (riser #6).
2. Spectral gamma drywell data shows a ^{137}Cs peak at 20 ft bgs; below 25 ft is predominantly other fission products (see Figure B1-7).
3. Calculation assumes entire ^{137}Cs plume concentration is 8.5E06 pCi/g (measured concentration in test well E33-205, near tank dome). Note: concentration measured at drywell 21-01-01 was <1,000 pCi/g.
4. Soil density = 1.8 g/cm^3.

Figure B1-13a. Assumed Configuration for Sluice Pit Riser Leak

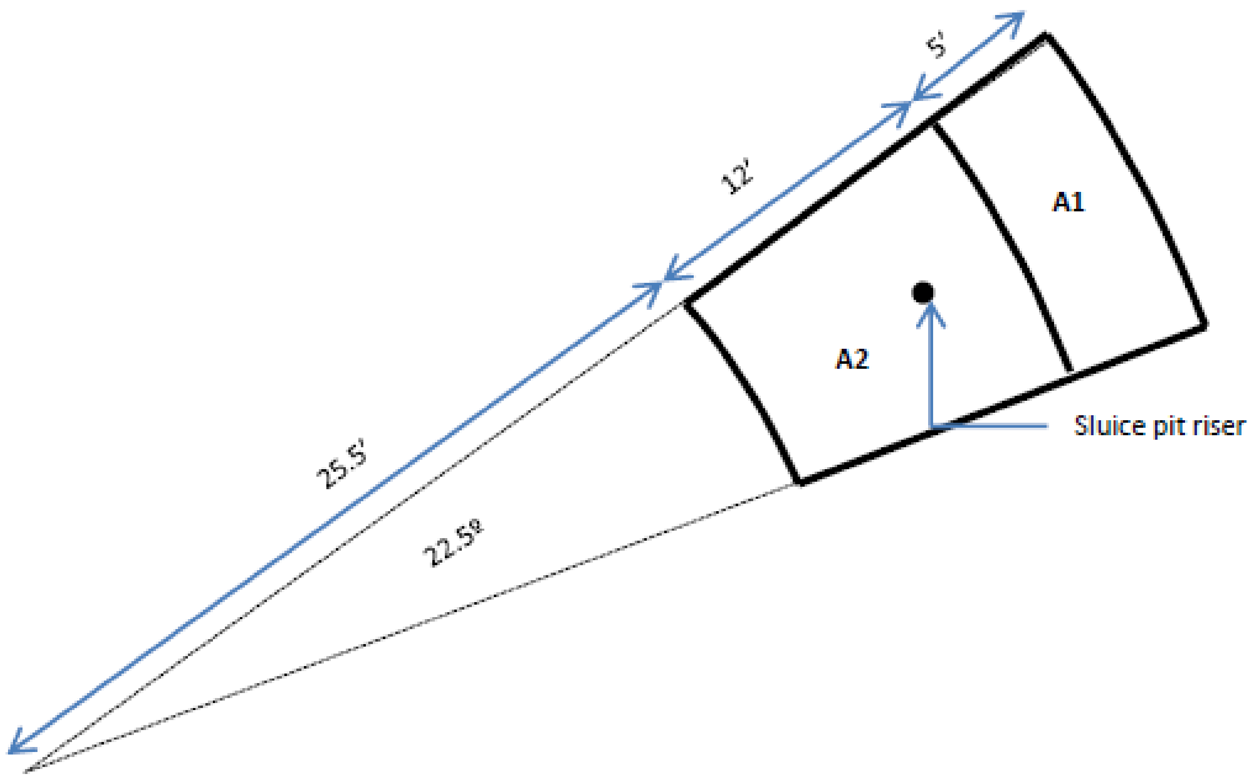


Reference: Letter Metz 1972, "Additional Information on Leak Investigation at 241-BX-101."

5. Size of plume or wetted area (see Figure B1-13a)
   a. Top of plume = 10 ft bgs.
   b. Plume extends from bottom of sluice pit down to tank dome in a triangular shape.

c. Plume extends from bottom of pump pit (~10 ft bgs) to 25 ft bgs between edge of tank and drywell 21-01-01.
d. Beyond drywell 21-01-01 plume concentration was assumed to be insignificant based on 3 orders of magnitude decrease in concentration between the test well near the tank dome and leaking riser (8.5E6 pCi/g) and the spectral gamma concentration measured at drywell 21-01-01 (<1000 pCi/g). No ^{137}Cs was detected in direct pushes near the drywell (see Table B1-3).
e. Assumed ^{137}Cs plume spreads to 1/16π of tank circumference (22.5°) (see Figure B1-13b).

Figure B1-13b. Assumed Aerial Spread of Sluice Pit Riser Leak



Calculation:

$A_1 = 1/16\pi\ ((42.5)^2 - (37.5)^2)$
$V_1 = A1(15)$
$A_2 = 1/16\pi\ ((37.5)^2 - (25.5)^2)$
$V_2 = 1/2A2(5)$
$V_T = V1 + V2$
$V_T \sim 1600\ ft^3$
$V_1 \sim 1200\ ft^3$
$V_2 \sim 400\ ft^3$
^{137}Cs mass = V_T (8.5E-6 Ci/g)(5.1E4 g/ft^3) ~ 700 Ci

This inventory is assumed to be an upper estimate for the tank BX-101 sluice pit riser leak.

The leak volume depends on the concentration of waste in the tank at the time of the leak. No tank BX-101 sample data was available during this time. There were three samples taken in 1970 of tank BX-102 waste; ^{137}Cs concentrations of 0.28 on January 27, 1970, 0.12 on March 1, 1970, and 0.73 on April 30, 1970 (ARH-2035). Tanks BX-101 and BX-102 received many types of waste in the late 1960s and early 1970. High ^{137}Cs concentrations in drywell 21-01-01 indicate the tank BX-101 riser leak probably occurred during IX from B Plant (CSR) transfers into the tank between 1971 and 1974. The Hanford Defined Waste (HDW) composition estimate for CSR waste in 1972 was ~1.5 Ci/gal. Assuming the April 1970 measured waste composition in tank BX-102 is representative of the waste leaked from the tank BX-101 sluice pit riser, a leak volume of 900 gal was estimated (700 Ci/0.8 Ci/gal). The leak volume estimate would be lower if the ^{137}Cs concentration of the waste released was higher.

The Hanford Soil Inventory Model (SIM) ^{137}Cs concentration for the tank BX-101 leak is 0.008 Ci/gal decayed to January 1, 1972 based on a waste type of Sr-Cs Recovery Organic waste (P2') BL. This is a factor of 100 lower than the upper 1970 sample value for tank BX-102 waste, suggesting the SIM waste type may be incorrect (a leak volume of 88,000 gal or 32 in. [700/0.008] would be expected to spread more and should have resulted in a large liquid level decrease). It is recommended that the SIM estimate for tank BX-101 be revised to use HDW values for a CSR supernate waste. The inventory for other constituents can be estimated by multiplying the leak volume estimate of 900 gal by half the CSR supernate concentration (0.8/1.5).

B1.7 CONCLUSION

The tank BX-101 sluice pit riser leak observed in September 1972 was determined to be the most likely source of the fission product gamma activity in drywell 21-01-01. The uranium deeper in the profile is attributed to a 1951 MW overflow from tank BX-102 or tank BX-101 or both. Inventory estimates for the sluice pit riser leak are highly uncertain. The date the leak started could not be determined and previous leak estimates for this tank do not have a good technical basis. Based on the 21-01-01 drywell data (soil samples collected from near the riser leak on the tank dome and surrounding drywells), the riser leak was estimated to be < 700 Ci of ^{137}Cs and < 900 gal total (for an assumed ^{137}Cs concentration in the tank at the time of the leak of 0.8 Ci/gal). There is no indication of a breech in the tank BX-101 steel liner; therefore, a formal re-evaluation of the current classification for this tank is recommended and additional characterization is recommended to better quantify inventory losses near tank BX-101.

B2.0 TANK 241-BX-102

This section provides information on the historical waste loss event associated with tank BX-102. Waste operations for tank BX-102 are summarized in Figure B2-1. Figure B2-2 shows a plan view of tank BX-102 with the location of the pump pit, sluice pit, spare inlet nozzles (N1, N2, N3 and N4) and tank risers.

B2.1 TANK 241-BX-102 WASTE HISTORY

Tank BX-102 was constructed during 1946 and 1947 and was placed in service in 1948 (Internal memo 13240-88-30). Figure B2-3 shows tank surface levels during operations. This tank received and stored MW from 1948 to 1954 (MW contained 90% of the original fission products, all of the uranium, and 1% of the plutonium). In 1954, the tank was sluiced to recover uranium. From 1956 to 1963, tank BX-102 received and stored uranium recovery waste streams from U Plant. From 1963 to 1970, the tank received and stored CW, concentrator and evaporator waste streams, BL, and OWW. In 1972, 95 tons of diatomaceous earth was added to the tank to absorb and help stabilize the remaining liquid in the tank. Table B2-1 shows the waste transfer history for tank BX-102 from 1948 to 1976.

B2.2 INTEGRITY OF TANK 241-BX-102

A leak in tank BX-102 was suspected in March 1951 due to anomalous gamma activity in drywell 21-27-11, located 72 ft from tank BX-102. The tank was placed on limited service, but was not emptied or stabilized. The contents were reduced to a level of about 22 in., and this level was maintained during its continued use until 1962. From 1962 to 1968, the waste level was raised to tank capacity, and only minimal additions or withdrawals were made to the tank contents. The gamma-ray activity in drywell 21-27-11 decreased steadily from 1959 through 1968; however, the gamma-ray activity increased in 1969, when the tank was returned to active status, and it continued to increase in 1970. In May 1970, tank BX-102 was pumped to a minimum level and was removed from service. Additional drywells were installed and monitored and a tank leak assessment was completed in 1971 (ARH-2035). The assessment concluded that tank BX-102 leaked and classified the tank as a confirmed leaker.

B2.3 INTERIM STABILIZATION

Tank BX-102 was interim stabilized in 1978 and intrusion prevention was completed in 1980 (SD-WM-TI-356). In-tank photos taken November 13, 1978 showed a dry and cracked surface. The diatomaceous earth appeared to have stabilized all surface liquid (HNF-SD-WM-TI-178). As of January 2010, BX-102 contained an estimated 40 kgal of sludge and 39 kgal of diatomaceous earth (HNF-EP-0182). Figure B2-4 shows a photo mosaic of the BX-102 tank surface in September 1985.

Figure B2-1. Tank 241-BX-102 Waste Operations Timeline

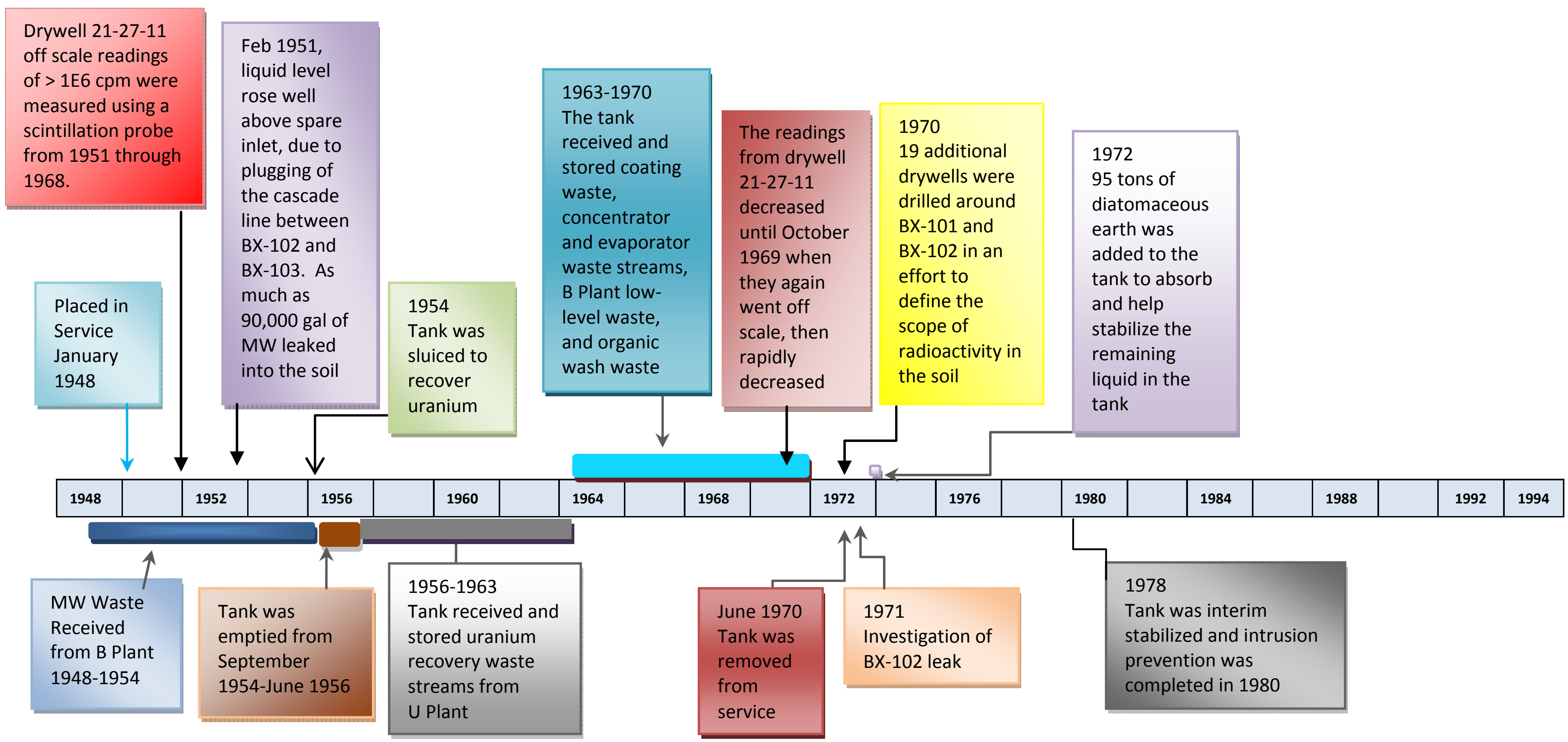
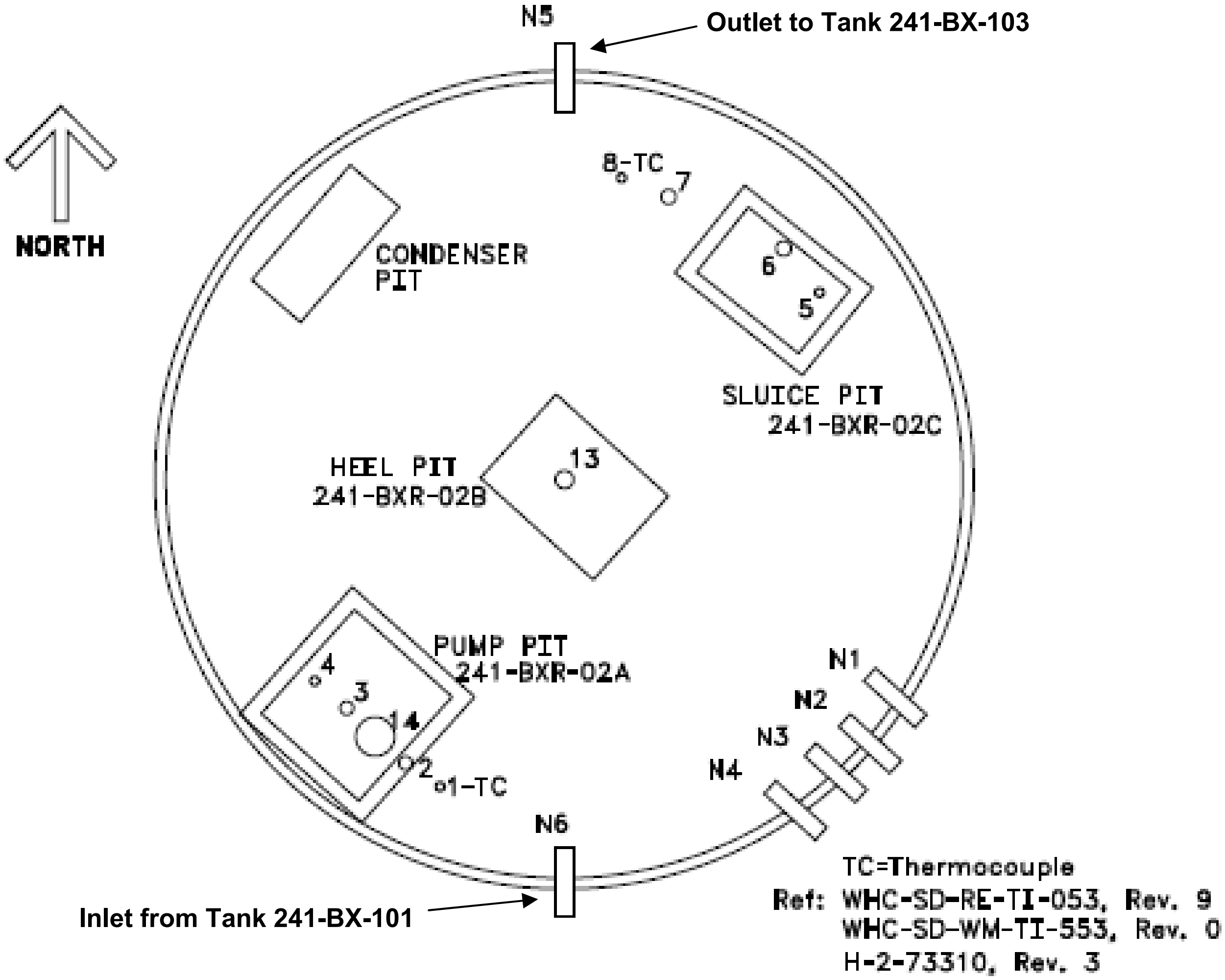


Figure B2-2. Tank 241-BX-102 Plan View



B2.4 TANK 241-BX-102 TEMPERATURE HISTORY

No temperature measurements were found before 1974. As shown in Figure B2-5, between 1974 and 1995 the tank temperature ranged between 50 and 80° F indicating that the tank is a low heat tank. Tank temperature is being monitored by a single thermocouple tree.

B2.5 DATA REVIEW AND OBSERVATIONS

B2.5.1 Liquid Level Measurements

Table B2-1 shows tank liquid volumes from March 1948 to 1976. Frequent measurements were made in the 1950s when the cascade line plugged between tanks BX-102 and BX-103. These were recorded as static liquid level measurements in the tank and are included in Table B2-1.

Figure B2-3. Tank 241-BX-102 Waste Surface Level Diagram

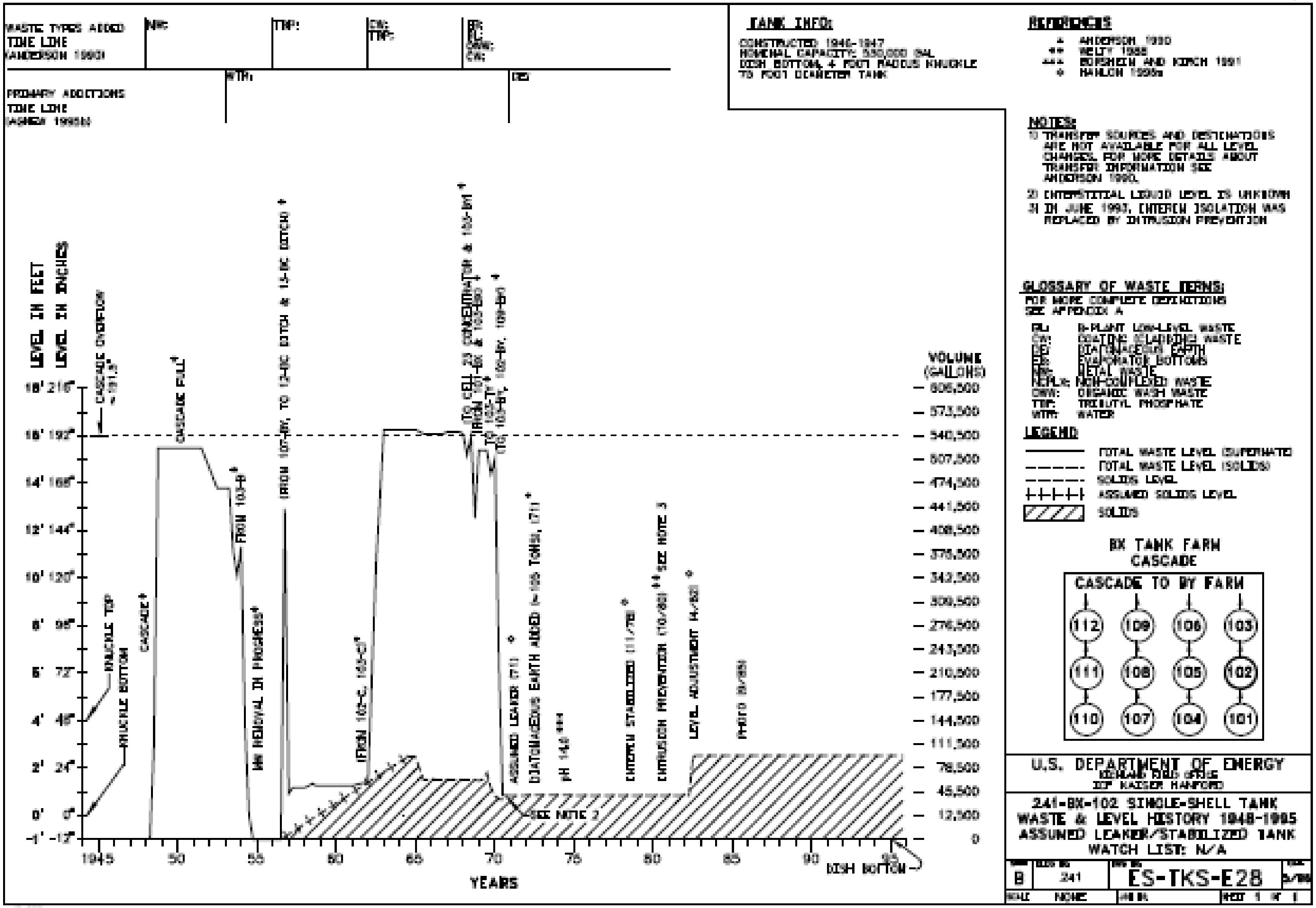


Table B2-1. Tank 241-BX-102 Waste Transfer History (1948 to 1976) (3 sheets)

Date/Date Range	*Transfer Type*	*Transfer Volume (gal*1000)*	*Total Vol. In Tank (gal*1000)*	*Discrepancy with previous reading (gal*1000)*	*Waste type*	*Transfer tank from/to*	*Document Number (see Section B6.0 for full reference)/Comment*
Mar. 1948	STAT		0				WHC-MR-0132
Apr. to June 1948	REC	111	111		MW	BX-101	WHC-MR-0132
July to Sep. 1948	REC	426			MW	BX-101	WHC-SD-WM-TI-615
July to Sep. 1948	SEND	-8			MW	BX-103	WHC-SD-WM-TI-615
Sep. 1948	STAT		523	-6	MW		WHC-MR-0132 WHC-SD-WM-TI-615 shows 530 kgal from 1948 through February 1951
Oct. to Dec. 1948	REC	489			MW	BX-101	WHC-SD-WM-TI-615
Oct. to Dec. 1948	SEND	-489			MW	BX-103	WHC-SD-WM-TI-615
Jan. 1949	STAT		523		MW		WHC-MR-0132
Jan. to Mar. 1949	REC	33			MW	BX-101	WHC-SD-WM-TI-615
Jan. to Mar. 1949	SEND	-33			MW	BX-103	WHC-SD-WM-TI-615
Mar. 1949	STAT		523		MW		WHC-MR-0132
Jan. to Mar. 1950	REC	285			MW	BX-101	WHC-SD-WM-TI-615
Jan. to Mar. 1950	SEND	-285			MW		WHC-SD-WM-TI-615
Mar. 1950	STAT		523		MW		WHC-MR-0132
Apr. to June 1950	REC	377			MW	BX-101	WHC-SD-WM-TI-615
Apr. to June 1950	SEND	-377			MW		WHC-SD-WM-TI-615
June 1950	STAT		523		MW		WHC-MR-0132
July to Sep. 1950	REC	571			MW	BX-101	WHC-SD-WM-TI-615
July to Sep. 1950	SEND	-571			MW		WHC-SD-WM-TI-615
Sep. 1950	STAT		523		MW		WHC-MR-0132
Oct. to Dec 1950	REC	428			MW	BX-101	WHC-SD-WM-TI-615
Oct. to Dec 1950	REC	-428			MW	BX-101	WHC-SD-WM-TI-615
Dec. 1950	STAT		523		MW		WHC-MR-0132
Jan. 1951	REC	438			MW	BX-101	WHC-SD-WM-TI-615,
Jan. 1951	SEND	-438	523		MW	BX-103	WHC-SD-WM-TI-615,
Feb. 1951	REC	145.6			MW	BX-101	HW-20742 Line plug, liq level rose well above spare inlets (to 576 kgal on Feb 23). Transfer volume shown is volume jetted to BX-101 cascade in February.
Feb 1951	SEND	-54			MW	BX-103	HW-20742 Transfer volume shown is measured inventory increase in cascade during February. Estimated 91.6 kgal Loss to soil
Mar. 15, 1951	STAT		533	-81.6	MW		HW-20742

Table B2-1. Tank 241-BX-102 Waste Transfer History (1948 to 1976) (3 sheets)

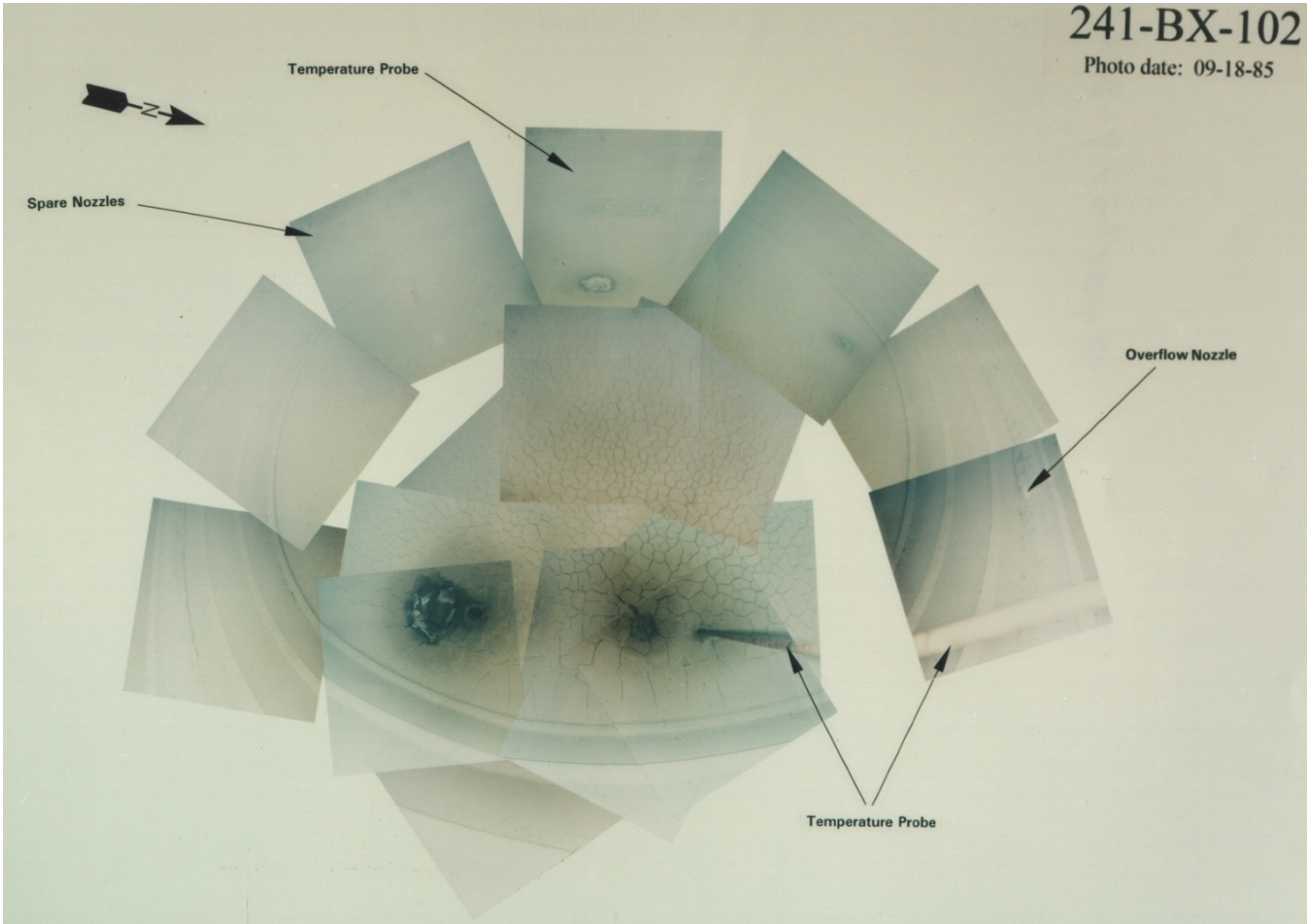
Date/Date Range	Transfer Type	Transfer Volume (gal*1000)	Total Vol. In Tank (gal*1000)	Discrepancy with previous reading (gal*1000)	Waste type	Transfer tank from/to	Document Number (see Section B6.0 for full reference)/Comment
Mar. 1951 to Mar. 1952	STAT		530		MW		WHC-SD-WM-TI-615
Apr. to June 1952	SEND	-63			MW		HW-27838
June 1952 to Mar. 1953	STAT		467		MW		HW-27838, HW-27775
Apr. to June 1953	SEND	-87	380		MW		HW-28043, HW-28712
June 1953	STAT		380		MW		HW-28712
July to Sep. 1953	SEND	-34	346		MW	UR Plant	HW-29054, HW-29624
Sep. 1953	STAT		346		MW		HW-29624
Oct. to Nov. 1953	REC	40	386		MW	B-103	HW-30250
Dec. 1953	STAT		386		MW		HW-30498
Mar. 1954	SEND	250	136		MW	UR	HW-31374
Apr. to June 1954	SEND	-124	12		MW	UR	HW-31811, HW-32389
July to Aug. 1954	SEND	-12	0		MW	UR	HW-32697, HW-33002
Sep. 1954 to June 1956	STAT		0				HW-33396, HW-43895
July 1956	REC	184	184		TBP	BY-107	HW-44860
Aug. 1956	REC	255	439		TBP	BY-107	HW-45140
Sep. to Nov. 1956	STAT		439		TBP		HW-45738, HW-47052
Dec. 1956	SEND	-396	43		TBP	CRIB	HW-47640
Jan. 1957	STAT		43		TBP		HW-48144
Feb. 1957 to Jan. 1958	STAT		51	8	TBP		HW-48846, HW-56761
Feb. to Apr. 1958	STAT		54	3	TBP		HW-55264
May to July 1958	STAT		57	3	TBP		HW-56357, HW-57122
Aug. 1958 to Dec. 1960	STAT		54		TBP		HW-57550, HW-68292
Jan. to June 1961	STAT		57		TBP		HW-71610
July to Dec. 1961	STAT		59		TBP		HW-72625
Jan. to June 1962	REC	300	359		TBP-CW	C-102, 103	HW-74647
July to Dec. 1962	REC	190	549		TBP-CW	C-102	HW-76223
Jan 1962 to Dec. 1964	STAT		549		TBP-CW		HW-78279, RL-SEP-260
Jan 1965 to Sep. 1966	STAT		543	-6	TBP-CW		RL-SEP-659, ISO-538
Oct 1966 to Sep. 1967	STAT		546	3	TBP-CW		ISO-674, ARH-95
Oct. to Dec. 1967	STAT		543	-3	TBP-CW		ARH-326
Jan. to Mar. 1968	REC	641			TBP-CW	BX-103	ARH-534
Jan. to Mar. 1968	SEND	-673			CW	BY-112	ARH-534
Mar. 1968	STAT		513		CW		ARH-534
Apr. to June 1968	REC	576			CW	BX-103	ARH-721
Apr. to June 1968	SEND	-550			CW	BY-103	ARH-721
June 1968	STAT		539		CW		ARH-721

Table B2-1. Tank 241-BX-102 Waste Transfer History (1948 to 1976) (3 sheets)

Date/Date Range	***Transfer Type***	***Transfer Volume (gal*1000)***	***Total Vol. In Tank (gal*1000)***	***Discrepancy with previous reading (gal*1000)***	***Waste type***	***Transfer tank from/to***	***Document Number (see Section B6.0 for full reference)/Comment***
July to Sep. 1968	REC	274			CW,EB	BX-101	ARH-871
July to Sep. 1968	REC	392			CW,EB	BX-103	ARH-871
July to Sep. 1968	SEND	-780			CW,EB	TY-103	ARH-871
Sep. 1968	STAT		426	1	CW,EB		ARH-871
Oct. to Dec. 1968	REC	94			CW,BL	BX-101	ARH-1061
Dec. 1968	STAT		520		CW,BL		ARH-1061
Jan 1969 to Jun 1969	STAT		520		CW,BL		ARH-1200A, ARH-1200B
July to Sep. 1969	STAT		487	-33	CW,BL		ARH-1200C Sludge vol. reestimated
Oct. to Dec. 1969	REC	1909			CW,BL	BX-103	ARH-1200D
Oct. to Dec. 1969	SEND	-1888			CW,BL	BY-103	ARH-1200D
Dec. 1969	STAT		508		CW,BL		ARH-1200D
Jan. to Mar. 1970	REC	1394			CW,OWW	BX-103	ARH-1666 A
Jan. to Mar. 1970	SEND	-608			CW,OWW	BY-103	ARH-1666 A
Jan. to Mar. 1970	SEND	-664			CW,OWW	BY-109	ARH-1666 A
Jan. to Mar. 1970	SEND	-399			CW,OWW	BY-102	ARH-1666 A
Mar. 1970	STAT		233	2	CW,OWW		ARH-1666 A
Apr. to June 1970	REC	413			BL	BX-103	ARH-1666 B
Apr. to June 1970	SEND	-602			BL	BY-109	ARH-1666 B
June 1970	STAT		41	-3	BL		ARH-1666 B
July 1970 to June 1971	STAT		40				ARH-1666 C, ARH-2074 B
June 1971	STAT		40				ARH-2074 B First note in transfer record tank leaks
July to Sep. 1971	STAT		40				ARH-2074 C
Oct. to Dec. 1971	REC	1	41			105 ton DE added	ARH-2074 D
Jan. 1972 to Dec. 1976	STAT		41				ARH-2456 A, ARH-CD-336 D

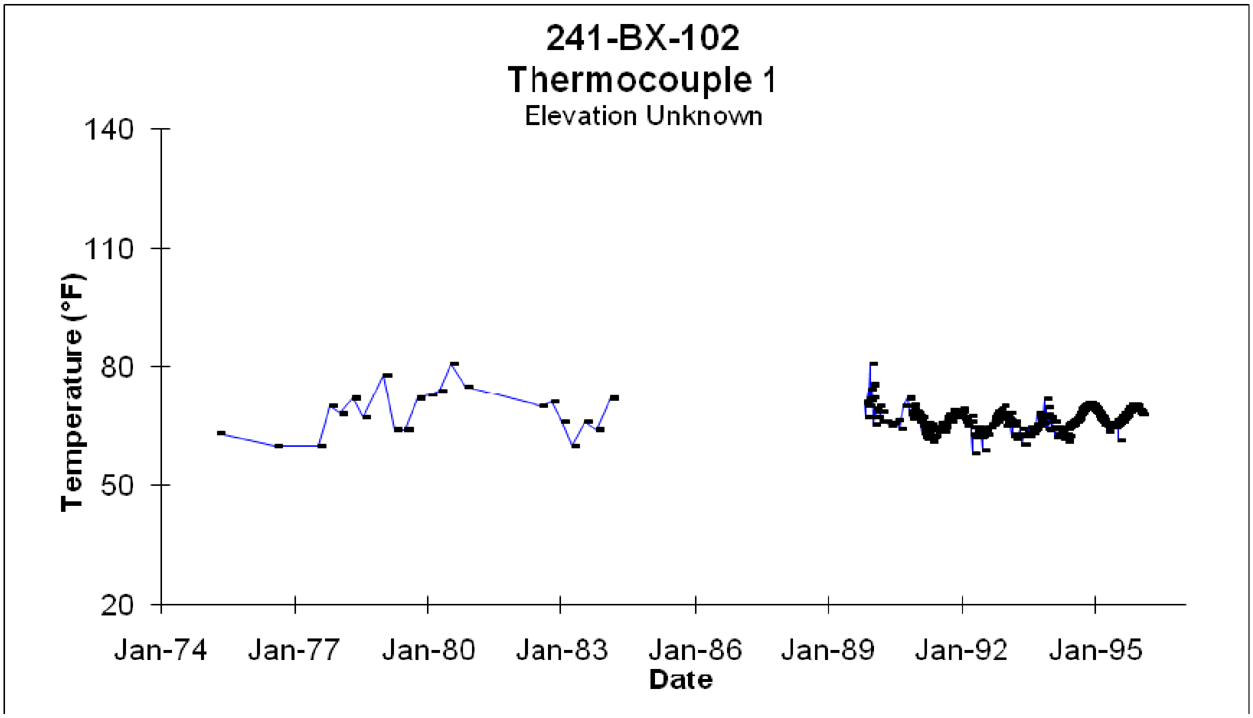
BL = B Plant low-level waste
EB = Evaporator Bottoms (waste)
TBP = tributyl phosphate (waste)
CW = cladding (coating) removal waste
MW = metal waste
DE = diatomaceous earth
OWW = organic solvent wash waste

Figure B2-4. 241-BX-102 In-Tank Photo Mosaic



Reference: WHC-SD-WM-ER-349, *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Area*.

Figure B2-5. Tank 241-BX-102 Waste Temperature Measurements



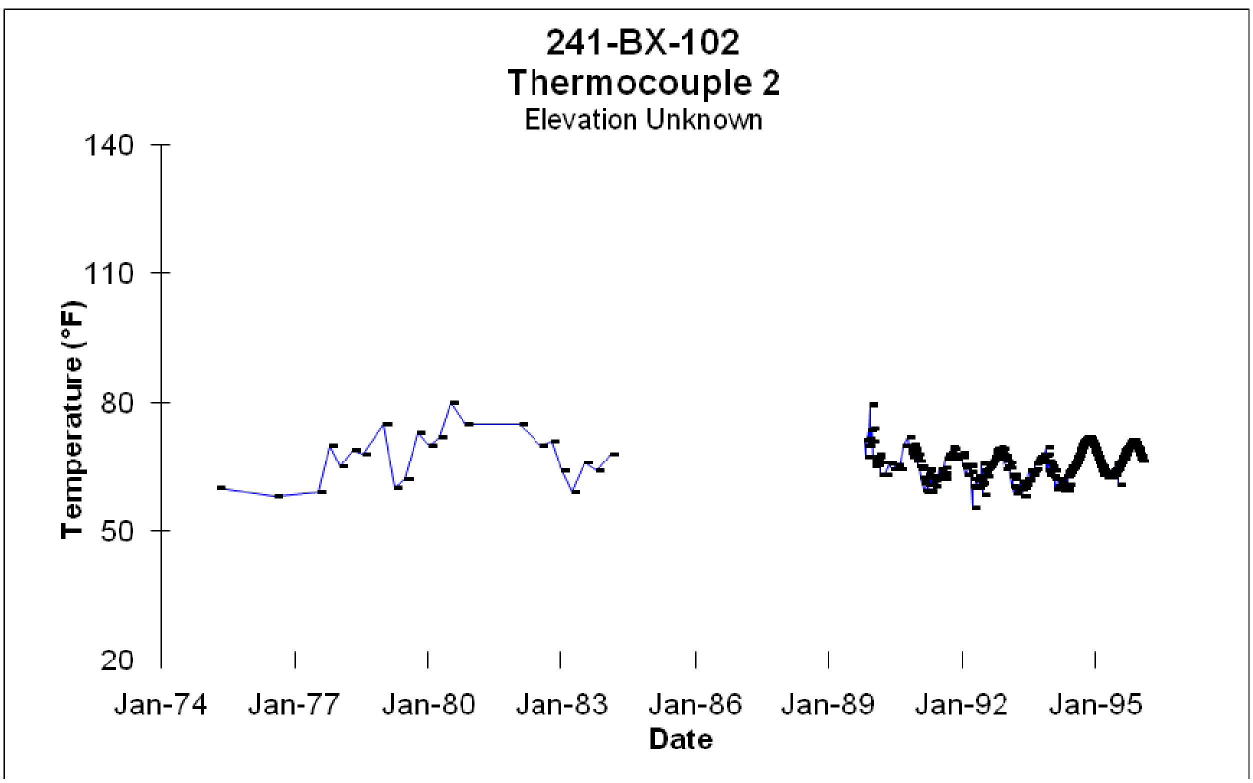


Table B2-2 shows liquid level measurements from April 1975 to January 1987 (SD-WM-TI-356). Figure B2-6 shows liquid level plots from the tank surveillance monitoring system from 1974 to 1995. Increased liquid levels were observed in the late 1970s. A steady surface level decrease was observed in manual tape readings between 1981 and 1992, but the surface level gage was sitting on sludge solids after 1980. The manual tape was replaced with an ENRAF gage in 1996 and the liquid level baseline was shifted 12 in. (in Figure B2-6 a manual tape measurement of 28 in. measured from the top of the tank dish is equivalent to an ENRAF measurement of 40 in. measured from the bottom of the tank). The ENRAF measurements oscillated between 34 and 36 inches.

Table B2-2. Tank 241-BX-102 Liquid Level Measurements (1975 to 1987)

Date	Liquid level (in.)	Baseline ref.	Change from previous reading (in.)	Cumulative change (in.)	Comments
04/10/75	30.75				Manual tape sludge reading
01/21/76	33.00		+2.25	+2.25	Slow erratic increase
09/16/76	31.00		-2.00	+0.25	Slow erratic decrease
02/22/77	31.25		+0.25	+0.50	Erratic readings from 31.00 to 32.50 in.
02/01/79*		30.25			Baseline adjusted for increase
02/05/79	30.25				Very slow decrease
03/03/80	30.25				Stable
02/18/81	30.25				Stable
02/22/82	30.50				Stable
02/14/83	30.50				Stable
01/03/84	30.50				Stable
02/15/85	30.25				Stable
01/01/86	29.75				Slow decrease
01/02/87	30.00				Stable

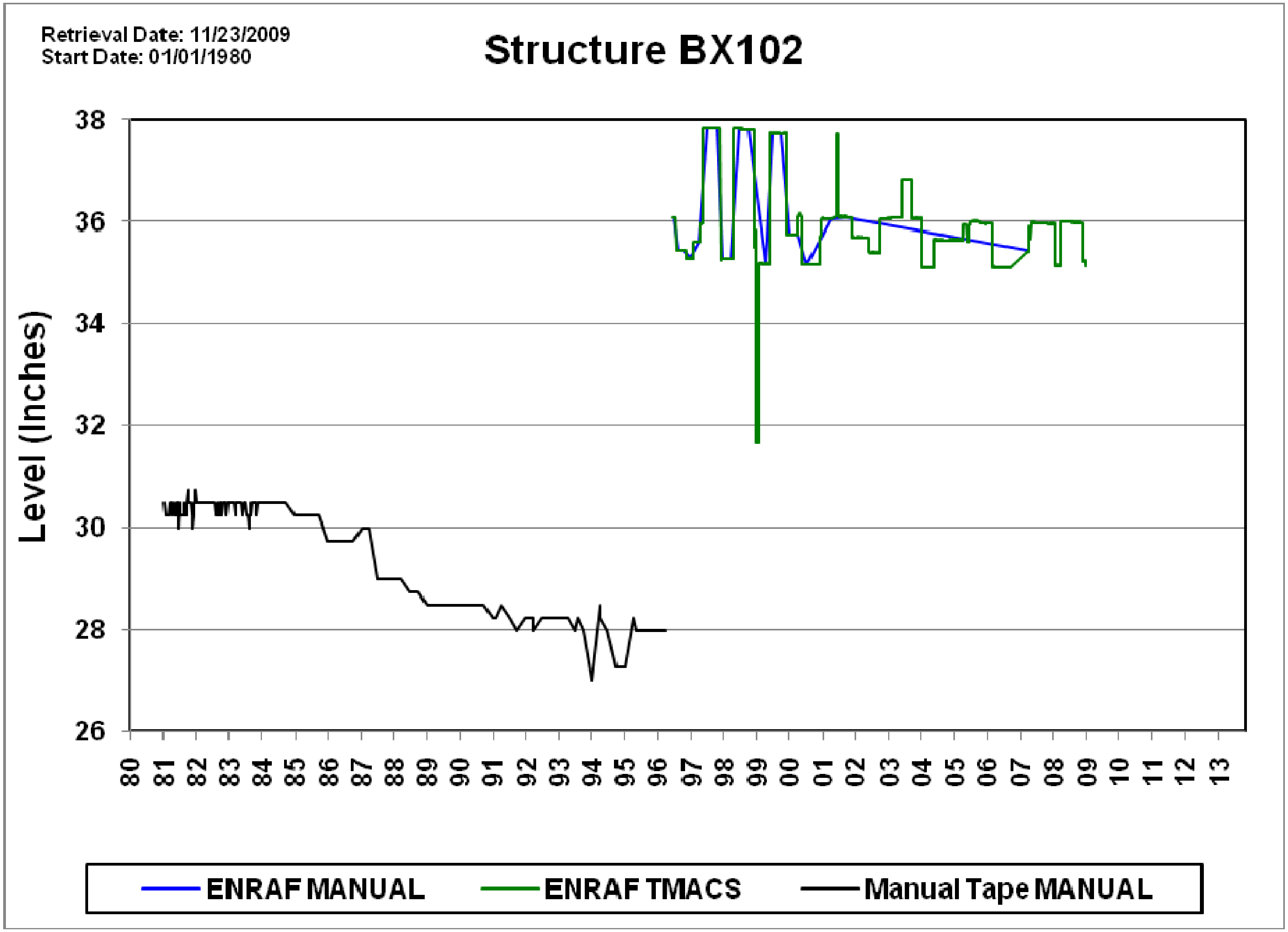
*Liquid-level changes for this tank will not be accumulated because the tank is being salt-well pumped, or the FIC and/or manual tape plummet is contacting solids and measurements are primarily to detect intrusions.

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

B2.5.2 Drywell Logging Data (GJ-HAN-89, *Hanford Tank Farms Vadose Zone: Tank Summary Data Report for Tank BX-102*)

Before 1970 the highest gamma activity observed in BX-Farm drywells was in drywell 61 (now 21-27-11). Off scale readings of > 1E6 cpm were measured using a scintillation probe through 1968. The readings decreased until October 1969 when they again went off scale, then rapidly decreased. Nineteen additional drywells were drilled around tanks BX-101 and BX-102 in 1970 in an effort to define the extent of radioactivity in the soil (ARH-1509, *200 Areas Operation Monthly Report September 1970*, p. G1-4, PR-REPORT-SEP70, *Monthly Status and Progress Report September 1970*, p. AV-5). Neutron probe moisture content measurements generally showed high peaks at the same level as high radioactivity peaks. The highest activity was

Figure B2-6. Liquid Level Measurements



observed in drywell 27 (now 21-02-04) at 1E8 pCi/g at 40 to 50 ft. This well is near tank BX-102, and like drywell 61 activity increases were attributed to leaks from the tank. Figure B2-7 shows 2000 SGLS logging results for drywells near tank BX-102 (GJ-HAN-19, *Vadose Zone Characterization Project at the Hanford Tank Farms Tank Summary Data Report for Tank BY-102*). Drywell 21-02-03, 21-02-04, 21-02-06, 21-27-01 and other 21-27 series drywells are discussed in the following sections.

Drywell 21-02-03

Drywell 21-02-03 is located approximately 5 ft from the east side of tank BX-102. It was installed in August 1970 to a depth of 100 ft using 6-in.-inside-diameter steel casing (GJ-HAN-89).

Historical gross gamma log data from 1975 to 1994 (Figure B2-8) show zones of anomalous activity at 39 ft and from 73 to 74 ft, 82 to 85 ft, and 88 to 92 ft. SD-WM-TI-356 records an anomalous peak at 84 ft as early as mid-1972. Activity in the zones from 73 to 92 ft decayed to activity levels that were not detectable by the tank farm gross gamma system by 1988. The activity zone at 39 ft is still evident in the latest gross gamma log.

In 1998 the man-made radionuclides ^{137}Cs, ^{60}Co, ^{125}Sb, and processed uranium were detected around this drywell using SGLS. Measurable ^{137}Cs contamination was detected from the ground surface to a depth of 18 ft, from 38 to 41 ft, and intermittently from 41 ft to the bottom of the drywell. The maximum ^{137}Cs concentration was 4 pCi/g at a depth of 39 ft. Cobalt-60 concentrations just above the maximum detectable limit were measured between 93 and 95 ft. Low ^{125}Sb activity was detected from 83 to 84 ft with a maximum concentration of ~2 pCi/g. Processed uranium was measured at several intervals between the depths of 73.5 and 99 ft (Figure B2-7).

Drywell 21-02-04

Drywell 21-02-04 is located approximately 4 ft from the southeast side of tank BX-102. It was constructed in July 1970 to a depth of 255 ft using 6-in. steel casing and was completed at the top of groundwater. In 1976, this drywell was perforated from a depth of 236 to 90 ft and from 20 ft to the ground surface because of concerns contamination in the groundwater was due to this drywell. A packer was set at a depth of 240 ft and a 4-in. steel casing was installed to the same depth. Grout was added from the surface to the depth of the packer. According to the driller's log, anomalous activity (apparently measured with a hand-held detector) was detected between 198 and 254 ft (GJ-HAN-89).

Drilling samples were collected every 5 to 10 ft from the ground surface to about 105 ft, every 1 ft from 105 to 122 ft, and every 5 to 10 ft from 122 ft to the bottom of the drywell (255 ft); Figure B2-9 shows the ^{137}Cs concentration data from lab analysis of the samples acquired during construction of this drywell (ARH-2035). The drilling samples are consistent with historical gross gamma log data from 1975 to 1994 (Figure B2-10) showing high gamma activity between 35 and 70 ft bgs. Spectral gamma logging system logs were obtained in 1997 and high rate logs in 2000 to a depth of 231 ft. Cesium-137 contamination was measured continuously from the ground surface to groundwater with a peak of ~1.E5 pCi/g from 5 to 12 ft bgs and > 1E7 pCi/g from 32 to 65 ft bgs (Figure B1-7). Uranium appears to be masked by high activity ^{137}Cs in this drywell.

Figure B2-7. Spectral Gamma Logging System/High Rate Logging System Data (3 sheets)

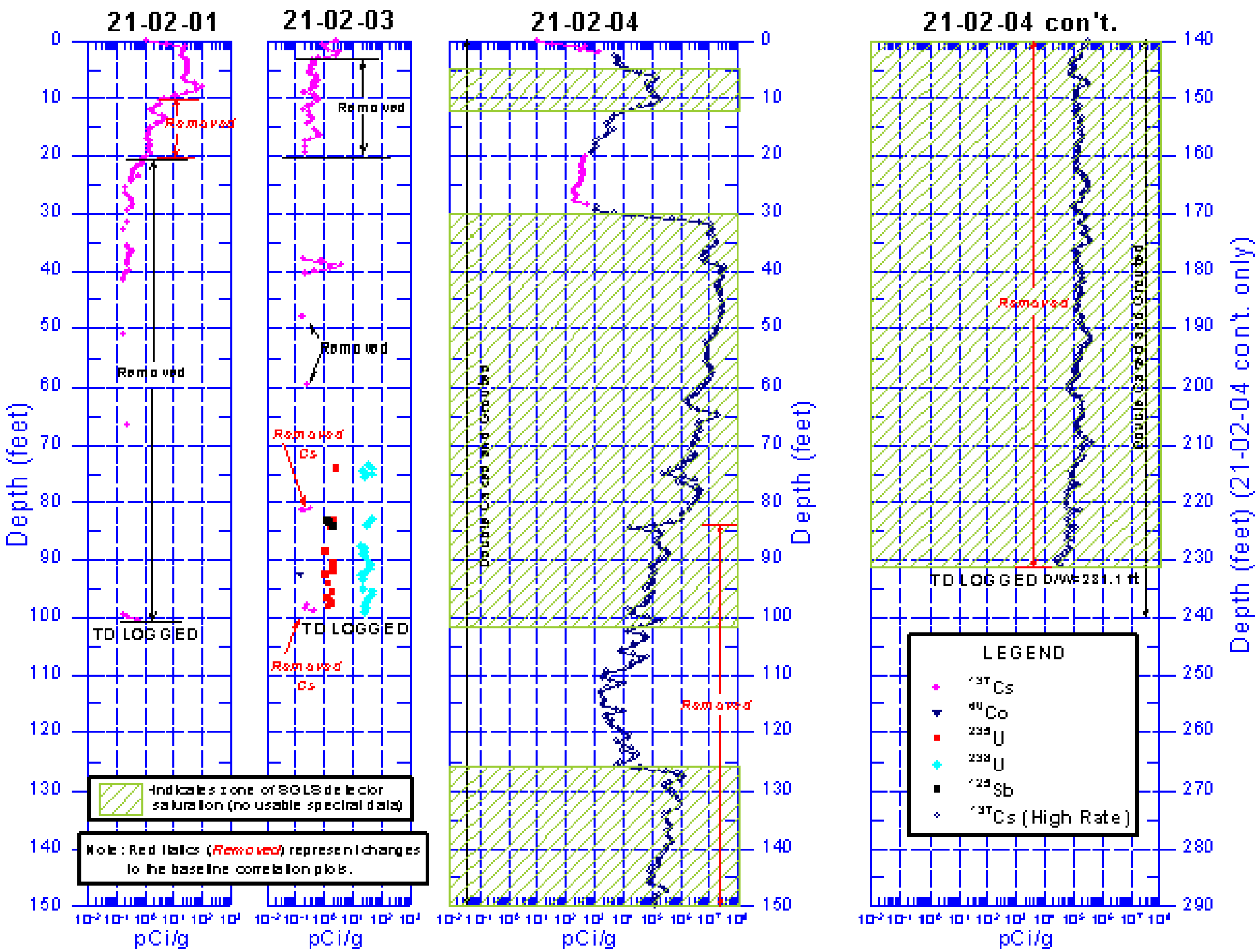


Figure B2-7. Spectral Gamma Logging System/High Rate Logging System Data (3 sheets)

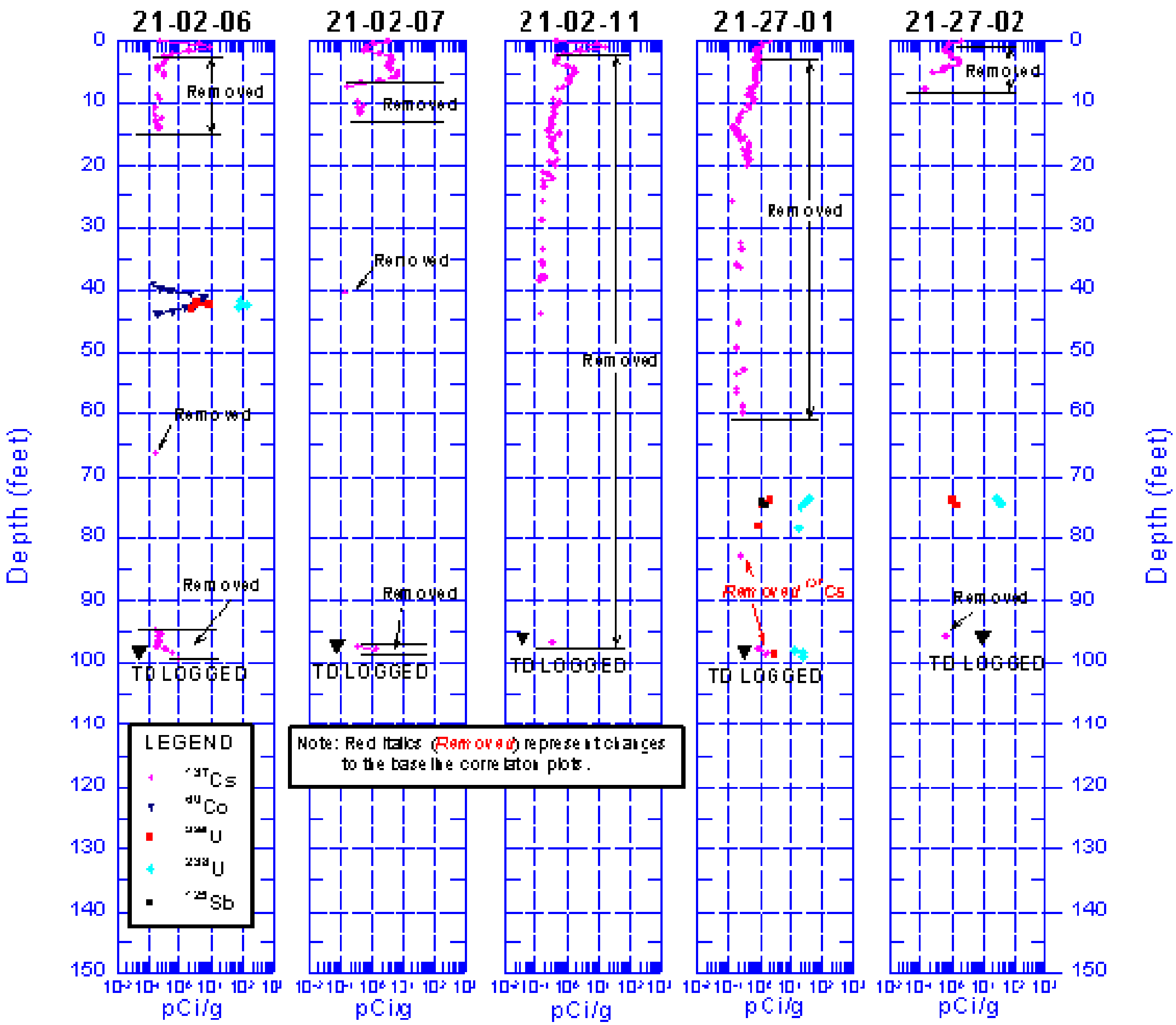
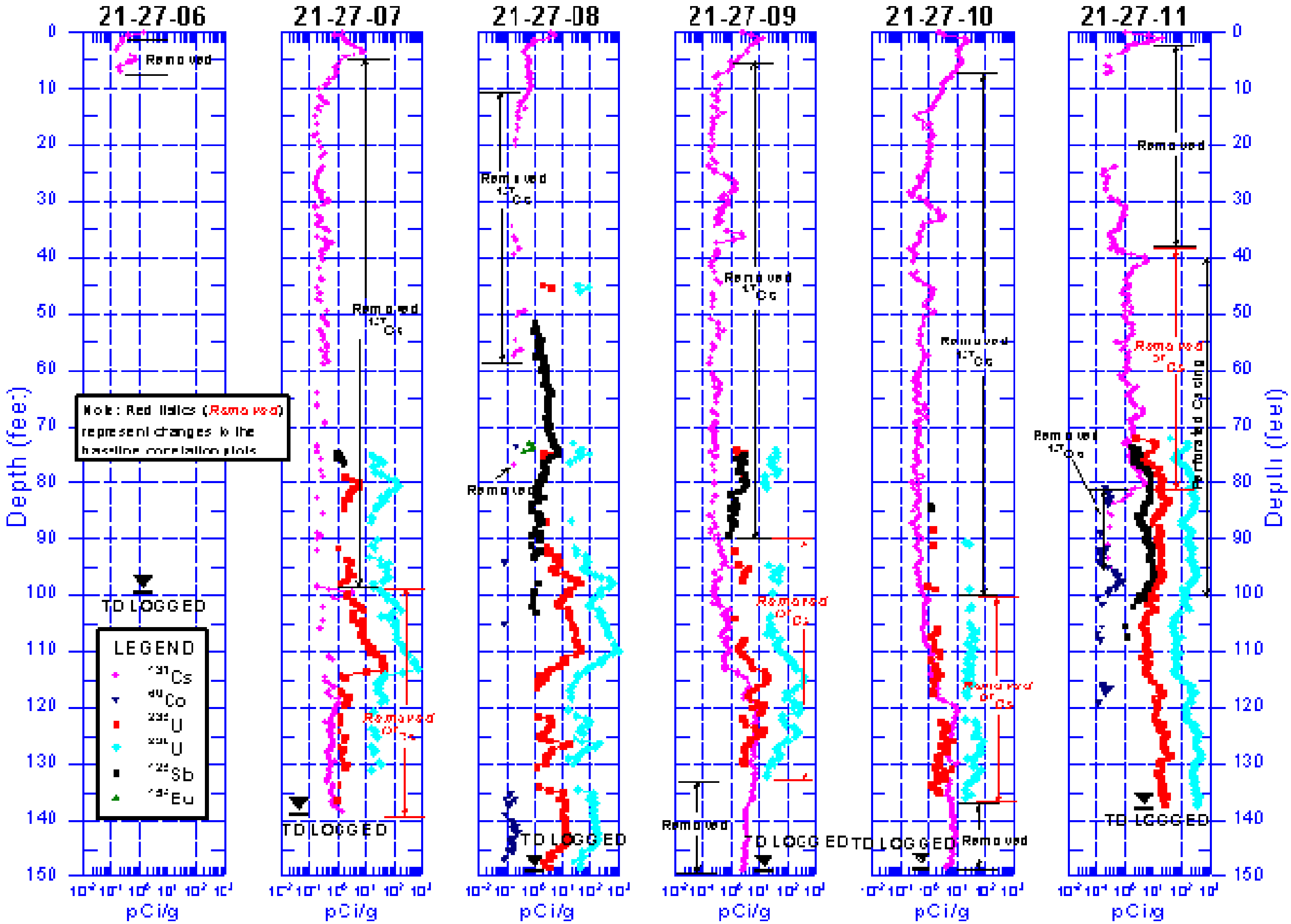


Figure B2-7. Spectral Gamma Logging System/High Rate Logging System Data (3 sheets)



Reference: GJO-98-40-TARA/GJ-HAN-19, *Hanford Tank Farms Vadose Zone: Addendum to the BX Tank Farm Report.*

Figure B2-8. Drywell 21-02-03 Total Gamma Measurements (1975 to 1995)

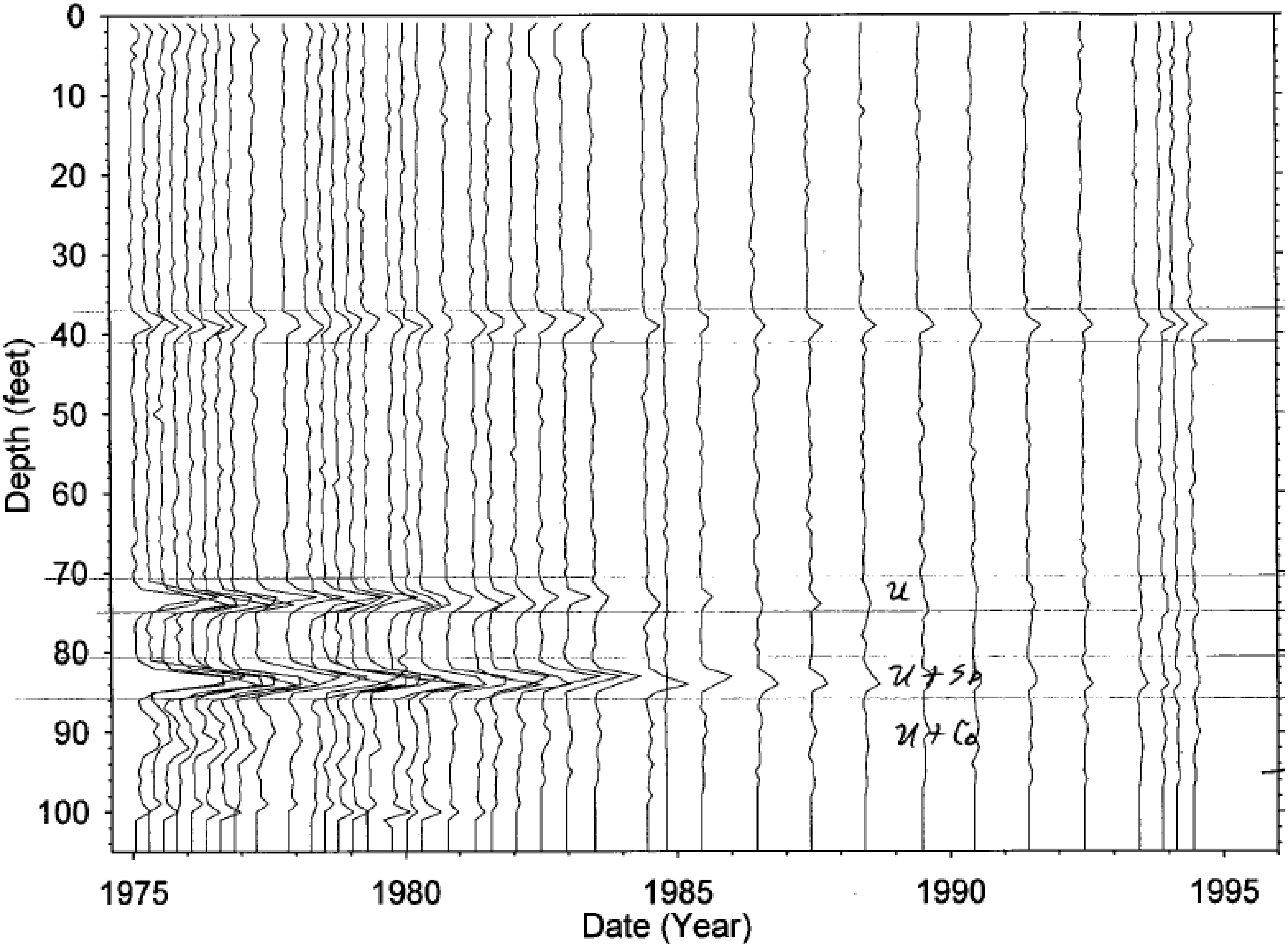
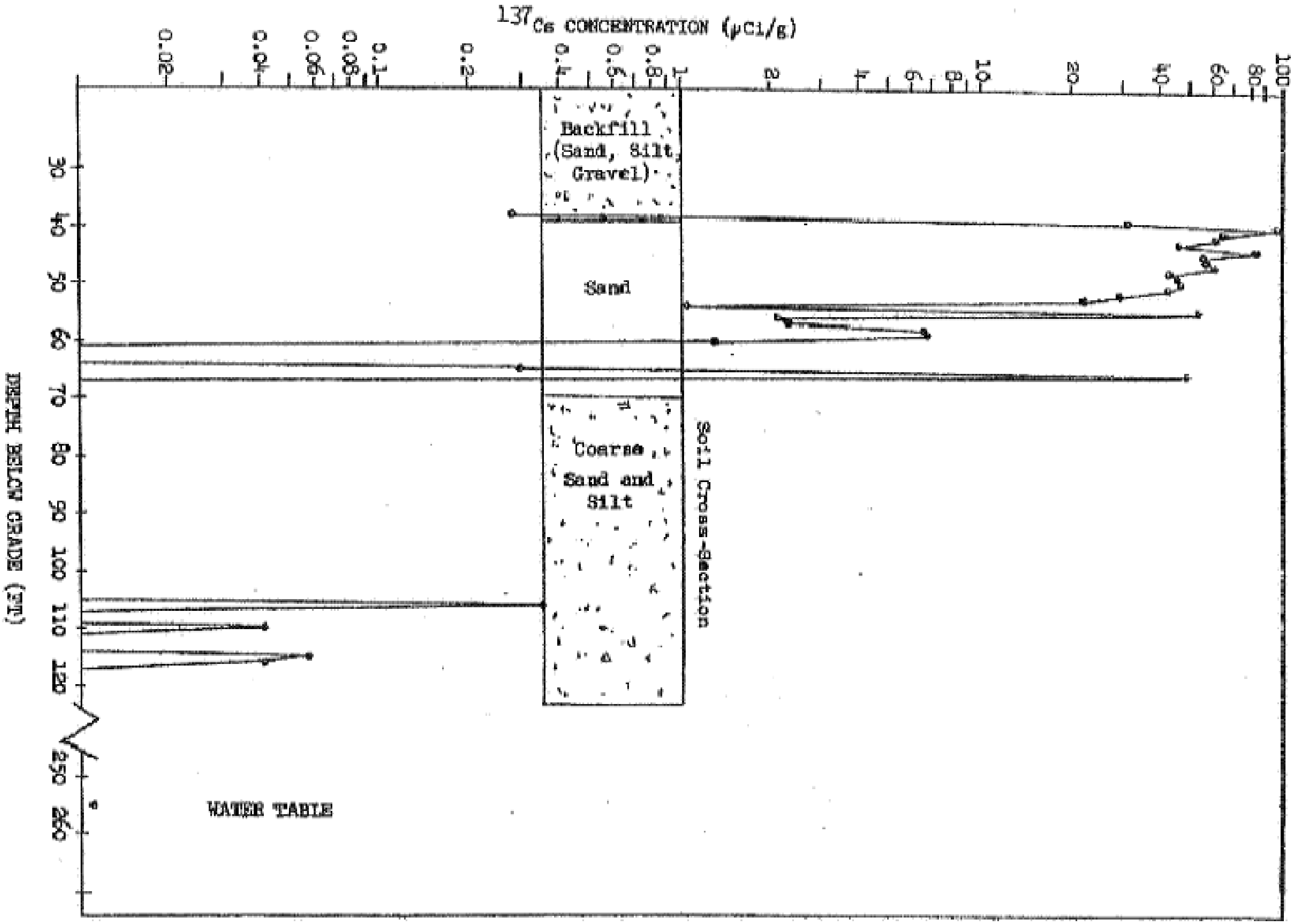
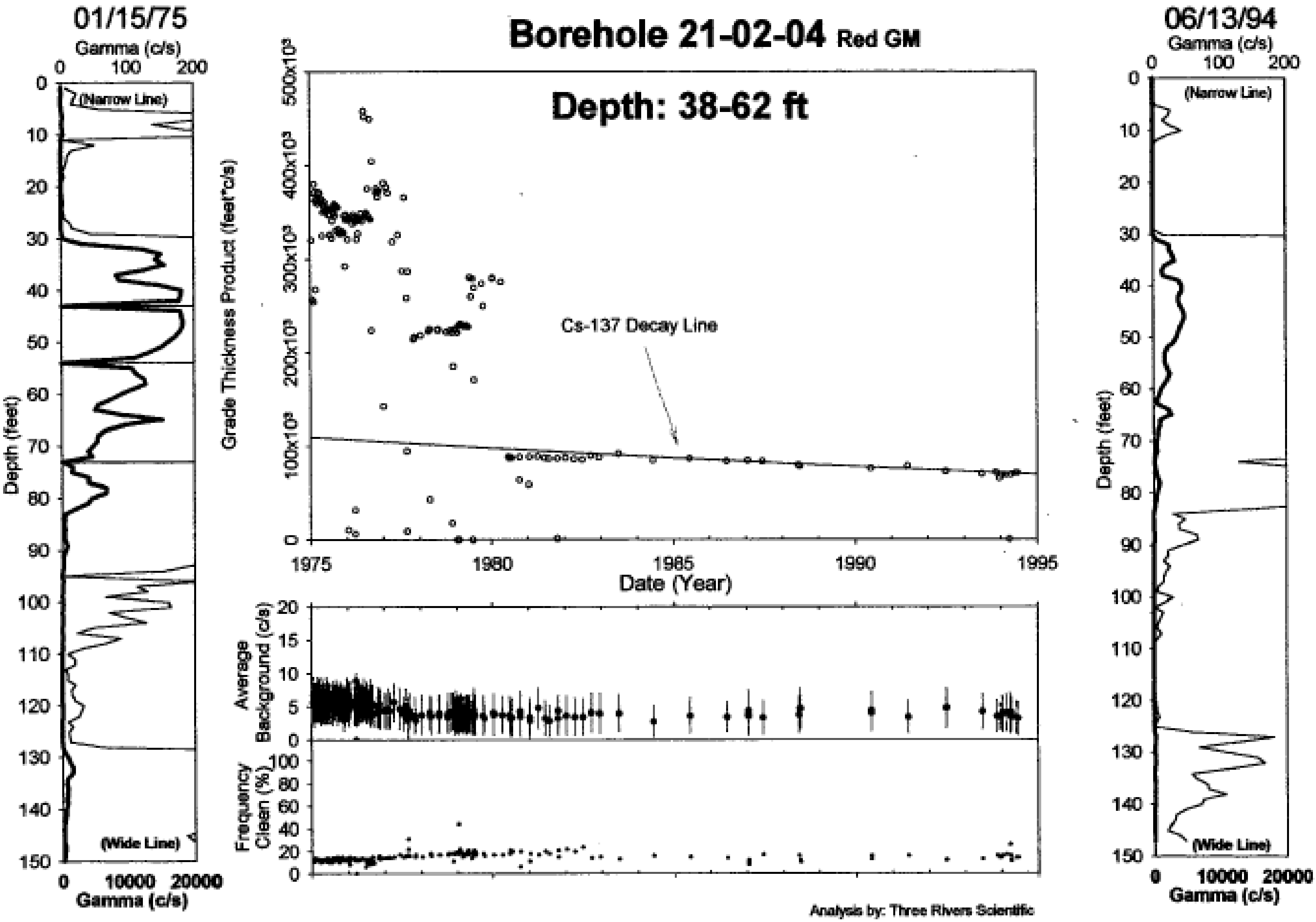


Figure B2-9. Drywell 21-02-04 Soil Sample Results



Reference: ARH-2035, *Investigation and Evaluation of 102-BX Tank Leak*.

Figure B2-10. Total Gamma Results (1975 to 1994)



Drywell 21-02-06
Drywell 21-02-06 is located approximately 10 ft from the south side of tank BX-102. This drywell was completed in July 1970 to a depth of 100 ft using 6-in. casing. A starter casing of unknown dimensions was installed to a depth of ~12 ft; it is unknown whether the starter casing was removed.

Historical gross gamma log data from 1975 to 1994 (Figure B2-11) indicate gamma activity was present in 1975 and decreased from about 3,000 cps in 1975 to about 150 cps in 1994. The man-made radionuclides detected around this drywell in 1998 using SGLS were ^{137}Cs, ^{60}Co, and processed uranium. Measurable ^{137}Cs concentrations were detected almost continuously from the ground surface to about 5.5 ft and intermittently from 6 ft to the bottom of the logged interval (99.5 ft). The maximum ^{137}Cs concentration was 10.2 pCi/g at 1 ft. Cobalt-60 contamination was measured continuously from 39 to 44 ft with a maximum concentration of about 7 pCi/g at 41 ft. Processed uranium was measured from 42 to 43 ft (Figure B2-7).

Drywell 21-27-01
Drywell 21-27-01 is located approximately 99 ft from the east-northeast side of tank BX-102. This drywell was completed in June 1970 to a depth of 100 ft using 6-in. casing.

Historical gross gamma log data from 1975 to 1994 (Figure B2-12) indicate gamma activity was present in 1975. SD-WM-TI-356 shows that the activity decreased from about 1,300 cps in 1975 to less than 100 cps in 1986. The activity was less than 50 cps by 1995. The activity decreased following a ^{125}Sb and $^{235/238}$U decay curve (HNF-3531).

The man-made radionuclides ^{137}Cs, ^{125}Sb, and processed uranium were detected around this drywell in 1998 SGLS measurements. Measurable ^{137}Cs contamination was detected from the ground surface to a depth of 20 ft and intermittently to the bottom of the drywell. The maximum ^{137}Cs concentration was 2.5 pCi/g at the ground surface. The presence of ^{125}Sb was detected just above the maximum detectable limit from 74 to 74.5 ft. Processed uranium was detected intermittently from 73.5 to 99 ft.

Figure B2-13 through B2-17 show historical gamma results for 5 additional 21-27 series drywells that showed similar trends in gamma activity and indicate the extent of the distribution of uranium assumed to be caused by the 1951 tank BX-102 MW overflow. The activity decreased following a ^{125}Sb and $^{235/238}$U decay curve (HNF-3531).

B2.5.3 Direct Push Results Near Tanks 241-BX-101 and 241-BX-102

Direct push holes were logged in 2003 to further investigate the extent of contamination near tanks BX-101 and BX-102 (RPP-34623). Figure B2-18 and Table B2-3 show the location of direct push holes and summary of results.

Figure B2-11. Total Gamma Results (1975 to 1994)

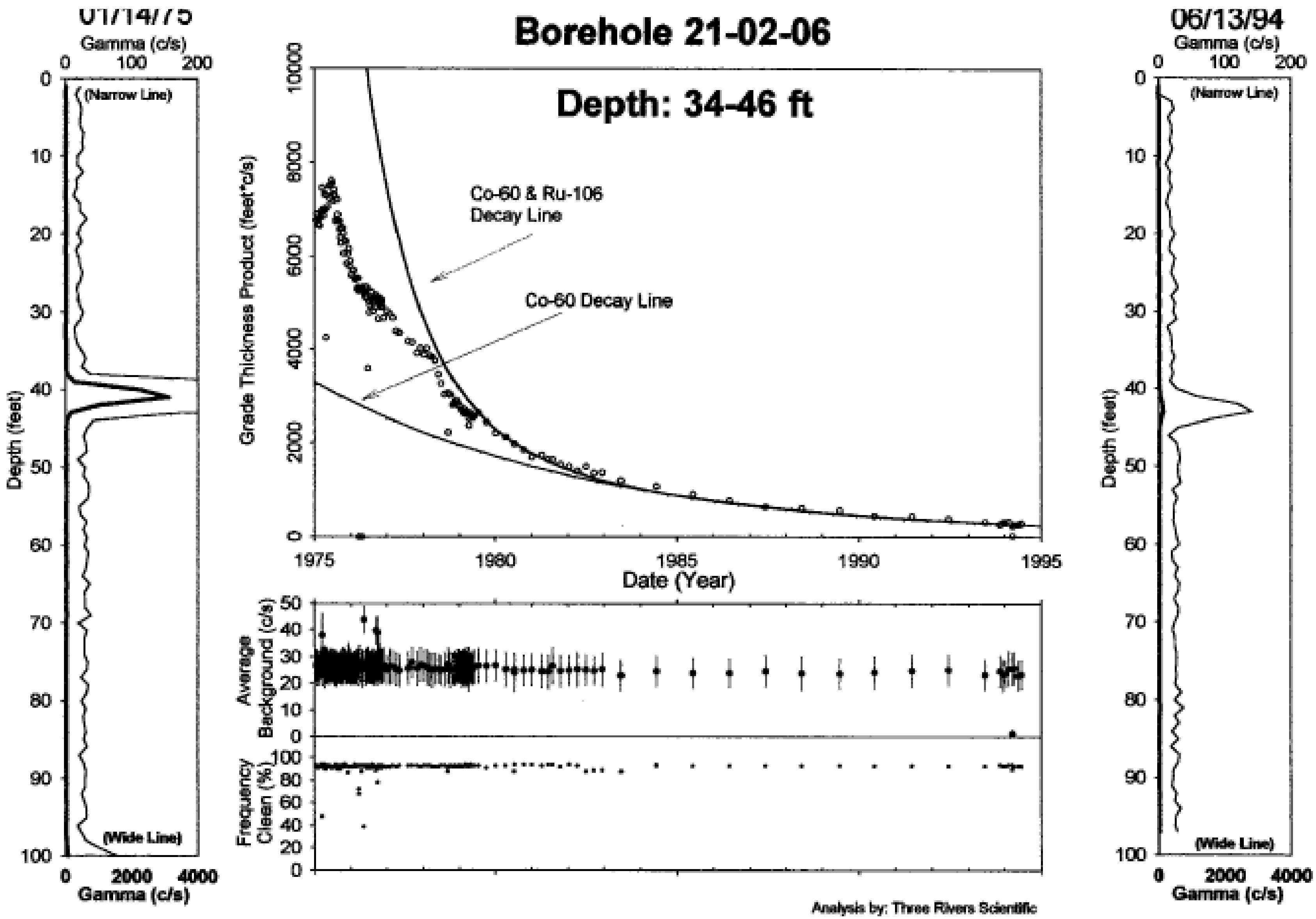


Figure B2-12. Drywell 21-27-01 Total Gamma Results (1975 to 1995)

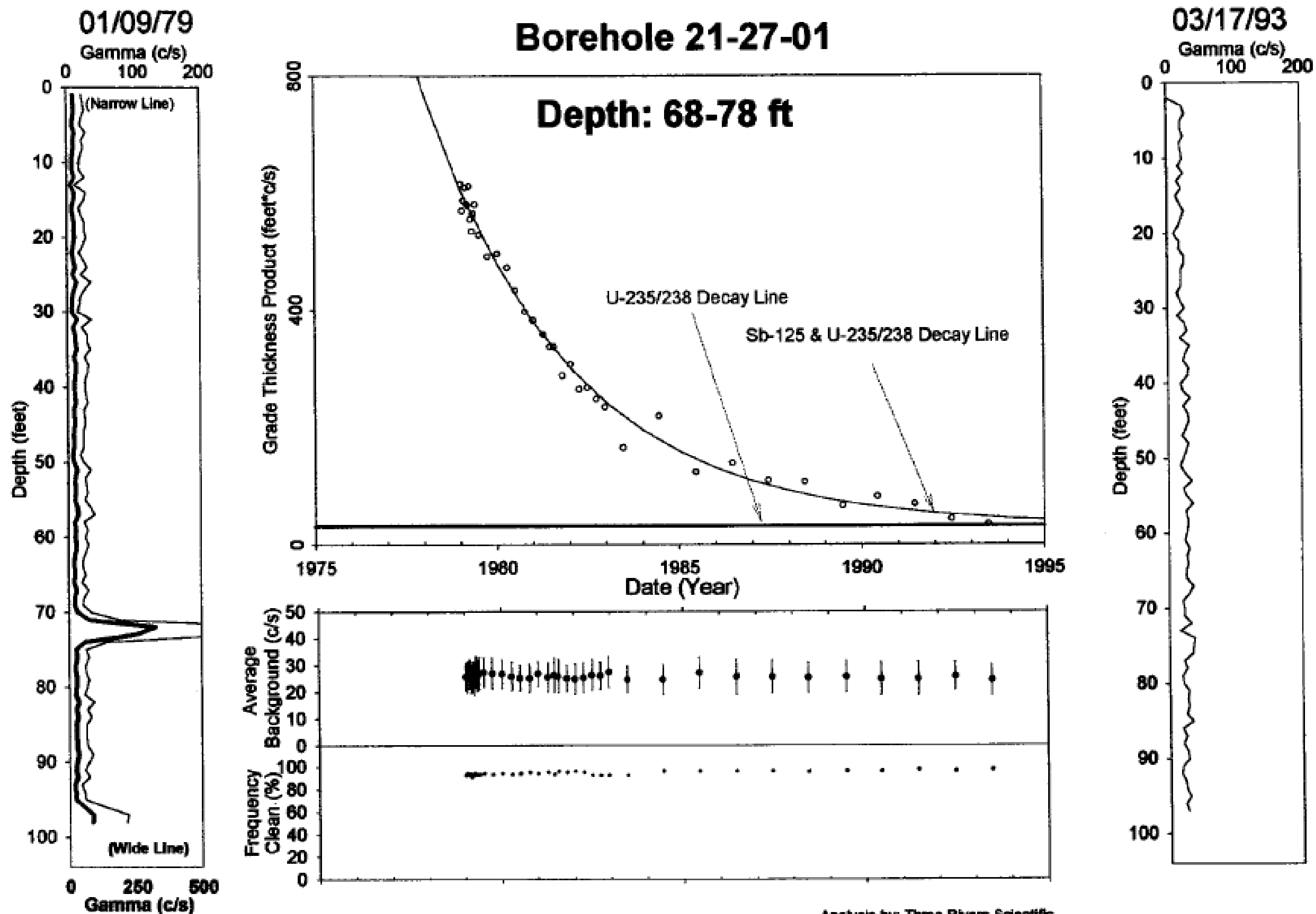


Figure B2-13. Drywell 21-27-07 Total Gamma Results (1975 to 1995)

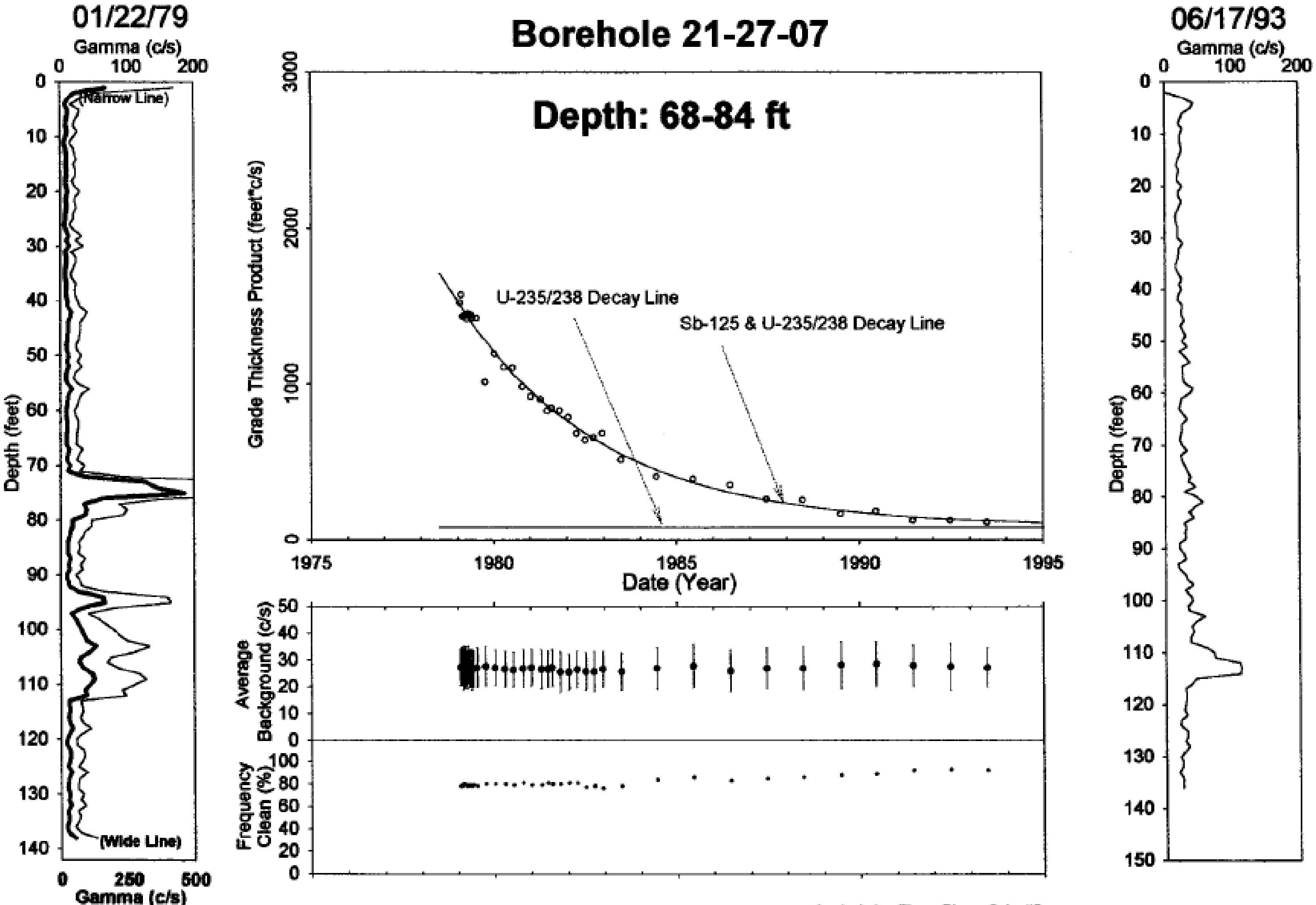


Figure B2-14. Drywell 21-27-08 Total Gamma Results (1975 to 1995)

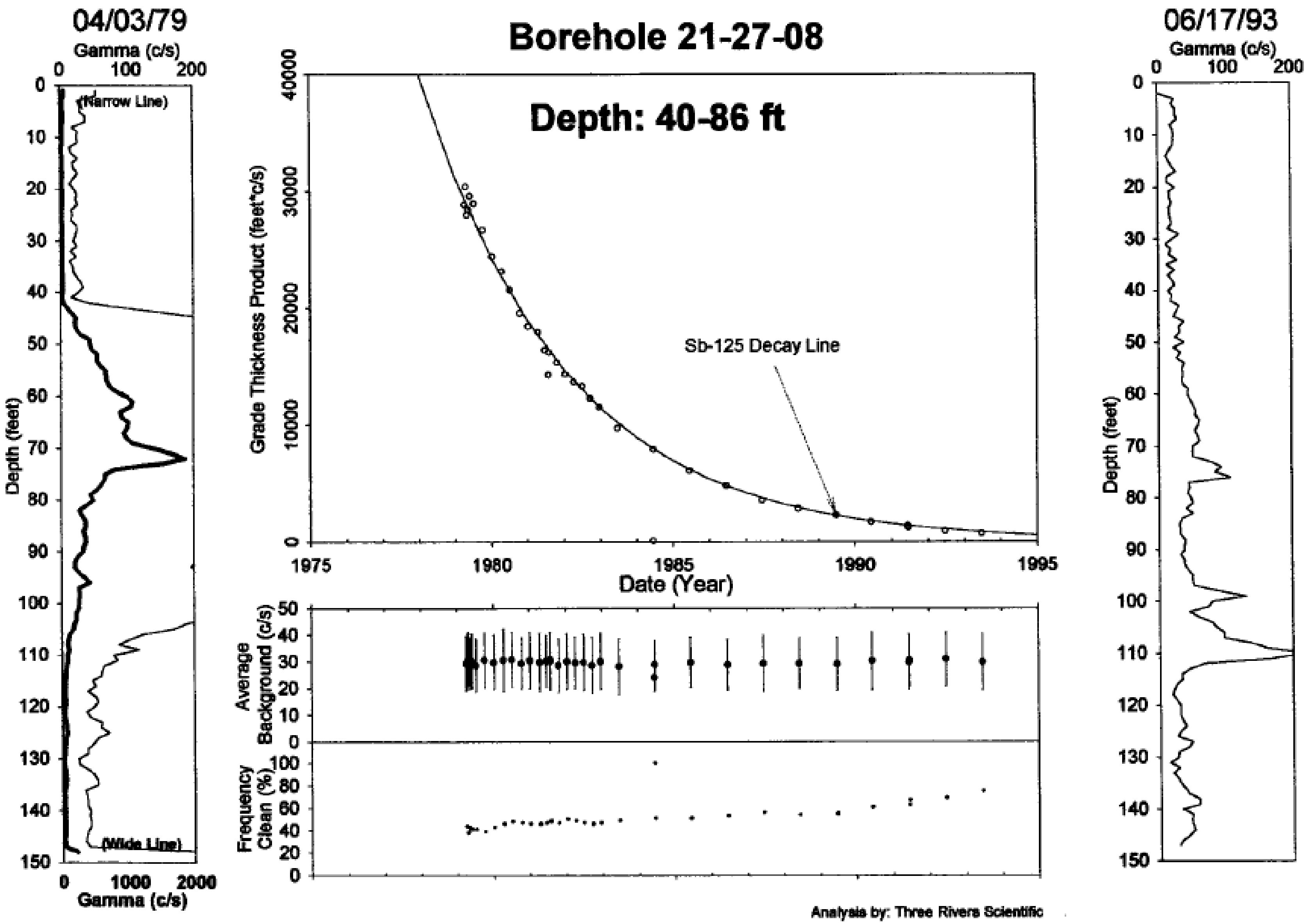


Figure B2-15. Drywell 21-27-09 Total Gamma Results (1975 to 1995)

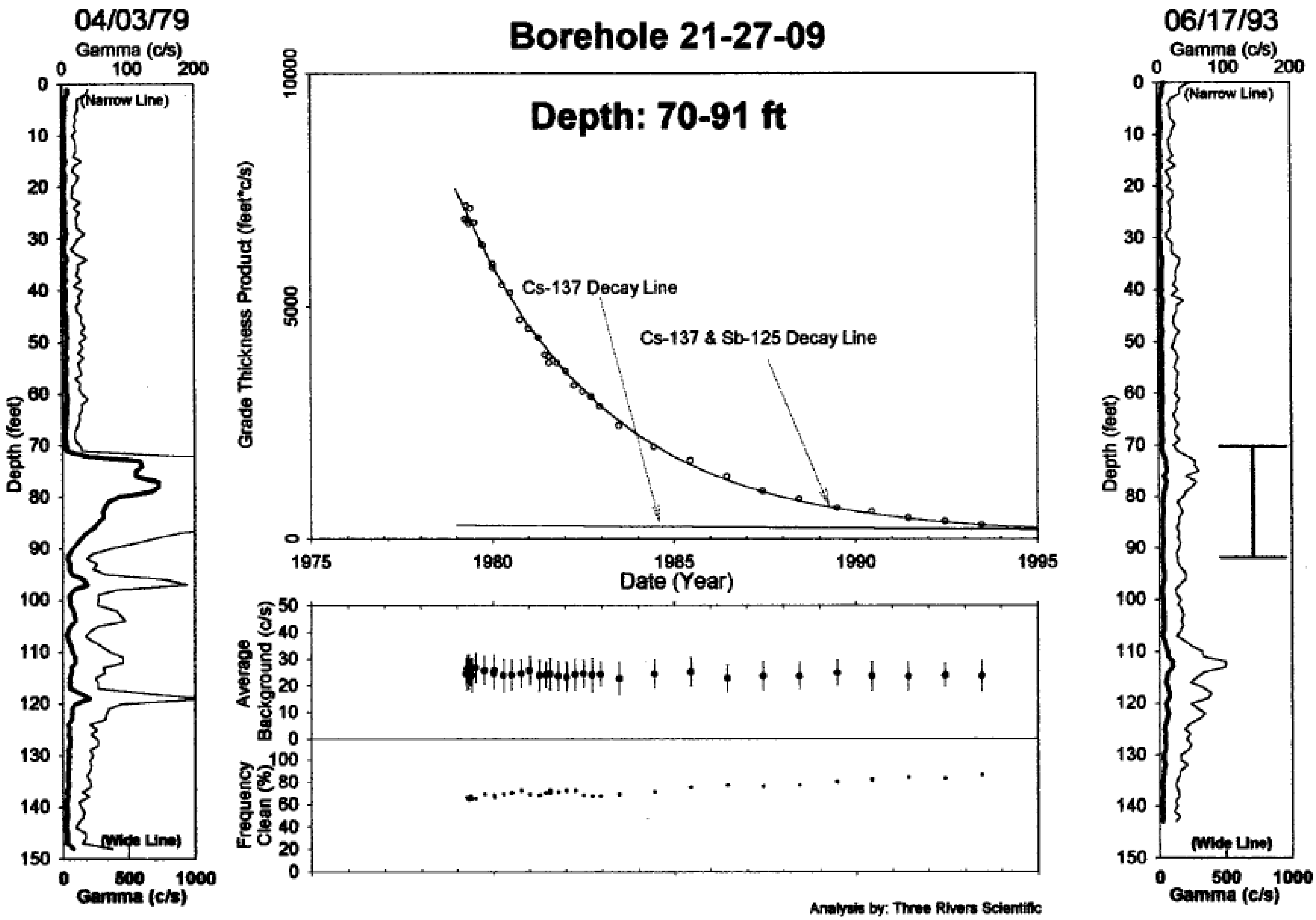


Figure B2-16. Drywell 21-27-10 Total Gamma Results (1975 to 1995)

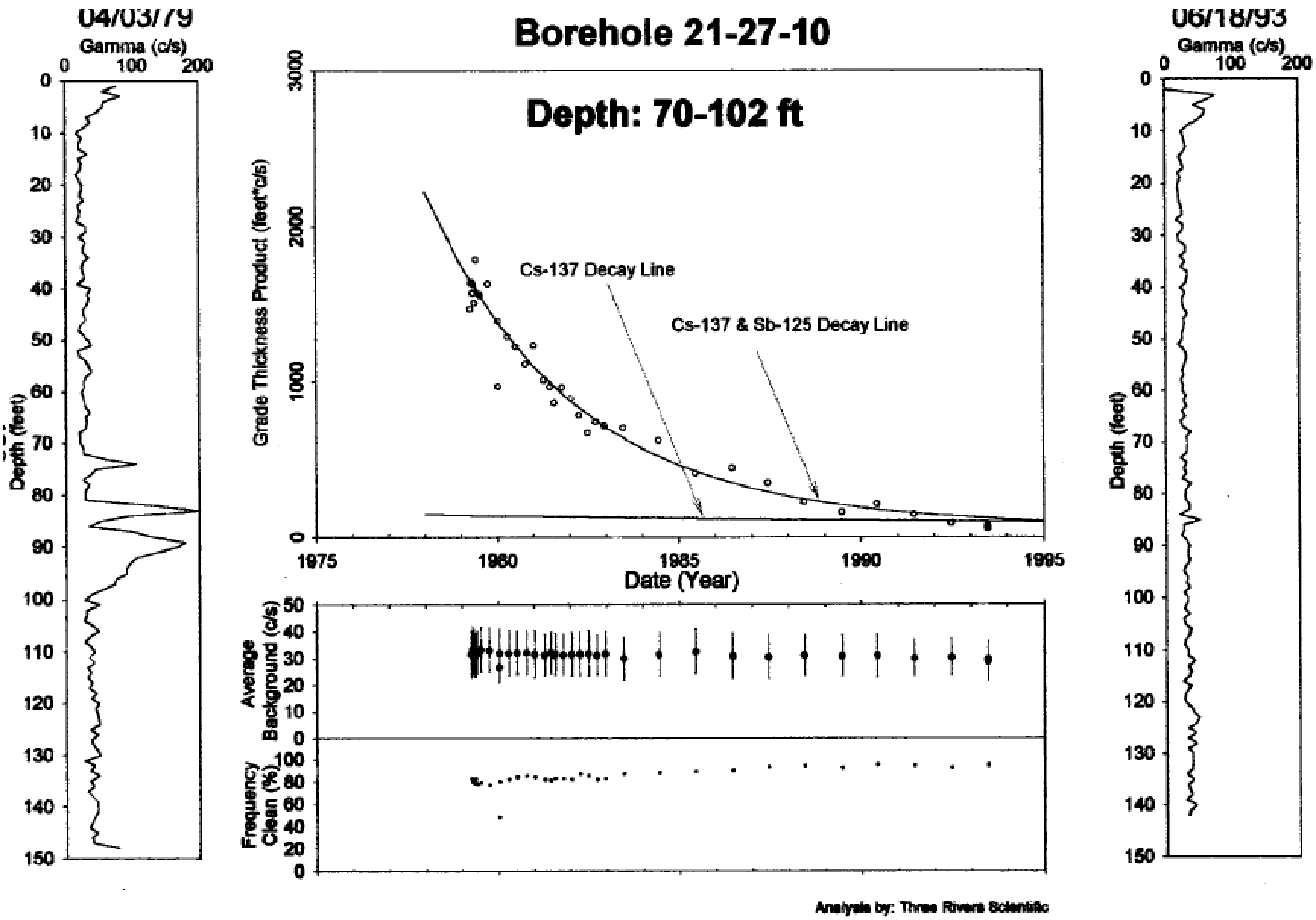


Figure B2-17. Drywell 21-27-11 Total Gamma Results (1975 to 1995)

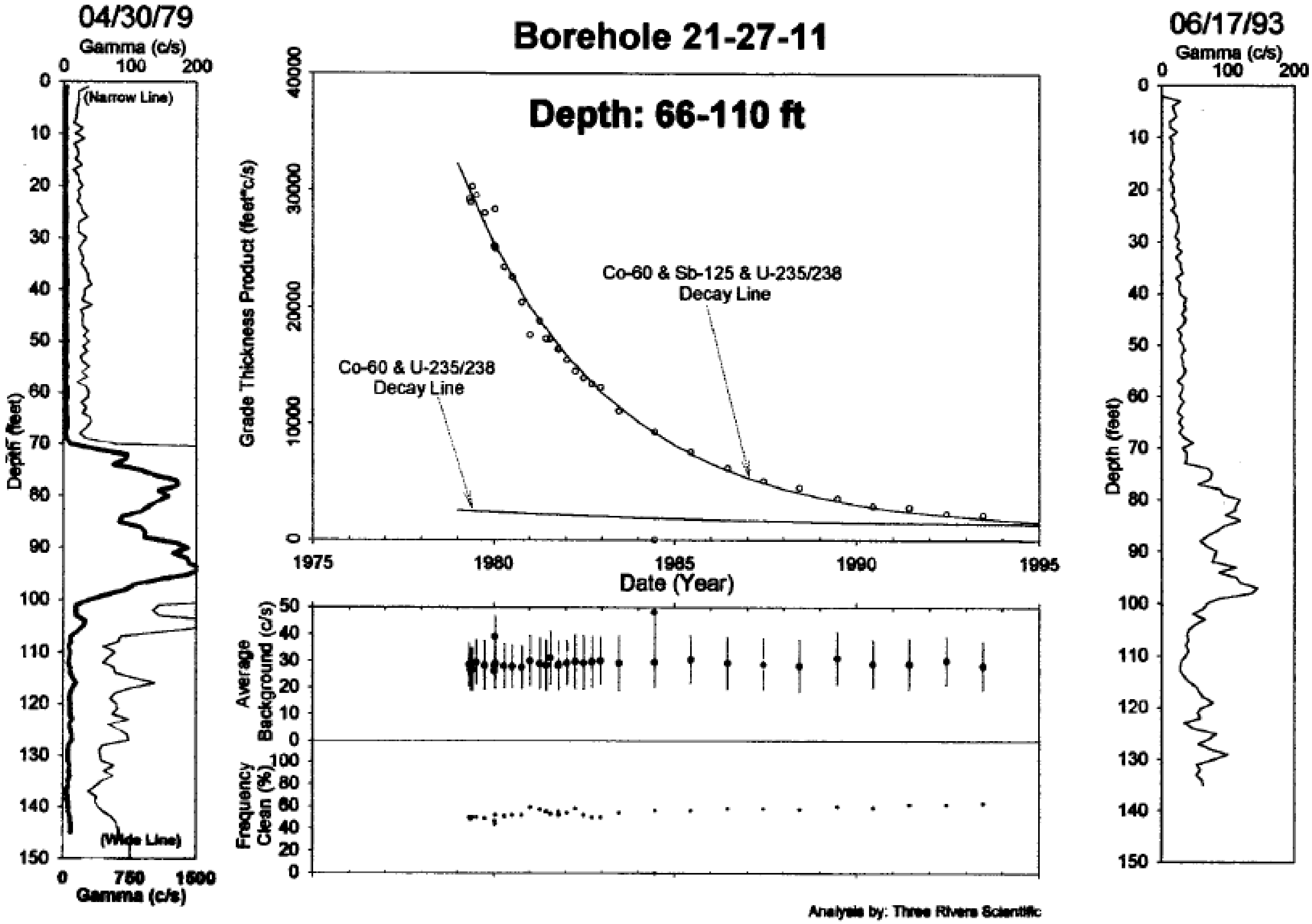
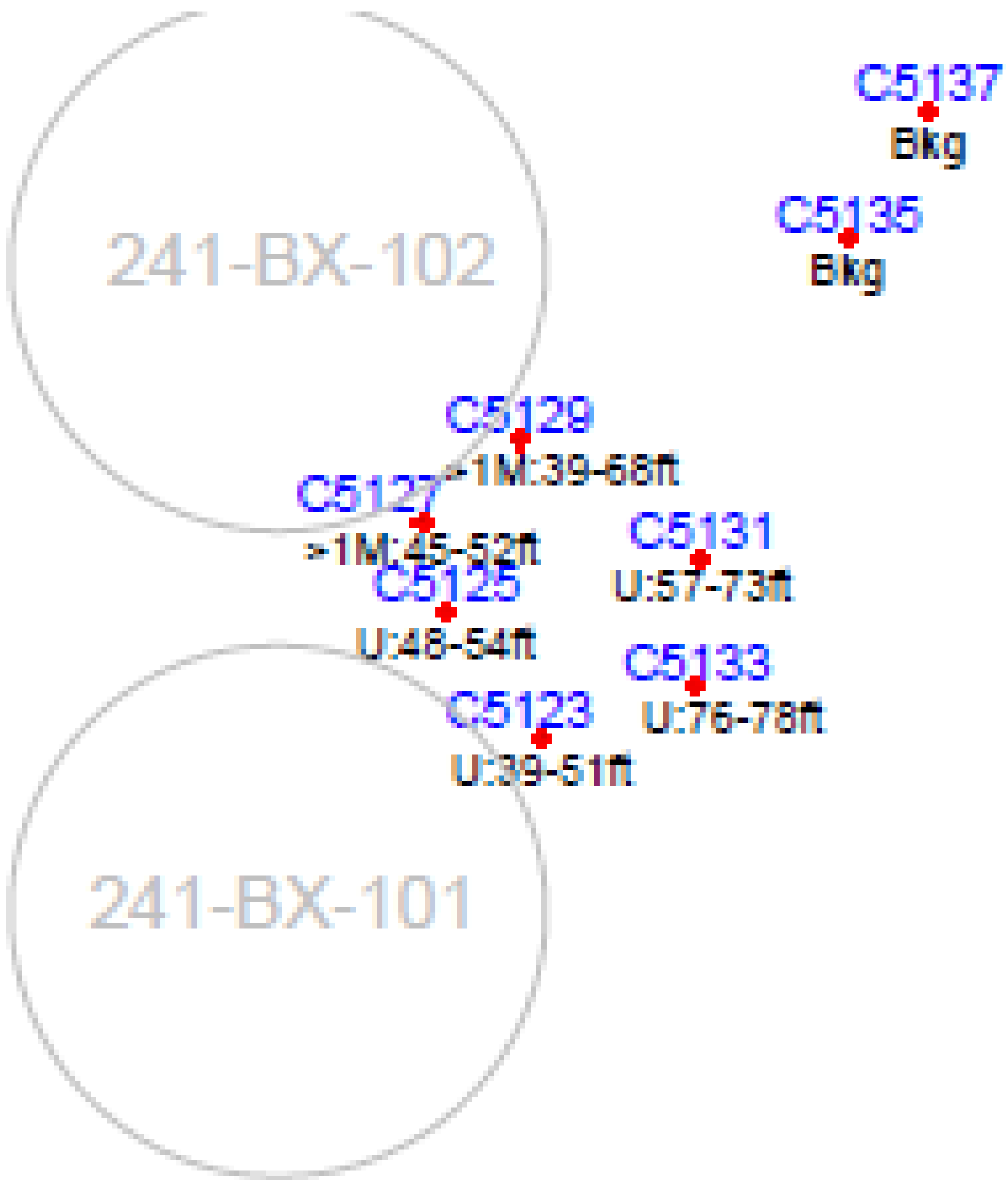


Figure B2-18. 2003 Direct Push Holes



B2.5.4 Drywell 299-E33-45

Well 299-E33-45 was installed and samples collected between November 13, 2000 and January 25, 2001. This drywell was installed to a depth of 260 ft bgs and is located ~70 ft from the edge of tank 241-BX-102 at about the 4 o'clock position (Figure B2-19). A perched water zone was encountered at a depth of 227 ft within a silty-to-clayey silt zone. Groundwater was reached at a depth of 255 ft. Figure B2-20 shows gamma and neutron logging and sample moisture results (RPP-7921, *BX-102 Borehole Completion Report*) and Figures B2-21 and B2-22 show analytical results for samples collected from the drywell (PNNL-14083, *Characterization of Vadose Zone Sediment: Borehole 299-E33-45 Near BX-102 in the B-BX-BY Waste Management Area*). Logging results show peak total gamma activity between 130 and 150 ft bgs and moisture spikes at 72, 120, 168 and 220 to 240 ft bgs.

Table B2-3. Summary of 2003 Direct Push Probe Hole Results

Probe Hole	Gross Gamma	Spectral Gamma	Green GM	Red GM	Hole Depth	Depth Max Activity	Max Cs-137 (pCi/g)	Comment
BX-02-04	X		Green	Red	80	31-72 ft	>1,000,000	Red GM max dead-time 12%
C5117	X	Spectra	Green		80	15-16 ft	> 500,000	Spectra 19-26ft
C5119	X	Spectra	Green		81.5	9-36 ft	>1,000,000	Green GM Dead-time > 80% 10-14ft Spectra 50-52, 58-60ft
C5121	X				80.5	10-18 ft	>1,000,000	Green GM Dead-time > 80% 11-14ft
C5123	X	Spectra			80.5	39-51 ft	U-238 (1001 keV)	Spectra 37-54ft
C5125	X	Spectra			80.4	48-54 ft	U-238 (1001 keV)	Spectra 47-56ft
C5127	X	Spectra	Green		80	45-52 ft	>1,000,000	Green GM Dead-time > 80% 46-50 ft Spectra 27-36, 59-66, 78-80ft
C5129	X		Green	Red	80.5	39-68 ft	>1,000,000	Red GM max dead-time 21%
C5131	X	Spectra			80.5	57-64, 71-73 ft	U-238 (1001 keV)	Spectra 58-60, 63-64, 71-73ft
C5133	X	Spectra			80.5	76-78 ft	U-238 (1001 keV)	Spectra 74-79ft
C5135	X				80.5			Background
C5137	X				80.5			Background

Figure B2-19. Drywell 299-E33-45 Location

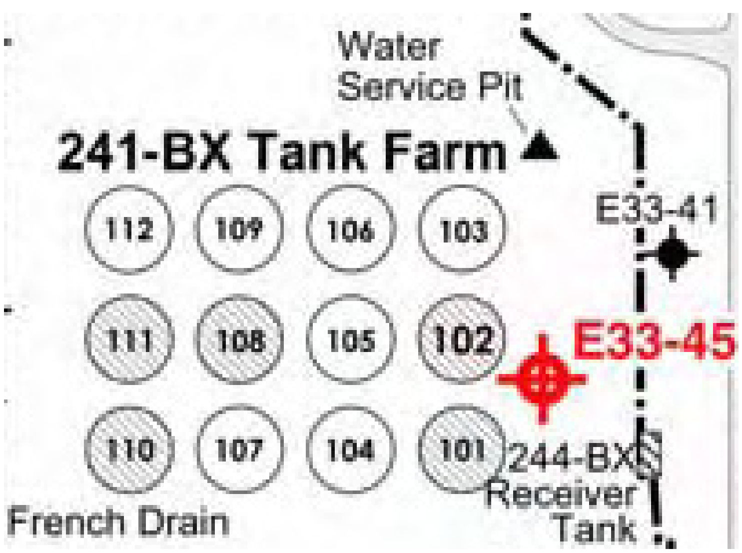
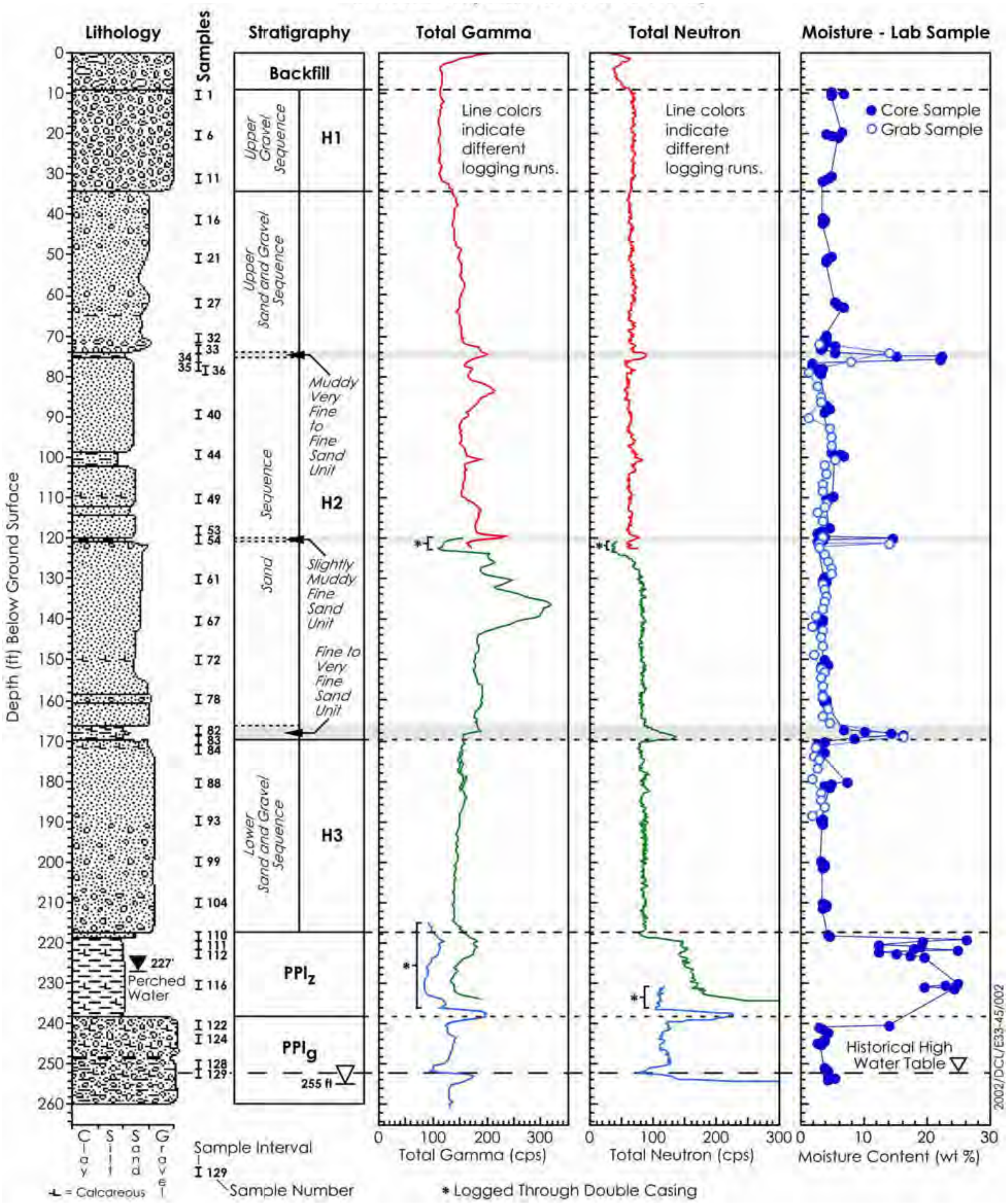


Figure B2-20. Drywell 299-E33-45 Logging and Lab Sample Moisture Results



References: PNNL-14083, *Characterization of Vadose Zone Sediment: Borehole 299-E33-45 Near BX-102 in the B-BX-BY Waste Management Area.*
RPP-7921, *BX-102 Borehole Completion Report.*

Figure B2-21. Drywell 299-E33-45 pH and Electrical Conductivity Results

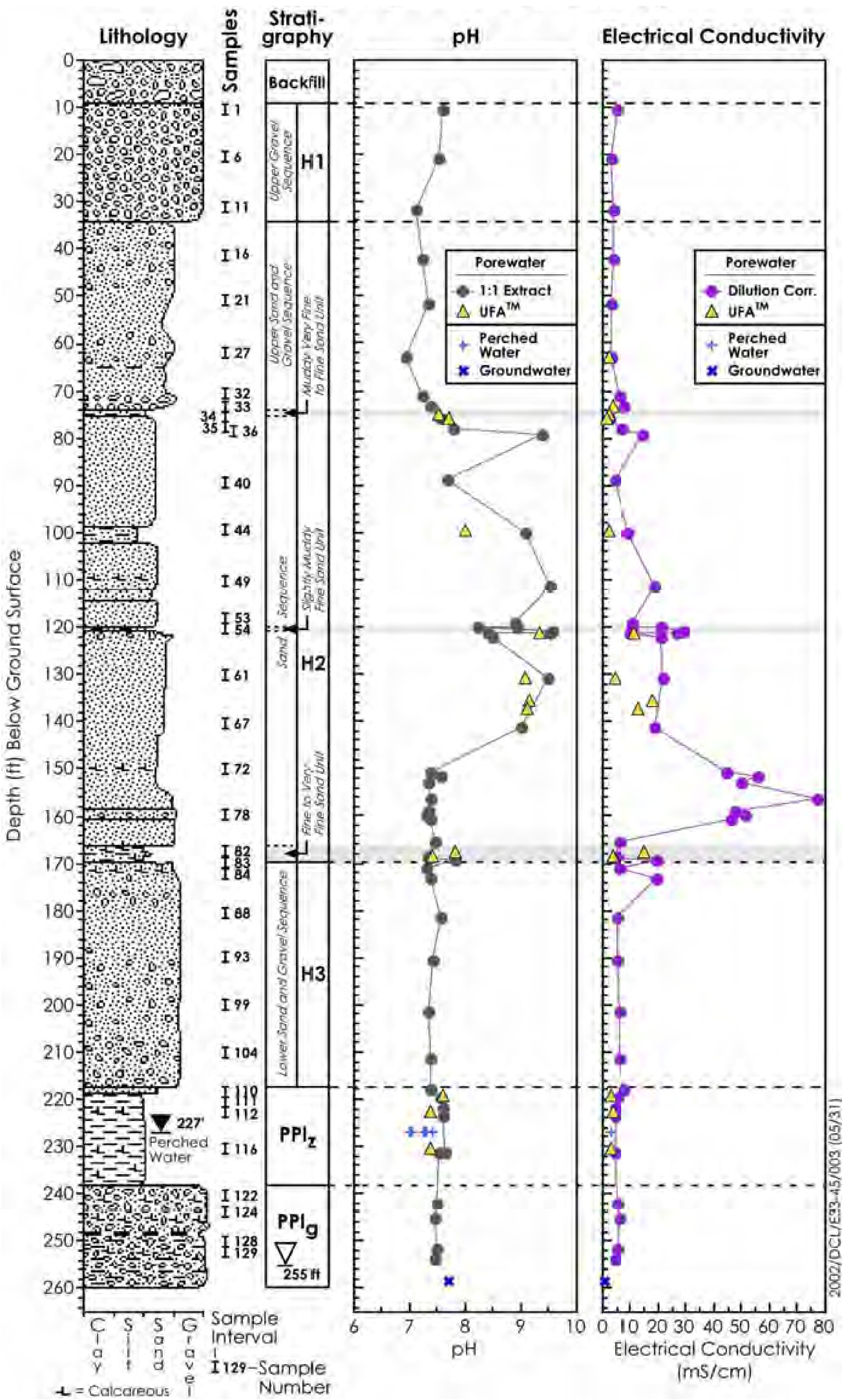
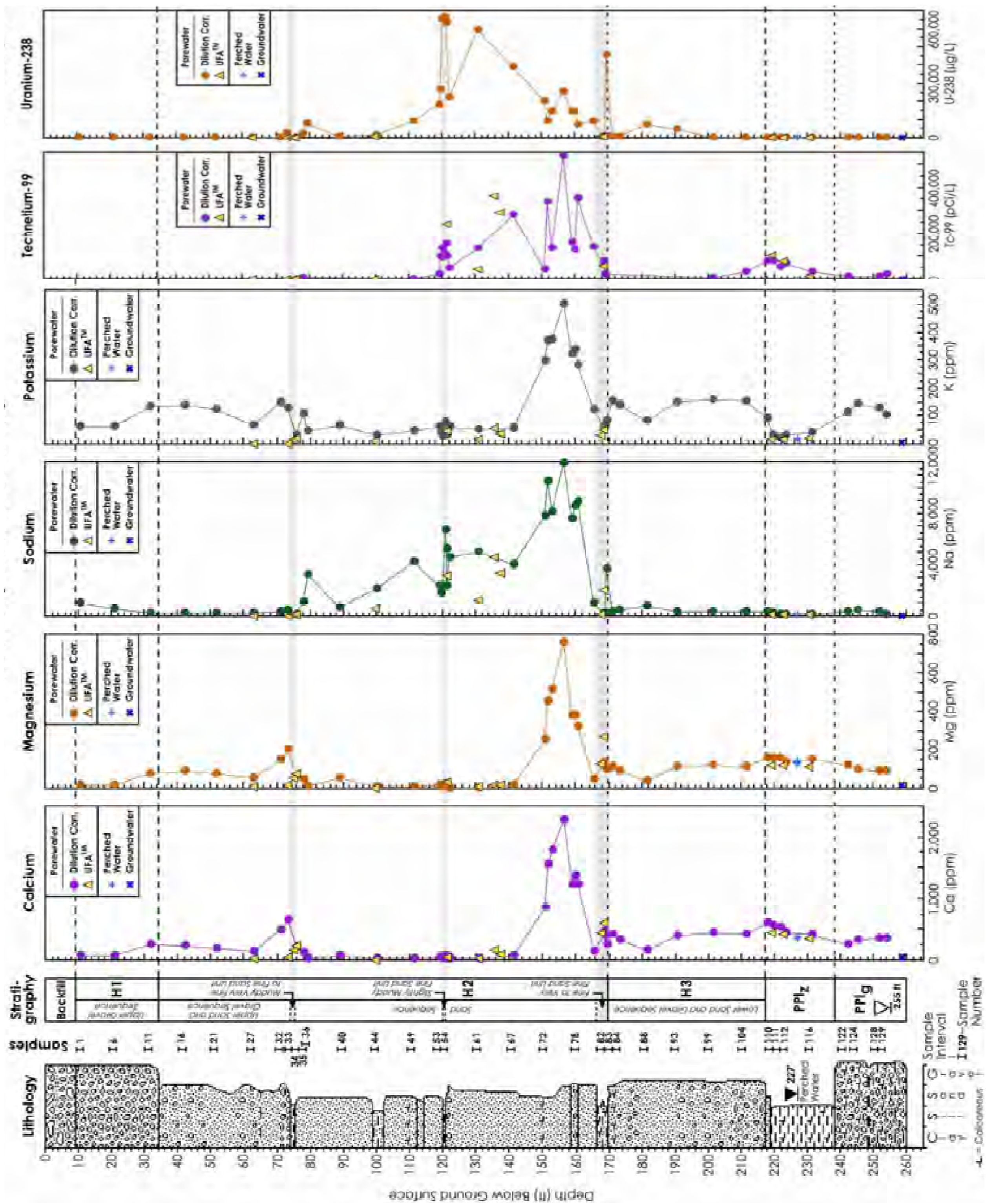


Figure B2-22. Drywell 299-E33-45 Cation, Technetium-99 and Uranium-238 Results



Elevated moisture content, pH, electrical conductivity, sodium, uranium and technetium-99 (^{99}Tc) were found in drywell 299-E33-45 vadose zone samples to a depth of 170 ft bgs. In general, the ratios of constituents found is consistent with an MW type and the contaminants are attributed to the 1951 MW loss from BX-102. The near horizontally bedded, northeasterly dipping sediment likely caused horizontal flow of the migrating contaminants. At drywell 299-E33-45, there are several fine-grained lenses at 74, 120, and 167 ft bgs that could have caused horizontal spreading of fluids. The 21-ft thick Plio-Pleistocene fine-grained silt/clay unit is also a horizontal flow conduit, as evidenced by the perched water zone between 227 and 232 ft bgs.

Analytical samples show a two-lobed plume of elevated electrical conductivity. The shallower lobe, between 79 and 120 feet bgs appears to pond on top of the fine-grained paleosol at 120 ft bgs. A more concentrated lobe resides between 150 and 173 ft bgs with the most concentrated fluid between 150 and 160 ft bgs (within the Hanford H2 unit). This may be attributed to ponding on the fine-grained wet zone (167 to 170 ft bgs) at the bottom of the Hanford H2 unit.

Elevated cation concentrations were observed throughout the drywell from about 10 feet bgs to 255 ft bgs. The bulk of the water-extractable cations are bounded between two thin fine-grained lenses at 120 ft bgs and 167 to 170 ft bgs.

Elevated uranium-238 (^{238}U) concentrations appear at 73 ft bgs in the Hanford H2 unit sediment just above a one-ft thick lens at 74 ft bgs. From about 90 ft to ~111 ft bgs, little uranium was present in samples taken. Between 111 and 120 ft bgs, the uranium content in the sediment averages about 100 ppm. In the thin lens at 120 ft bgs, the uranium concentration is very high (i.e., up to 1,649 ppm). Below 120 ft bgs down to 145 ft bgs, the uranium content in the sediment is quite high (reaching values between 200 and 500 ppm). Between 145 and 167 ft bgs, in the lower portion of the H2 middle sand sequence, there are slightly elevated uranium concentrations (between 50 and 200 ppm). Within the fine-grained lens between 167 and 170 ft bgs, the uranium concentration increases again to values between 200 and 400 ppm. There was no elevated uranium in samples below 170 ft bgs.

Elevated concentrations of ^{99}Tc were found in the vadose zone samples between 120 and 167 ft bgs (within the middle sand sequence of H2). There appears to be a second less concentrated plume of ^{99}Tc between the H3 unit and the PPlz unit (220 to 235 ft bgs).

B2.5.5 Tank 241-BX-102 Leak Assessment

The February, 1951 monthly report (HW-20438-DEL, *Hanford Works Monthly Report for February 1951*, page 51), states that the failure of the tank 241-BY-103 cascade to continue filling with MW was traced back to tank BX-102, and that the loss was either attributable to a tank BX-102 leak or a plug in the cascade overflow line from tank BX-102 to tank BX-103. The level in tank BX-102 was raised above the level of the spare inlet lines (Table B2-4) in an attempt to dislodge the suspected plug in the overflow line using a higher liquid head. The February 1951 monthly report indicates that after a period of time, the level in tank BX-102 began to slowly decrease, but the level in tank BX-103 did not increase. The spare inlet lines on tank BX-102 are at about the 4 o'clock position and extend only a few inches away from the tank wall (Figure B2-2). They are sealed to the tank with asphalt and closed with a metal end cap.

Table B2-4. Level of Cascade Overflow lines and Spare Inlets (level above dish, 12-inch offset)

Location	Elev. above sea level (ft)	Depth bgs (ft)	Level (in)	Waste Vol (kgal)	Reference
Cascade BX-101 to BX-102 BX-102 to BX-103	 632.96 631.96	 23.4 23.4	 191.5 191.5	 539.1 539.1 (ht*2750+12500)	 H-2-1745
Cascade BX-101 to BX-102 BX-102 to BX-103	 633.12 632.12	 23.2 23.2	 193.44 193.44	 544.5 (ht*2.75+12.5)	 H-2-611
Cascade BX-102 from BX-101	 632.37 632.21	 22.96 23.12	 196.44 194.52	 552.7 547.4	 H-2-611 H-2-1745
spare inlet nozzle (C) BX-101 BX-102	 633.33 632.33	 23 23	 195.96 195.96	 551.4 551.4	 H-2-1745
BX-101 sluice pit bottom (drain line)	647.25	9.1	363.0		H-2-41803
BX-101 above dish BX-102 above dish (12 " above tank bottom)	617.0 616.0	39.33 39.33		12.5 12.5	H-2-1745
Ground Surface BX-101 BX-102	 656.33 655.33				H-2-41803

References:
H-2-611, *Piping & Concrete 241-BX*, Sheet 1, Rev. 18.
H-2-1745, *Tank Farm Riser & Nozzle Elev.*, Sheet 1, Rev. 6.
H-2-41803, *Piping – Cascade Sluice Pit Plan & Sections – 101 Cascade*, Sheet 1, Rev. 2.

The liquid level rise submerged the spare inlet lines, which allowed as much as 90,000 gal of metal waste to leak out of the tank into the soil (HW-28471, *Unconfined Underground Radioactive Waste and Contamination in the 200 Areas*, page 5). Drywell 61 (now 21-27-01) (BHI-01119, Hanford Site Atlas, Rev. 1, page 74), located about 100 ft northeast of tank BX-102 became grossly contaminated when this liquid seeped into it (HW-28471 page 5)[1].

During 1954 tank BX-102 was pumped to a minimum heel, and, except for a brief fill during 1956, continued to be held static at a minimum heel until mid-1962. It was then refilled at various times with PUREX CW and OWW, and B Plant IX Cell 23 Concentrator Bottoms waste

[1] Note: Both HW-28471 and ARH-2035 mistakenly identify the waste that leaked out of the spare inlet lines as "1' Cycle Waste." The February 1951 monthly report states that the cascade was flowing metal waste at the time the tank BX-102 overflow line became plugged (HW-20438-DEL, page 51). This is consistent with the ^{238}U content of the plume discussed in the draft document statement quoted above.

(e.g., ISO-226, *Chemical Processing Division Waste Status Summary January 1, 1966 Through March 31, 1966* states tank BX-102 contained 484 kgal coating removal waste and 59 kgal TBP Plant waste, with a sludge depth equivalent to 62 kgal) and remained so until May 1970 when the tank was again pumped to minimum heel and taken out of service (ARH-2035, page 5). Between November 1971 (PPD-485-DEL, *Monthly Status and Progress Report November 1971*, page AIV-17) and January 1972, 107 tons of diatomaceous earth were added to tank BX-102 to absorb the remaining free liquid (PPD-493-5-DEL, *Monthly Status and Progress Report May 1972*, page AIV-20). Between 1959 and 1963 the gamma radiation probe readings in Drywell 61 decreased from 100,000 cpm to 10,000 cpm. A change was made to a more sensitive probe and offscale readings > 1E+06 cpm were recorded through 1968. Beginning in 1969 the readings decreased until October, when they again increased to off-scale (Figure B2-23). These reading changes correspond to the post-mid-1962 period when the tank was filled to capacity (ARH-2035, page 5). Between May 1970 when the tank was pumped to a minimum heel, and March 1971, when ARH-2035 was published, the readings in Drywell 61 had dropped to less than one-third of the early 1970 readings (ARH-2035, page 6).

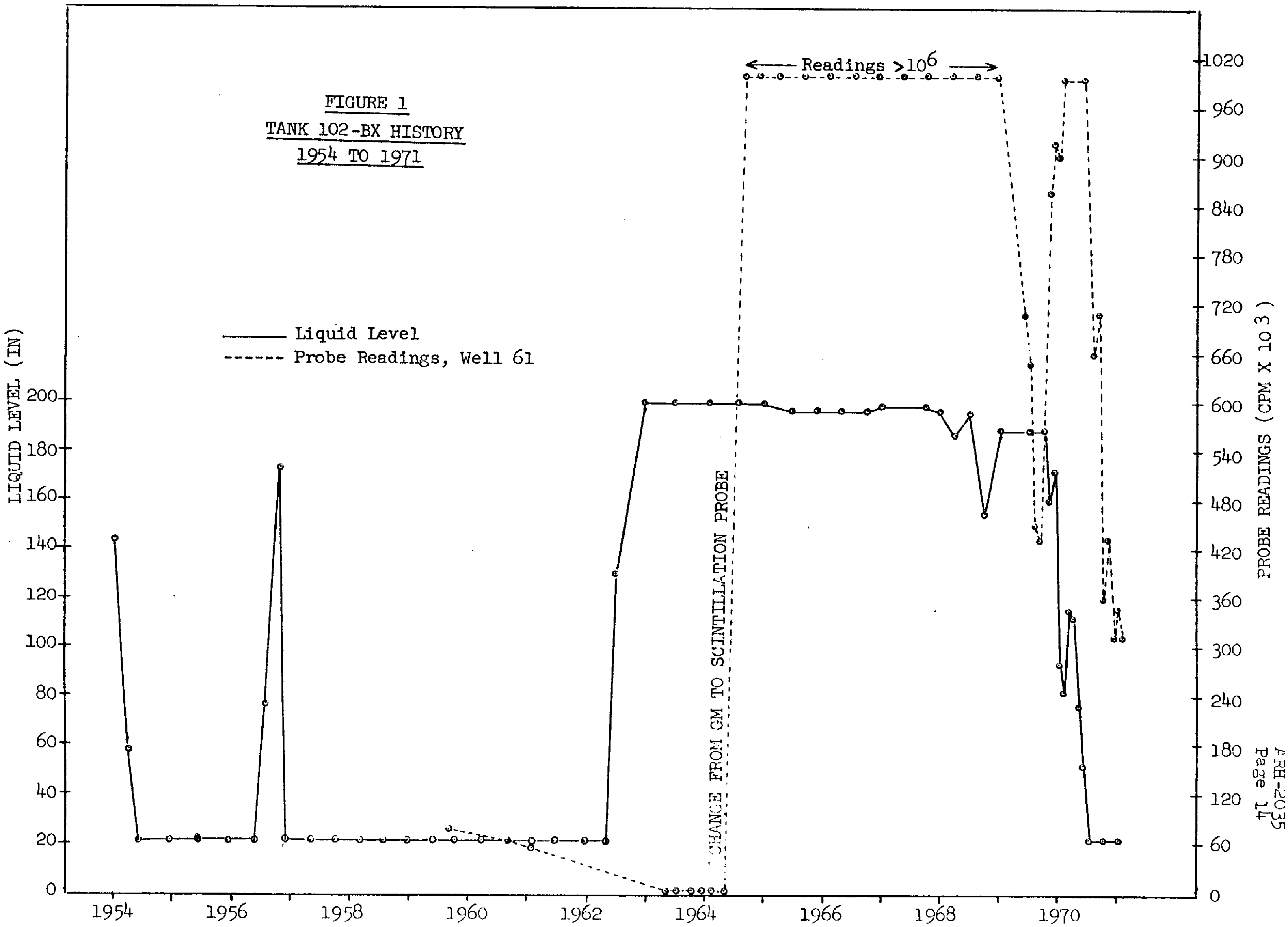
Subsequently, 19 additional drywells were drilled in the vicinity of tank BX-102, with the majority extending east and northeast from the tank. Neutron probe measurements, taken in the drywells in May 1970, indicated that relative moisture content as a function of depth generally corresponded with the radiation probe readings in the wells. At the Drywell 27 site (21-02-04), near the southeast corner of the tank (and close to the spare inlet lines suspected to be the source of the 1951 leak), soil samples were collected at one-foot intervals as drilling progressed, and were analyzed for ^{137}Cs. The peak ^{137}Cs concentration occurred at about 40 ft below grade. Drywell 27 had the highest ^{137}Cs readings of any of the wells in the immediate area, and also the only peak readings at 40 feet bgs. Table B2-5 shows supplemental information summarized in RPP-RPT-29191 related to the tank BX-102 release.

B2.5.6 Leak Inventory Estimate

The total leak volume and activity of waste released to the soil near tank BX-102 and the volume and activity of releases after 1962 were re-estimated based on the information in ARH-2035, the volume and composition for the 1951 release; SGLS/high rate logging system (HRLS) data and the 2009 direct push characterization information. Cesium-137 was used as a tracer/carrier element for this estimate.

The estimated 1951 leak loss from the tank BX-102 overflow was 91,600 gal of MW supernate. In the Standard Inventories of Chemicals and Radionuclides in Hanford Single Shell Tank Wastes (HNF-SD-WM-TI-740, *Standard Inventories of Chemicals and Radionuclides in Hanford Tank Wastes*) the estimated ^{137}Cs concentration for MW is ~0.0035 Ci/gal and the uranium concentration is 60 g/L. Therefore, a loss of 91,600 gal of metal waste equates to a loss of 320 Ci of ^{137}Cs and ~20,000 kg uranium based on standard inventory estimates. In comparison, the SIM (RPP-26744, *Hanford Soil Inventory Model, Rev. 1*) estimated the ^{137}Cs inventory from the 1951 leak was ~4,600 Ci with a range of ~90 to slightly less than ~11,000 Ci (max. 0.12 Ci ^{137}Cs/gal); and the uranium inventory was 10,000 kg with a maximum of 44,000 kg. This indicates that the SIM estimated values and standard inventory estimates are reasonably close for the 1951 leak.

Figure B2-23. Drywell 61 (21-27-01) Gamma and Tank 241-BX-102 Liquid Levels



Reference: ARH-2035, *Investigation and Evaluation of 102-BX Tank Leak.*

Table B2-5. Tank 241-BX-102 Supplemental Leak Information (2 sheets)

Date	Event as Described in Reference	Reference
7-27-1956 to 8-3-1956	241-BXR The 102-BX tank was filled to the 12' 11" level due to information that there is a leak in the tank at approximately that level.	HW-44024 RD, *TBP Plant and Tank Farm Weekly Summary – Process Unit – 6-29-56 thru 8-31-56*, page 38
4-1970 to 5-1970	4-28-1970, page 38: 102-BX: Third drywell at this location was started on 4-24-70. Encountered contamination (740 c/m) at 38 foot level. 4-29-1970, page 40: 102-BX: Third dry well completed 4-27. Fourth well started 4-28. Ran into contamination at 36 ft. (150-mr/hr). 4R at 40 ft. Shut down temporarily. 5-1-1970, page 44: 102-BX: Resumed drilling 4th dry well. At 63 ft. Picking up 1500 c/m. 5-4-1970, page 59: 102-BX: Still drilling dry well (4th). Now at 87 foot level and appear to be out of contamination. 5-5-1970, page 61: 102-BX: Dry well 4 completed on 5-1-70. Started No. 5 on 5-4-70. Now at 16 foot level (3 p.m., 5-4-70). 5-6-170, page 63: 102-BX: Continued drilling dry well 5. Now at 65 foot level. No contamination encountered. 5-15-1970, page 77: 102-BX: Drilling of dry well 7 completed (5-14-70) and started No. 8 (5-14-70). Some contamination detected in soil samples at 80-100 foot level. 5-25-1970, page 89: 102-BX: Driller moved rig to position for well 13 on 5/22/70. However, drillers pulled off this job & are hand augering #9 & #10 on top of 241-BX-102 tank dome. 5-27-1970, page 93: 102-BX: Dry well 13 at 63 ft. level. No contamination detected in soil samples. Wells 9 & 10, which are being hand drilled on top of tank are now at 12 and 8 ft. levels, respectively. No contamination detected so far. Tank dome is calculated to be at 12-14 foot level.	ARH-1526 2, *Chemical Processing Division Daily Production Reports April 1970 Through June 1970*

Table B2-5. Tank 241-BX-102 Supplemental Leak Information (2 sheets)

Date	Event as Described in Reference	Reference
9-1970	Radioactivity around TK-102-BX – A total of 19 wells has been drilled around 102-BX in an effort to define the extent of the radioactivity in the soil around the tank. Logging of these wells with radiation and neutron (for the presence of moisture) probes revealed that the deepest activity is located adjacent to TK-102-BX in a southeasterly direction. Radioactivity was noted to terminate at a depth of 120 feet (100 feet above groundwater) in test well No. 2. Groundwater samples obtained from the well were within AEC release guides as shown in the table. | | µCi/ml | AEC Release Guide µCi/ml | | Pu-239 | $< 2.6 \times 10^{-8}$ | $< 5 \times 10^{-6}$ | | RuRh-106 | 0.7×10^{-5} | $< 1 \times 10^{-5}$ | | Cs-137 | 8.4×10^{-6} | $< 2 \times 10^{-5}$ | The radioactivity in the groundwater at this location is attributed to the B-7 crib site located north of the tank farm complex.	PR-REPORT-SEP70, *Monthly Status and Progress Report September 1970*, page AV-5 and ARH-1509-DEL, *200 Areas Operation Monthly Report September 1970*, page G1-4

Comments:
See also ARH-2035, *Investigation and Evaluation of 102-BX Tank Leak*, and Johnson and Washenfelder 2003, Interoffice memo "Evaluation of Tank BX-102 Leak Data and Historical Records" for additional information on tank 241-BX-102.

Reference: RPP-RPT-29191, *Supplemental Information Hanford Tank Waste Leaks*.

ARH-2035 estimated a total ^{137}Cs loss of no more than 51,000 Ci based on liquid level history, dry-well readings, and soil samples available in 1971. The ARH-2035 estimates considered the 1951 leak information and surmised that a second more pronounced leak had occurred following the 1962 reuse of the tank. ARH-2035 estimated a leak volume of ~70,000 gal based on the maximum measured ^{137}Cs concentration in tank BX-102 in 1970 of 0.73 Ci/gal. There were three samples taken in 1970 of tank BX-102 waste; ^{137}Cs concentrations of 0.28 on January 27, 1970, 0.12 on March 1, 1970, and 0.73 on April 30, 1970. However, ARH-2035 assumed that all gamma readings were from ^{137}Cs. Subsequent SGLS data and direct push data shows that this assumption was not accurate and that much of the gamma activity deep in the 21-27 series wells and in 21-02-04 was uranium.

As discussed above, a 2003 review conducted by Johnson and Washenfelder (Interoffice memo "Evaluation of Tank BX-102 Leak Data and Historical Records") concluded that the plume at Tank BX-102 is likely associated with two leaks. They combined the two volume estimates into a range of 70,000 to 90,000 gal and assumed that the ARH-2035 estimate overlaid the 1951 leak. However, 1999 logging results for drywell 21-02-04 (drywell #27) show ^{137}Cs activity closer to the tank, all the way to ground water and show two distinct zones of activity that appear to be representative of an interface between the 1951 overflow and later leak loss. Other surrounding drywells show <10 pCi/g ^{137}Cs and show that gamma activity is mostly $^{235/238}$U and ^{125}Sb. The

2003 direct push data show high ^{137}Cs activity in well 21-02-04 and holes C5127 and C5129 (drilled about 10 ft on opposite sides of 21-02-04 next to tank BX-102). Other surrounding holes show <10 pCi/g ^{137}Cs. Also, as shown above, the ^{137}Cs activity in the 92,600 gal MW spill was comparatively small (320 Ci).

Based on the available data it was assumed that the ^{137}Cs plume for the release after 1962 could be as large as a 20- to 60-ft diameter half-cylinder plume with a ^{137}Cs concentration of 1E7 pCi/g from 30 ft to 85 ft bgs. This estimate is based on the distance between the spare inlet ports and direct push holes and drywells that showed little or no ^{137}Cs activity (Figure B2-24). A plume of this size would equate to a wetted volume of 7,850 to 78,000 ft^3 and an estimated 4,000 to 40,000 Ci of ^{137}Cs (assuming the concentration of the entire plume is 1E7 pCi/g). The leak volume estimate depends on when the release actually occurred and the concentration of ^{137}Cs in the tank, sometime between 1962 and 1970. For a concentration estimate of 0.8 pCi/gal (ARH-2035) the volume of waste released would range from ~5,000 gal to 50,000 gal. If the waste released was mostly IX (CSR) waste with an estimated concentration of ~1.5 Ci/gal (decayed to 1970) the leak volume could have been lower.

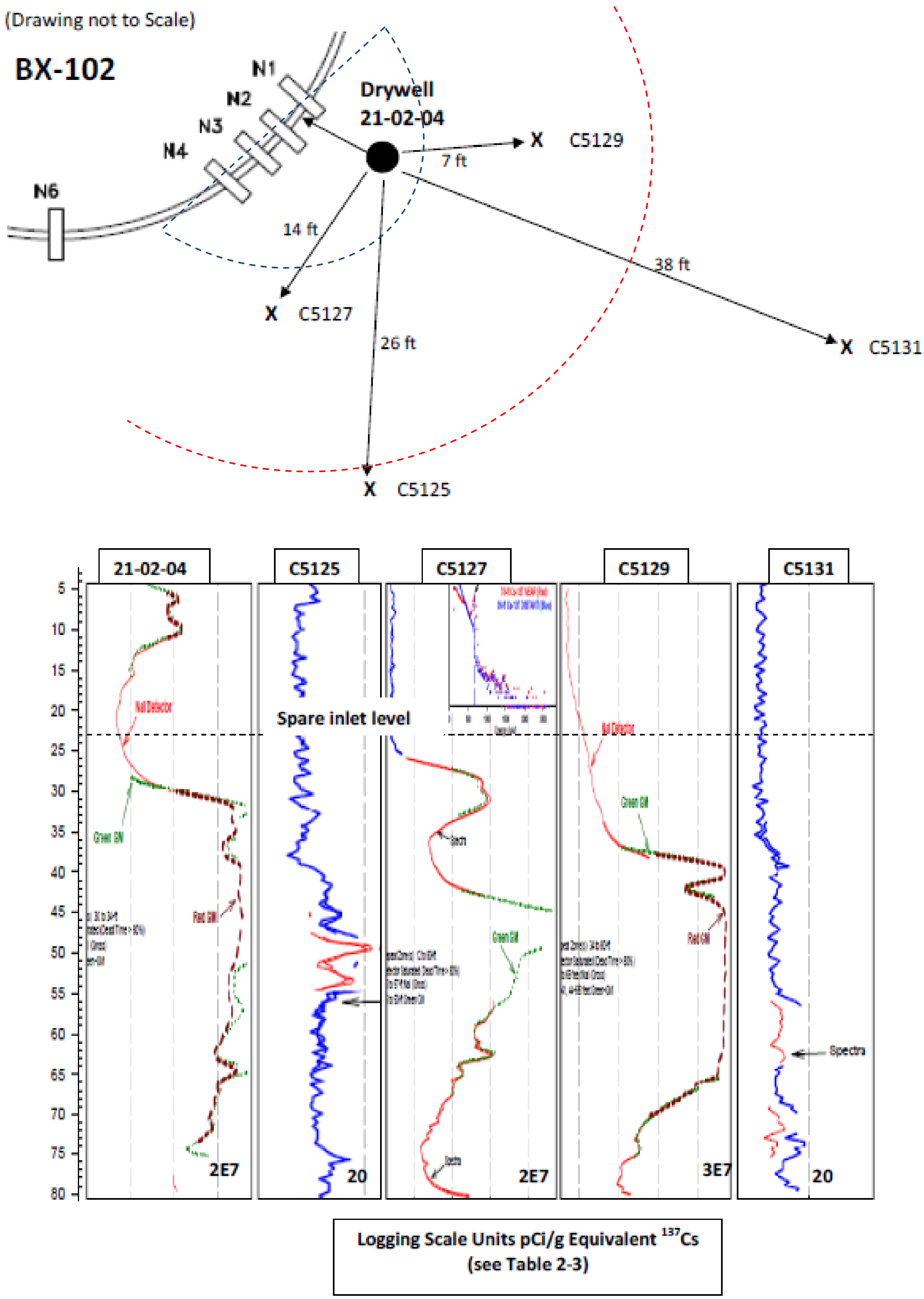
B2.6 CONCLUSION

Two leaks from the spare inlet ports likely occurred. The first release/overflow occurred in 1951 of 91,600 gal of bismuth phosphate process metal waste (1944 to 1951) supernate. The inventory estimates in SIM appear to be reasonable for the 1951 release. A second release occurred sometime between 1962 and 1970. Based on available data a ^{137}Cs inventory of 4,000 to 40,000 Ci with a leak volume of 5,000 to <50,000 gal was estimated for the second leak.

The current SIM estimate is for the 92,600 gal MW release only; the additional release after 1962 should be added to this. For other constituents for the later release multiply a leak volume of 5,000 to 50,000 gal by 1/2 the HDW concentration estimates for a IX(CSR) waste type.

As noted in meeting summaries (Appendix A) the tank BX-102 leak losses in 1951 and after 1962 appear to be due to the tank being overfilled and waste leaking from the spare inlet lines. Leak losses after 1962 could also be a result of a tank leak. A formal leak classification assessment per TFC-ENG-CHEM-D-42, “Tank Leak Assessment Process” is recommended for tank 241-BX-102.

Figure B2-24. Basis for Tank 241-BX-102 Leak Estimate



Reference: RPP-34623, *Small Diameter Geophysical Logging In the 241-BX Tank Farm*.

B3.0 TANK 241-BX-108 WASTE LOSS EVENT

This section provides information on the historical waste loss event associated with tank 241-BX-108 (BX-108). Waste operations for tank BX-108 are summarized in Figure B3-1. Figure B3-2 shows a plan view of tank BX-108 with the location of the pump pit, sluice pit, spare inlet nozzles (N1, N2, N3 and N4) and tank risers.

B3.1 TANK 241-BX-108 WASTE HISTORY

Tank 241-BX-108 was constructed between 1946 and 1947. Figure B3-3 shows tank waste surface levels during operations. In March 1949, tank BX-108 began to receive first decontamination cycle waste from the Bismuth Phosphate process (1C) via the cascade and was filled to capacity by September 1949. The tank received waste (from tank 241-BX-107 [BX-107]) and transferred waste (to tank 241-BX-109) via the cascade lines from March 1949 until 1953 (see Table B3-1).

Supernate was pumped from the tank in the second quarter of 1953. During this pumping operation, approximately 23,000 gal of waste was "lost to the ground" on December 16, 1952 (WHC-MR-0132). A heel of 11,000 gal of waste remained in the tank. From the second quarter of 1953 to the fourth quarter of 1954, the tank received uranium recovery waste from U-Plant via cascade lines. The tank was scavenged for uranium recovery in the fourth quarter of 1957. During the 1957 scavenging operation, the waste from tank BX-108 was pumped to the uranium recovery process vault (244-CR) where it was subsequently routed to U-Plant as feed to the uranium recovery process. Between the second quarter of 1964 and the third quarter of 1968, tank BX-108 received CW mixed with TBP waste. This waste matrix was held in the tank until 1968 when the tank contents were transferred to tank BX-106. From the second quarter of 1969 to the first quarter of 1976, the tank also received IX waste from cesium recovery campaigns at B Plant. Table B3-1 shows waste tank transfers from 1949 to 1976.

B3.2 INTEGRITY OF TANK 241-BX-108

The tank was declared a suspected leaker in the fourth quarter of 1973 and a confirmed leaker in 1974 with an estimated leak volume of 2,500 gal (SD-WM-TI-356). The confirmed leaker classification was apparently based on an increase in gross gamma activity detected in drywell 21-08-06 and declining liquid levels in the tank (SD-WM-TI-356). No occurrence reports showing liquid level decreases were identified for this tank.

B3.3 INTERIM STABILIZATION

Tank 241-BX-108 was saltwell pumped in the third quarter of 1976 (WHC-MR-0132). In 1977, tank BX-108 was declared inactive. However, February 7, 1977 photos showed a shallow liquid pool about 25 ft in diameter on the waste surface. The tank was declared interim stabilized in July 1979 after pumping (P-10) an additional 2,000 gal of interstitial liquid

Figure B3-1. Tank 241-BX-108 Operations Timeline

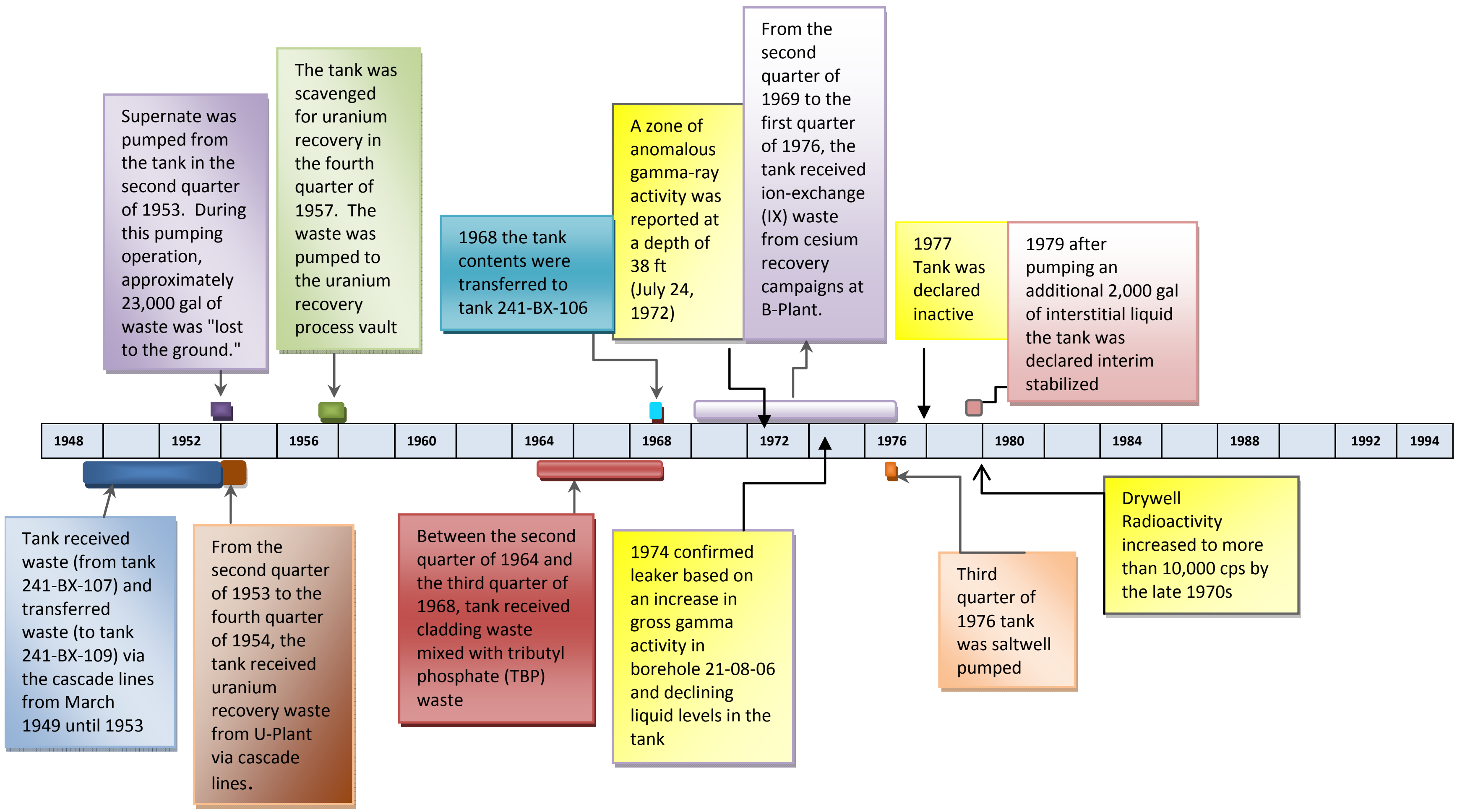


Figure B3-2. Tank 241-BX-108 Plan View

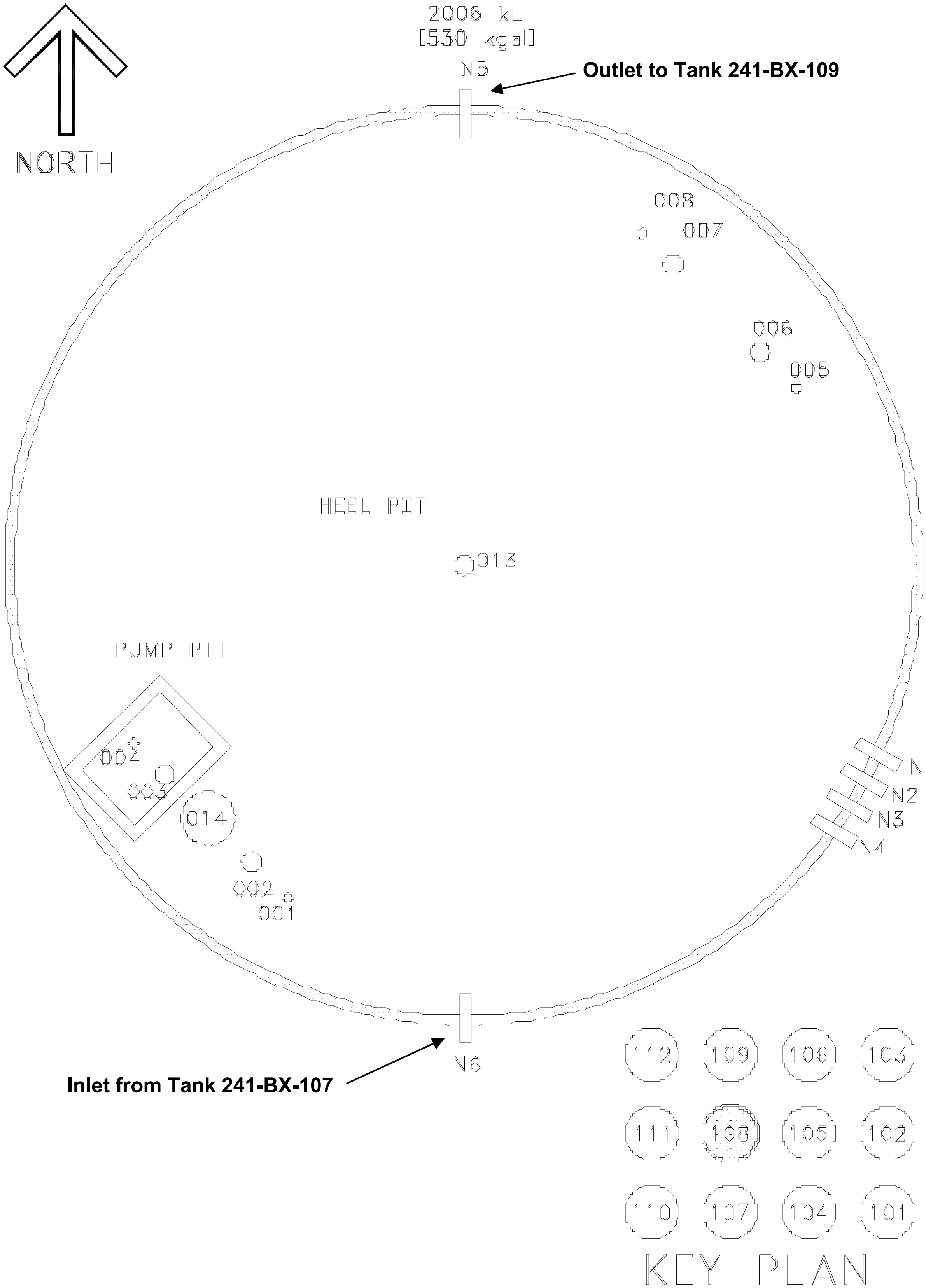
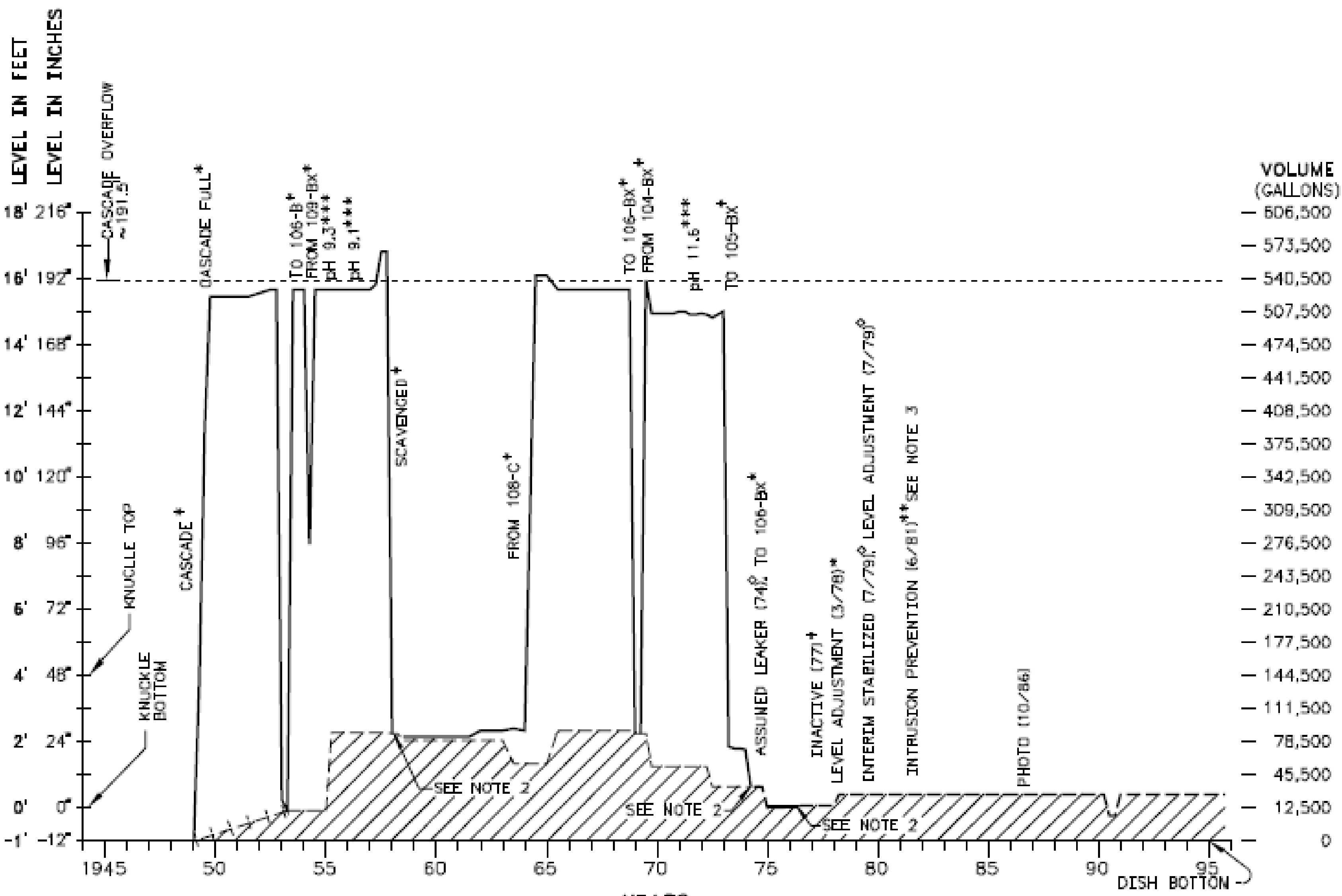


Figure B3-3. Tank 241-BX-108 Waste Surface Level Diagram



Reference: WHC-SD-WM-ER-349, *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Area*.

Table B3-1. Tank 241-BX-108 Waste Transfer History (2 sheets)

Date/Date Range	*Transfer Type*	*Transfer Volume (gal*1000)*	*Total Vol. In Tank (gal*1000)*	*Discrepancy with previous reading (gal*1000)*	*Waste type*	*Transfer tank from/to*	*Document Number (see Section B6.0 for full reference)*
Oct. to Dec. 1948	STAT		0				WHC-MR-0132
Jan. to Mar. 1949	REC	136	136		1C	BX-107, Cascade	WHC-MR-0132
Apr. to June 1949	REC	390	390		1C	BX-107	WHC-MR-0132
July to Sep. 1949	REC	235	523		1C	BX-107, cascade filled in Sep	WHC-MR-0132
Oct. 1949 to Sep. 1950	STAT		523		1C		WHC-MR-0132
Oct. to Dec. 1950	SEND	-530			1C	BX-109	WHC-MR-0132
Oct. to Dec. 1950	REC	530	523		1C	BX-107	WHC-MR-0132
Jan. 1951 to Dec. 1952	STAT		530		1C		WHC-MR-0132 HW-27840
Jan. 1953	SEND	-497			1C	B-106	WHC-MR-0132
Jan. 1953	SEND	-23	10		1C	Loss to ground from pumping on 12-16-52	WHC-MR-0132 HW-27841
Feb. to Mar. 1953	STAT		10		1C		HW-27842
Apr. to May 1953	REC	520	530		TBP	BX-107 cascade	HW-28043 HW-28377
June 1953 to Feb. 1954	STAT		530				HW-28712 HW-31126
Mar. 1954	SEND	-254	276		TBP	Sluiced to B-106	HW-31374
Apr. 1954	STAT		276		TBP		HW-32110
May 1954	REC	254	530		TBP	109-BX	HW-31811, HW-32389
June 1954 to Dec. 1956	STAT		530		TBP		HW-32389 HW-47640
Jan. to Feb. 1957	STAT		538	8	TBP	Electrode reading	HW-48144 HW-48846
Mar. to May 1957	STAT		535	-3	TBP	Electrode reading	HW-49523 HW-50617
June to Oct. 1957	STAT		568	32		New Electrode reading	HW-51348 HW-53573
Nov. 1957	SEND	-481	87		TBP	C-112 scavenged	HW-55264
Dec. 1957 to Apr. 1958	STAT		87			Electrode reading	HW-54519 HW-55997
May 1958 to June 1961	STAT		84	-3		Electrode reading	HW-56357 HW-71610
July 1961 to Dec. 1962	STAT		90	6		Electrode reading	HW-72625 HW-76223
Jan. to June 1963	STAT		92	2			HW-78279
July to Dec. 1963	STAT		90	-2		Electrode reading	HW-80379

Table B3-1. Tank 241-BX-108 Waste Transfer History (2 sheets)

Date/Date Range	*Transfer Type*	*Transfer Volume (gal*1000)*	*Total Vol. In Tank (gal*1000)*	*Discrepancy with previous reading (gal*1000)*	*Waste type*	*Transfer tank from/to*	*Document Number (see Section B6.0 for full reference)*
Jan. to June 1964	REC	454	544		TBP-CW	C-108	HW-83308
July to Dec. 1964	STAT		544		TBP-CW		RL-SEP-260
Jan. 1965 to Sep. 1968	STAT		530		CW	New Electrode	RL-SEP-659 ARH-871
Oct. to Dec. 1968	SEND	-443	87		CW	BX-106	ARH-1061
Jan. to Mar. 1969	STAT		87		CW		ARH-1200 A
Apr 1969 to June 1969	REC	452	539		IX	BX-104	ARH-1200 B ARH-2794 B
July to Sep. 1969	SEND	-33	506		IX	BY-102	ARH-1200 C LA-UR-97-311
Oct. 1969 to Sep. 1970	STAT		506		IX		ARH-1200 D ARH-1666 C
Oct. 1970 to Mar. 1971	STAT		508	2	IX		ARH-1666 D ARH-2074 A
Apr. to Sep. 1971	STAT		505	-3	IX		ARH-2074 B ARH-2074 C
Oct. to Dec. 1971	STAT		506	1	IX		ARH-2074 D
Jan. to Mar. 1972	STAT		505	-1	IX		ARH-2456 A
Apr. to June 1972	STAT		502	-3	IX		ARH-2456 B
July to Sep. 1972	STAT		505	3	IX		ARH-2456 C
Oct. to Dec. 1972			508		IX		ARH-2456 D
Jan. to Mar. 1973	SEND	-432	74	-2	IX	BX-105	ARH-2794 A
Apr. to Sep. 1973	STAT		72	-2	IX		ARH-2794 B ARH-2794 C
Oct. to Dec. 1973	STAT		71	-1	IX	Suspect leaker	ARH-2794 D
Jan. to Mar. 1974	SEND	-43	34	6	IX	BX-106 Tank leaks	ARH-CD-133A
Apr. to June 1974	SEND	-2	34	-2	IX	BX-106	ARH-CD-133B
July to Sep. 1974	SEND	-1	34	-1	IX	BX-106	ARH-CD-133C
Oct. to Dec. 1974	SEND	-1	15	-9		BX-106 Solids adjustment	ARH-CD-133D
Jan. 1975 to Feb. 1978	STAT		15				ARH-CD-336 A RHO-CD-14
Mar. 1978 to Dec. 1980	STAT		26			New solids reading	RHO-CD-14

1C = first cycle waste
CW = cladding (coating) removal waste
IX = ion-exchange (waste)
TBP = tributyl phosphate (waste)

(HNF-SD-WM-TI-178). The tank currently contains an estimated 31 kgal of sludge and no supernate. Figure B3-4 shows a photo mosaic of the BX-108 tank surface in October 1986 in which the liquid pool is no longer visible.

B3.4 TANK 241-BX-108 TEMPERATURE HISTORY

No temperature measurements were found before 1974. As shown in Figure B3-5, between 1974 and 2009 the tank temperature ranged between 55 and 77°F and continues to vary seasonally between 60 and 67°F indicating that the waste temperature for tank BX-108 is low. Tank temperature is being monitored by a single thermocouple tree.

B3.5 DATA REVIEW AND OBSERVATIONS

B3.5.1 Liquid Level Measurements

Table B3-2 shows liquid level measurements from 1973 to 1987 (SD-WM-TI-356). Cumulative liquid level measurement decreases of 1.9 in. were observed between July, 1973 and February, 1983. However, there was no liquid level decrease criteria for this tank due to the nature of the waste (SD-WM-TI-356). The tank was subjected to potential in-leakage from a broken water valve during 1977 (OR-77-23, *Occurrence Report 77-23 Water Leakage to 108-BX*). There were no visible effects from the in-leakage. Figure B3-6b shows current liquid level measurements. Manual tape measurements varied from a low of three to a high of 7 in. above the top of the tank dish (15 to 19 in. above the bottom of the tank) between 1989 and April 1996. In June 1996 an ENRAF was installed in the tank and measurements remained steady at about 19 in. above the bottom of the tank. The jump in Figure B3-6b between manual tape and ENRAF measurements was due to changing the “0-level” measurements from the top of the dish to the bottom of the tank for ENRAF measurements (a 12 in. off-set).

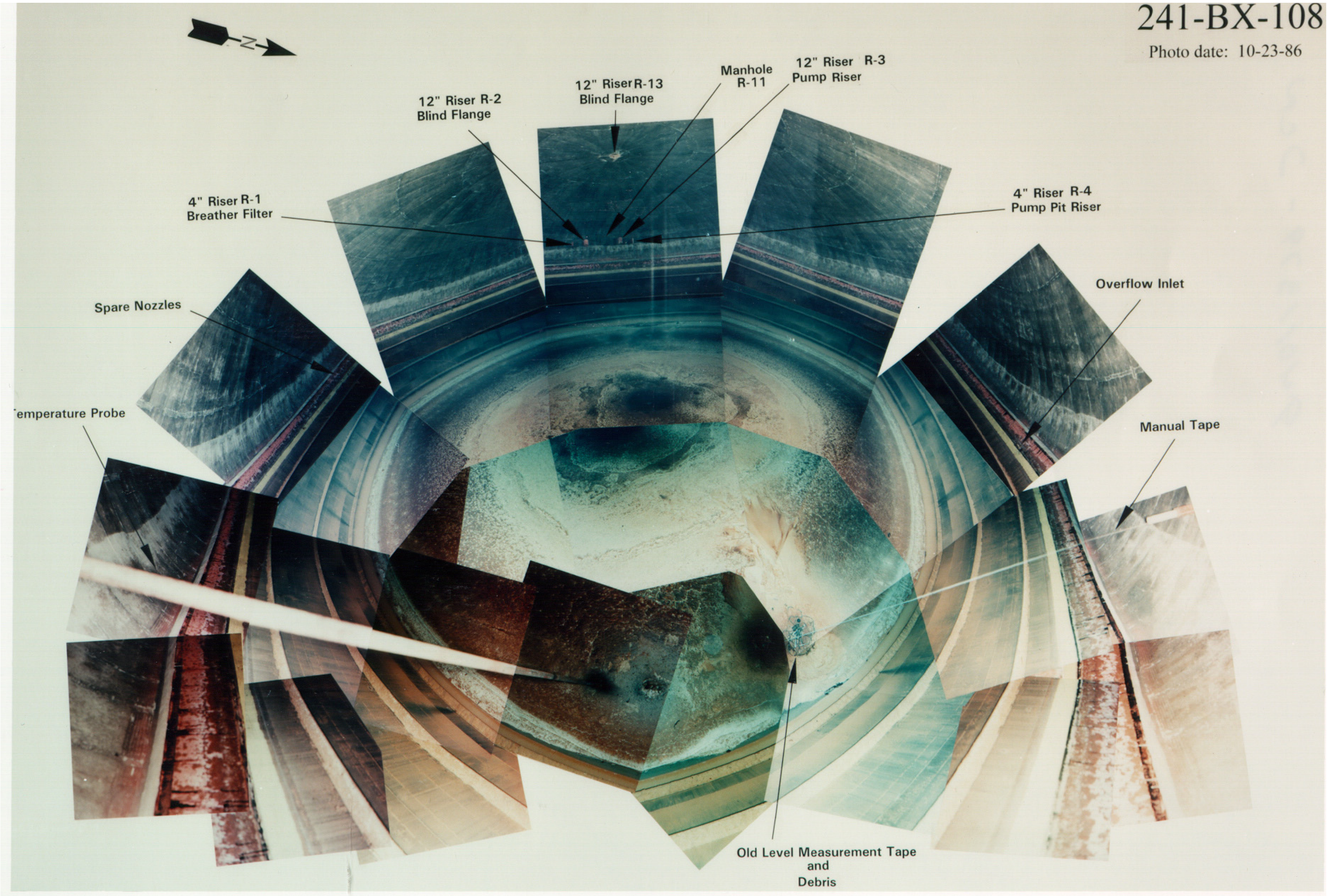
B3.5.2 Drywell Logging Data (GJ-HAN-89)

Nine drywells surround tank BX-108 (Figure 3-3). Figure B3-7 shows SGLS results for these drywells. Of the eight, three show higher levels of contamination (21-08-07, 21-11-03 and 21-08-12). Historical total gamma and more recent SGLS results for these three drywells are described below. In addition, drywell 21-08-06 is described because historical activity in this well was attributed to a leak from tank BX-108.

Drywell 21-08-07 is located approximately 2 ft from the southwest side of tank BX-108. This drywell was completed in January 1972 to a depth of 100 ft using 6-in. casing. The total logging depth achieved by the SGLS was 99.5 ft.

The historical gross gamma log data from 1975 to 1994 (HNF-3531) were reviewed, as well as summaries of the historical gross gamma log data from 1972 to 1986 presented in SD-WM-TI-356 (Figure B3-8). Zones of anomalous gamma-activity are present in the historical logs from about 5 to 10 ft and about 31 to 50 ft. A zone of anomalous gamma-activity is present from about 5 to 10 ft on the earliest log available (January 14, 1975). The activity in this interval

Figure B3-4. 241-BX-108 In-Tank Photo Mosaic



Reference: WHC-SD-WM-ER-349, *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Area*.

Figure B3-5. Tank 241-BX-108 Waste Temperature Measurements

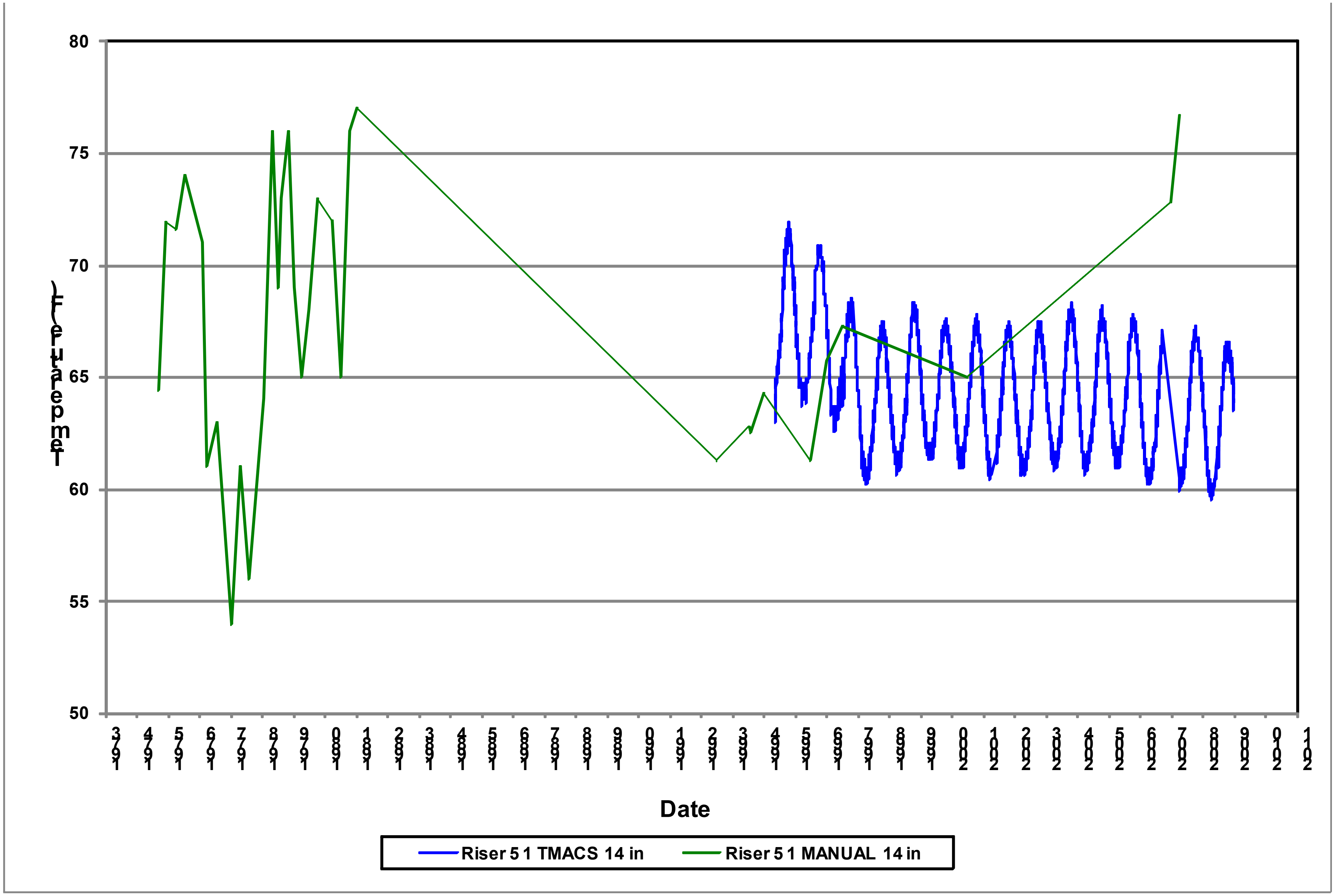


Table B3-2. Tank 241-BX-108 Liquid Level Measurements (1973 to 1987)

Date	Liquid level (in.)	Baseline ref.	Change from previous reading (in.)	Cumulative change (in.)	Comments
06/15/73	33.80				FIC gage
07/13/73	33.60		-0.20	-0.20	Slow decrease
07/14/73	22.20			-0.20	Recalibration
03/14/74	21.10		-1.10	-1.30	Slow decrease
04/22/74	12.25			-1.30	Transfer FIC o/s. Now using manual tape
06/02/74	12.25			-1.30	Stable
06/10/74	7.80			-1.30	Transfers. Now using FIC gage.
07/03/74	7.80			-1.30	Stable
07/11/74	5.00			-1.30	Erratic readings. FIC repaired
10/17/74	4.90			-1.30	Salt-well transfers
02/14/79	4.95		+0.05	-1.25	Stable
10/25/79	5.00		+0.05	-1.20	Very slow increase. FIC o/s
10/26/79		5.75		-1.20	Installed new tape. Now on manual tape
03/03/80	5.25		-0.50	-1.70	Slow decrease
02/18/81	5.15			-1.70	Stable
02/22/82	5.00		-0.25	-1.95	Stable
02/14/83*	5.00				Stable
02/09/84	5.00				Stable
02/12/85	4.75				Stable
01/01/86	4.75				Stable
07/01/86	4.75				Stable
10/03/86	3.00				Unexplained decrease. Contacting solids
01/02/87	3.00				Stable

Manual Tape measurements – Liquid level measurements are offset 12 in. from tank center bottom.

increased to more than 10,000 cps by the late 1970s. An activity of 17,000 cps was recorded at a depth of 9 ft on the latest gross gamma log (May 16, 1994). A zone of anomalous gamma-ray activity was also reported at a depth of 38 ft on the earliest log (July 24, 1972) summarized in SD-WM-TI-356. A zone of anomalous gamma ray activity was still present at about this depth on the latest historical gross gamma log (May 16, 1994).

The man-made radionuclides ^{137}Cs, ^{60}Co, ^{154}Eu, and ^{152}Eu were detected in this drywell in December 1997 SGLS measurements (Figure B3-7). Cesium-137 contamination was measured almost continuously from the ground surface to about 27 ft, except for a zone of high dead time from 8 to 8.5 ft. High rate logging system measurements in 1999 showed peak levels of ~1000 pCi/g ^{137}Cs from 5 to 8.5 ft. Lower levels of ^{137}Cs activity were measured almost continuously from 30 ft to the bottom of the logged interval (99.5 ft). Distinct peaks of ^{137}Cs contamination were detected at about 5 ft, 34 ft, from 60 to 63 ft, and 69.5 to 73 ft. Cobalt-60

Figure B3-6. Surface Level Surveillance Plot, 1980 to 2010

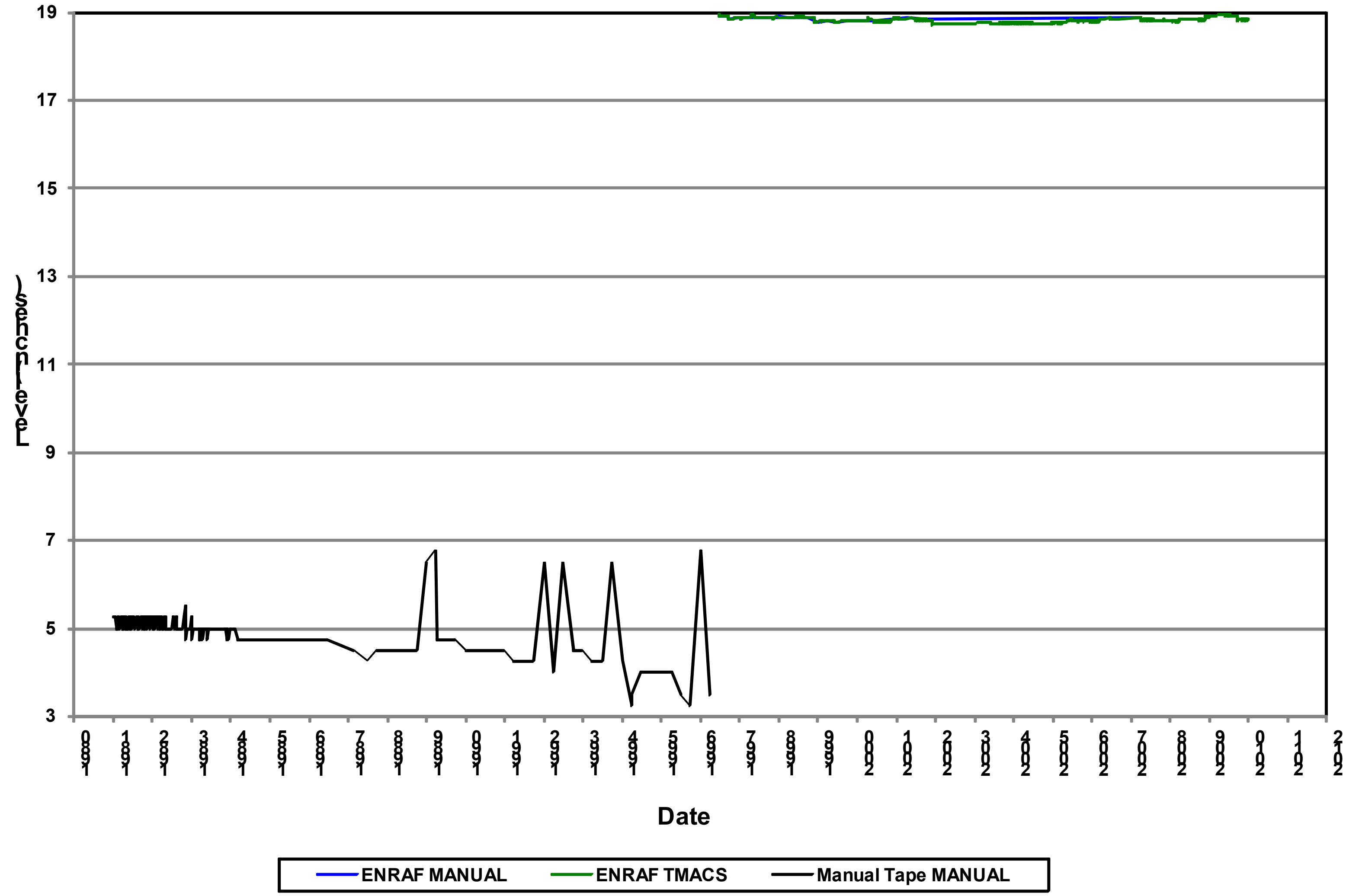
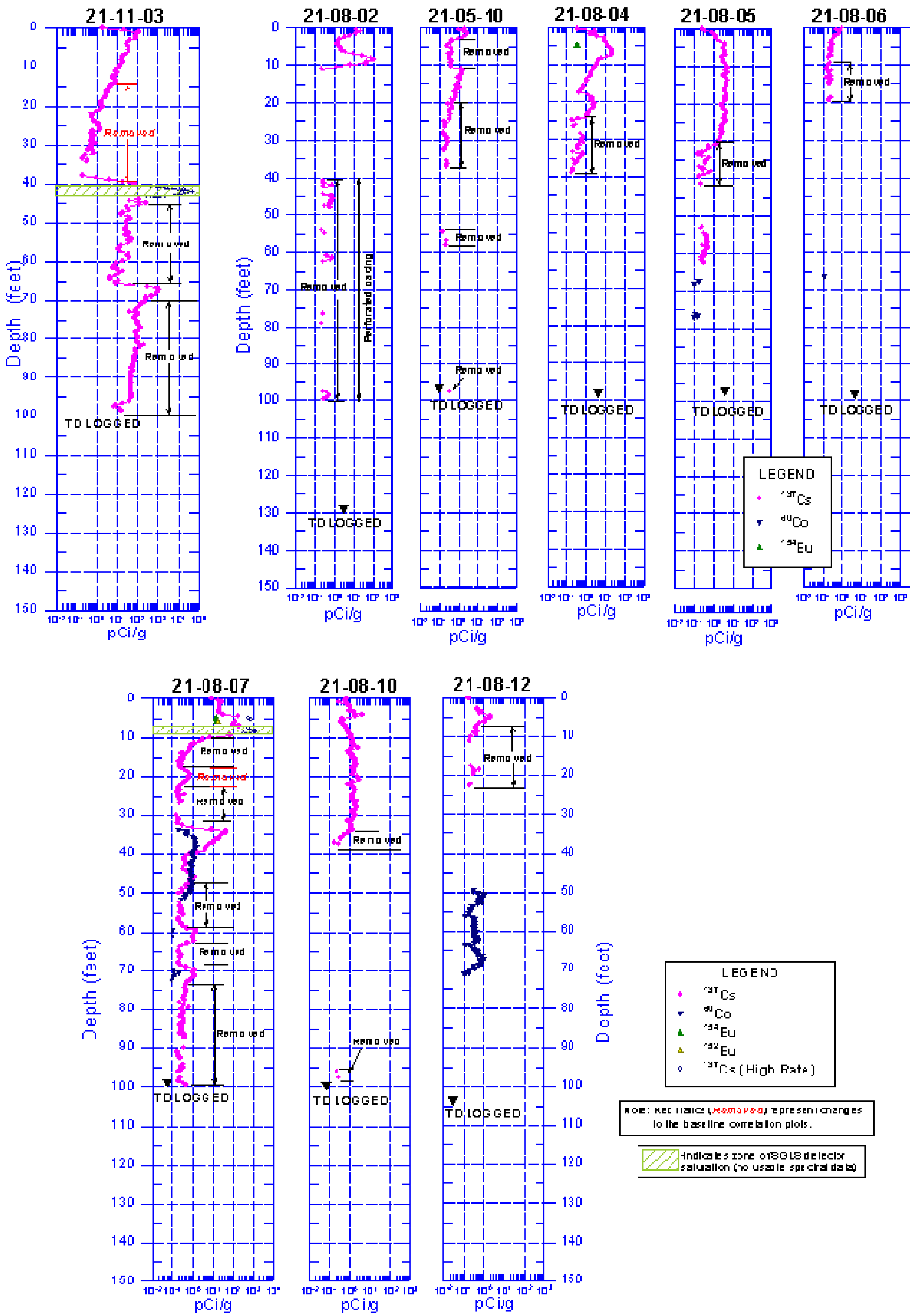
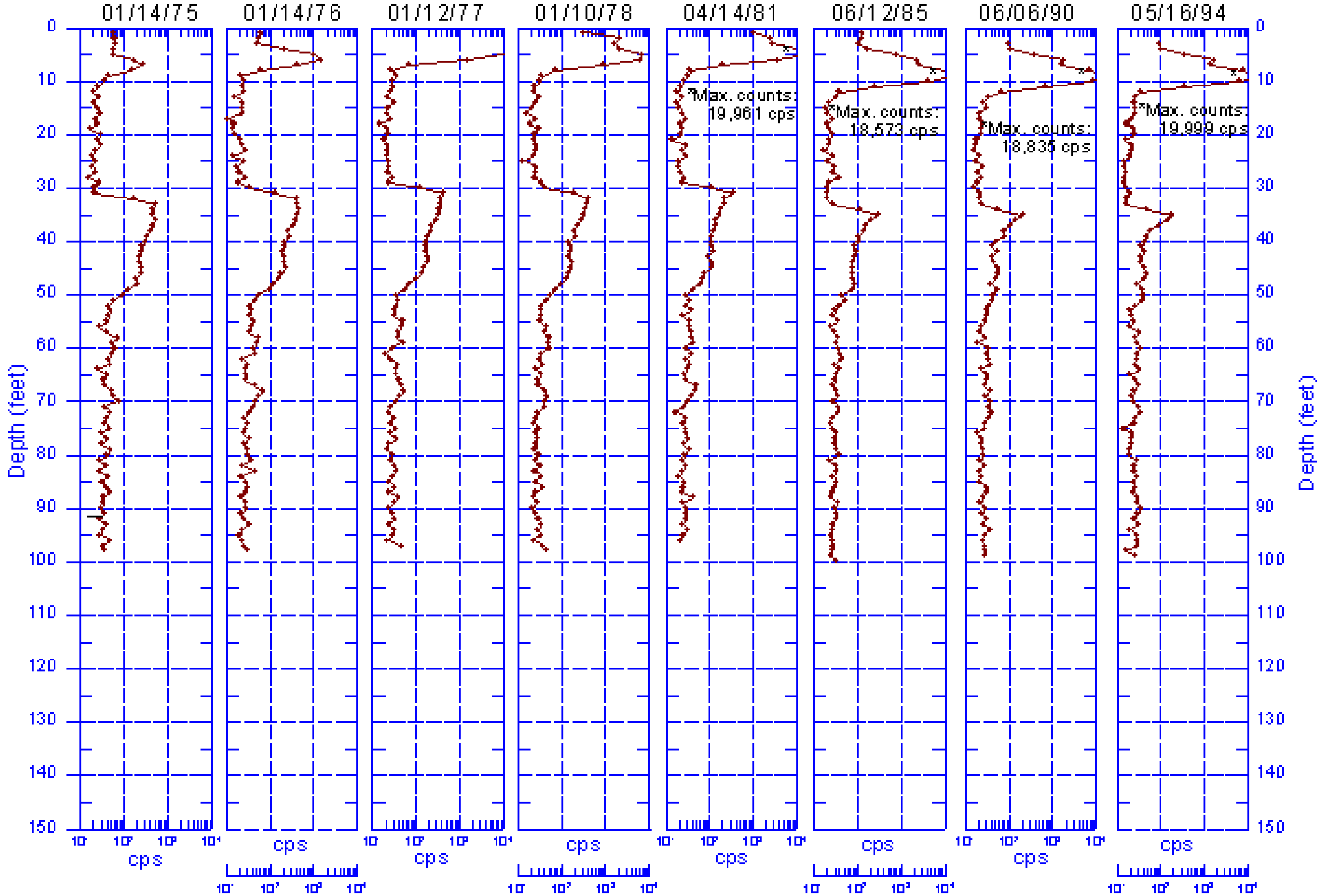


Figure B3-7. Spectral Gamma Logging System Data



Reference: GJO-98-40-TARA/GJO-HAN-19, *Hanford Tank Farms Vadose Zone: Addendum to the BX Tank Farm Report.*

Figure B3-8. Historical Gross Gamma Logs for Drywell 21-08-07



contamination was detected continuously from 33.5 to 52 ft, almost continuously from 69.5 to 72.5 ft, and at 59.5 and 61 ft. Europium-154 contamination was detected at 5 and 6 ft, and ^{152}Eu contamination was detected at 6 ft.

Drywell 21-11-03 is located approximately 11 ft from the west side of tank BX-108. This drywell was completed in October 1973 to a depth of 100 ft using 6-in. casing. The maximum logging depth achieved by the SGLS was 98.5 ft.

Historical gross gamma log data from 1980 to 1989 (HNF-3531) and data summarized in SD-WM-TI-356 were reviewed (Figure B3-9). Anomalously high gamma-ray activity was present throughout this drywell. In the earliest gross gamma log data available, from November 1973 (SD-WM-TI-356), gamma activity was greater than 50,000 cps at 42 ft.

The only man-made radionuclide detected around this drywell in 1997 SGLS measurements was ^{137}Cs. Measurable ^{137}Cs concentrations were detected almost continuously from the ground surface to the bottom of the logged interval (98.5 ft) (Figure B3-7). A zone of high dead time was encountered from 41 to 43 ft. High rate logging system measurements from 1999 showed a narrow peak of 1E5 pCi/g ^{137}Cs at ~41 ft.

Drywell 21-08-12 is located approximately 8 ft from the north side of tank BX-108. This drywell was completed in December 1971 to a depth of 100 ft using 6-in. casing. The zero reference point for logging is the top of the drywell casing, approximately 3 ft above the surrounding ground surface. The maximum logging depth achieved by the SGLS was 103.0 ft.

Historical gross gamma log data from 1980 to 1989 (HNF-3531) and data summarized in SD-WM-TI-356 were reviewed (Figure B3-10). Anomalously high gamma-ray activity was present at a depth of about 46 ft in the earliest gross gamma log data (January 1975) available. This contamination appears to have moved downward about 4 ft between April and June 1982, apparently due to berm construction around the tank (similar to apparent downward contaminant movement observed in other drywells around tank BX-108 at this time).

The man-made radionuclides ^{137}Cs and ^{60}Co were detected in this drywell during the 1997 SGLS survey. Cesium-137 contamination was measured almost continuously from 3 to 11 ft, continuously from 17.5 to 19.5 ft, and from 22 to 22.5 ft. A well-defined peak in ^{137}Cs concentrations occurs at 5 ft with the maximum ^{137}Cs concentration of 2.03 pCi/g. Cobalt-60 contamination was detected continuously from 49.5 to 71 ft. The maximum ^{60}Co concentration was 1.02 pCi/g measured at 50.5 ft.

Drywell 21-08-06 is located approximately 4 ft from the south side of tank BX-108. It was given the Hanford Site designation 299-E33-151. This drywell was completed in January 1972 to a depth of 100 ft using 6-in. casing. Figure B3-11 shows gross gamma logs from 1975 to 1992. Anomalous gamma-ray activity was identified in the historical logs from about 44 to 51 ft in the earliest available historical log data (January 1975). SD-WM-TI-356 records a zone of anomalous activity at 48 ft as early as July 1972, the earliest data provided. The gamma-ray activity at about 48 ft decreased rapidly and reached near background activity levels by 1985. The decay of activity closely matches a decay curve for ^{106}Ru. In SGLS measurements, ^{137}Cs was detected in this drywell from surface to 20 ft bgs at less than 1 pCi/g.

Figure B3-9. Historical Gross Gamma for Drywell 21-11-03 (1975 to 1994)

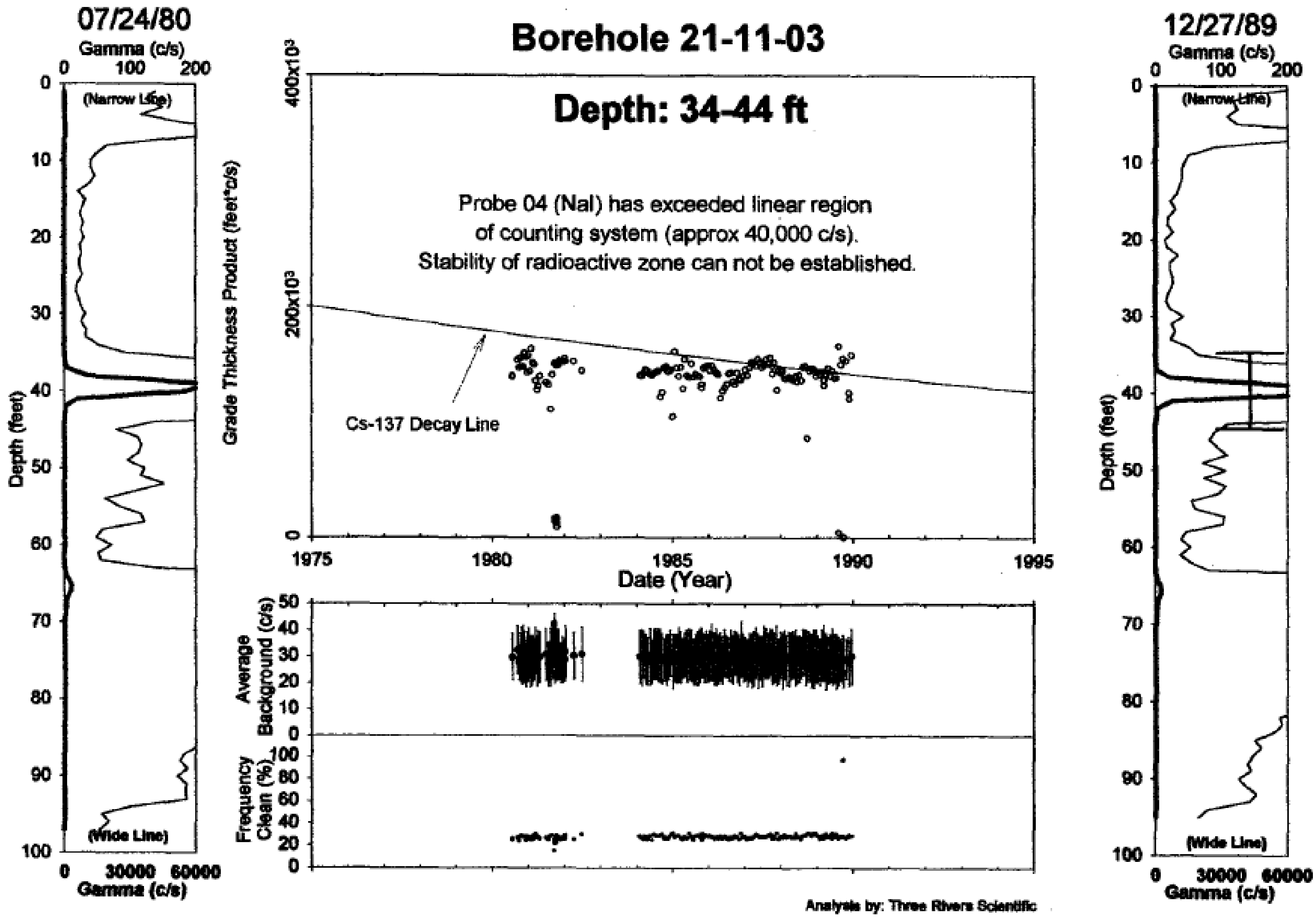


Figure B3-10. Drywell 21-08-12 Historical Gross Gamma (1975 to 1994)

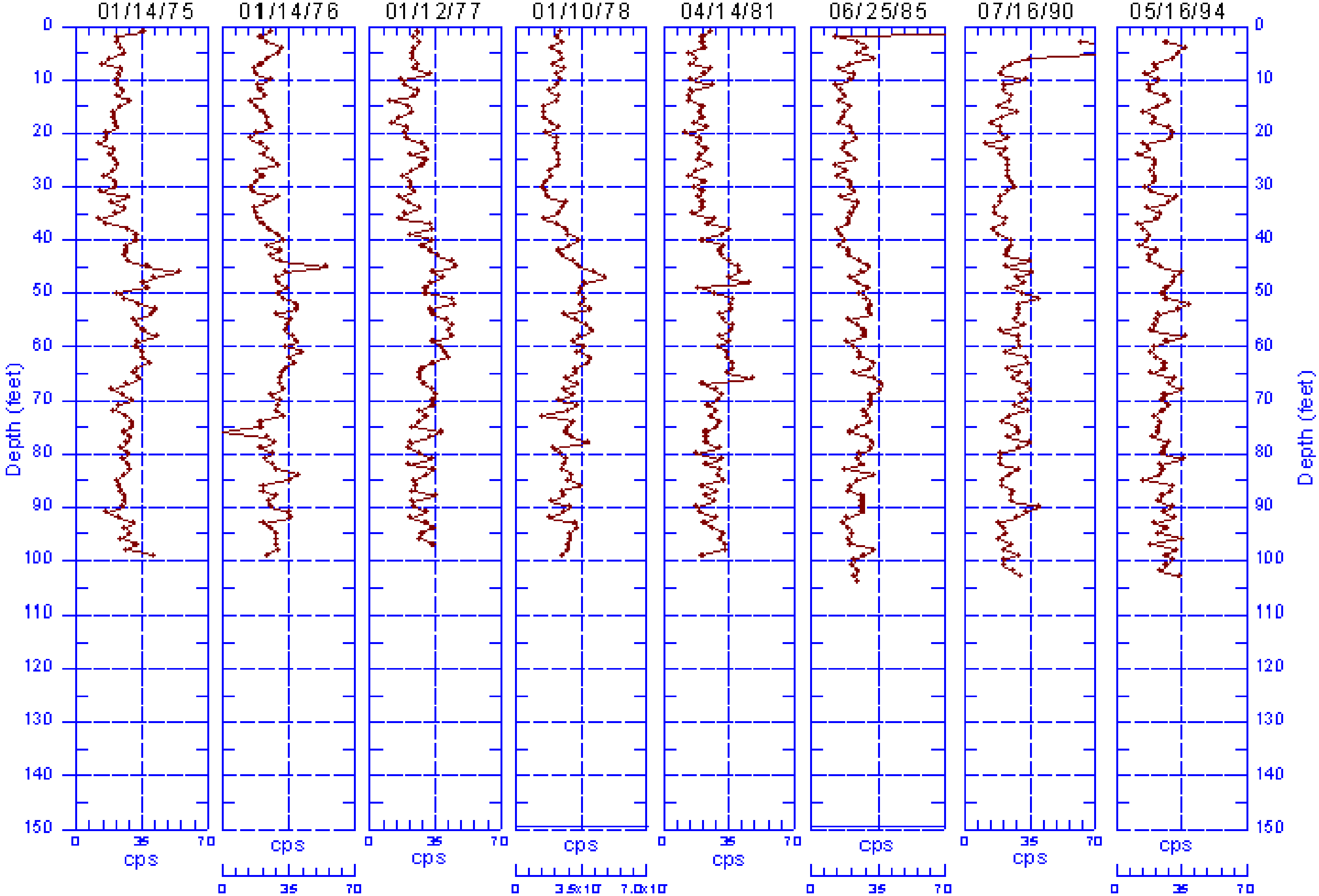
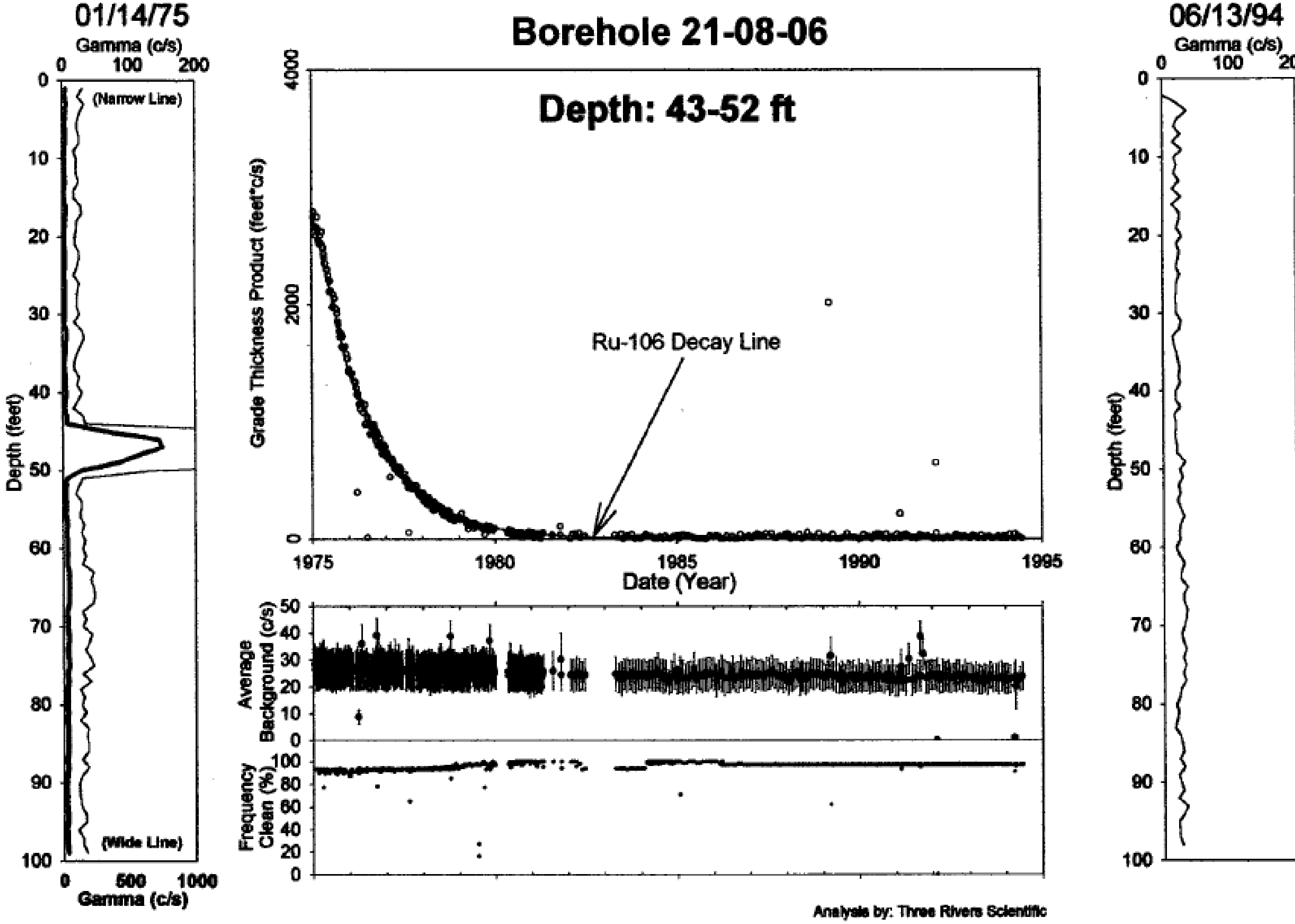


Figure B3-11. Historical Gross Gamma for Drywell 21-18-06 (1975 to 1994)



B3.6 ASSESSMENT

Auger wells drilled in 1974 near drywell 21-07-06 indicated that the high activity near tanks BX-107 (21-07-06) and BX-110 (21-10-03 and 21-10-05) were associated with transfer line leaks (SD-WM-TI-356), but no additional information was found regarding the auger wells.

Figure 5-2 in the main text shows transfer lines near drywell 21-07-06. Several transfer lines from B Plant to tank farms failed pressure tests in 1974 (Memo from Fraser, M. C. to R. L. Walser, August 14, 1974, "Status of Direct Buried Waste Transfer Lines from B Plant to the Tank Farms").

Historical gamma logs, spectral gamma logs, and direct push logs were reviewed and discussed. The logs show peak activity at about 12 ft bgs in some drywells extending to below the base of the tanks in other drywells. The logging data showing near surface contamination indicates multiple transfer line leaks or other near surface leaks likely occurred and the ^{137}Cs activity near the base of the tank may indicate migration from these releases. The activity near the base of the tank may also be the result of a tank leak.

SD-WM-TI-356 observed that the liquid level is not a reliable indicator for the waste in this tank and no liquid level decrease criteria was assigned for this tank. Internal memo ARHCO-040174, "108-BX Tank Leak" notes that, "the validity of data collected prior to July 1973, however is suspect due to the development status of the then newly installed Food Instrument Corporation (FIC) gauges and problems with their calibration and sensitivity." Surface level instrumentation counters were also found to give erroneous readings in 1973 and 1974 (Internal memo ARHCO-040174). In May 1974 a letter of direction was received to replace the counters and install new circuit boards for surface level monitoring instruments (Memo Stocking 1974, "108-BX Tank Leak Contract AT(45-1)-2130").

Although historical information and drywell data clearly show the presence of contamination near tank BX-108, no inventory estimate could be determined from the information available. Based on the narrow peak and comparatively low gamma activity, the data suggests that if there was a tank leak, the tank leak inventory was likely small compared to the inventory of transfer line and/or operations leaks.

B3.7 CONCLUSION

Because the data suggests two potential sources (tank overfill and transfer line leaks) for activity near tank BX-108 in addition to a potential tank leak it is recommended that this tank be re-assessed per TFC-ENG-CHEM-D-42. As noted above, there was no basis for an inventory estimate near tank BX-108.

B4.0 TANK 241-BX-110 WASTE LOSS EVENT

This section provides information on the historical waste loss event associated with tank 241-BX-110 (BX-110). Waste operations for tank BX-110 are summarized in Figure B4-1. Figure B4-2 shows a plan view of tank BX-110 with the location of the pump pit, sluice pit, spare inlet nozzles (N1, N2, N3 and N4) and tank risers.

B4.1 TANK 241-BX-110 WASTE HISTORY

Tank 241-BX-110 is one of 12 tanks located in the Hanford Site 200 East Area BX Tank Farm. It is the first in a three-tank cascade that includes tanks 241-BX-111 (BX-111) and 241-BX-112. Tank 241-BX-110 was constructed between 1946 and 1947 and went into service in September 1949 when it received 1C waste from the B Plant bismuth phosphate (BiPO4) process. The supernate was decanted to the B-39 crib in 1953 and 1954. In 1954, the tank received supernatant concentrate evaporator bottoms (EB) waste from tank 241-B-105, and in 1957, much of this supernate was transferred to tank 241-C-111 for the ferrocyanide scavenging campaign. In 1964, PUREX plant CW from tank 241-C-102 was transferred into tank BX-110, and in 1968 supernate was removed to tank BX-106. In 1969, the tank received cesium recovery supernatant (IX) waste from the B Plant cesium recovery process, some of which was transferred to tank 241-BX-104 in 1970. In 1972, tank 241-BX-110 received in-tank solidification (ITS) waste (EB waste) from tanks 241-BY-109 (BY-109) and 241-BY-112 (BY-112), and continued receiving this waste until it completed active service in 1977 [WHC-MR-0132, LA-UR-97-311, *Waste Status and Transaction Record Summary (WSTRS Rev. 4)*]. Figure B4-3 shows tank waste surface levels during operations and Table B4-1 shows transfers to and from the tank during its operational lifetime.

B4.2 INTEGRITY OF TANK 241-BX-110

In 1976, the tank was declared "questionable integrity" and in 1977 it was removed from service. A leak volume estimate could not be determined.

The questionable integrity classification was apparently based on an increase in gross gamma activity detected in drywells 21-10-03 and 21-10-05 (SD-WM-TI-356). Based on the absence of detectable ^{134}Cs in 1972 samples, indicate the source of activity in drywell 21-10-05 is older than 10 years (Buckingham 1972, "Gamma Energy Analysis of Soil from Well E 33-168"). SD-WM-TI-356 attributes this increase to an old transfer line leak. This appears plausible given the high activity observed at 12 ft bgs but no information was found regarding the transfer line leak.

A liquid level decrease of 1.25 in. (3,700 gal) was reported in May 1977 (OR-77-76, *Occurrence Report OR-77-76 Liquid Level Decrease Exceeding Criterion*). This decrease was attributed to inaccurate liquid level measurements. Occurrence report 80-04 (Letter LET-011880, "110-BX Liquid Level Increase") was issued January 1980 because the liquid level increased. This

Figure B4-1. Tank 241-BX-110 Operations Timeline

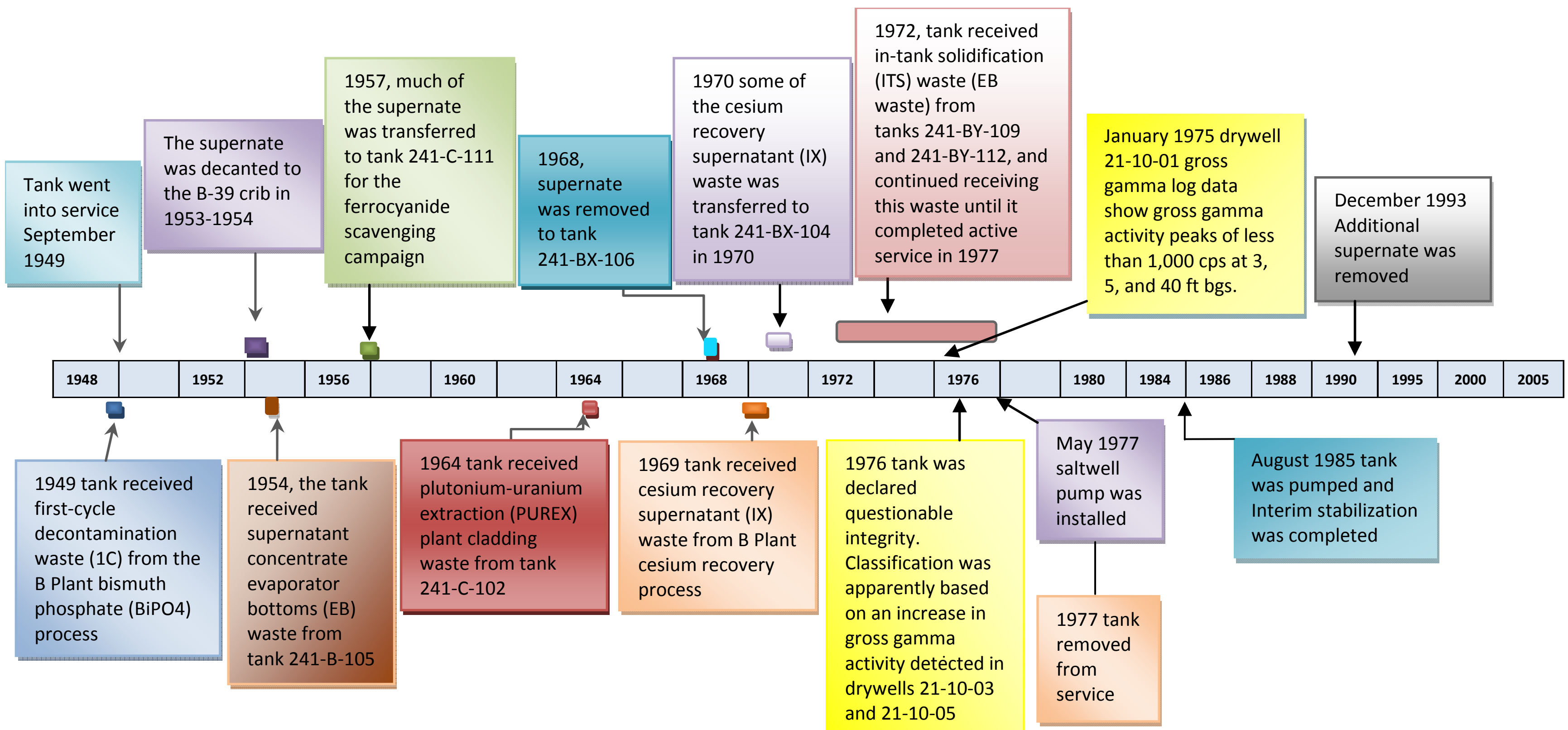
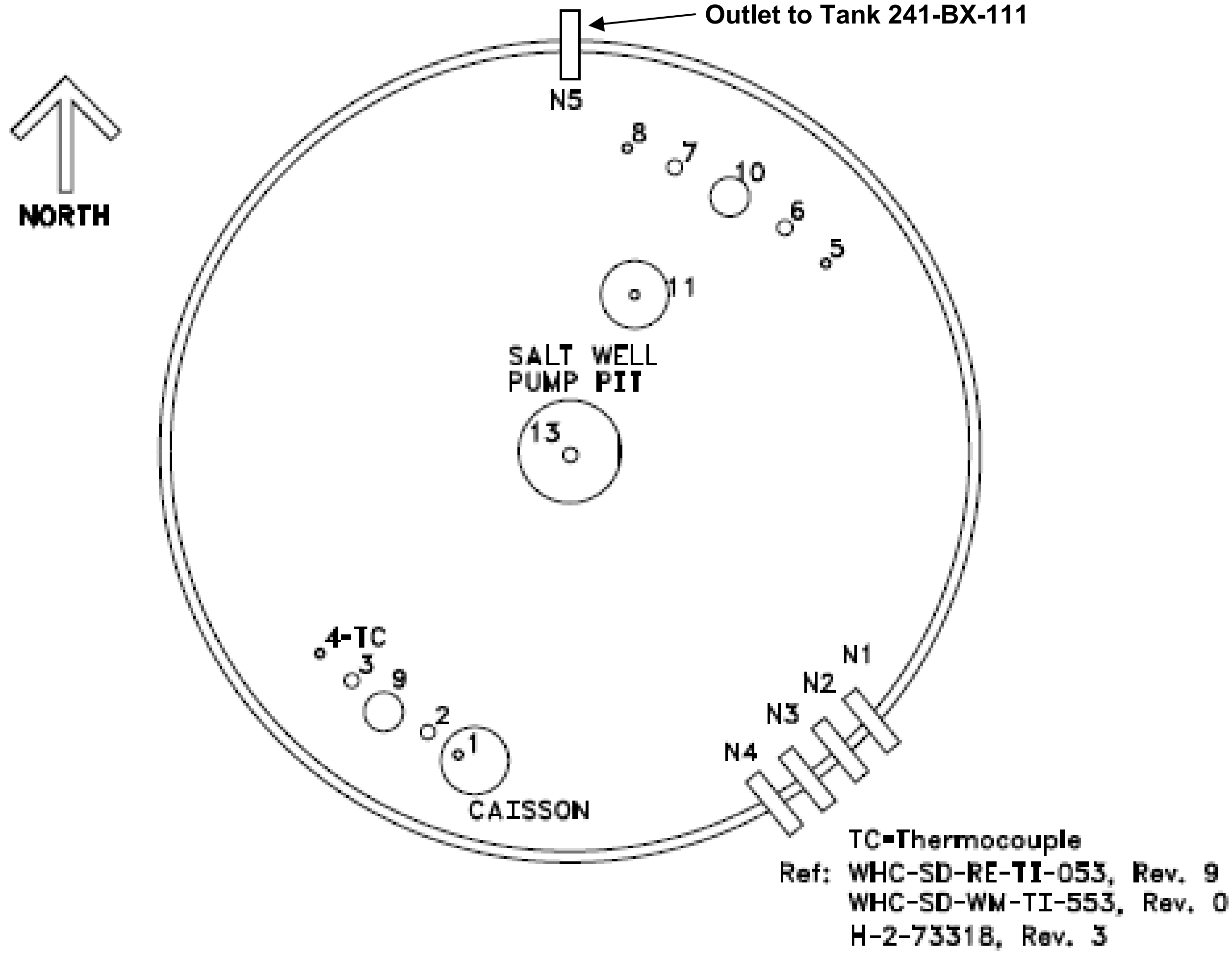


Figure B4-2. Tank 241-BX-110 Plan View

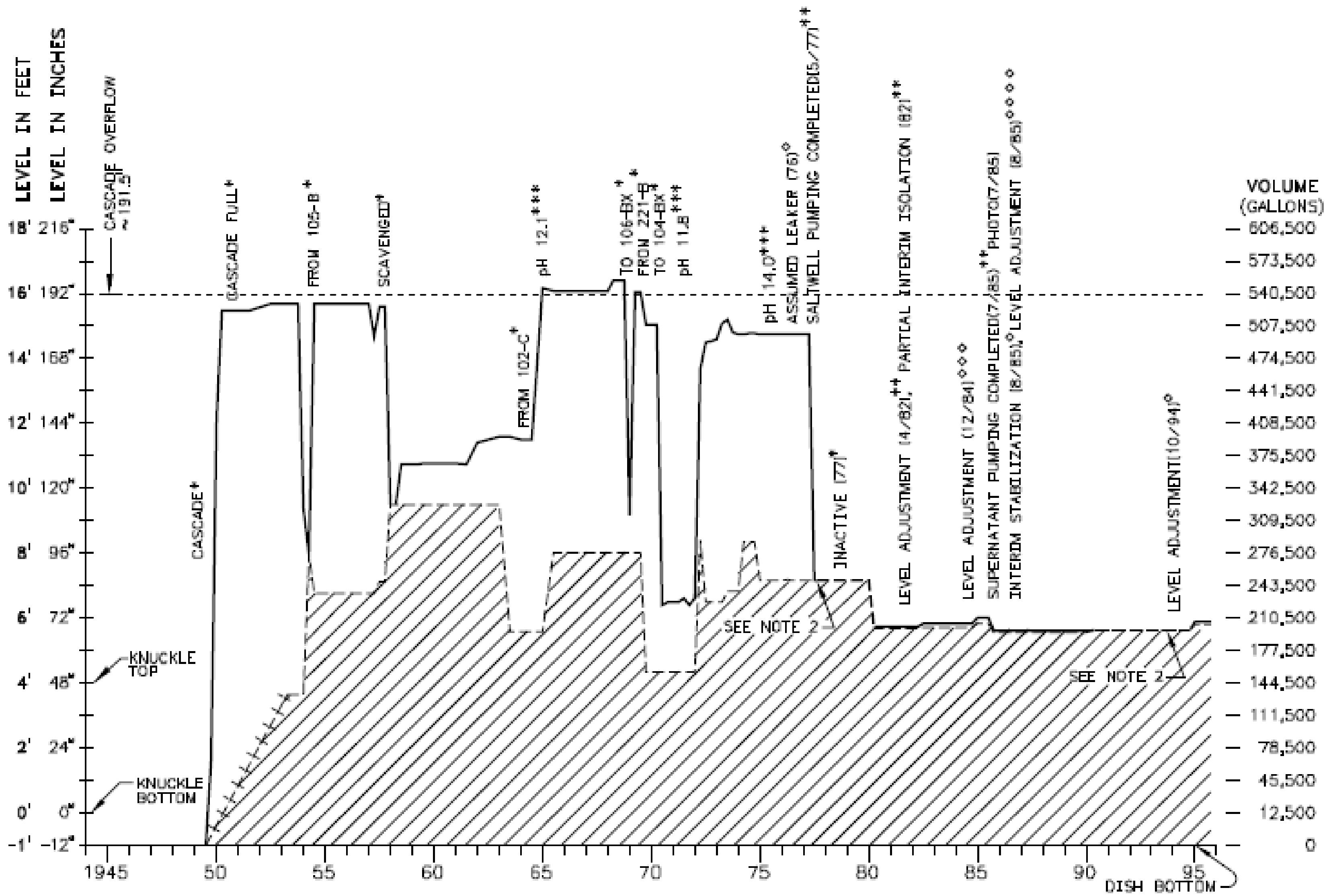


intrusion was attributed to rapid snow melt via a new pump pit under construction. Occurrence report 81-04 (OR-81-04, *Occurrence Report Tank 110-BX Liquid Level Measurement and Apparent Surface Liquid Increase*) was also due to liquid level increases in January 1981 attributed to precipitation via the R-9 riser in the new pump pit. Additional liquid level increases from intrusions were observed prior to supernate pumping in July 1985.

B4.3 INTERIM STABILIZATION

In 1977, tank BX-110 was declared inactive. A P-10 saltwell pump was installed in May 1977, but the tank was not pumped until July 1985. A photo taken after saltwell pumping on July 31, 1985, showed a liquid pool covering 15% of the surface with an estimated maximum depth of 3 inches. Interim stabilization was completed in August 1985 (HNF-SD-RE-TI-178). Additional supernate was removed in December 1993. As of December 2009 the tank contains an estimated 65 kgal of sludge, 148 kgal of saltcake, and 1 kgal of supernate (HNF-EP-0182). Figure B4-4 shows a photo mosaic of the BX-110 tank surface in October 1986.

Figure B4-3. Tank 241-BX-110 Waste Surface Level Diagram



Reference: WHC-SD-WM-ER-349, *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Area*.

Table B4-1. Tank 241-BX-110 Waste Transfer History (2 sheet)

Date/Date Range	*Transfer Type*	*Transfer Volume (gal*1000)*	*Total Vol. In Tank (gal*1000)*	*Discrepancy with previous reading (gal*1000)*	*Waste type*	*Transfer tank from/to*	*Document Number (see Section B6.0 for full reference)*
Apr. to June 1949	STAT	0				0	WHC-MR-0132
Jul. to Sep. 1949	REC	66			1C	BX-109	WHC-MR-0132
Oct. to Dec. 1949	REC	348	414		1C	BX-109	WHC-MR-0132
Jan. to Mar. 1950	REC	394			1C	BX-109	LA-UR-97-311
Jan. to Mar. 1950	SEND	-278	530		1C	BX-111	LA-UR-97-311
Apr. to June 1950	REC	246			1C	BX-109	LA-UR-97-311
Apr. to June 1950	SEND	-246	530		1C	BX-111	LA-UR-97-311
July 1950 to Nov. 1953	STAT		530		1C	0	LA-UR-97-311 HW-30498
Dec. 1953	SEND	-208	322		1C	B-039 CRIB	HW-30498 LA-UR-97-311
Jan. 1954	STAT				1C		HW-30851
Feb. 1954	SEND	-86			1C	B-039 Crib	LA-UR-97-311
Mar. 1954	STAT		276	34	1C	No explanation for discrepancy	HW-31374
Apr. 1954	SEND	-40	236		1C	B-039 CRIB	HW-31811
May 1954	STAT		236		1C		HW-32110
June 1954	REC	294	530		EB	B-105	HW-32389
July 1954 to Dec. 1956	STAT		530		EB		HW-32697 HW-47640
Jan. to Sep 1957	STAT		497 to 527		EB	Electrode readings variation	HW-48144 HW-52932
Oct. 1957	SEND	-91	436		EB	Scavenged to C-111	HW-53573
Nov. 1957	STAT	-110	326		EB	C-111	HW-54067
Dec. 1957 to Apr. 1958	STAT		326		EB		HW-54519
May 1958	STAT		367	41	EB	New electrode reading	HW-56357
June 1958 to Mar. 1959	STAT		367		EB		HW-56761 HW-60005
Apr. 1959 to Dec. 1960	STAT		368		EB		HW-60419 HW-68292
Jan. to Jun 1961	STAT		367		EB		HW-71610
July to Dec. 1961	REC		389		EB	22 flush from BXR Vault	HW-72625
Jan. 1962 to June 1964	STAT		392-395		EB	Electrode readings	HW-74647 HW-83368
July to Dec. 1964	REC	154	546		1C-EB-CW	C-102	RL-SEP-260
Jan. 1965 to Dec. 1967	STAT		543		EB-CW		RL-SEP-659 ARH-326
Jan. to Mar. 1968	REC	11	554		EB-CW	Catch tank	ARH-534

Table B4-1. Tank 241-BX-110 Waste Transfer History (2 sheet)

Date/Date Range	Transfer Type	Transfer Volume (gal*1000)	Total Vol. In Tank (gal*1000)	Discrepancy with previous reading (gal*1000)	Waste type	Transfer tank from/to	Document Number (see Section B6.0 for full reference)
Apr. to Sep. 1968	STAT		554		EB-CW		ARH-721 ARH-871
Oct. to Dec. 1968	SEND	-239	315		EB	BX-106	ARH-1061
Jan. to Mar. 1969	REC	229	542		EB-IX	221-B	ARH-1200 A
Apr. to June 1969	STAT		542		EB-IX		ARH-1200 B
July to Sep. 1969	SEND	-33	509		EB-IX	BY-102	ARH-1200 C
Oct. 1969 to Mar. 1970	STAT		509		EB-IX		ARH-1200 D ARH-1666 A
Apr. to Jun 1970	SEND	-285	224		EB	BX-104	ARH-1666 B
July 1970 to Dec. 1971	STAT		224-231		EB		ARH-1666 C ARH-2074 D
Jan. to Mar. 1972	REC	813			EB	BY-109	LA-UR-97-311
Jan. to Mar. 1972	SEND	-580	464		EB	BY-112	LA-UR-97-311 ARH-2456 A
Apr. to June 1972	REC	27	491		EB	BY-112	ARH-2456 B
July to Sep. 1972	REC	1	492		EB	BY-112	ARH-2456 C
Oct. to Dec. 1972	REC	2	494		EB	BY-112	ARH-2456 D
Jan. to Mar. 1973	REC	16	510		EB	BY-112	ARH-2794 A
Apr. to June 1973	REC	4	514		EB	BY-112	ARH-2794 B
July to Sep 1973	SEND	-13	501		EB	BY-112	ARH-2794 C
Oct. to Dec. 1973	SEND	-2	499		EB	BY-112	ARH-2794 D
Jan. 1974 to Apr. 1977	STAT		499		EB		ARH-CD-133A ARH-CD-822 APR
May 1977	SEND	-67	442			A-102	ARH-CD-822 MAY
June 1977	SEND	-193	249		EB/EVAP	A-102	RHO-CD-14 JUN 77
July 1977 to May 1978	STAT		249		EB/EVAP		RHO-CD-14 JULY 77 RHO-CD-14-MAY
June 1978	STAT		249		EB/EVAP	Questionable Integrity Tank	RHO-CD-14-JUN-78 WHC-MR-0132
July 1978 to Dec 1979	STAT		249		EB/EVAP		WHC-MR-0132
Jan. to Feb. 1980	SEND	-51	202		EB/EVAP	Through BX-105 to A-102	LA-UR-97-311 WHC-MR-0132
Mar. 1980	STAT		202		New Photo 2/19/80		WHC-MR-0132
Apr 1980 to Dec. 1980	STAT		202		EB/EVAP		WHC-MR-0132

1C = first cycle waste
CW = cladding (coating) removal waste
EB = Evaporator Bottoms (waste)
EVAP = Evaporator feed (waste)
IX = ion-exchange (waste)

B4.4 TANK 241-BX-110 TEMPERATURE HISTORY

No temperature measurements were found before 1974. As shown in Figure B4-5, between 1974 and 2009 the tank temperature ranged between 55 and 77°F indicating that the tank is a low heat tank. Tank temperature is monitored by a single thermocouple tree.

B4.5 DATA REVIEW AND OBSERVATIONS

B4.5.1 Liquid Level Measurements

Table B4-2 shows liquid level measurement from 1973 to 1987 (SD-WM-TI-356). As noted previously, several liquid level increases were observed, but no significant decreases were noted during this period. In-tank photos taken July 1985 showed the liquid level plummet contacting solids in a depression and an uneven waste surface with some shallow surface liquid (SD-WM-TI-356). The waste transfer history indicates as much as 554 kgal of waste in the tank in 1968, above the spare inlet level of 551.4 kgal.

B4.5.2 Drywell Logging Data

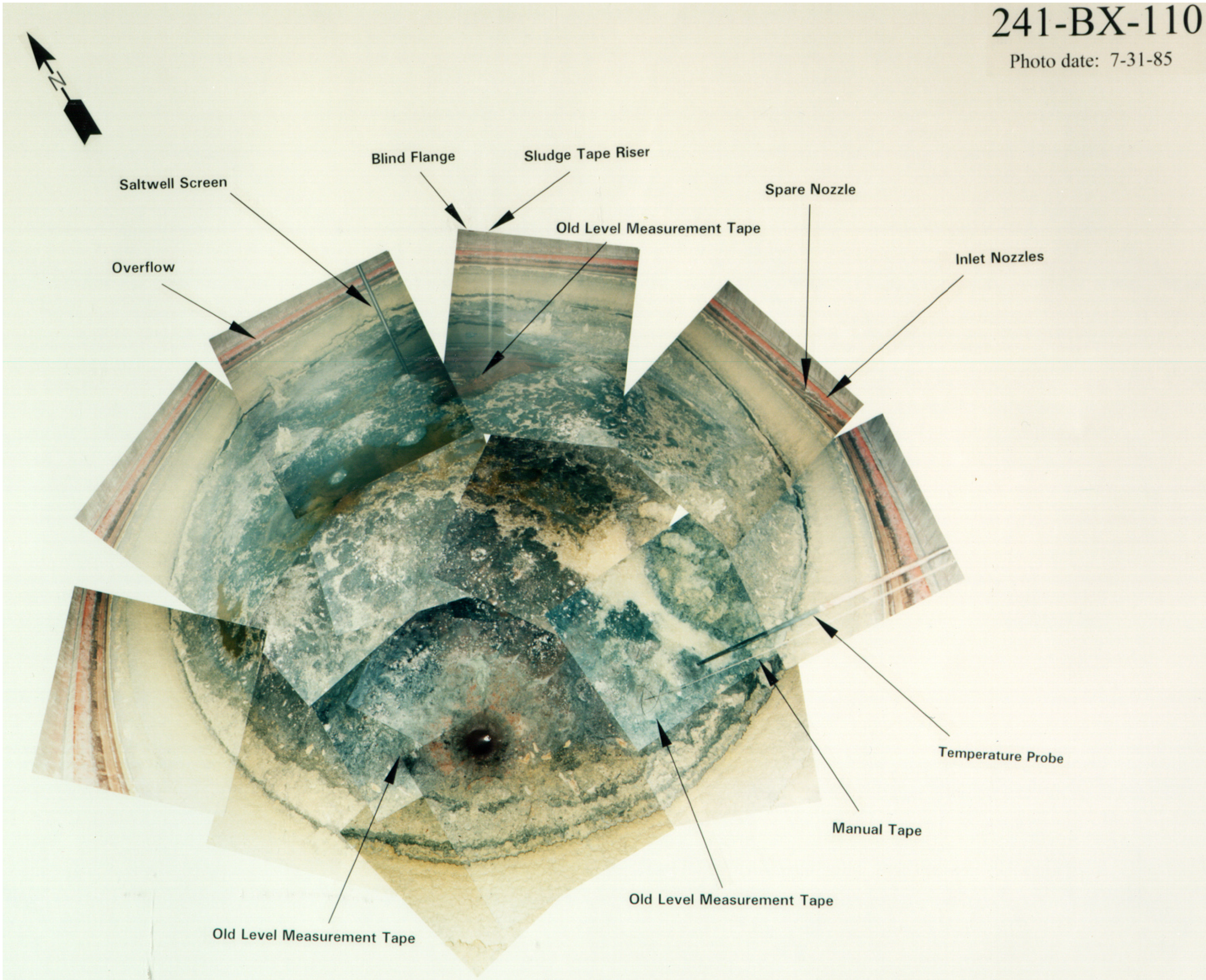
Six drywells surround tank BX-110. Figure B4-6 shows SGLS results for these drywells. Of the six, drywells 21-10-03 and 21-10-05 show the highest gamma activity. An increase in activity was also observed at 21-10-01. Historical total gamma results (HNF-3531) and SGLS results (GJ-HAN-103, *Hanford Tank Farms Vadose Zone: Tank Summary Data Report for Tank BX-110*, GJO-98-40-TARA/GJO-HAN-19, *Hanford Tank Farms Vadose Zone: Addendum to the BX Tank Farm Report*) for these three drywells are summarized below.

Drywell 21-10-01 is located approximately 6 ft from the northeast side of tank BX-110. This drywell was drilled in September 1971 and completed at a depth of 100 ft with 6-in. casing. The total logging depth achieved by the SGLS was 98.5 ft.

Historical gross gamma log data (Figure B4-7) show gross gamma activity peaks of less than 1,000 cps at 3, 5, and 40 ft bgs. Zones of anomalous gamma-ray activity are evident on the earliest gross gamma log shown (January 1975), indicating that contamination was present before that time. The intensity of the gamma-ray activity decreased only slightly between 1975 and 1989 indicating that the activity is from a relatively long-lived isotope, such as ^{137}Cs. The earliest recorded log found (July 24, 1972) indicates a zone of anomalous gamma-ray activity at a depth of about 40 ft (SD-WM-TI-356).

The 1998 SGLS results (Figure B4-6) show ^{137}Cs contamination from the ground surface to a depth of about 29 ft at a peak of about 10 pCi/g, from 38 to 56 ft ranging up to 60 pCi/g, and from 68 to 75 ft at less than 1 pCi/g. Cesium-137 was also observed intermittently from 76 to 91 ft. The ^{60}Co contamination was detected intermittently from 41.5 to 62 ft at 0.1 to 0.5 pCi/g.

Figure B4-4. 241-BX-110 In-Tank Photo Mosaic



Reference: WHC-SD-WM-ER-349, *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Area*.

Figure B4-5. Tank 241-BX-110 Waste Temperature Measurements

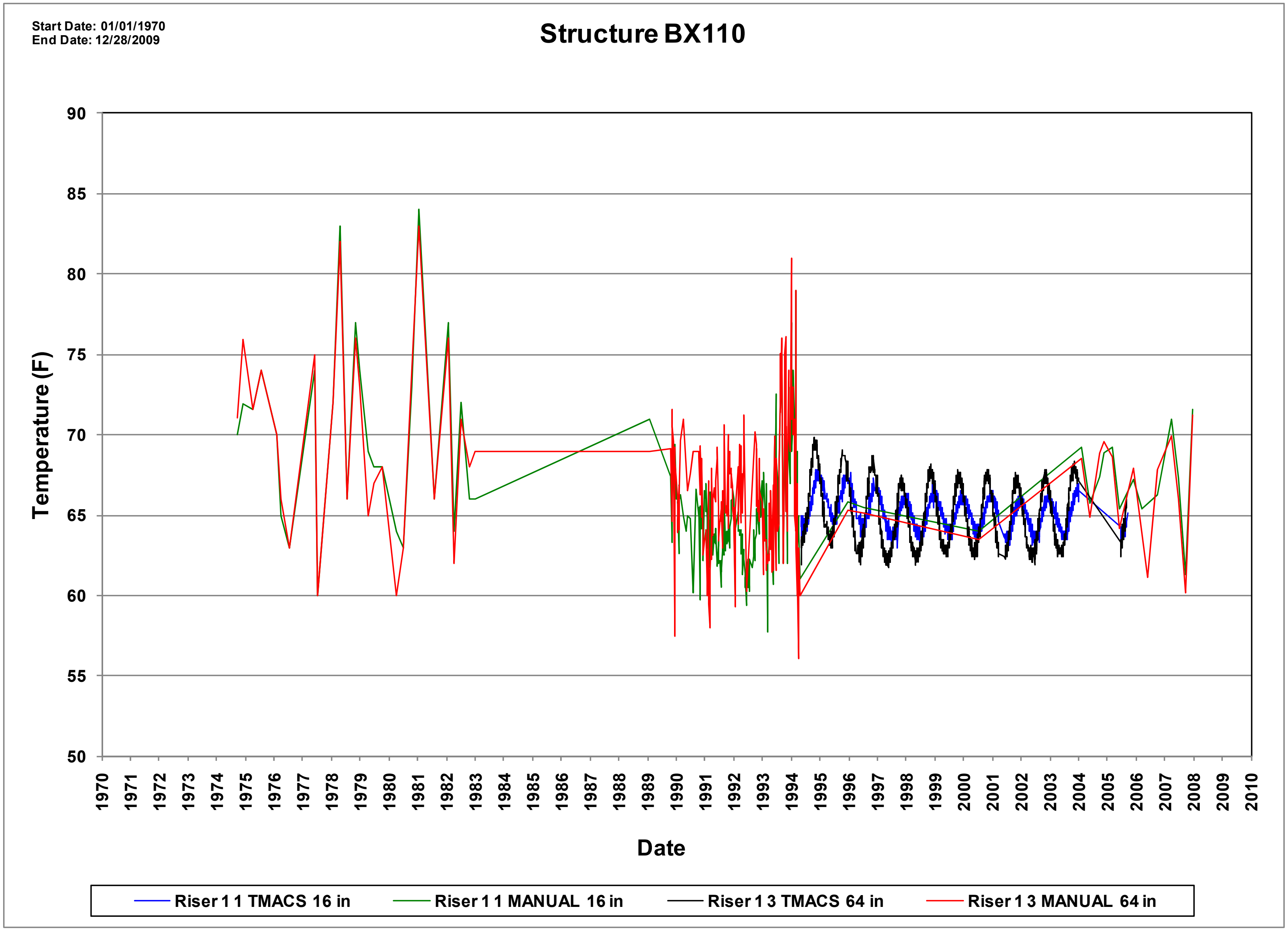


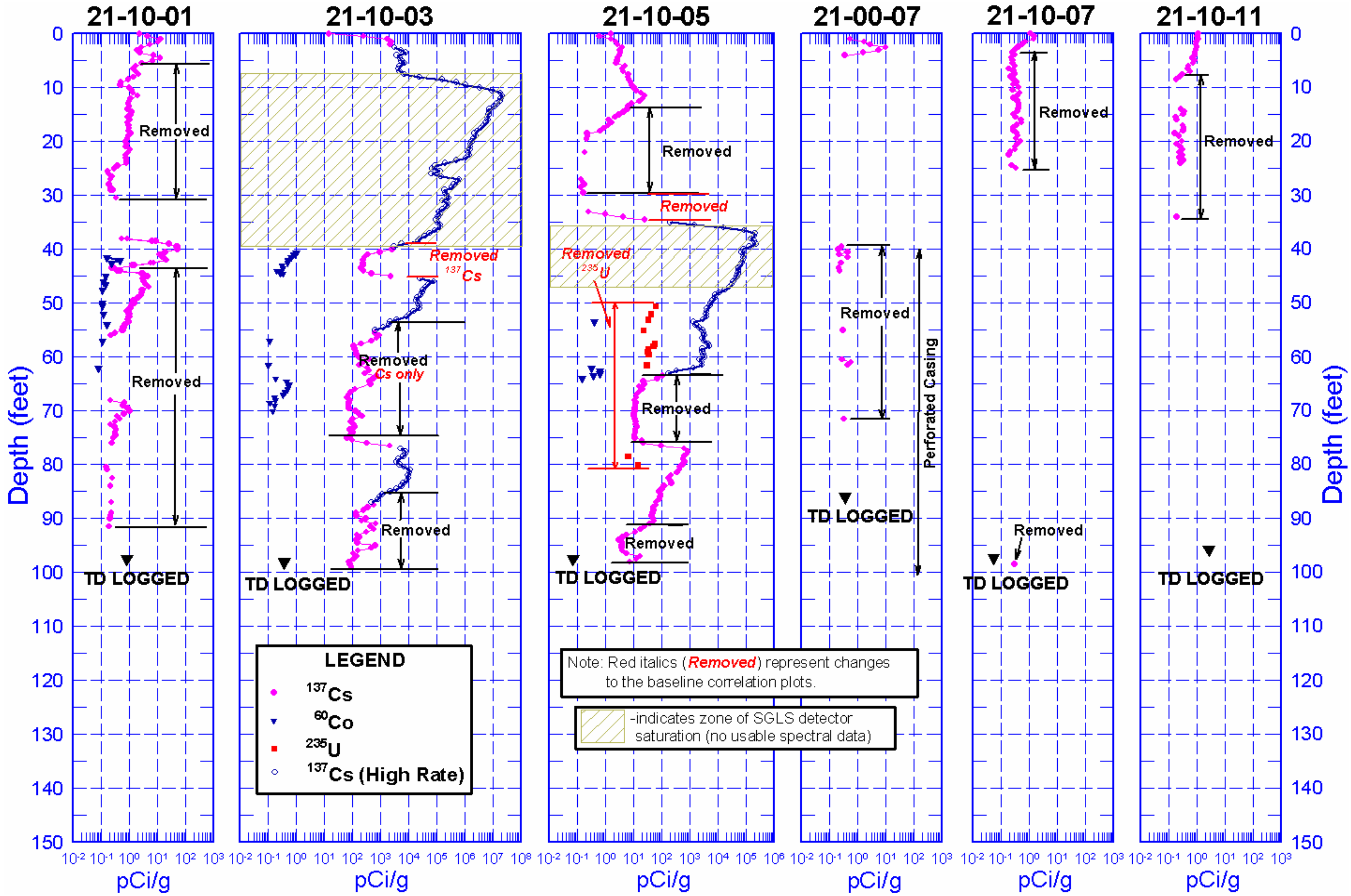
Table B4-2. Tank 241-BX-110 Liquid Level Measurements (1973 to 1987)

Liquid Level.

Date	Liquid level (in.)	Baseline ref.	Change from previous reading (in.)	Cumulative change (in.)	Comments
06/15/73	194.00				Manual tape
07/24/73	194.50		+0.50	+0.50	Slow increase
07/25/73	177.50			+0.50	New tape installed
11/12/73	177.75		+0.25	+0.75	Slow increase
11/13/73	177.00		-0.75		Unexplained drop
06/12/74	177.00				Stable
06/13/74	177.25				Slow decrease
12/01/76	177.25				Stable
12/02/76	177.00		-0.25	-0.25	Slow decrease
04/18/77	177.00			-0.25	Stable
05/11/77	177.25		+0.25		Slow increase
05/28/77		75.50			Transfers
10/20/77	76.50		+1.00	+1.00	Slow increase
04/26/78		76.50		+1.00	Drainage after transfer
01/12/80	76.50			+1.00	Stable
01/13/80	79.00			+1.00	Snow melt drainage (OR 80-4)
01/30/80	73.00			+1.00	Transfers
02/19/80		69.00		+1.00	Photographs 2/20/80
05/04/80	69.00			+1.00	Stable
06/02/80	69.25			+1.00	Precipitation
09/11/80	70.00			+1.00	Precipitation (OR 81-04)
12/22/80	70.25			+1.00	Unexplained increase
02/18/81	70.25			+1.00	Stable
03/02/81	70.25	70.00		+1.00	Stable
02/22/82	70.75			+1.00	Slow increase
07/28/82	71.00			+1.00	Steady increase
08/20/82		71.00		+1.00	Intrusions OLDR 82-11
02/14/83	71.00			+1.00	Stable
02/13/84	71.25		+0.25	+1.00	Readings fluctuate from 71.00 to 71.50 in.
02/15/85	71.75		+0.50	+1.75	Slow increase
07/15/85	71.50		-0.25	+1.50	Stable
08/05/85*		66.50			Transfer to 244-BX
02/10/86	66.25				Stable
07/01/86	66.25				Stable
03/04/87	67.00				Steady 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 plummet is contacting solids and measurements are primarily to detect intrusions.

Figure B4-6. Spectral Gamma Logging System Data for Drywells Surrounding Tank 241-BX-110



Reference: GJO-98-40-TARA/GJO-HAN-19, *Hanford Tank Farms Vadose Zone: Addendum to the BX Tank Farm Report.*

Drywell 21-10-03 is located approximately 7 ft from the east side of tank BX-110. This drywell was drilled in September 1973 and completed at a depth of 100 ft with 6-in. casing. The total logging depth achieved by the SGLS was 99.0 ft.

Historical gross gamma log data from 1980 to 1994 (HNF-3531) and data summarized in SD-WM-TI-356 were reviewed (Figure B4-8). The zones of high gamma-ray activity in this drywell appear on the earliest gross gamma-ray log (July 1980), indicating that the associated contamination was in place before that date. The activity decreased gradually between 1980 and 1994 indicating that the contaminants are relatively long-lived radionuclides, such as ^{137}Cs.

The 1998 SGLS results (Figure B4-6) show ^{137}Cs contamination continuously from the ground surface to the bottom of the drywell. High gamma-ray activity resulted in excessive detector dead time from 7 to 39 ft, 45.5 to 51.5 ft, and 81 to 82.5 ft. Subsequent HRLS measurements showed ^{137}Cs levels greater than 1E7 pCi/g starting at about 12 ft bgs and decreasing to less than 1E5 pCi/g between 40 and 90 ft bgs. Cobalt-60 contamination was detected ranging from 0.5 to about 1.0 pCi/g from 40 to 45 ft and from 57 to 70 ft.

Drywell 21-10-05 is located approximately 5 ft from the southeast side of tank BX-110. This drywell was constructed in September 1971 and completed at a depth of 100 ft with 6-in. casing. The total logging depth achieved by the SGLS was 98.0 ft.

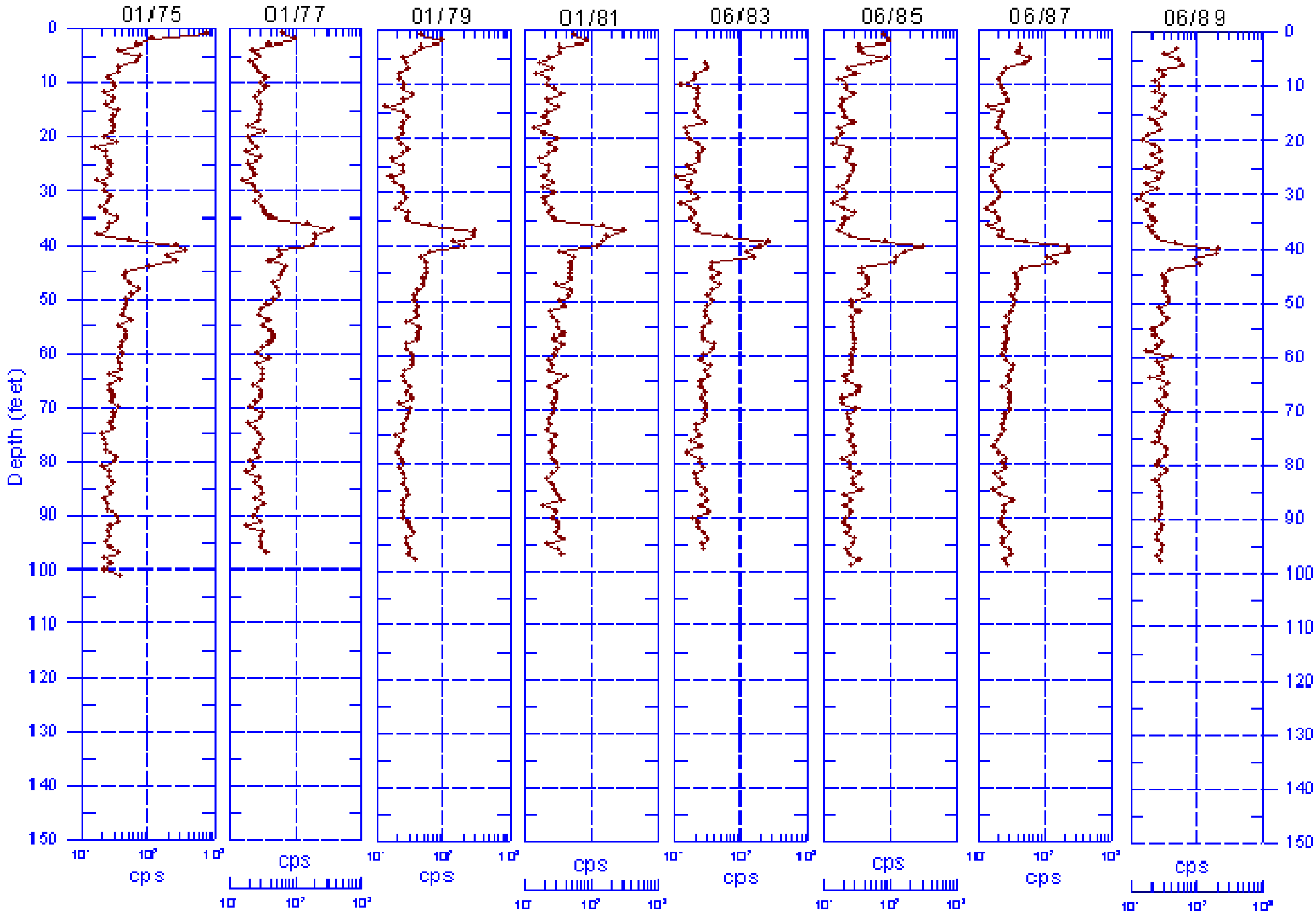
Figure B4-9 shows historical gross gamma data acquired in this drywell from 1980 through 1989. The figure shows activity was present before July 1980. SD-WM-TI-356 shows high gamma activity present between 35 and 40 ft bgs as early as July 24, 1972. The gamma activity decreased slowly with time, indicating a relatively long-lived radionuclide, such as ^{137}Cs.

In 1998 the man-made radionuclides ^{137}Cs, ^{60}Co, and ^{235}U were detected using SGLS. The ^{137}Cs contamination occurs continuously from the ground surface to a depth of about 20 ft, intermittently from 20 to 30 ft, continuously from 33 to 35 ft, and continuously from 46 ft to the bottom of the logged interval (98 ft). High dead time was observed from 35 to 45 ft bgs. High rate logging system measurements in 2000 showed that the peak activity in this region was >1E7 pCi/g between 35 and 40 ft and decreased to <1E4 below 60 ft. Cobalt-60 contamination between 0.1 and 1 pCi/g was detected at about 54 ft and continuously from 62 to 64 ft. Uranium-235 contamination between 10 and 100 pCi/g was detected intermittently from 50 to 62 ft and at 79 and 80 ft.

B4.5.3 Direct Push 2006

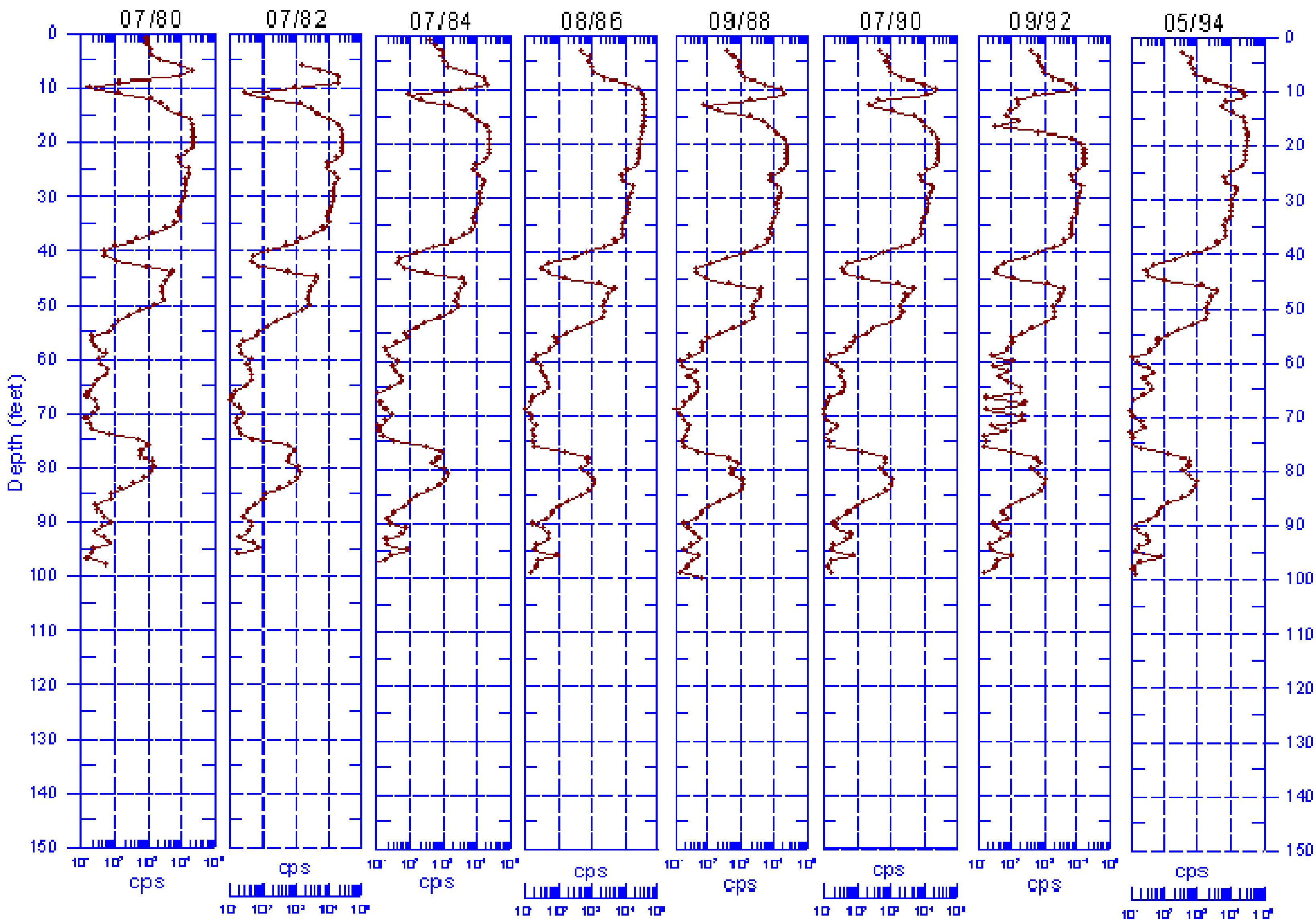
Direct push measurements near tank BX-110 also showed high activity in small diameter push holes C5117, C-5119 and C-5121. Figure B4-10 shows the location of the holes drilled and peak logging results. The holes were too hot to obtain samples.

Figure B4-7. Drywell 21-10-01 Historical Gamma Data (1975 to 1989)



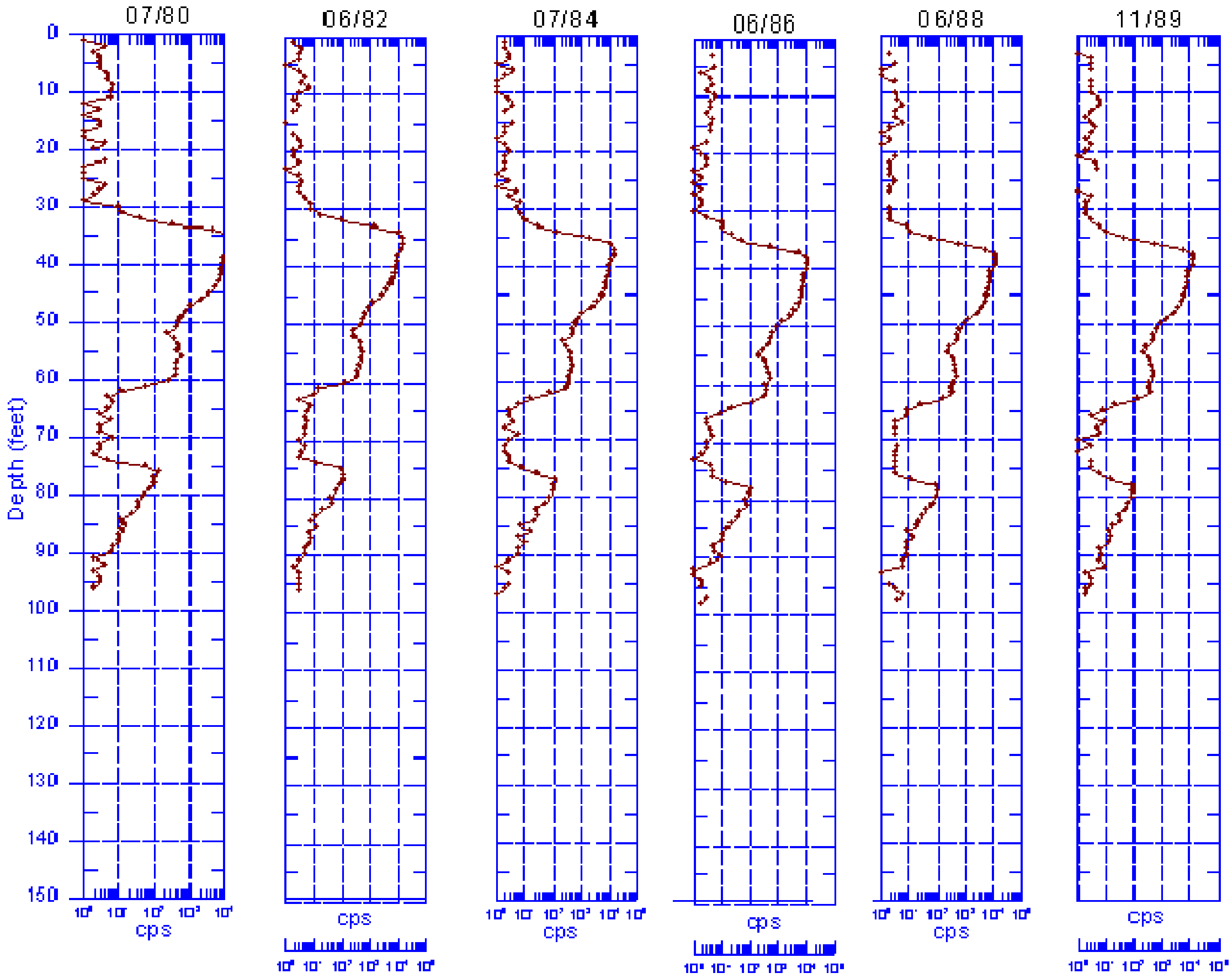
Reference: HNF-3531, *Analysis of Historical Gross Gamma Logging Data from BX Tank Farm.*

Figure B4-8. Historical Gross Gamma for Drywell 21-10-03 (1980 to 1994)



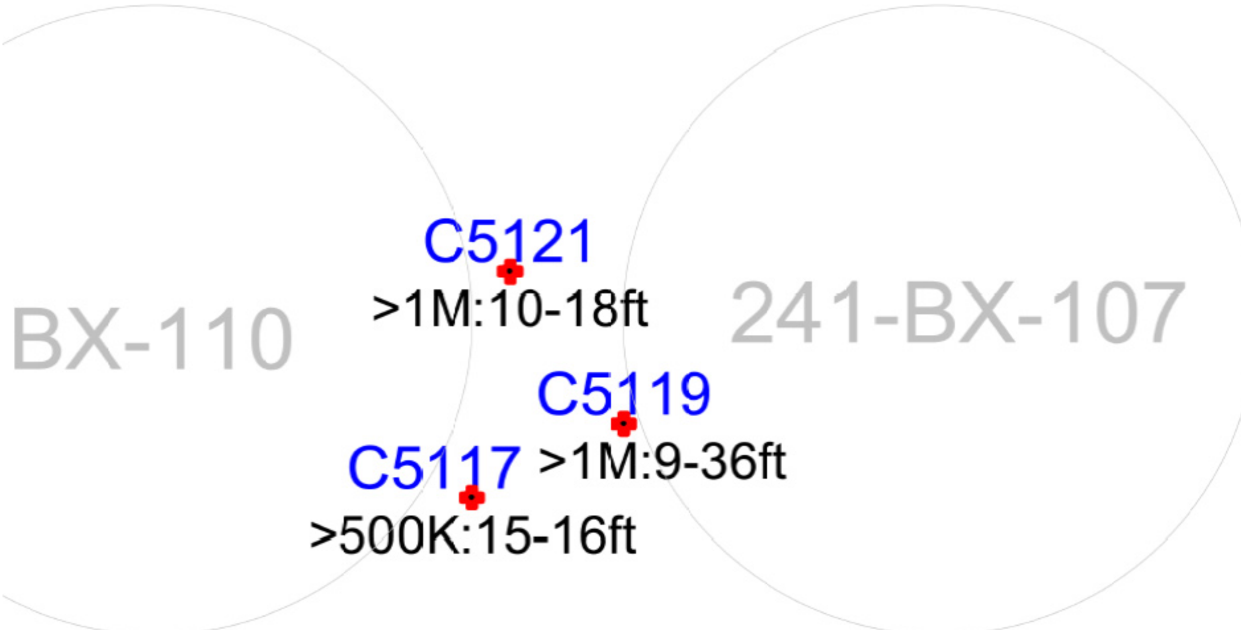
Reference: HNF-3531, *Analysis of Historical Gross Gamma Logging Data from BX Tank Farm*.

Figure B4-9. Drywell 21-10-05 Historical Gross Gamma (1980 to 1989)



Reference: HNF-3531, *Analysis of Historical Gross Gamma Logging Data from BX Tank Farm*.

Figure B4-10. Direct Push Logging Results near Tank 241-BX-110 (logging units pCi/g equivalent Cesium-137)



B4.6 ASSESSMENT

Process information, in-tank monitoring data, and associated drywell logging data for tank 241-BX-110 presented in Sections 4.1 through 4.4 were reviewed. No previous assessments were found for this tank. In-tank liquid level monitoring results indicate small decreases and increases for the waste surface in tank BX-110. Photos reviewed showed salt crystals on the BX-110 manual tape gauge in 1974 that likely contributed to changes in the manual tape readings (Figure B4-11). Historical transfer records show that tank BX-110 liquid levels were higher than spare inlet port levels at different periods and drywells near the spare inlet outlets show increased activity. Earlier assessments for tanks BX-102 (HW-20438-DEL and HW-20742) and BX-106 (RPP-9752, *Leak Assessment for Tank 241-BX-106*) concluded that activity near these tanks was due to spare inlet overflows. SD-WM-TI-356 states that early drywell gamma activity near tanks BX-107 (21-07-06) and BX-110 (21-10-03 and 21-10-05) were associated with transfer line leaks. SD-WM-TI-356 also states that auger wells drilled in 1974 near 21-07-06 indicated that the high activity was associated with a transfer line leak, but no additional information was found regarding transfer line leaks. MEM-092672 presents data for drywell 21-10-05. Based on the absence of ^{134}Cs he concluded that the source of activity in the well was more than 10 years old. Historical gamma logs, spectral gamma logs, and direct push logs show peak activity at about 12 ft bgs in some drywells extending to below the base of the tanks in other drywells. The logging data indicates multiple transfer line leaks or other near surface leaks may have occurred.

Figure B4-11. Salt Crystals on Tank 241-BX-110 Manual Tape (January 31, 1974)

B4.7 CONCLUSION

Because the data suggests two potential leak sources (tank over flow and transfer line leaks) for activity near tank BX-110 in addition to a potential tank leak it is recommended that tank BX-110 be re-assessed per TFC-ENG-CHEM-D-42.

B5.0 TANK 241-BX-111 WASTE LOSS EVENT

This section provides information on the historical waste loss event associated with tank BX-111. Waste operations for tank BX-111 are summarized in Figure B5-1. Figure B5-2 shows a plan view of tank BX-110 with the location of the pump pit, flush pit, spare inlet nozzles (N1, N2, N3 and N4) and tank risers.

B5.1 TANK 241-BX-111 WASTE HISTORY

Tank BX-111 is one of 12 tanks located in the Hanford Site 200 East Area 241-BX Tank Farm. It is the second in a three-tank cascade that includes tanks 241-BX-110 and 241-BX-112. Tank BX-111 was constructed between 1946 and 1947 and went into service in 1950.

Tank BX-111 was filled with 1C waste via cascade from tank 241-BX-110 from January to May 1950. From the second to the third quarters of 1954, the tank again received 1C waste from tank 241-BX-110 and supernatant waste from various tanks. During this time period, supernatant waste was transferred to crib B-040. In the first quarter of 1957, flush water from miscellaneous sources was added. In the fourth quarter of 1957, waste was transferred to tank 241-C-109 for ferrocyanide scavenging. In the fourth quarter of 1961 flush water was again added. Waste was transferred to the tank from tank 241-C-108 in the second quarter of 1964. From the third quarter of 1968 to the third quarter of 1970, supernatant waste was transferred to various 241-BX and 241-BY tanks. During this time, the tank received supernatant waste from tank 241-BX-104.

From the third quarter of 1971 to the third quarter of 1974, tank BX-111 was used as a bottoms receiver and feed recycle tank for ITS. Transfers from various 241-BY tanks into and out of tank BX-111 were made during this time. From the first quarter of 1977 to the fourth quarter of 1977, supernatant waste was transferred to and received from tank 241-A-102 as part of the 242-A Evaporator campaign. Saltwell liquor was transferred to tank 241-AN-101 in the second quarter of 1984 and the third quarter of 1989. Saltwell liquor was transferred again to tank 241-AN-101 from the fourth quarter of 1993 to near the end of the first quarter of 1995 when tank BX-111 completed active service (WHC-MR-0132, LA-UR-97-311). Figure B5-3 shows tank waste surface levels during operations and Table B5-1 shows transfers to and from the tank during operations.

B5.2 INTEGRITY OF TANK 241-BX-111

In 1976, the tank was declared “questionable integrity” and in 1977, it was removed from service.

The questionable integrity classification was apparently based on an increase in gross gamma activity detected in drywells 21-11-03, 21-11-04, 21-11-05, and 21-11-07 (August 17, 1988 Memo 13331-88-460) and a liquid level decrease in 1974. No leak volume estimate is assigned in HNF-EP-0182.

Figure B5-1. Tank 241-BX-111 Operations Timeline

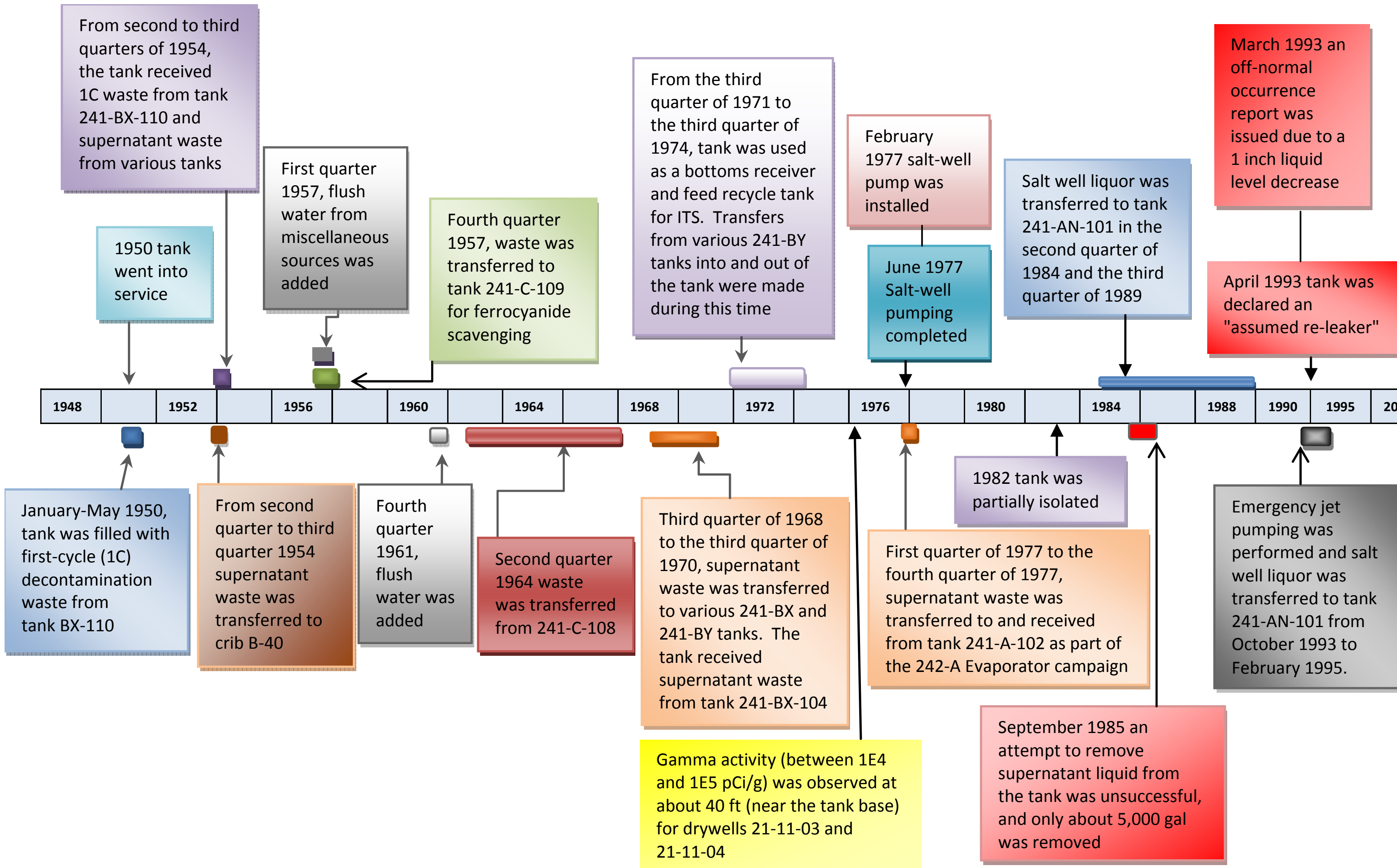
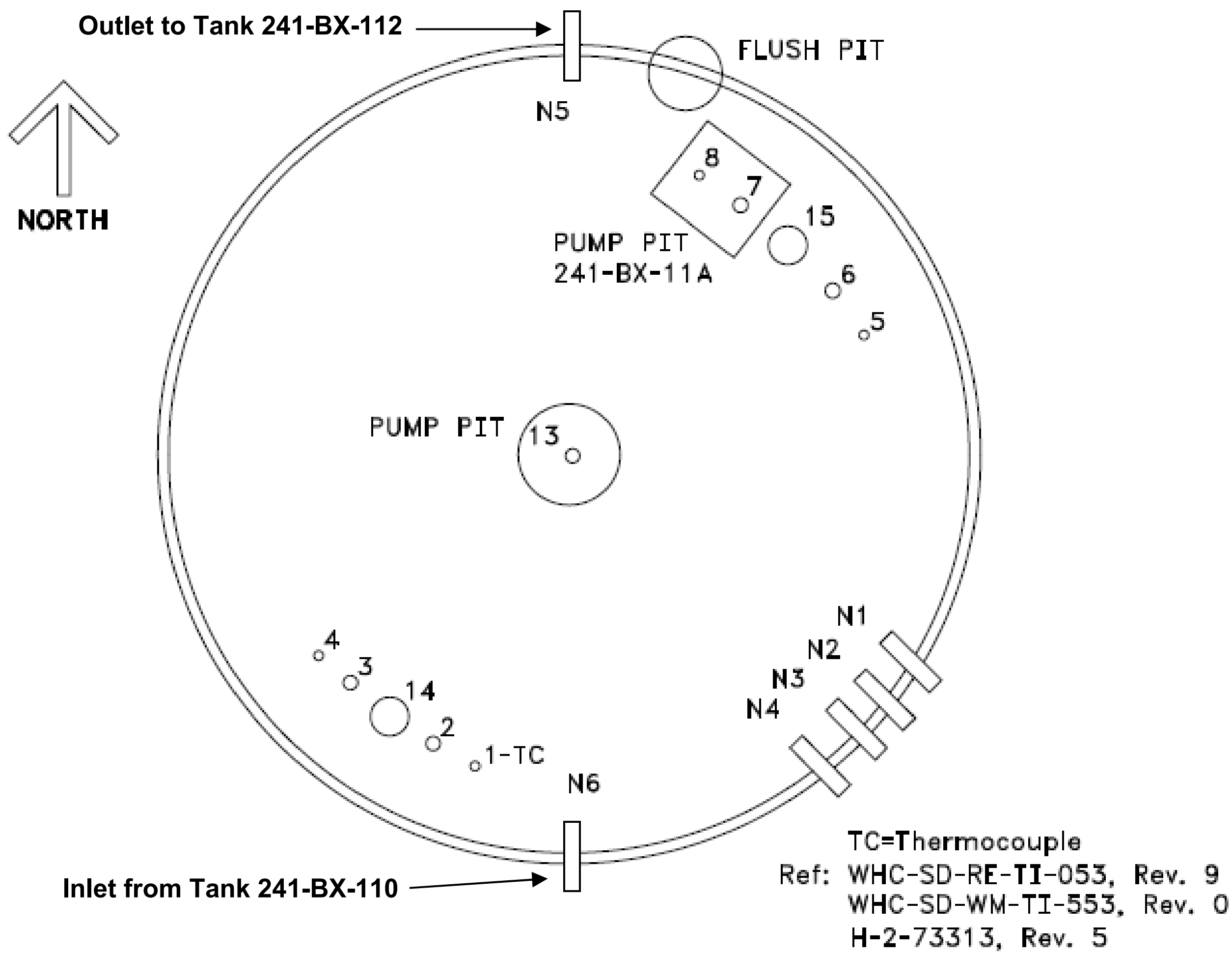


Figure B5-2. Tank 241-BX-111 Plan View



B5.3 INTERIM STABILIZATION

A P-10 saltwell pump was installed in February 1977, and saltwell pumping was completed in June 1977 and the tank was partially isolated in 1982 (SD-WM-TI-356). An attempt to remove supernatant liquid from the tank in September 1985 was unsuccessful, and only about 5,000 gal was removed. An off-normal occurrence report was issued in March 1993 due to a 1-in. liquid level decrease; the manual tape was determined to be repeatable within 0.5 in (RL-WHC-TANKFARM-1993-0035, *Single-Shell Underground Waste Storage Tank 241-BX-111 Surface Level Decrease and Change From Steady State Condition*). As of the final report (January 1994), the surface level decrease was still under investigation. Prior to the decrease the manual tape showed a surface level increase (SD-WM-TI-356) and there was no observed changed in the liquid observation well. The liquid observation well was "considered accurate within 1.2 inches, and would not be expected to reflect a 1 inch drop." The tank was declared an "assumed re-leaker" in April 1993 and emergency jet pumping to remove supernatant liquid was performed from Oct 1993 to February 1995. In March 1995 the tank was administratively stabilized due to a major equipment failure. A total of 117 kgal of supernate

Figure B5-3. Tank 241-BX-111 Waste Surface Level Diagram

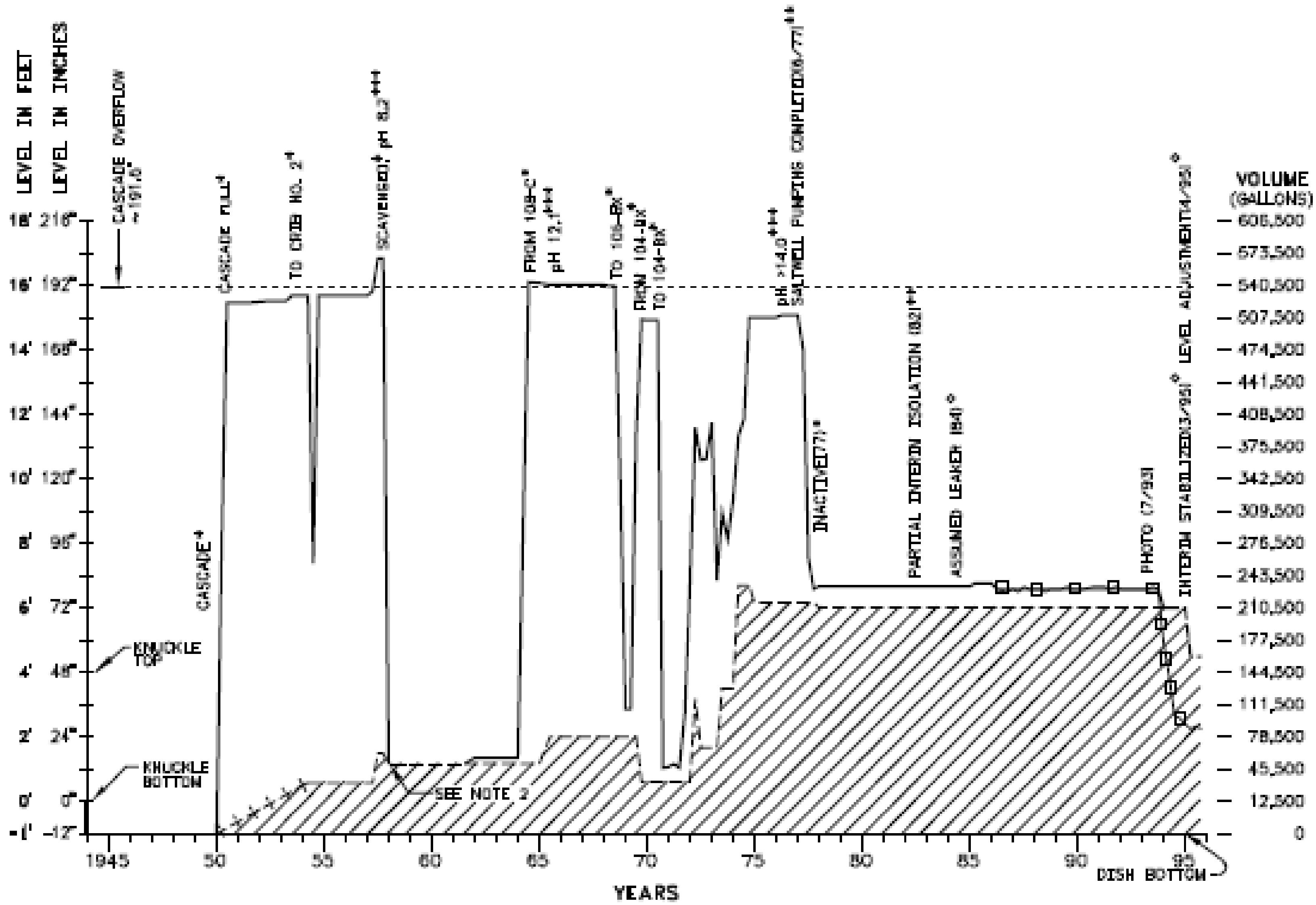


Table B5-1. Tank 241-BX-111 Waste Transfer History (2 sheets)

Date/Date Range	*Transfer Type*	*Transfer Volume (gal*1000)*	*Total Vol. In Tank (gal*1000)*	*Discrepancy with previous reading (gal*1000)*	*Waste type*	*Transfer tank from/to*	*Document Number (see Section B6.0 for full reference)*
Jan. to Mar. 1950	REC	281	281		1C	BX-110 cascade	WHC-MR-0132
Apr. to June 1950	REC	249	530		1C	BX-110 full in May	WHC-MR-0132/LA-UR-97-311
July 1950 to Mar. 1953	STAT		525		1C		HW-27775
Apr. 1953 to Mar. 1954	STAT		530		1C		HW-28043/HW-31374
Apr. 1954	SEND	-457	73		1C	CRIB #2	HW-31811
May 1954	STAT		73		1C		HW-32110
June 1954	REC	183	256		1C-EB	B-105	HW-32389
July 1954 to Dec. 1956	STAT	274	530		1C-EB		HW-32697/HW-47640
Jan. to May 1957	STAT		535	5	1C-EB	Electrode reading	HW-48144/HW-50617
June 1957	STAT		568		1C-EB	Electrode reading	HW-51348
July to Oct. 1957	STAT		565		1C-EB	Scavenged to C-111	HW-51858/HW-53573
Nov. 1957	SEND	-514	51		1C-EB	C-111	HW-54067
Dec. 1957 to June 1961	STAT		51		1C-EB		HW-54519/HW-71610
July 1961 to Dec. 1963	STAT		57	6	1C-EB		HW-72625/HW-80379
Jan. to June 1964	REC		544		CW	C-108	HW-83368
July to Dec. 1964	STAT		543	-1	CW	C-102	RL-SEP-260
Jan. 1965 to Dec. 1967	STAT		541		CW		RL-SEP-659/ARH-326
Jan. to June 1968	STAT		540		CW		ARH-534/ARH-721
July to Sep. 1968	SEND	-198	342		CW	BX-106	ARH-871
Oct. to Dec. 1968	SEND	-236	107	1	CW	BX-106	ARH-1061
Jan. to Mar. 1969	STAT		107				ARH-1200 A
Apr. to June 1969	REC	183	390		CW-IX	BX-104	ARH-1200 B
July to Sep. 1969	REC	149	506		CW-IX	BX-104	ARH-1200 C
Oct 1969 to June 1970	STAT		505	-1	CW-IX		ARH-1200 D/ARH-1666 B
July to Sep. 1970	STAT	-458	47		CW-IX		ARH-1666 C
Oct. to Dec. 1970	STAT		48	1	CW-IX		ARH-1666 D
Jan. to Mar. 1971	STAT		51	3			ARH-2074 A

Table B5-1. Tank 241-BX-111 Waste Transfer History (2 sheets)

Date/Date Range	Transfer Type	Transfer Volume (gal*1000)	Total Vol. In Tank (gal*1000)	Discrepancy with previous reading (gal*1000)	Waste type	Transfer tank from/to	Document Number (see Section B6.0 for full reference)
Apr. to June 1971	STAT		47	-4			ARH-2074 B
July to Sep. 1971	REC	55	102		EB	ITS bottoms, BY-112	ARH-2074 C
Oct. to Dec. 1971	REC	133	235		EB	BY-112	ARH-2074 D
Jan. to Mar. 1972	REC	160	395		EB	BY-112	ARH-2456 A
Apr. to June 1972	SEND	-33	362		EB	BY-112	LA-UR-97-311/ARH-2456 A
July to Sep. 1972	STAT		363	1	EB	BY-112	ARH-2456 C
Oct. to Dec. 1972	REC	37	400		EB	BY-112	ARH-2456 D
Jan. to Mar. 1973	SEND	-161	239		EB	BY-112	ARH-2794 A
Apr. to June 1973	REC	69	308		EB	BY-112/ BY-109	ARH-2794 B/LA-UR-97-311
July to Sep 1973	SEND	-27	281		EB	BY-112	ARH-2794 B/LA-UR-97-311
Oct. to Dec. 1973	REC	40	321		EB	BY-112	ARH-2794 D
Jan. to Mar. 1974	SEND	-5			EB	BY-112	LA-UR-97-311
Jan. to Mar. 1974	REC	71	387		EB	BY-112/BY-109	ARH-CD-133A
Apr. to June 1974	REC	17	404		EB		ARH-CD-133B/LA-UR-97-311
July to Sep. 1974	STAT		404		EB	BY-112	ARH-CD-133C
Oct. to Dec. 1974	REC	104	508		EB	BY-112	ARH-CD-133D
Jan. to Dec. 1975	STAT		508				ARH-CD-336 A ARH-CD-336 D
Jan 1976 to Jan. 1977	STAT		510	2	EB		ARH-CD-702 A ARH-CD-822 JAN
Feb. to Mar. 1977	SEND	-45	475		EB/EVAP	Saltwell installed A-102	ARH-CD-822 FEB
Apr. to May 1977	SEND	-193	282		EB/EVAP	A-102	ARH-CD-822 APR ARH-CD-822 MAY
June 1977	SEND	-22	260		EB/EVAP	A-102	RHO-CD-14 JUN-77
July 1977	STAT	-29	231		EB/EVAP	A-102	RHO-CD-14 JUL-77
Aug. 1977 to Dec. 1979	STAT		230 to 233		EB/EVAP		RHO-CD-14

1C = first cycle waste
CW = cladding (coating) removal waste
EB = Evaporator Bottoms (waste)
EVAP = Evaporator feed (waste)
IX = ion-exchange (waste)

was removed from the tank before the equipment failure and an estimated 1300 gal of supernate remained at that time. It was determined that the supernate was contained on a solid waste surface in a pocket of saltcake at the center of the tank and "does not impose a threat of leakage into the environment" (HNF-SD-RE-TI-178). As of December 2009 the tank contains an estimated 156 kgal of saltcake, 32 kgal of sludge and no supernate (HNF-EP-0182). Figure B5-4 shows a photo mosaic of the BX-111 tank surface in July 1993.

B5.4 TANK 241-BX-111 TEMPERATURE HISTORY

No temperature measurements were found before 1974. As shown in Figure B5-5, between 1974 and 2009 the tank temperature has decreased from 90 to ~65°F indicating that the tank is a low heat tank. Tank temperature is monitored by a single thermocouple tree in Riser #1.

B5.5 DATA REVIEW AND OBSERVATIONS

B5.5.1 Liquid Level Measurements

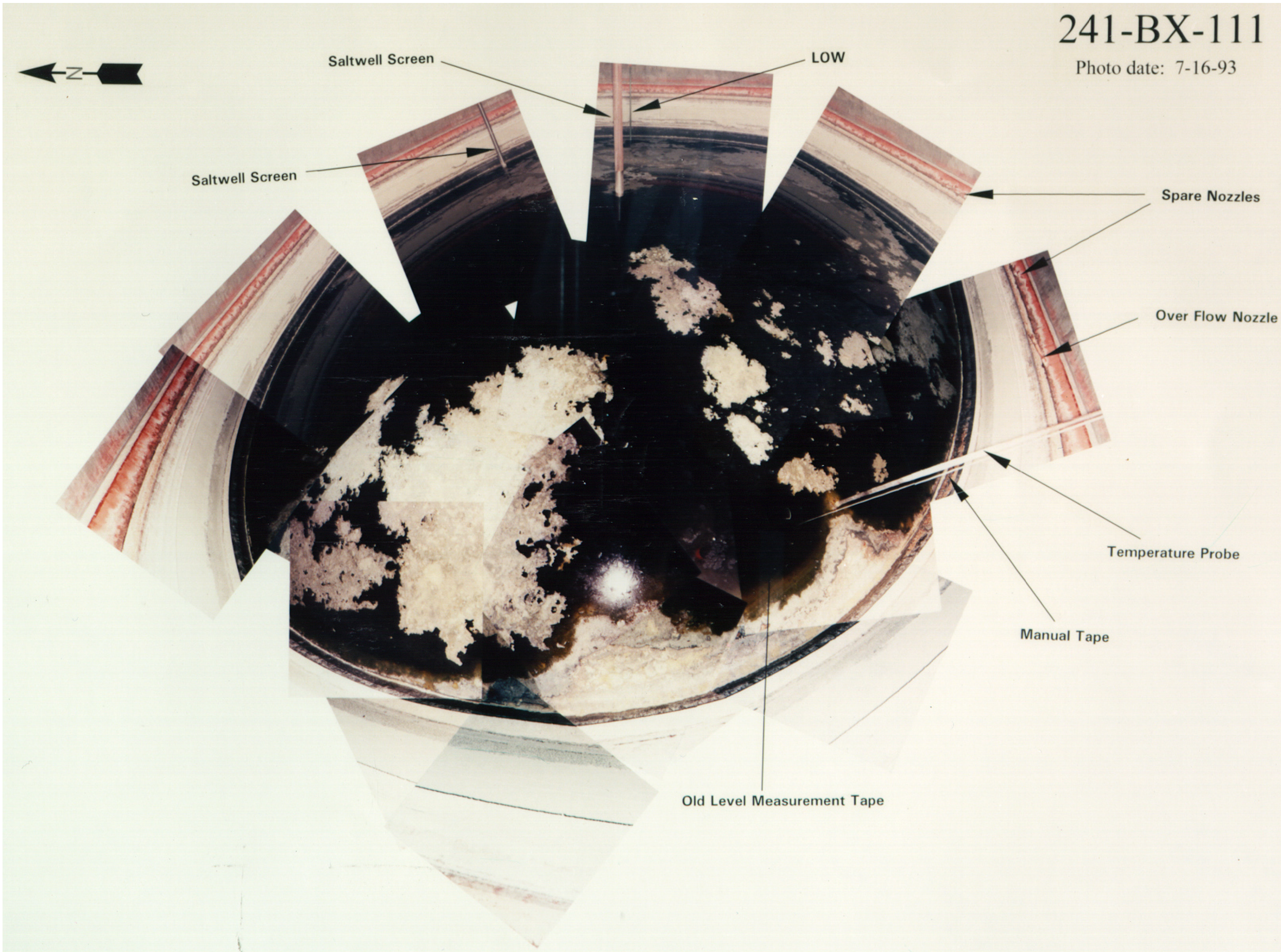
Table B5-2 shows liquid level measurement from 1973 to 1987 (SD-WM-TI-356). No significant liquid level decreases were measured during this period. Overall the liquid level increased by about 3.5 in. (SD-WM-TI-356). A transfer was made from tank 241-BY-102 to tank BX-111 on March 26, 1974. The liquid level measurements decreased 10 in. in tank 241-BY-102 and increased 10.75 in. in tank BX-111 after this transfer. Subsequently the liquid level in tank BX-111 decreased 0.75 in. between March 29, 1974 to May 5, 1974 and RL Occurrence Report 74-37, *Significant Liquid Level Decrease – 241-BX-111* was written. RL Occurrence Report 74-37 shows liquid level measurements up and down between June 15, 1973 and May 24, 1974. An investigation of the 0.75-in. drop concluded, "it is believed that the observed liquid level decrease was due to stabilization of the crust surface after the transfer. No further decreases in liquid levels and no dry well radiation increases have been observed. Based on these reasons, the tank is believed sound for continued storage of waste."

B5.5.2 Drywell Logging Data

Six drywells surround tank BX-111. Figure B5-6 shows 1998 and 2000 SGLS/HRLS results for these drywells. All six drywells show low levels of ^{137}Cs activity at the surface. The highest gamma activity (between 1E4 and 1E5 pCi/g) was observed at about 40 ft (near the tank base) for drywells 21-11-03 and 21-11-04. Drywells 21-11-05 and 21-11-07 showed small ^{137}Cs peaks (between 5 and 15 pCi/g) at about 40 ft. Historical total gamma results (HNF-3531) and SGLS results (GJ-HAN-103, GJO-98-40-TARA/GJO-HAN-19) for these drywells are summarized below.

Drywell 21-11-03 is located approximately 7 ft from the east side of tank BX-111. This drywell was completed in October 1973 to a depth of 100 ft using 6-in. casing. The maximum logging depth achieved by the SGLS was 98.5 ft.

Figure B5-4. 241-BX-111 In-Tank Photo Mosaic



Reference: WHC-SD-WM-ER-349, *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Area*.

Figure B5-5. Tank 241-BX-111 Waste Temperature Measurements

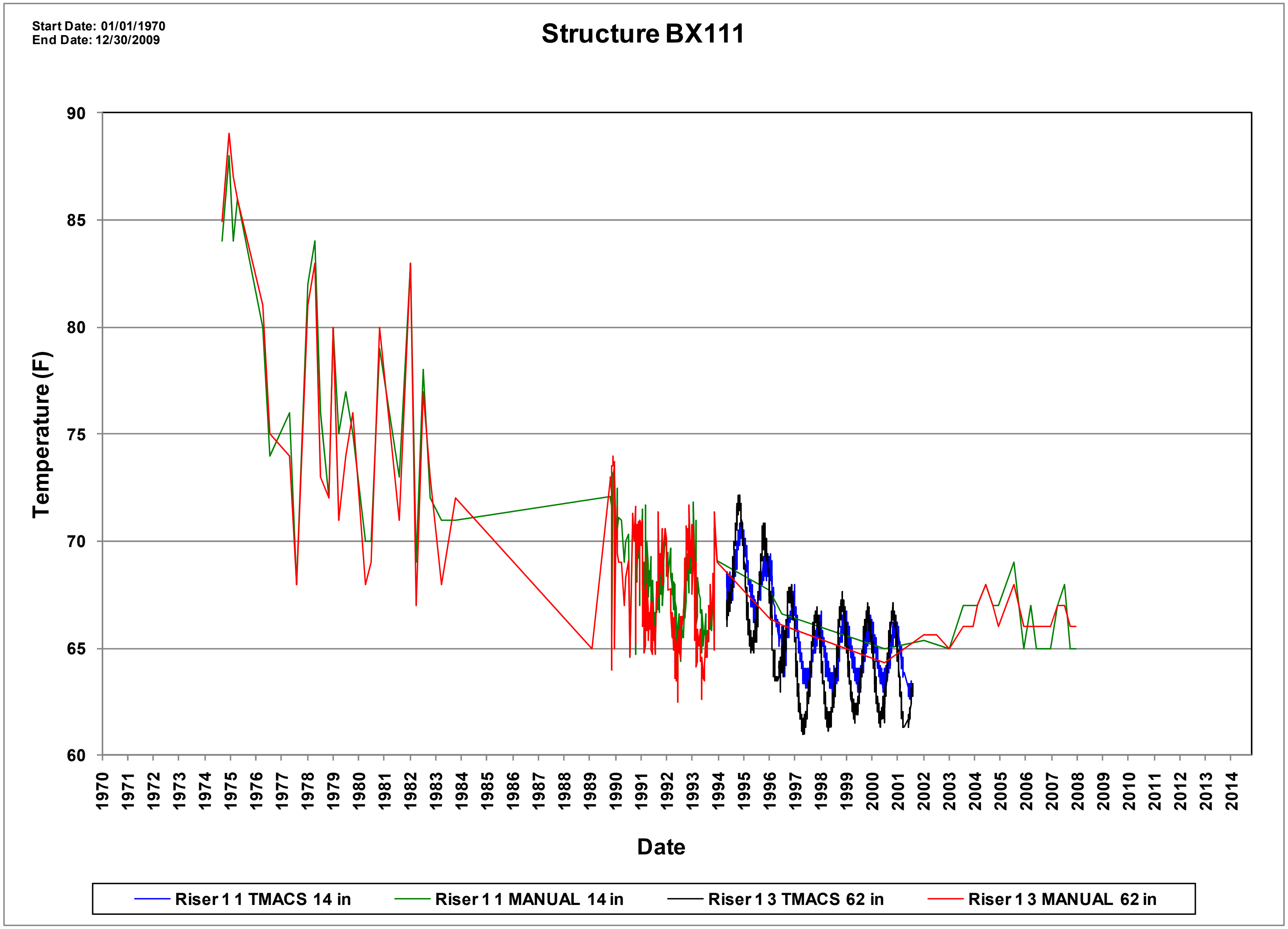
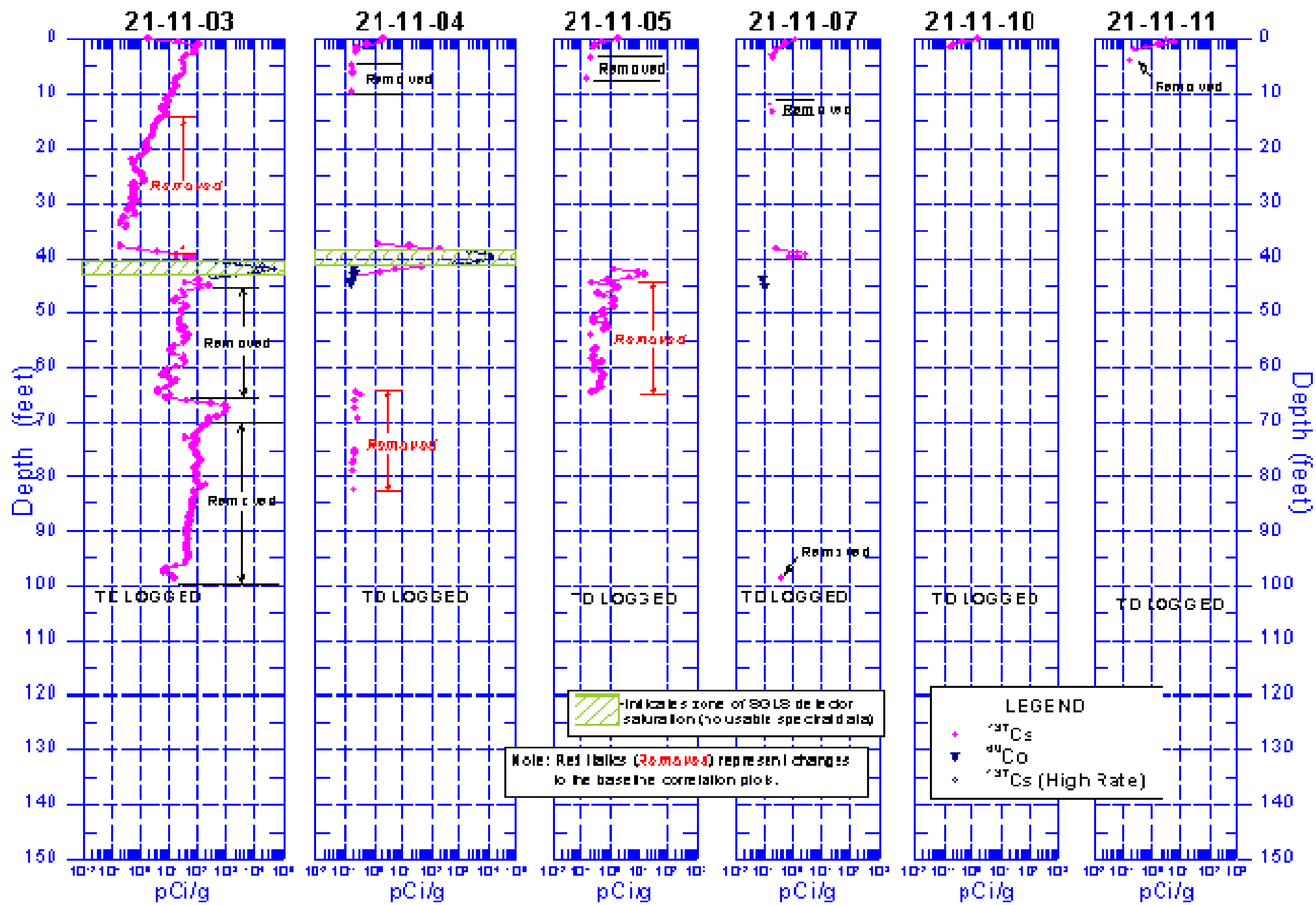


Table B5-2. Tank 241-BX-111 Liquid Level Measurements (1973 to 1987)

Liquid Level.

Date	Liquid level (in.)	Baseline ref.	Change from previous reading (in.)	Cumulative change (in.)	Comments
06/15/73	119.00				Manual tape
07/24/73	119.75		+0.75	+0.75	Erratic increase
07/25/73	97.00			+0.75	New tape installed
11/12/73	97.75		+0.75	+1.50	Slow increase
11/13/73	97.00		-0.75	+0.75	Unexplained drop
11/29/73	97.25		+0.25	+1.00	Slow increase
11/30/73	98.00		+0.75	+1.75	Unexplained rise
12/17/73	98.00			+1.75	Stable
01/18/74	125.50			+1.75	Transfers
03/28/74	125.50			+1.75	Stable
03/29/74	136.50			+1.75	Transfer
04/26/74	135.75		-0.75	+1.00	Slow decrease
06/11/74	135.75			+1.00	Stable
06/12/74	142.25			+1.00	New tape and spoolpiece
08/09/74	142.25			+1.00	Stable
08/25/74	180.00			+1.00	Transfer
02/12/75	180.00			+1.00	Stable
05/31/75	180.50		+0.50	+1.50	Slow increase
11/23/75	180.50			+1.50	Stable
01/27/76	181.00		+0.50	+2.00	Slow increase
02/14/77	181.00			+2.00	Stable
02/25/77	168.00			+2.00	Transfer and flushes
04/14/77	168.25		+0.25	+2.25	Slow increase
04/19/77	98.00			+2.25	Transfers
06/25/77	98.25		+0.25	+2.50	Slow increase
07/29/77		79.50		+2.50	Transfers
05/15/78	80.00		+0.50	+3.00	Very slow increase
05/23/78		80.00		+3.00	Very slow increase. Floating surface material. Baseline adjusted 03/02/81
07/21/79	80.00			+3.00	Stable
07/22/79	80.25			+3.00	Unexplained increase
01/31/80	80.25			+3.00	Stable
01/10/81	80.75			+3.00	Unexplained increase
02/22/82	80.75			+3.00	Stable
11/15/82	81.00			+3.00	Readings fluctuate from 80.75 to 81.00 in.
12/14/82	80.75	80.75		+3.00	Intrusions prior to 2/81
02/14/83	81.00		+0.25	+3.00	Stable--readings fluctuate from 80.75 to 81.00 in.
02/13/84	80.75		-0.25	+3.00	Stable
02/15/85	81.25		+0.50	+3.50	Slow increase
07/15/85	81.25			+3.50	Stable
09/02/85		79.00		+3.50	Transfer to 244-BX
02/10/86	79.00			+3.50	Stable
03/02/87	79.00			+3.50	Stable

Figure B5-6. Spectral Gamma Logging System Data for Drywells Surrounding Tank 241-BX-111



Reference: GJO-98-40-TARA/GJO-HAN-19, *Hanford Tank Farms Vadose Zone: Addendum to the BX Tank Farm Report.*

Historical gross gamma log data (Figure B5-7) show a gross gamma activity peak of 50,000 cps at 40 ft bg and about 4,000 cps at 65 ft. This appears to have been the limit of the detector used at that time. Zones of anomalous gamma-ray activity are evident on the earliest gross gamma log shown (July 1980), indicating that contamination was present before 1980. The earliest recorded log shown in SD-WM-TI-356 (November 1973) also shows 50,000 cps at 40 ft. RL Occurrence Report 74-37 shows that this is when the drywell was first monitored. The depth of the peak activity moved downward approximately 3 ft between May and June 1982, suggesting that the drywell casing may have been extended to accommodate the construction of a berm at that time (GJ-HAN-104, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank BX-111*). The intensity of the gamma-ray activity decreased only slightly between 1980 and 1989 indicating that the activity is from a relatively long-lived isotope, such as ^{137}Cs.

The 1998 SGLS results (Figure B5-6) showed that the gamma activity was ^{137}Cs contamination at about 40 ft and 65 ft. High rate logging system logs showed peak activity levels of less than 1E5 pCi/g.

Drywell 21-11-04 is located approximately 3 ft from the southeast side of tank BX-111. This drywell was drilled in September 1971 to a depth of 100 ft using 6-in. casing. The total logging depth achieved by the SGLS was 97.5 ft.

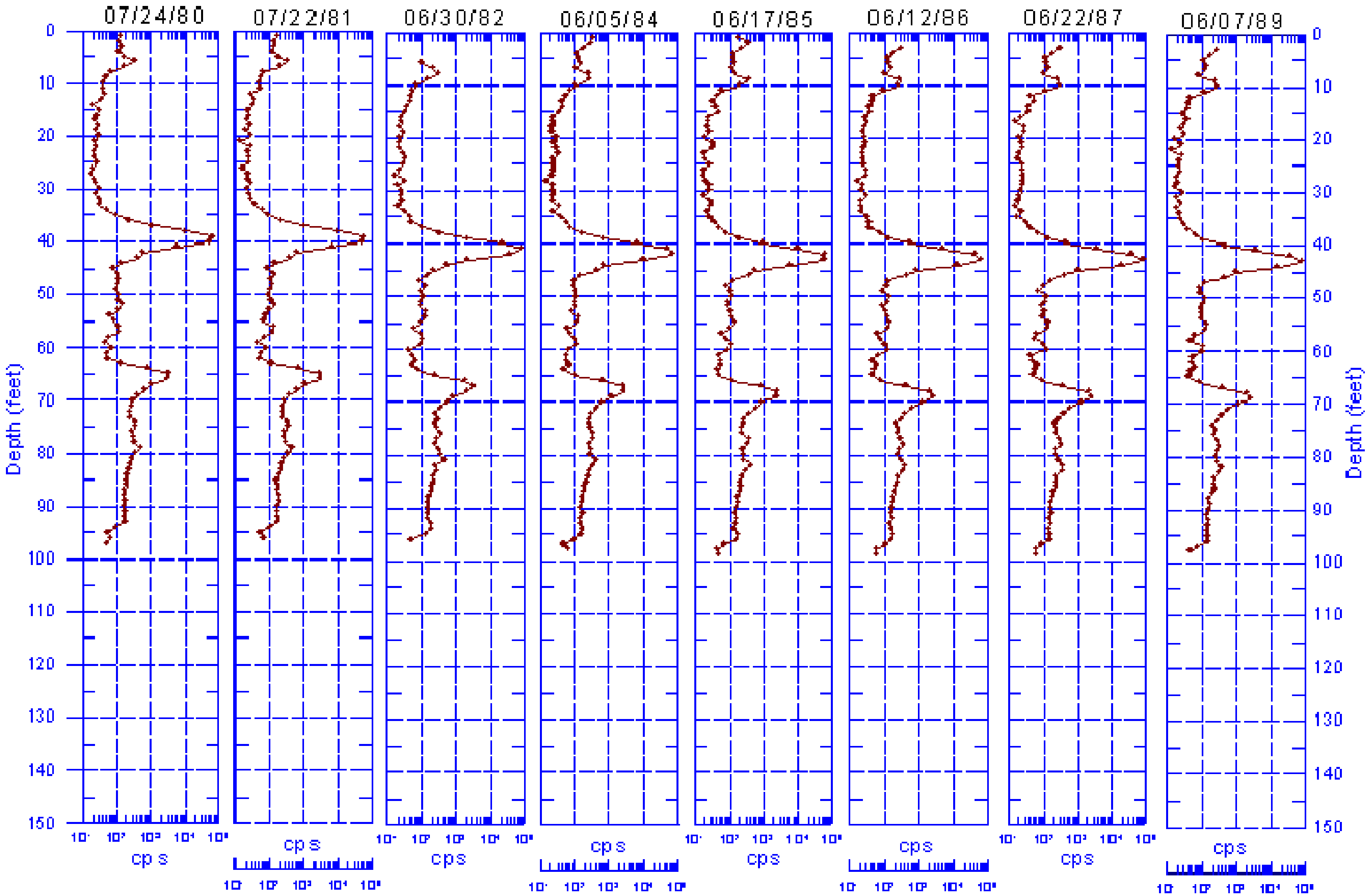
Historical gross gamma log data from 1980 to 1994 (HNF-3531) and data summarized in SD-WM-TI-356 were reviewed (Figure B5-8). The zones of high gamma-ray activity (>50,000 cps) in this drywell appear on the earliest gross gamma-ray log (July 1980), indicating that the associated contamination was in place before that date. The activity increased slightly between 1980 and 1989 indicating that the contaminants are relatively long-lived radionuclides, such as ^{137}Cs. SD-WM-TI-356 shows high activity levels in drywell 21-11-04 as early as July 1972.

The 1998 SGLS results (Figure B5-6) show ^{137}Cs contamination intermittently from the ground surface to 9.5 ft, continuously from 37.5 to 43 ft except in the zone of high dead time, and intermittently from 64.5 to 82.5 ft. Cobalt-60 contamination was detected almost continuously from 42 to 44.5 ft. High rate logging system measurements showed a peak ^{137}Cs level of 1E4 pCi/g at about 40 ft bgs. Cobalt-60 contamination was detected at 0.1 to 0.2 pCi/g from 40 to 45 ft.

Drywell 21-11-05 is located approximately 3 ft from the southeast side of tank BX-111. This drywell was drilled in August and September 1971 to a depth of 100 ft using 6-in. casing. The total logging depth achieved by the SGLS was 98.0.

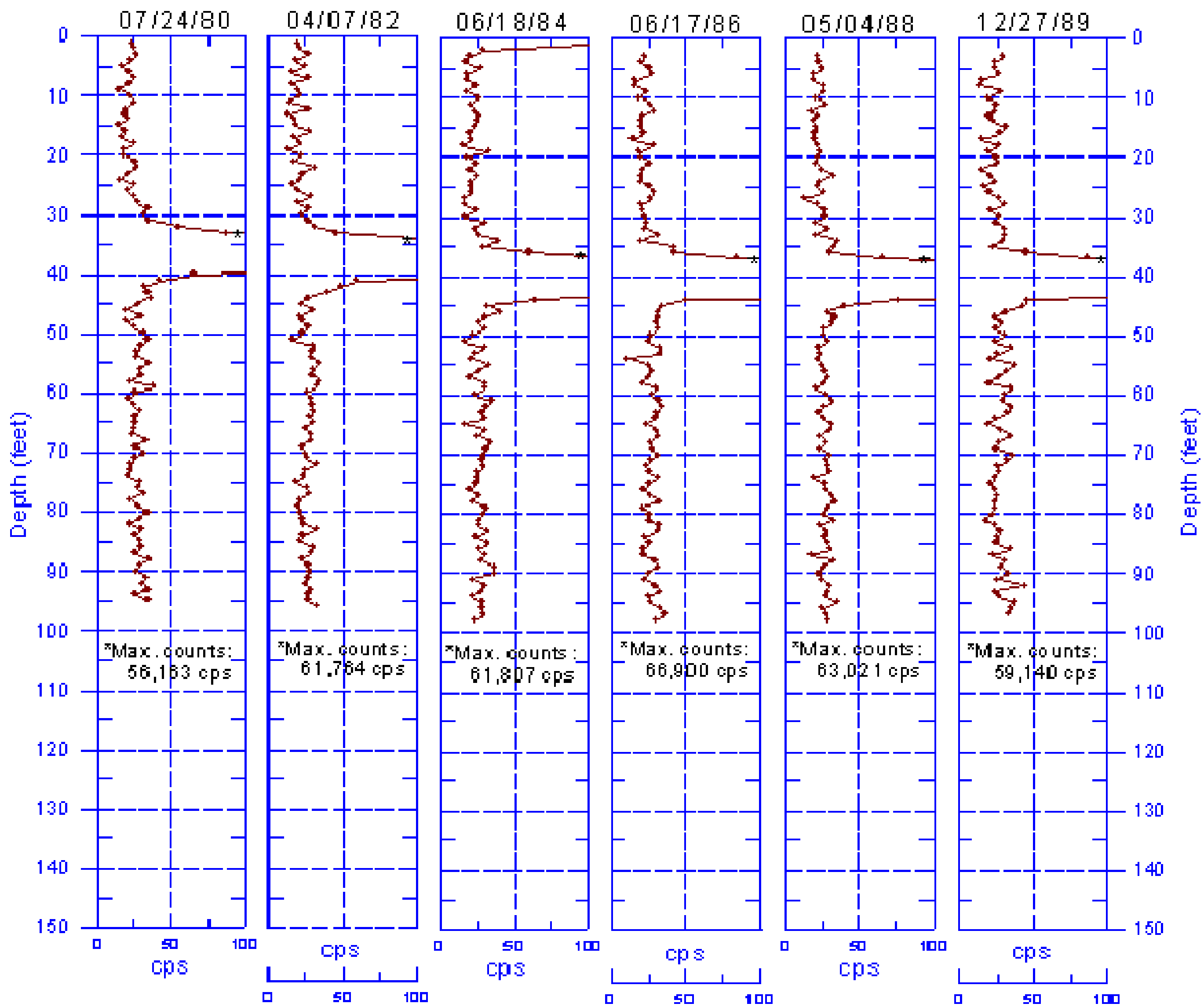
Historical gross gamma data from 1975 to 1992 (Figure B5-9) show about 100 cps gamma activity in this drywell from 1975 through 1992. The peak anomalous activity occurring at ~40 ft bgs was observed in January 1975, indicating that gamma activity was present before that time. This level of activity may have been present earlier, but SD-WM-TI-356 does not record values below 100 cps and no other gamma logs were available. Spectral gamma logging system data show a ^{137}Cs peak of ~20 pCi/g at ~40 ft bgs and no indication of ^{60}Co contamination.

Figure B5-7. Drywell 21-11-03 Historical Gamma Data (1980 to 1989)



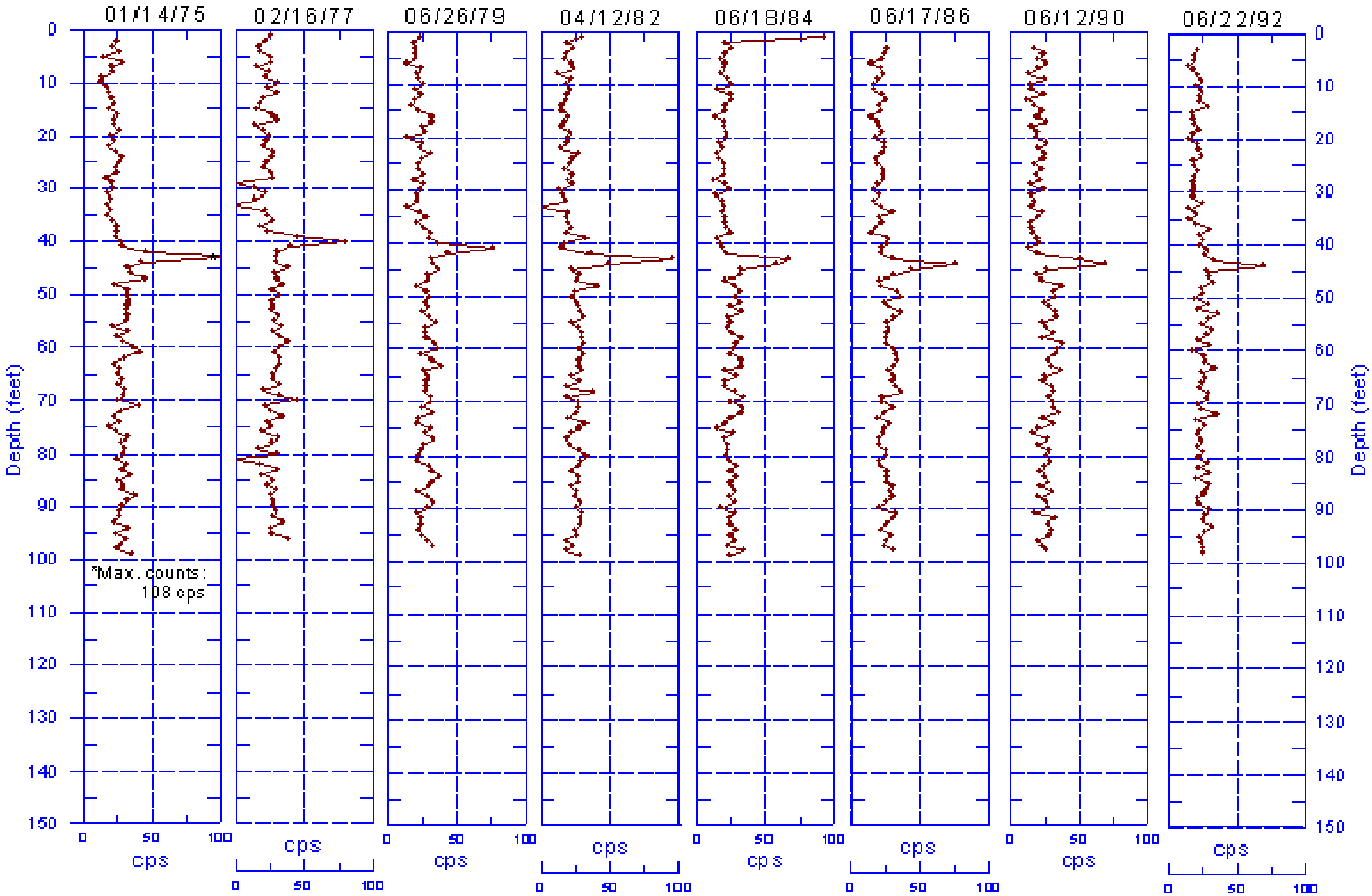
HNF-3531, *Analysis of Historical Gross Gamma Logging Data from BX Tank Farm.*

Figure B5-8. Historical Gross Gamma for Drywell 21-11-04 (1980 to 1989)



HNF-3531, *Analysis of Historical Gross Gamma Logging Data from BX Tank Farm.*

Figure B5-9. Drywell 21-11-05 Historical Gross Gamma (1975 to 1992)



HNF-3531, *Analysis of Historical Gross Gamma Logging Data from BX Tank Farm.*

Drywell 21-11-07 is located approximately 2 ft from the southwest side of tank BX-111. This drywell was drilled in September 1971 and completed to a depth of 100 ft using 6-in. casing. The total logging depth achieved by the SGLS was 98.5 ft. A peak SGLS ^{137}Cs value of 0.6 pCi/g was measured at about 40 ft. Historical logs (Figure B5-10) show peak gamma readings of about 75 cps in 1975. The 40 ft gamma peak decayed through 1990. In 1997 SGLS measurements less than 5 pCi/g ^{137}Cs was detected between the ground surface and 15 ft bgs and at 40 ft bgs and 0.1 pCi/g of ^{60}Co was detected at 45 ft bgs.

B5.6 ASSESSMENT

Process information, in-tank monitoring data, and associated drywell logging data for tank 241-BX-111 were reviewed. In-tank liquid level monitoring results indicate small decreases and increases for this tank. RL Occurrence Report 74-37 concluded that the liquid level decreases observed in the tank in 1974 were due to a stabilization of the crust surface after transfers.

Historical transfer records show that tank BX-111 liquid levels were higher than spare inlet port levels at different periods and drywells near the spare inlet ports show increased activity. Therefore, spare inlets overfills were identified as a potential source for the activity.

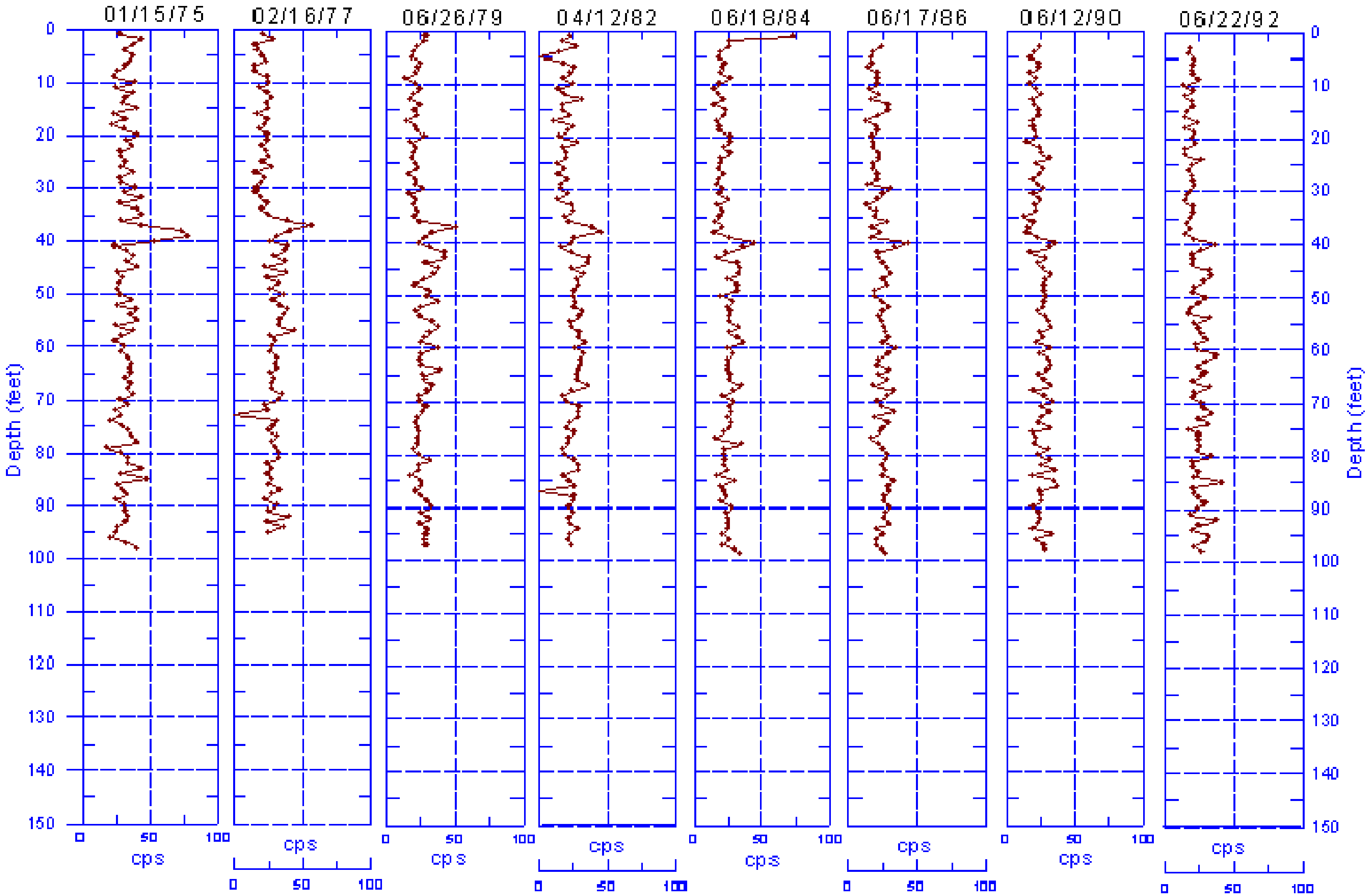
Historical gamma logs, spectral gamma logs, and direct push logs were also reviewed and discussed. The logs show near surface activity and peak activity from about 30 to 40 ft bgs in drywells 21-11-03 and 21-11-04. The logging data and historical information (see Section 6.0 text) indicates that multiple transfer line leaks or other near surface leaks in lines that run between tanks BX-110 and BX-111 occurred that may account for deeper activity in the drywells.

Although other potential sources are present, the high peak activity at 40 ft with lower near surface activity and little or no activity in drywells 21-11-03 and 21-11-04 indicates the potential for a tank leak.

B5.7 CONCLUSION

Because the data suggests two potential sources (tank over flow and transfer line leaks) for activity near tank BX-111 in addition to a potential tank leak it is recommended that this tank be re-assessed per TFC-ENG-CHEM-D-42.

Figure B5-10. Drywell 21-11-07 Historical Gross Gamma (1975 to 1992)



HNF-3531, *Analysis of Historical Gross Gamma Logging Data from BX Tank Farm.*

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APPENDIX C

241-BX TANK FARM INFORMATION SUMMARIES: TANKS CLASSIFIED AS SOUND

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LIST OF TERMS

Abbreviations and Acronyms

1C	first cycle waste
BL	B Plant low-level (waste)
CSR	cesium recovery operations (waste)
CW	cladding waste
CWP	PUREX cladding (coating) removal waste (1961 to 1972)
CWP1	aluminum-cladding wastes (1956 to 1960)
EB	evaporator bottoms
FIC	Food Instrument Corporation (conductivity gauge)
ITS	in-tank solidification
IX	ion exchange (waste)
MW	metal waste
MW1	metal waste from the bismuth phosphate process, 1944 to 1951
PUREX	plutonium-uranium extraction
REDOX	reduction-oxidation
SACS	Surveillance Analysis Computer System
SST	single-shell tank
TBP	tributyl phosphate waste
UR	uranium recovery (waste)

C1.0 241-BX-TANK FARM DESIGNATED SOUND TANKS (HNF-EP-0182, *Waste Tank Summary Report for Month Ending December 31, 2009*, Rev. 261)

C1.1 TANK 241-BX-103

As of July 2010 single-shell tank (SST) 241-BX-103 (BX-103) contained 75 kgal (34.8 in.) of waste type CWP1 (1956 to 1960 aluminum-cladding) and tributyl phosphate (TBP) waste with 13 kgal of supernate (HNF-EP-0182, *Waste Tank Summary Report for Month Ending December 31, 2009*, Rev. 261; RPP-RPT-42985, *2009 Auto-TCR for Tank 241-BX-103*). This tank was saltwell pumped in 1977 and administratively interim stabilized in 1983 (HNF-SD-RE-TI-178, *Single-Shell Tank Leak Stabilization Record*), and intrusion prevention efforts were completed in October 1985.

C1.1.1 History

Tank 241-BX-103 was constructed between 1946 and 1947 and is the last tank in the cascade series of tanks 241-BX-101 (BX-101), 241-BX-102 (BX-102), and BX-103. It is one of twelve 100-series tanks in the 241-BX Tank Farm and began operations in September 1948. The tank has a capacity of 530 kgal and a diameter of 75 ft. The cascade lines for the cascade series that includes tank BX-103 were opened in 1948. Metal waste (MW) from the bismuth phosphate process began cascading into tank BX-103 from tank BX-102 during September 1948. Transfers of MW to and from the cascade series continued until 1951 when the cascade was closed. Tank BX-103 remained filled with MW until it was sluiced for uranium recovery (UR) in 1954. It was declared empty in July of that year.

In 1956, tank BX-103 was filled with UR waste from tank 241-BY-108 (BY-108).

During 1956 and 1957, most of the waste in the tank was pumped to cribs. Transfer activity resumed in 1962 as tank BX-103 began receiving a series of transfers of plutonium-uranium extraction (PUREX) cladding and organic wash waste from tanks in the 241-C Tank Farm. From 1969 to 1976, tank BX-103 received wastes from the PUREX Plant, B Plant, and other sources through tanks 241-B-101 (B-101), BX-101, 241-BX-104 (BX-104), 241-BX-105 (BX-105), and 241-BX-106 (BX-106). During this time period, there also were frequent transfers from tank BX-103 to tanks in the 241-B, 241-BY, 241-BX, 241-C, 241-S, and 241-SX Tank Farms.

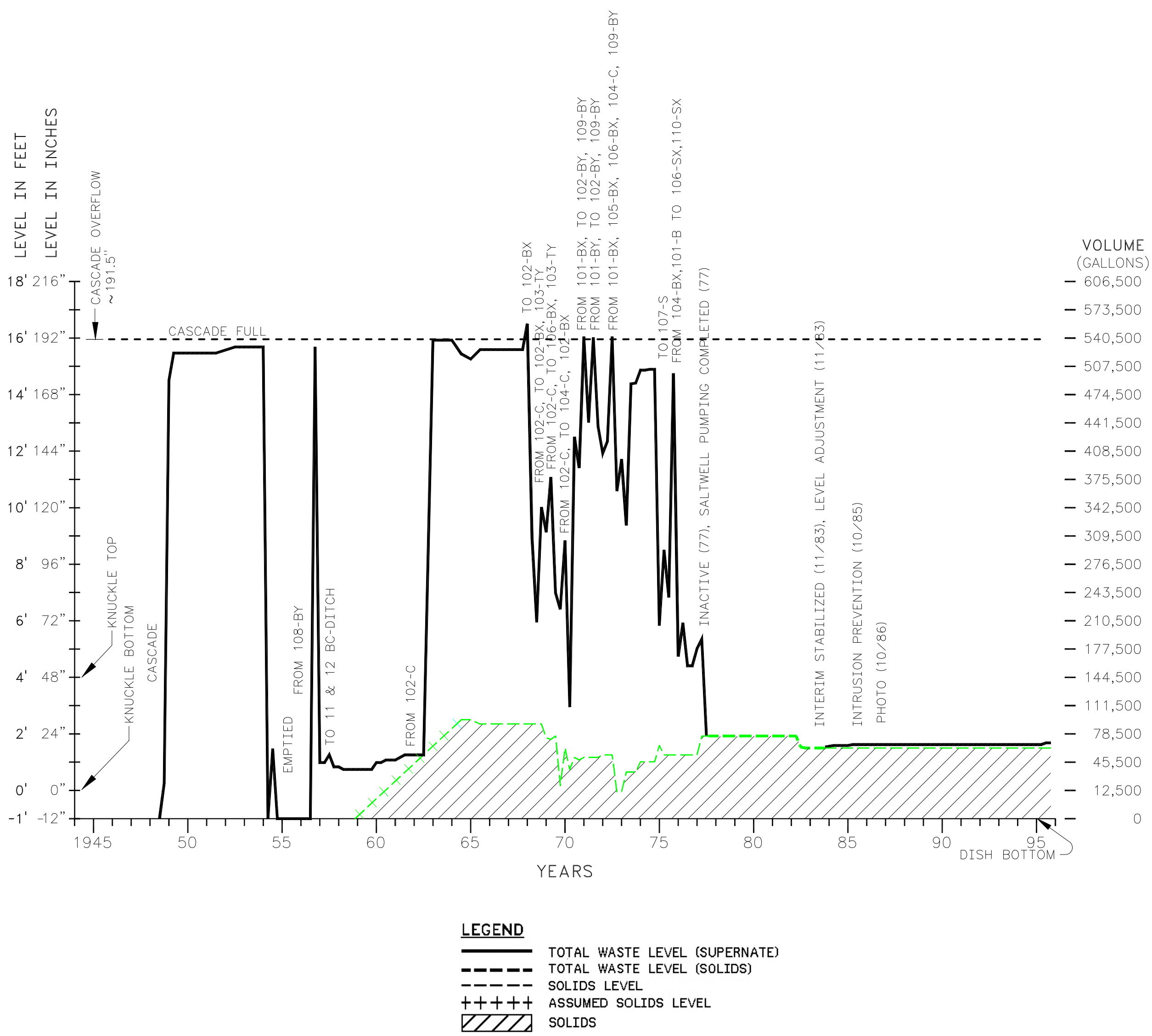
C1.1.2 Tank 241-BX-103 Waste Surface Level

Surface level measurements have increased since January 1986, caused by a potential intrusion.

Letter 77B60-96-008, "Resolution of BX-103 Intrusion Investigation" dated November 13, 1996 states that data and photos show there was an ongoing intrusion at the time of administrative stabilization. It appears that subsequent isolation did not halt the intrusion. The level increased steadily until mid-1986 where it leveled off. The increase resumed in 1991 and continues as of

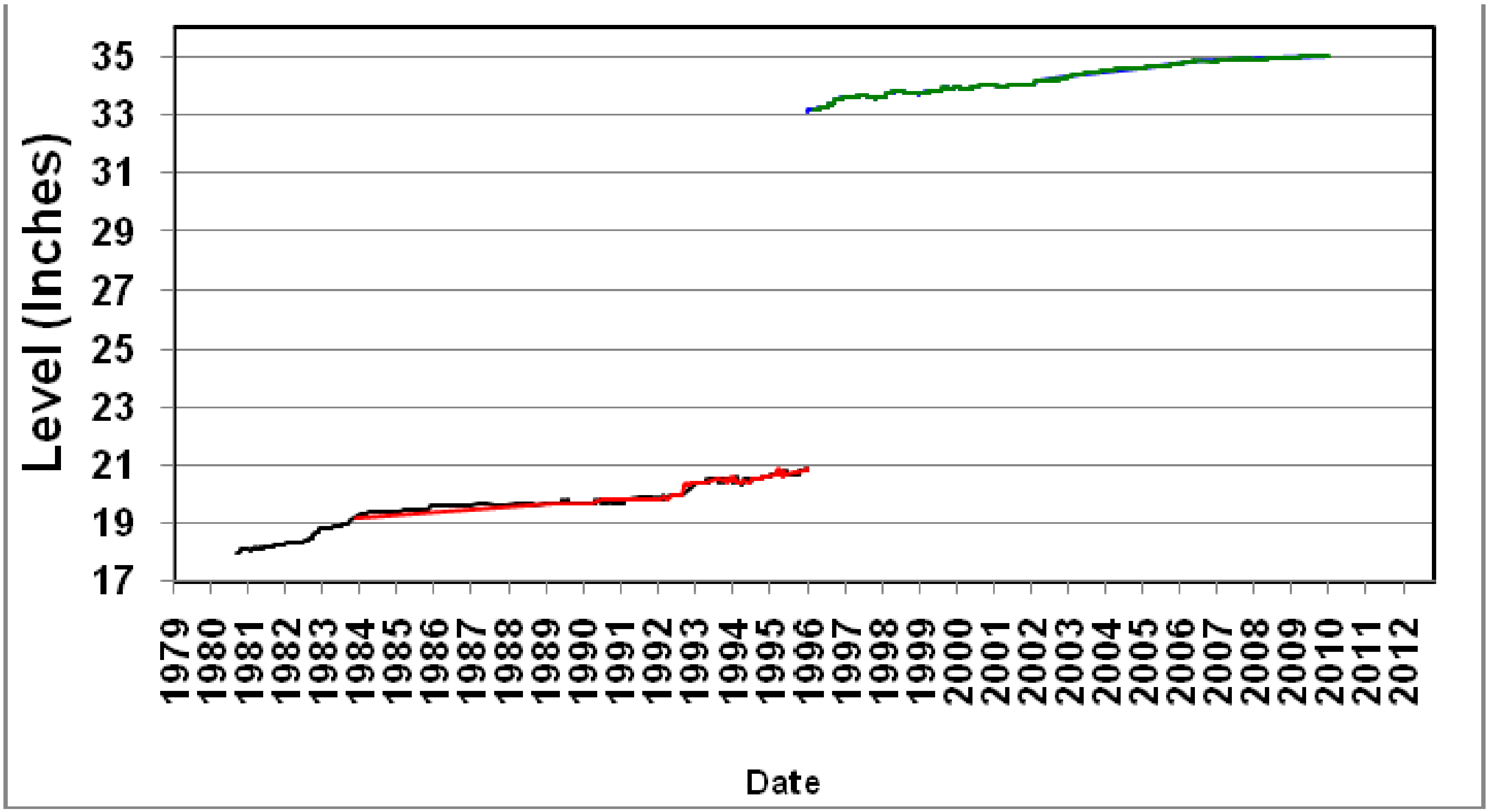
2010. As noted in Appendix B, a similar intrusion is also continuing in tank BX-101. In-tank videos of BX-103 taken in 2006 show dripping down the outside of riser 014. No liquid has been observed in tank pits or open pipelines to the pits. As of 2008, the intrusions were believed to be due to leaking seals between the riser and tank dome. The source of the intrusions is unknown, but may be a result of rainwater intrusions around one or more risers. No indications were observed as to unknown surface level decreases inside this SST. Tank BX-103 was filled to over 540 kgal in the mid-1960s and a maximum waste level of 542 kgal was reported in 1972. Figure C-1 shows quarterly tank waste surface levels since the tank first received waste. Figure C-2 shows liquid level monitoring data from SACS (Surveillance Analysis Computer System).

Figure C-1. Tank 241-BX-103 Waste Surface Levels



Reference: WHC-SD-WM-ER-349, *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Area*.

Figure C-2. Tank 241-BX-103 Waste Monitoring Data



C1.1.3 Tank 241-BX-103 Logging and Assessments

SD-WM-TI-356, *Waste Storage Tank Status and Leak Detection Criteria* states that contaminated soil between tanks BX-102 and BX-103 is believed to have been caused by tank overflows and spills from BX-102; raw-water hose bibs and hydrant-type valve misalignment caused considerable water releases in the southeast quadrant of the tank farm in 1972. GJO-HAN-19, *Vadose Zone Characterization Project at the Hanford Tank Farms BX Tank Farm Report* shows that a plume of ^{137}Cs occurs on the north side of the tank to a depth of about 20 ft (Figure C-3) and concludes that this contamination most likely resulted from surface spills or leaks that migrated downward and some of the contamination may have resulted from dragdown during drilling. A high count-rate zone within this plume may represent a leak from the cascade line connecting tank BX-103 with tank 241-BY-101 in the BY Tank Farm. The thin interval of ^{60}Co below 0.2 pCi/g most likely resulted from releases from tank BX-102 or from a large surface spill that occurred between tanks BX-102 and BX-103 in 1951.

The following occurrence/deviation reports were issued due to liquid level decreases and liquid level increases in tank BX-103.

OR-77-93, *Occurrence Report 77-93 Tank 103-BX Liquid Level Decrease Exceeding Criterion*

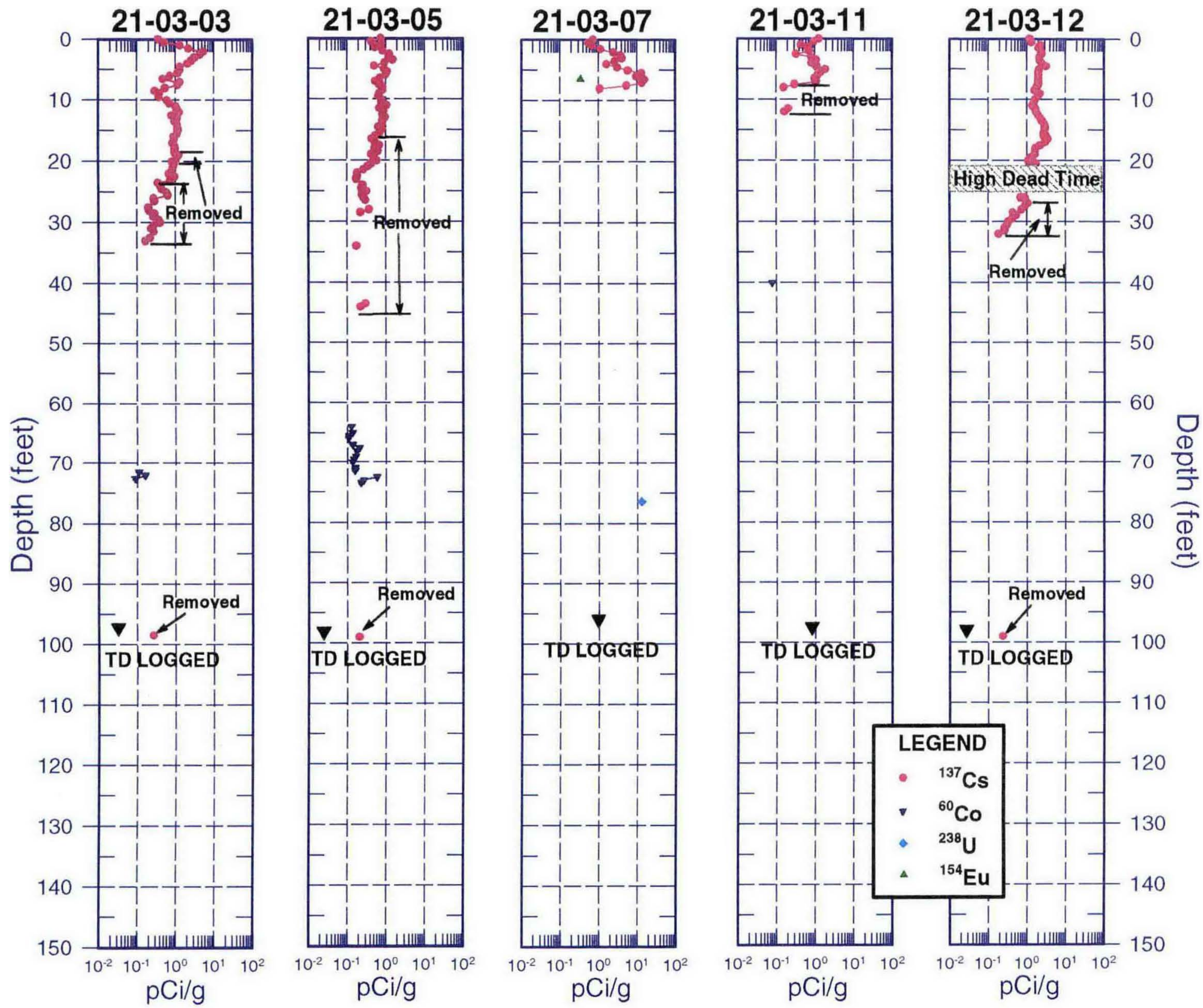
> "A baseline of 18.30 inches was established for 103-BX Tank on June 1, 1977. (This followed a period of nine months during which the baseline was at or near 64.30 inches prior to transfer on May 24, 1977.) On June 11, at 9:00 a.m., the liquid level measurement had fallen to 17.7 inches, exceeding the allowed .5 inch drop below the baseline. …It is likely that redistribution of the sludge in the tank has occurred following the transfer of 46.1 inches of material from 103-BX on May 24-26, 1977. The tank is now at a minimum heel, awaiting salt well pumping."

RL-WHC-TANKFARM-1993-0036, *Tank 241-BX-103 Exceeded the Surface Level Increase Criteria During Quarterly Surveillance; Tank is Sound; Cause is Under Investigation*

> "Direct and root causes are considered to be inattention to detail in leaving the drains and transfer lines open, resulting in open pathways for precipitation to enter the tank.
>
> This incident is not expected to have any serious impact on the plant or program. The tank level is well below maximum operating limits. At the current rate of increase as noted above, it would take approximately 14 years to reach the maximum operating limit. At this point, management is notified and conditions are evaluated to determine necessary corrective actions."

Environmental Protection Deviation Report 83-03, *Tank 103-BX Liquid Level Exceeding Increased Criteria* indicated that the liquid level exceeded the 2-in. increase criteria. The slow periodic increases in liquid level since 1977 were attributed to intrusions.

Figure C-3. 1997 Tank 241-BX-103 Spectral Gamma Logging Data



Reference: GJO-98-40-TAR/GJO-HAN-19, *Hanford Tank Farms Vadose Zone: BX Tank Farm Report*.

C1.2 TANK 241-BX-104

As of July 2010 SST 241-BX-104 contained 100 kgal (44.2 in.) of waste types comprised of MW, TBP, and PUREX cladding waste (CWP) materials with 3 kgal of supernate (HNF-EP-0182, RPP-RPT-42986, *2009 Auto-TCR for Tank 241-BX-104*). This tank was interim stabilized in 1989 (HNF-SD-RE-TI-178) after being saltwell pumped; intrusion prevention was completed in September 1991.

C1.2.1 History

Tank 241-BX-104 first received MW from the bismuth phosphate process (1944 to 1951) (MW1) in January 1949 from B Plant. The tank cascaded MW1 waste to tanks BX-105 and BX-106 until the entire cascade was filled in January 1950. In January 1951, the 241-BX Tank Farm cascade series cascaded waste to the 241-BY Tank Farm through tank 241-BY-104 (BY-104). In 1954 and 1955, tank BX-104 transferred waste to the 221-U building for UR operations. In 1956, TBP waste was received from tank 241-BY-110 (BY-110). Supernate was sent to trench 216-B-26 during 1957, almost emptying the tank.

Tank 241-BX-104 was inactive until 1962, when it was filled with CWP from tank 241-C-102 (C-102). Tank 241-C-108 transferred cladding waste to tank BX-104 in 1964. Cesium recovery operations (CSR) waste from B Plant was added to tank BX-104 during 1967. Also during this time, supernatant waste held in the tank was sent to tank 241-BY-103. The CSR waste continued to be added to the tank until 1969. Tank 241-BY-112 (BY-112) sent waste from B Plant cell 23 to the tank during 1968. Tank BX-104 sent waste to the following tanks (year and quarter in parentheses): BX-105 (1968-4); BX-106 (1968-1, 1969-1); 241-BX-107 (BX-107) (1969-3); 241-BX-108 (BX-108) (1969-2); 241-BX-111 (BX-111) (1969-2, 1969-3); 241-BY-102 (BY-102) (1969-3); BY-104 (1968-2, 1968-3). During 1970, tank BX-104 received cesium recovery ion exchange (IX) waste from tanks BX-106 and 241-BX-110 (BX-110) and transferred waste to tank 241-C-110.

In 1970, the tank received IX waste from tank BX-111 and sent waste to tanks 241-B-102, 241-C-107, and 241-C-110. From 1971 until 1972, tank BX-104 sent waste to the CSR in B Plant. During 1971, the tank received reduction-oxidation (REDOX) high-level (R) waste from tank 241-SX-103. Tank 241-SX-102 sent R waste to tank BX-104 during 1971. The tank received IX waste from tank BX-101 during 1971. The addition of R waste, from tank 241-SX-102, continued until 1972. During 1972, tank BX-104 received CSR waste and B Plant low-level (BL) waste from tanks BX-101 and B-101, respectively, and sent waste to tanks 241-C-105 and 241-T-105. Tank B-101 continued to send BL waste to the tank until 1973. From 1972 until 1976, CSR waste was added to the tank. During 1974, 1975, and 1976, BL waste was transferred to the tank from tank BX-101. Tank BX-104 sent and received evaporator waste from the in-tank solidification (ITS) process during 1976. The tank transferred waste, from 1972 until 1976, to the following tanks (years and quarter in parentheses): 241-B-103 (1973-2); BX-103 (1975-2,3,4; 1976-1,2); BX-105 (1973-2); 241-C-105 (1972-4); 241-S-107 (S-107) (1974-4, 1975-1); 241-S-110 (1974-1); 241-T-105 (1972-4, 1973-1); 241-T-107 (1973-1,2); 241-TX-101 (1972-4, 1973-1). From 1976 to 1980, tank BX-104 provided a transfer connection for tank 241-A-102 (A-102) and the 242-A Evaporator.

Tank A-102 was the feed tank for the 242-A Evaporator during this time period. Tank BX-104 received strontium recovery supernatant waste from tank 241-C-103 during 1978. From 1978 to 1980, tank BX-105 sent waste to the tank, which was then transferred to tanks 241-A-101 and A-102. A transfer of supernatant waste in tank BX-104 to double-shell tanks 241-AY-102 and 241-AZ-101 occurred during 1980. The tank was labeled inactive on November 17, 1980. The final transfer involving tank BX-104 was saltwell pumping to tank 241-AN-101 during 1983.

C1.2.2 Tank 241-BX-104 Waste Surface Level

No indications were observed as to unknown surface level increase or decrease. The waste level has been relatively stable since the tank was saltwell pumped in 1989.

Tank BX-104 was overfilled to a maximum waste level of 571 kgal from 1963 through 1967 (WHC-MR-0132, *A History of the 200 Area Tank Farms*). Figure C-4 shows tank liquid levels from SACS. Figure C-5 shows quarterly tank waste surface levels since the tank first received waste.

C1.2.3 Tank 241-BX-104 Logging and Assessments

The geologic and historical information available from other sources did not identify any active leaks from tank BX-104. However, the data indicate that surface spills have occurred and subsurface contaminant plumes exist in the vicinity of the tank. The subsurface plumes shown in Figure C-6 are likely associated with releases from tank BX-102 (GJ-HAN-97, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank BX-104*).

The following occurrence/deviation reports were issued due to liquid level decreases and liquid level increases in tank BX-104.

Internal memo 65950-87-587, "July 1987 – Quarterly Trend Analysis of Surveillance Data"

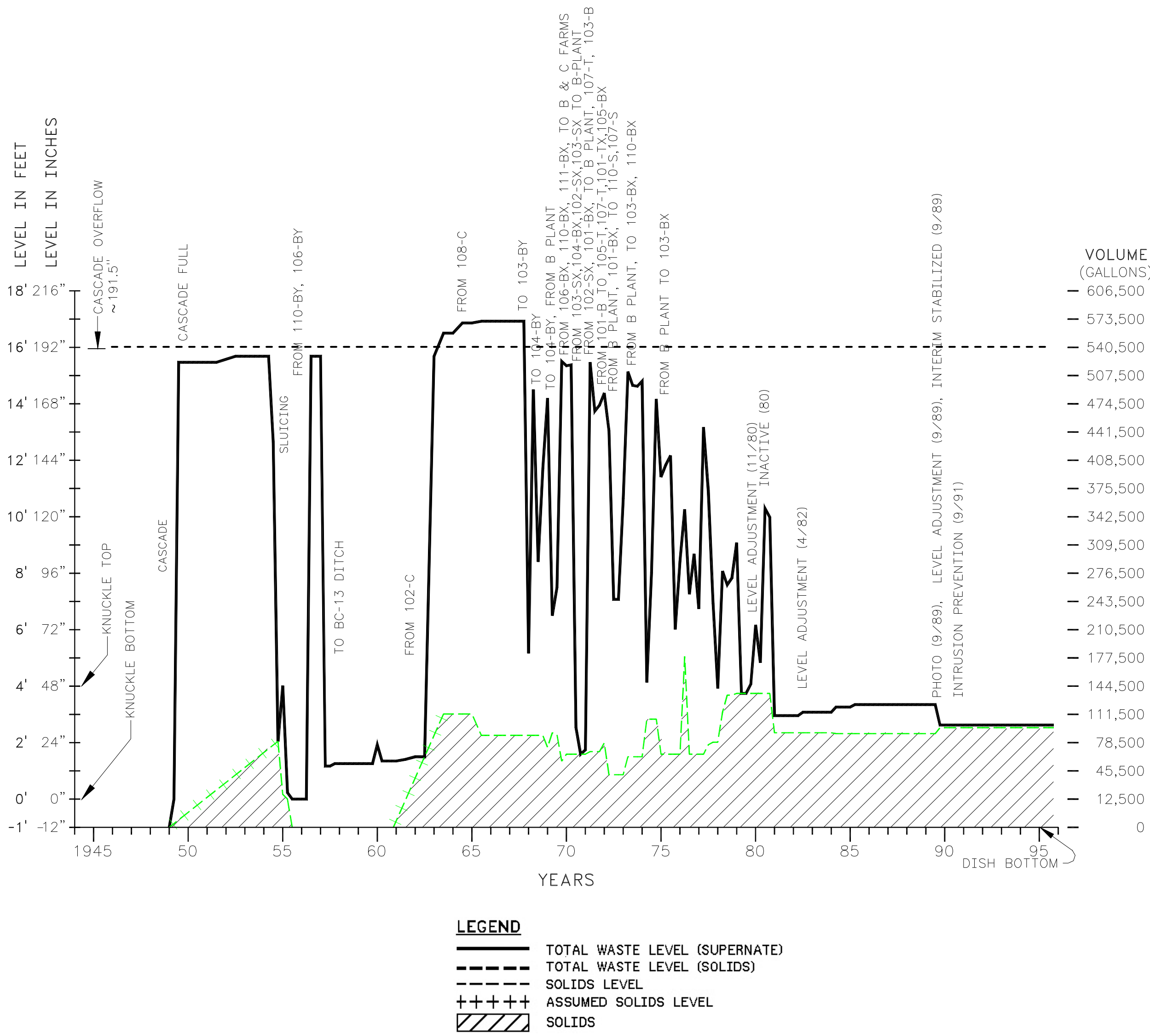
"EPDR 87-04: "Tank 241-101-BX, 104-BX and 107-BX Intrusions"

The report described results of photo updates which indicated evidence of surface pool area enlargement. The intrusion volumes were minimal, and no criteria violations occurred.

A letter [Reference (9)] on this subject was issued and EWR #87-255 was submitted requesting an excavation be performed to confirm that the 3-inch utility drain line to Tank 241-BX-101 is out-of-service.

Status: Excavation work has been delayed by higher priority activities and has been scheduled for August 15, 1987. All three tanks are to be included in a special intrusion study to be defined by September 1, 1987."

Figure C-4. Tank 241-BX-104 Waste Surface Levels



Reference: WHC-SD-WM-ER-349, *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Area*.

TF-EFS-89-041, *Surface level measurement in tank 241-BX-104 exceeds the 2.00 inch increase criteria*

> "In-tank photographs taken October 22, 1986, show a liquid surface with exposed sludge. The FIC plummet is contacting liquid.
>
> Drywells associated with tank 241-BX-104 were reviewed, and appear stable at this time."

Figure C-5. Tank 241-BX-104 Waste Monitoring Data

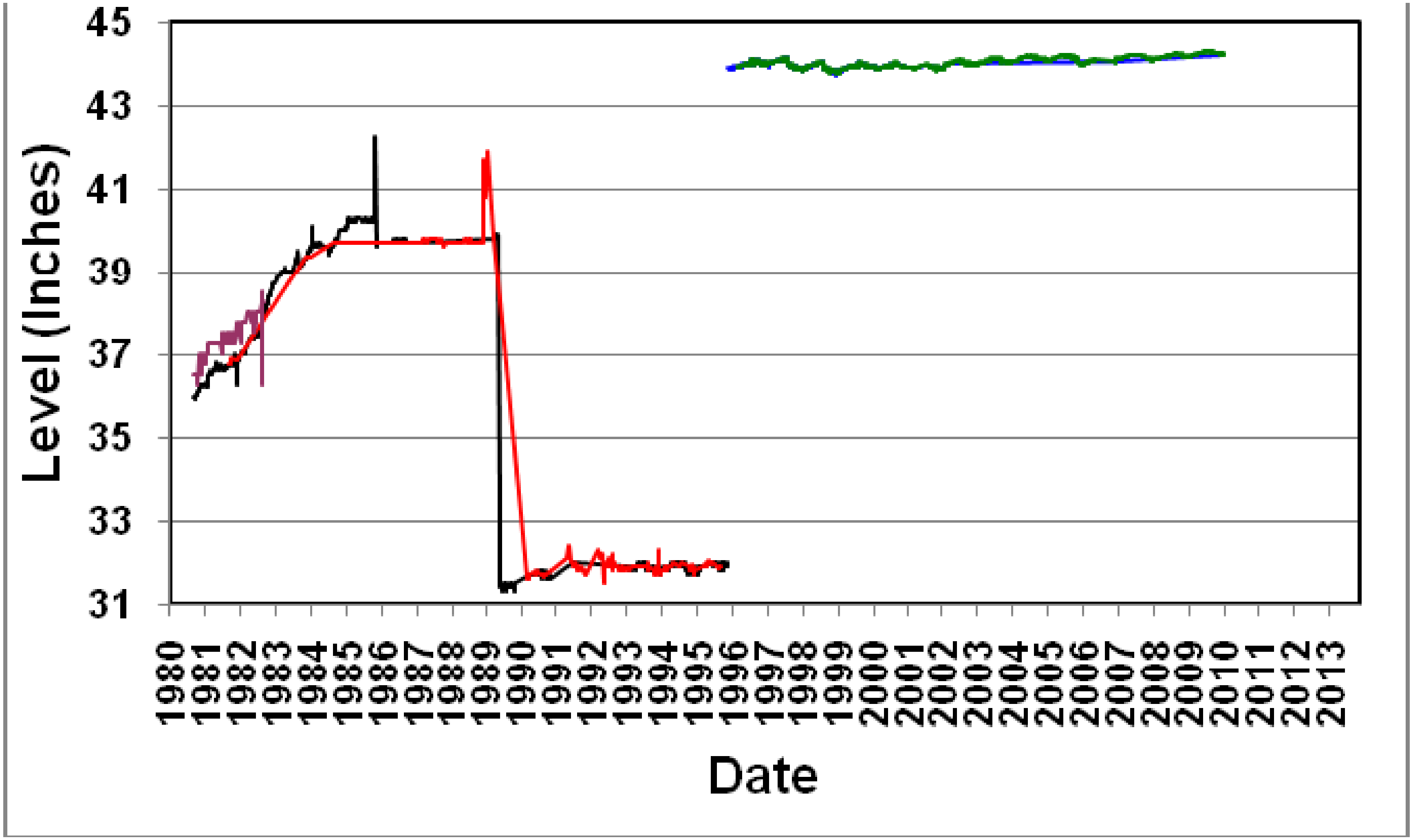
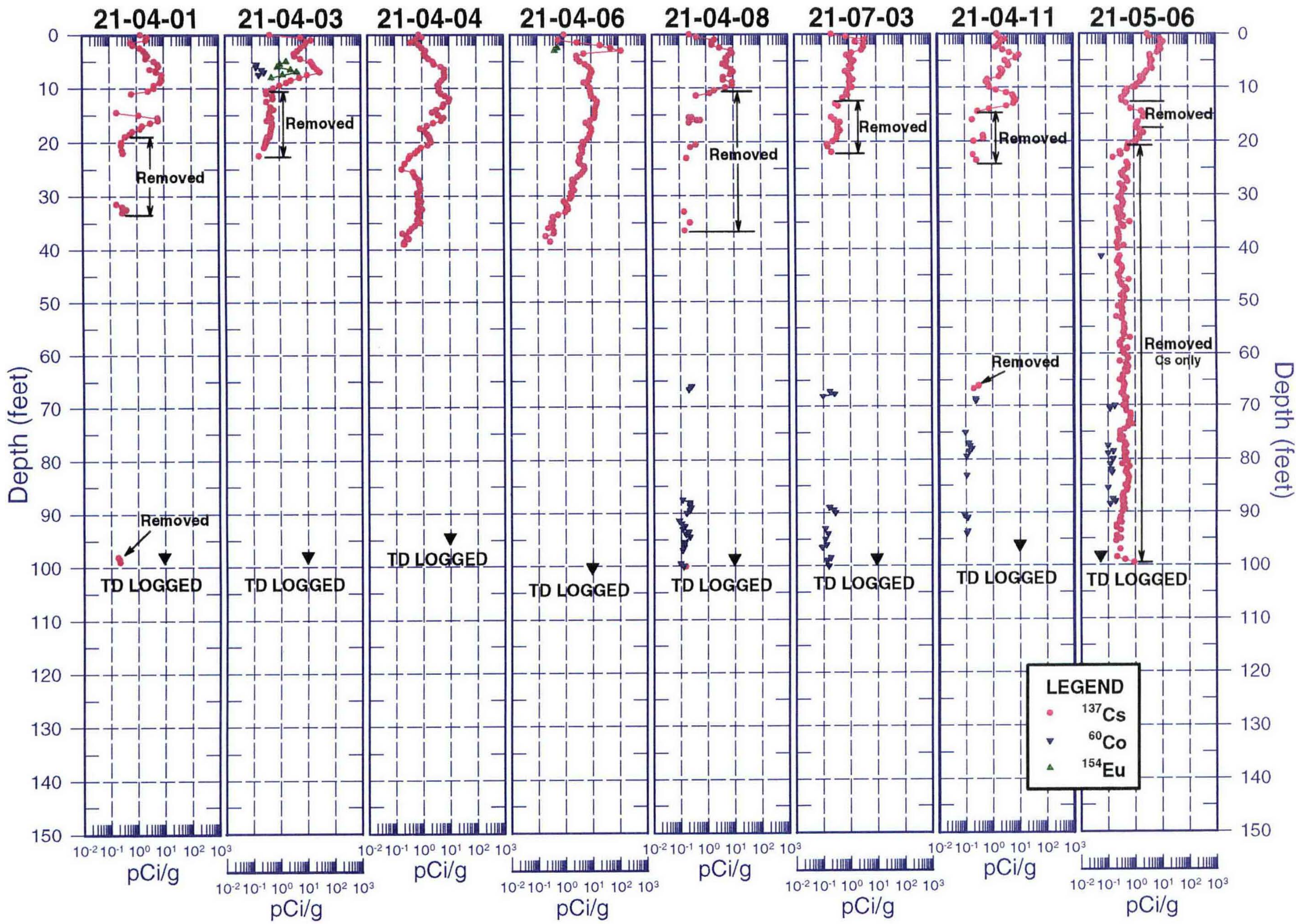


Figure C-6. 1997 Tank 241-BX-104 Spectral Gamma Logging Data



Reference: GJO-98-40-TAR/GJO-HAN-19, *Hanford Tank Farms Vadose Zone: BX Tank Farm Report*.

C1.3 TANK 241-BX-105

As of July 2010 SST BX-105 contained 72 kgal (32.6 in.) of waste types MW, TBP, CWP, and BY-Saltcake materials with 5 kgal of supernate (HNF-EP-0182, RPP-RPT-42987, *2009 Auto-TCR for Tank 241-BX-105*). This tank was interim stabilized in 1986 (HNF-SD-RE-TI-178); the tank was labeled inactive in 1980, interim stabilization completed in 1981, and additional supernate pumped out and intrusion prevention completed in 1986 (WHC-SD-WM-ER-406, *Tank Characterization Report for Single-Shell Tank 241-BX-105*).

C1.3.1 History

Tank BX-105 went into service in 1949 when it received B Plant MW. This waste was cascaded from tank BX-104. Tank BX-105 was filled by the cascade line with MW in 1949. The first tank in this cascade, tank BX-104, began filling in January 1949. Waste began overflowing into tank BX-105 through a cascade tie in April of the same year. Tank BX-105 was filled in September 1949 and waste began cascading to tank BX-106. Although most of the MW solids were expected to settle in the first tank of the cascade (tank BX-104), some of the insoluble material still entered tank BX-105 and settled there.

The tank was sluiced for UR in 1954 and was used as a leach tank to recover uranium from 1955 received to 1956. The tanks in this cascade were sluiced for UR during 1954 to 1955 because of the high uranium content in the MW. Sluicing operations in the 241-BX Tank Farm centered on tank BX-105 in January, February, and May 1955. Sluicing operations were completed by August of the same year. Liquid waste was then added to the tank to leach uranium from MW remnants. Tank BX-105 received U-Plant waste from 1956 to 1962. The tank was nearly refilled in 1956 with UR waste (TBP) that had been stored in the 241-BY Tank Farm. Much of this supernate was pumped to either a trench or to tank BY-102 the following year. During this time, the tank also received significant amounts of waste from sources that are now unknown. From 1963 to 1964, the tank received cladding waste from the PUREX Plant. From 1963 to 1968, the tank was filled with CWP supernate that had been stored previously in tank 241-C-109, and supernate from IX waste, cladding waste, and evaporator bottoms (EB) from tank BX-104. The tank received IX waste from 1969 to 1974. Between 1974 and 1980, the tank contained EB waste, IX waste, and evaporator feed.

Tank BX-105 received small additions of waste water from 1972 to 1976. In 1973, the tank received BL waste and IX waste that had been stored in tanks BX-104 and BX-108. The tank again had much of its waste volume removed in 1974. Subsequently, IX waste and EB supernate were directed to it from tanks in the 241-BY Tank Farm. Tank BX-105 was used as an evaporator feed storage tank from 1976 to 1977. During 1978 the tank became an active receiver of saltwell wastes pumped from tanks in the 241-BX and 241-BY Tank Farms (SD-WM-TI-356). During this time, the tank also received double-shell slurry feed, and comparatively large transfers of complexed and non-complexed waste from what are now unknown sources.

During its final year of operation (1980), tank BX-105 received a large amount of supernate from tank S-107, as that tank was removed from service. Most of this supernate was subsequently moved to tank BX-104. At the time of the transfer, tank S-107 contained a variety of wastes, including concentrated REDOX wastes and slurry feed.

C1.3.2 Tank 241-BX-105 Waste Surface Level

The 1986 photos show a ledge of waste around the outside of the tank, above the surface level Food Instrument Corporation conductivity gauge (FIC) plummet and a pile of debris (old measuring tapes, pipes) around the FIC plummet. The FIC was changed to an ENRAF™[1] in 1995. This would be expected to give approximately a 12-in. change in level measurement due to the change in reference point (tank side versus bottom), though only an 8-in. change was noted. Readings with both instruments were relatively constant before/after the change out. The 4-in. discrepancy was likely caused by the uneven debris surface under the FIC plummet. Tank BX-105 was filled to a maximum waste level of 546 kgal a number of times, in 1964, 1968, and 1969.

Figure C-7 shows quarterly tank waste surface levels since the tank first received waste. Figure C-8 shows tank liquid levels from SACS.

C1.3.3 Tank 241-BX-105 Logging and Assessments

Geologic and historical information available from other sources did not identify any active leaks from tank BX-105. However, the data indicate that surface spills have occurred and subsurface contaminant plumes that exist in the vicinity of the tank (Figure C-9) are most likely associated with releases from nearby tanks BX-101 and BX-102 (GJ-HAN-98, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank BX-105*).

C1.4 TANK 241-BX-106

As of July 2010 SST BX-106 contained 38 kgal (20.7 in.) of waste type TBP, CWP, and BY-Saltcake material with no supernate (HNF-EP-0182, RPP-RPT-42988, *2009 Auto-TCR for Tank 241-BX-106*). This tank was removed from service in 1977 and was interim stabilized in July 1995 (HNF-SD-RE-TI-178). The interim stabilization evaluation estimated the tank waste volume to be 38 kgal; however, the surface level measurement was 20.7 in. which is a waste volume of 36 kgal. Based on the interim stabilization evaluation and because no waste has been added to or removed from the tank since interim stabilization, a waste volume of 38 kgal was chosen as the total tank waste volume.

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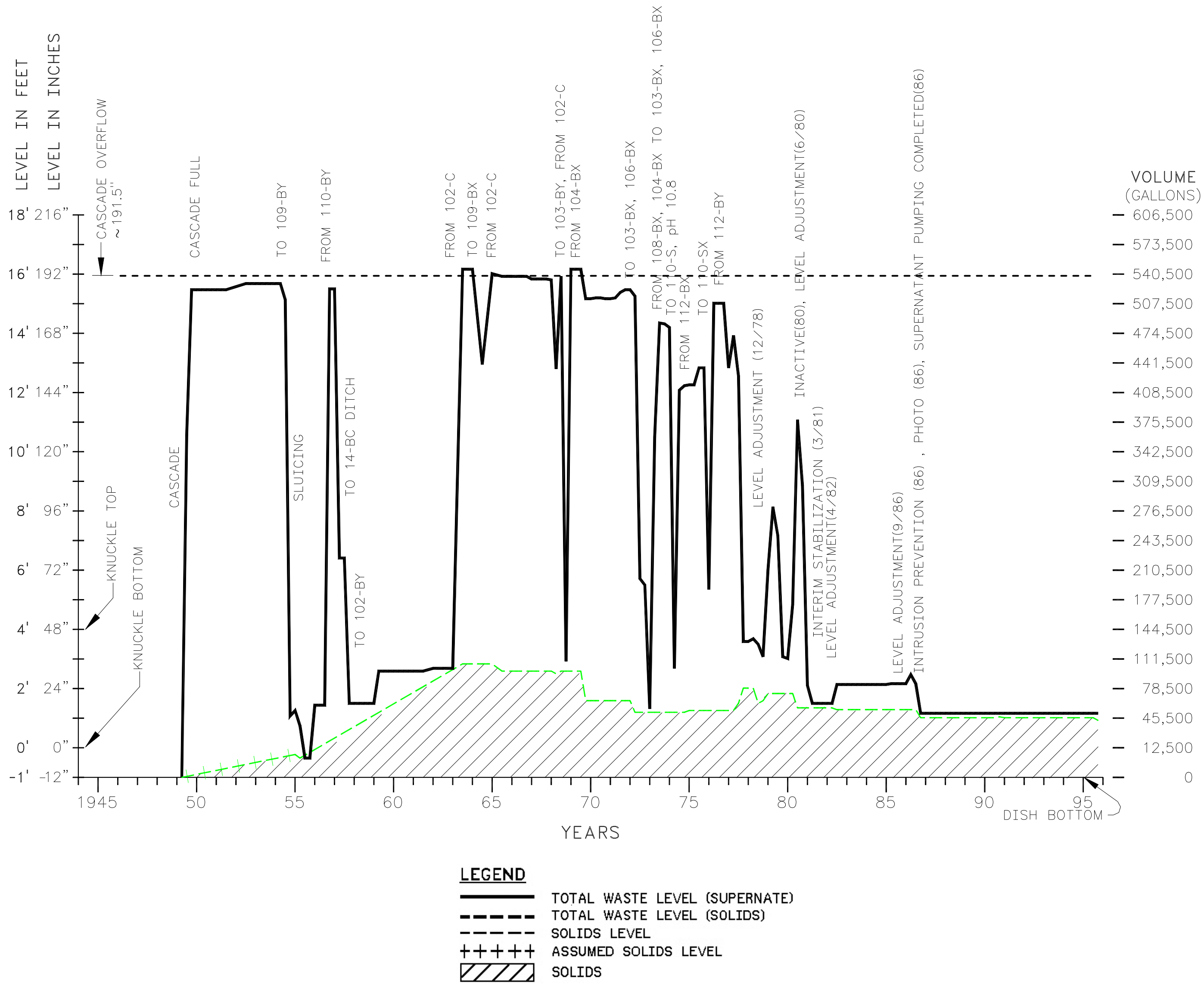
[1] ENRAF - Nonius Series 854 is a trademark of ENRAF-Nonius, N.V. Verenigde Instrumentenfabrieken, ENRAF Nonius Corporation Netherlands, Rontegenweg 1, Delft, Netherlands.

Figure C-7. Tank 241-BX-105 Waste Surface Levels



Reference: WHC-SD-WM-ER-349, *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Area*.

Figure C-8. Tank 241-BX-105 Monitoring Data

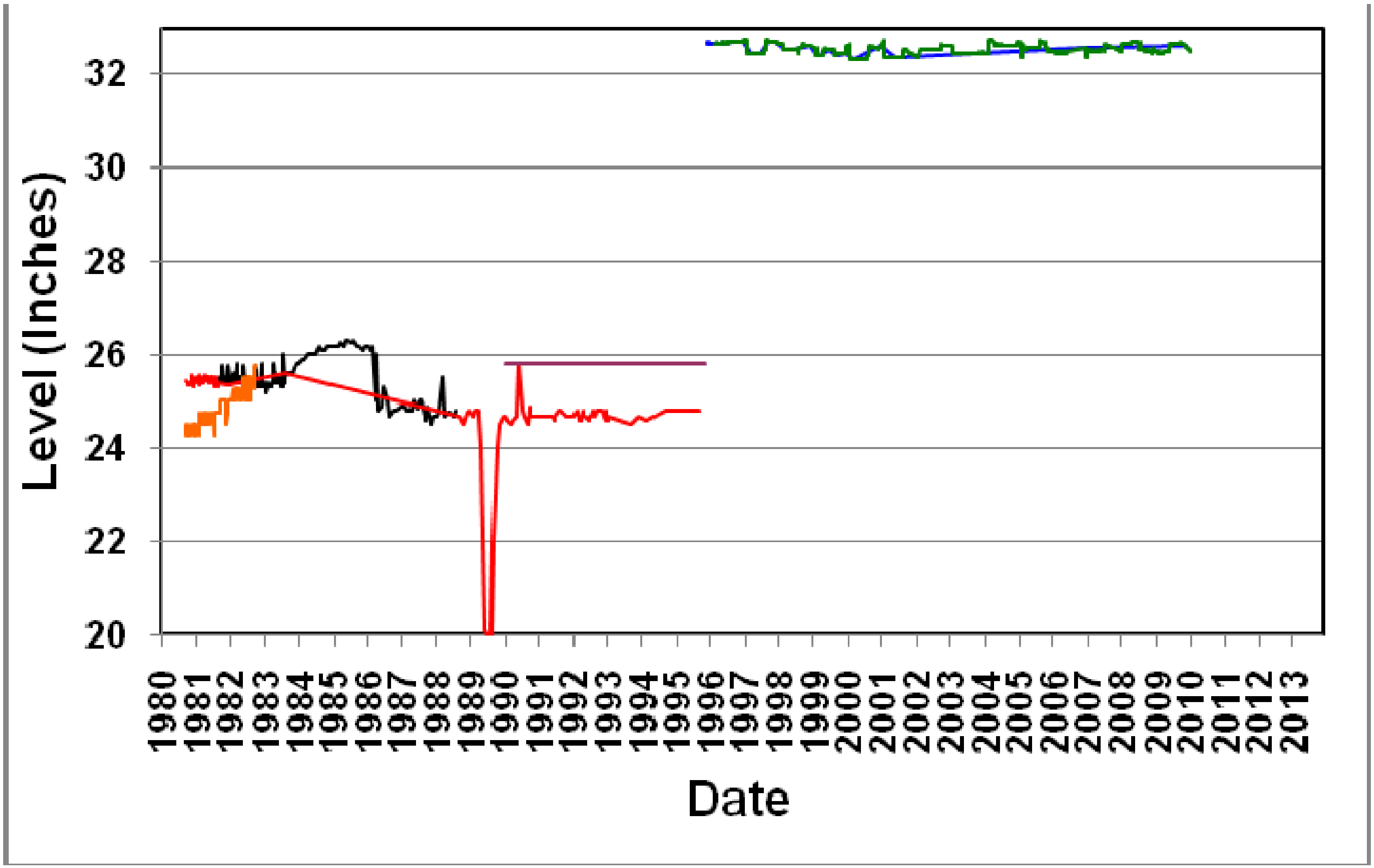
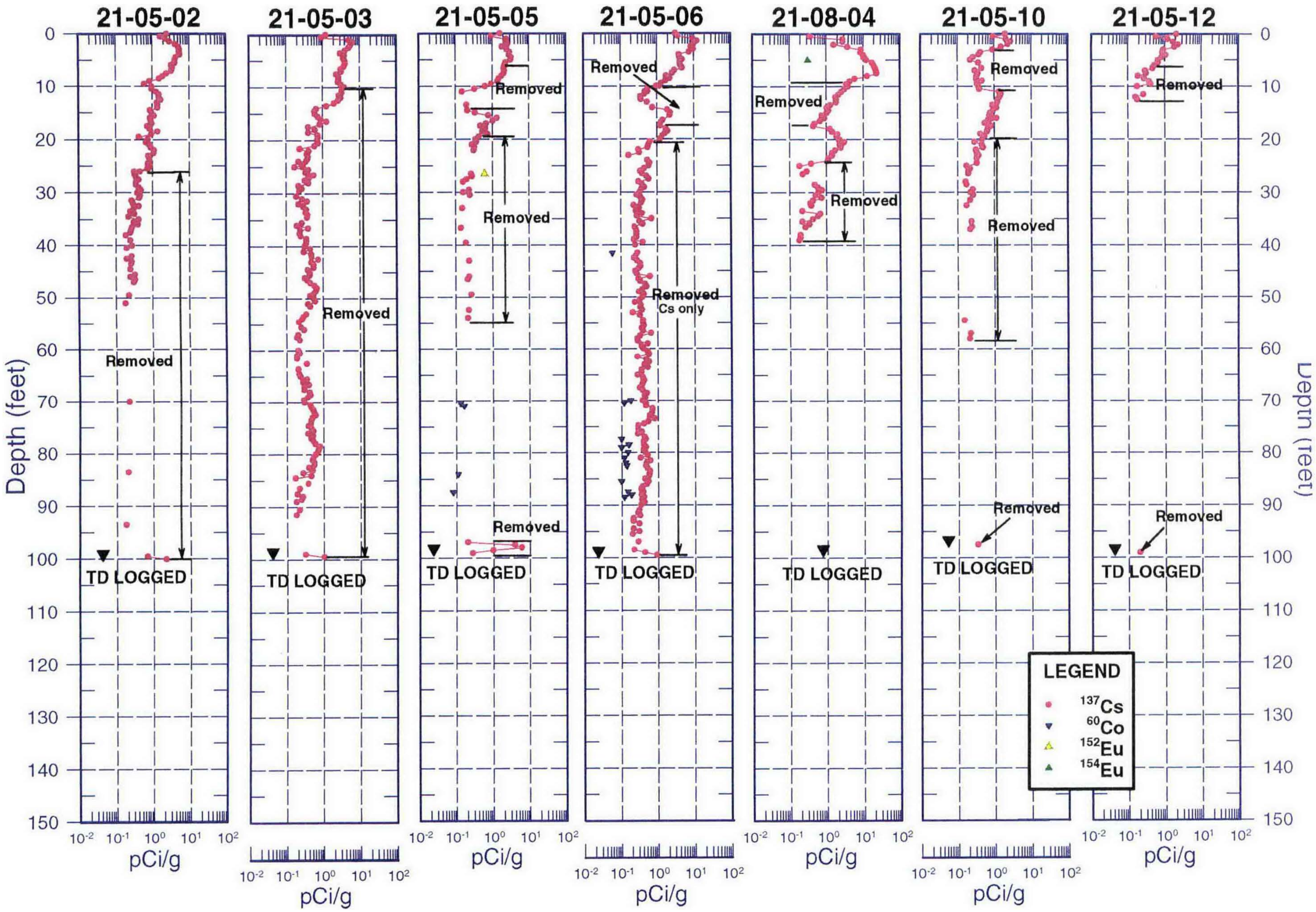


Figure C-9. 1997 Tank 241-BX-105 Spectral Gamma Logging Data



Reference: GJO-98-40-TAR/GJO-HAN-19, *Hanford Tank Farms Vadose Zone: BX Tank Farm Report*.

C1.4.1 History

Waste was first added to tank BX-106 in September 1949 from the cascade of B Plant MW from tank BX-105. The cascade of MW continued until the entire cascade was filled in January 1950. Supernate, presumably MW from B Plant, was pumped to tank BX-106 from several tanks during the second quarter of 1954. The tanks transferring waste were BX-104, BX-105, BY-104, 241-BY-105, and 241-BY-111. The waste was sluiced from tank BX-106 in May 1955 to provide feed for the UR process. Additional supernate was added in the second quarter of 1956 from tank BY-108. This waste is assumed to be first decontamination cycle (1C) waste from B Plant and TBP waste. In the third quarter of 1957, supernate was transferred from tank BX-106 to tank BY-102. In the first and second quarters of 1963, tank BX-106 received liquid cladding waste from tank C-102.

The tank did not receive waste again until the first quarter of 1968 when IX waste from the cesium recovery operations and EB waste from the ITS campaign were transferred from tank BX-104 into tank BX-106. Additional EB waste was added from several tanks during the fourth quarter of 1968. The tanks involved in this transfer of waste were BX-103, BX-107, BX-108, 241-BX-109 (BX-109), BX-110, BX-111, and 241-BX-112 (BX-112). Tank BX-106 received an additional amount of IX waste from tank BX-104 in the first quarter of 1969. From the third quarter of 1957 to the third quarter of 1969, supernate transfers from tank BX-106 were made to tanks 241-BY-103 and BY-102. From the second quarter of 1970 through the second quarter of 1971, tank BX-106 received liquid BL waste from tank BX-101. Tank BX-104 received supernate from tank BX-106 in the second quarter of 1970. From the fourth quarter of 1970 to the second quarter of 1971, supernate transfers went to tanks in 241-TX and 241-TY Farms (tanks 241-TY-103, 241-TX-118, 241-TX-101, and 241-TX-105).

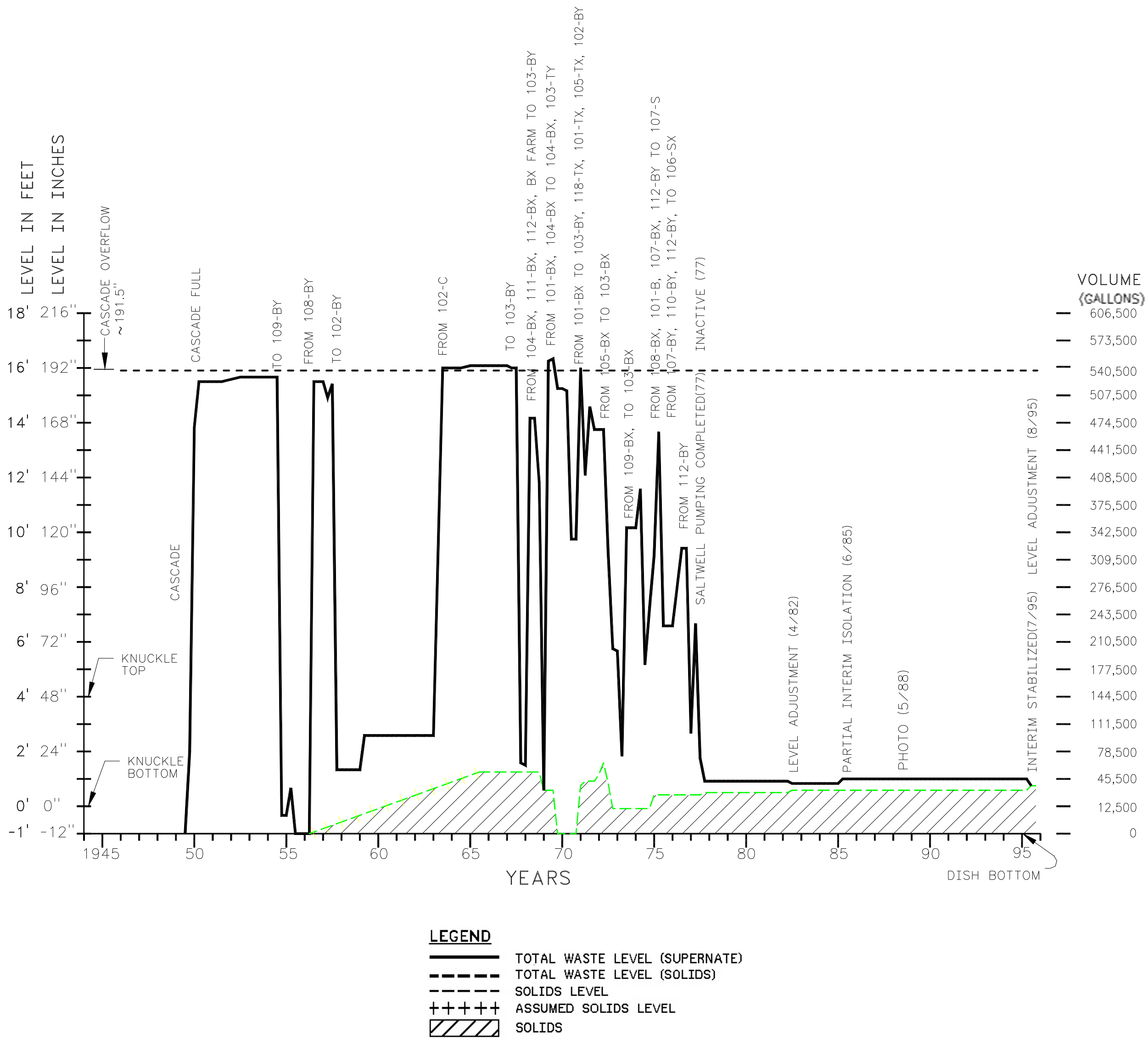
Waste from several tanks was transferred to tank BX-106 from the fourth quarter of 1972 through the second quarter of 1976. The waste was comprised of organic wash waste from the PUREX process plant, and BL and IX liquid wastes. The tanks involved in the transfer were B-101, BX-105, BX-107, BX-108, BX-109, 241-BY-107, BY-110, and BY-112. Tank BX-103 received supernate from tank BX-106 from the second quarter of 1972 to the first quarter of 1973. Between the second quarter of 1974 and the second quarter of 1977, tank BX-106 supernate went to tanks 241-S-107, 241-SX-106, and A-102. The final two waste transfers to tank BX-106 were EB saltcake from ITS during the first quarter of 1976. This addition preceded the waste transfer from tank BY-112 mentioned above. The final waste addition was an unspecified waste from tank A-102. Historical records indicate that the waste appears to be 242-A EB waste.

C1.4.2 Tank 241-BX-106 Waste Surface Level

No basis was found as to unknown surface level increases. Tank BX-106 was filled to a maximum waste level of 541 kgal in 1963, remained well above 530 kgal waste volume through 1967 and again filled to 552 kgal in 1969.

Figure C-10 shows quarterly tank waste surface levels since the tank first received waste. Figure C-11 shows tank liquid levels from SACS.

Figure C-10. Tank 241-BX-106 Waste Surface Levels



Reference: WHC-SD-WM-ER-349, *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Area*.

C1.4.3 Tank 241-BX-106 Logging and Assessments

Reference SD-WM-TI-356 states the surface-level measurement anomalies in later 1979 and through 1982 were associated with FIC calibrations and the FIC plummet contacting solids, and photographs taken in 1982 show more surface liquid than previous photographs. GJ-HAN-99, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank BX-106* reports that geologic and historical information available from other sources did not identify any active leaks from tank BX-106. However, the data indicated that surface spills have occurred and subsurface contaminant plumes exist below the tank (Figure C-12).

Figure C-11. Tank 241-BX-106 Monitoring Data

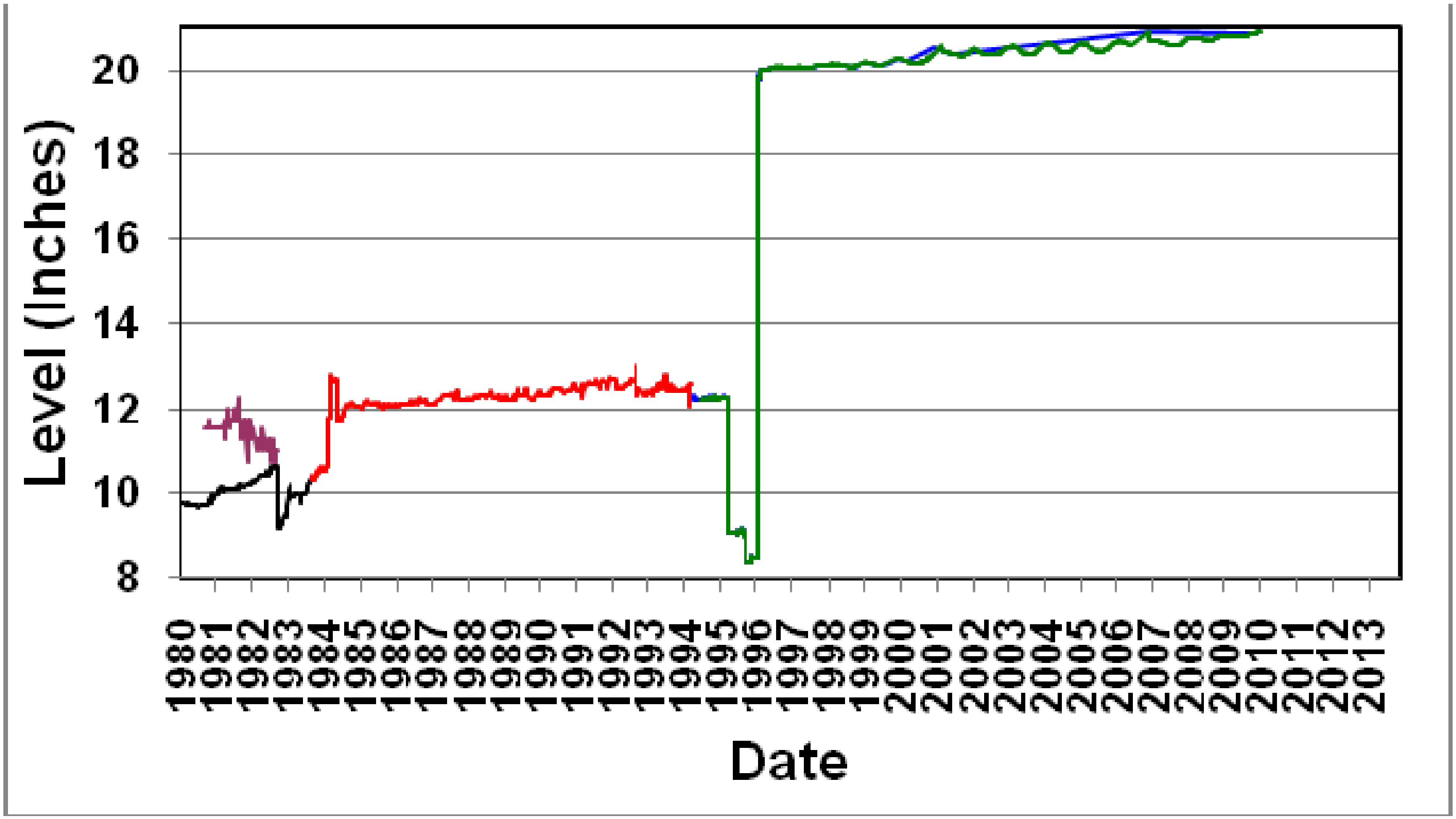
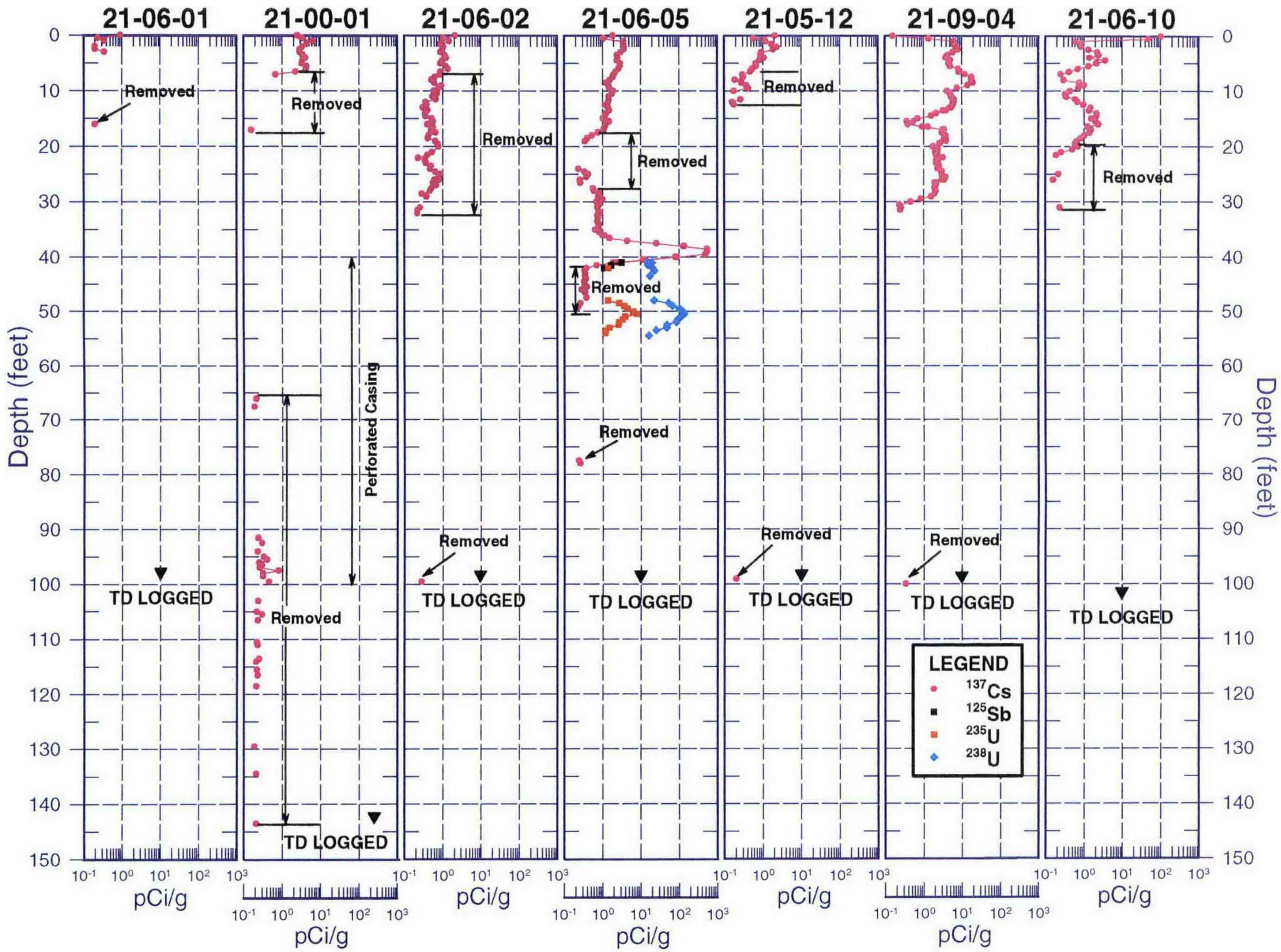


Figure C-12. 1997 Tank 241-BX-106 Spectral Gamma Logging Data



Reference: GJO-98-40-TAR/GJO-HAN-19, *Hanford Tank Farms Vadose Zone: BX Tank Farm Report*.

At the end of calendar year 2001 a leak assessment was conducted based on spectral gamma logging data that identified gamma activity near the tank bottom in drywell 21-06-05. The conclusion of the assessment is that the tank did not leak. Operations activities resulted in overfilling tank BX-106. The contamination detected is either from a cascade or a spare nozzle leakage, which likely flowed down the outside or between the steel tank liner and concrete, and pooled at the base of the tank (RPP-9752, *Leak Assessment for Tank 241-BX-106*).

C1.5 TANK 241-BX-107

As of July 2010 SST BX-107 contained 347 kgal (113.6 in.) of waste type 1C sludge material with no supernate (HNF-EP-0182, RPP-RPT-42989, *2009 Auto-TCR for Tank 241-BX-107*). This tank was interim stabilized in 1990 (HNF-SD-RE-TI-178). Tank BX-107 was partially interim isolated in June 1985.

C1.5.1 History

Tank BX-107 is the first in the tank BX-107, BX-108, and BX-109 cascade series.
In September 1948, the tank began receiving 1C waste from the first decontamination cycle residues generated in the B Plant canyon building, which supported the bismuth-phosphate process. At the end of 1952, all released supernatant liquid was pumped out of tank BX-107 leaving settled sludge in the tank. During 1953, TBP, also known as UR waste, was added to tank BX-107. Between 1953 and 1968, the volume of the sludge remained fairly constant while liquid volumes fluctuated. In 1968, supernatant waste was transferred to tank BX-106, which left tank BX-107 again with only sludge waste. The sludge was a mixture of 1C and TBP residues. In 1969, tank BX-107 began receiving IX type waste. Records show that the sludge volume decreased and the liquid volume increased.

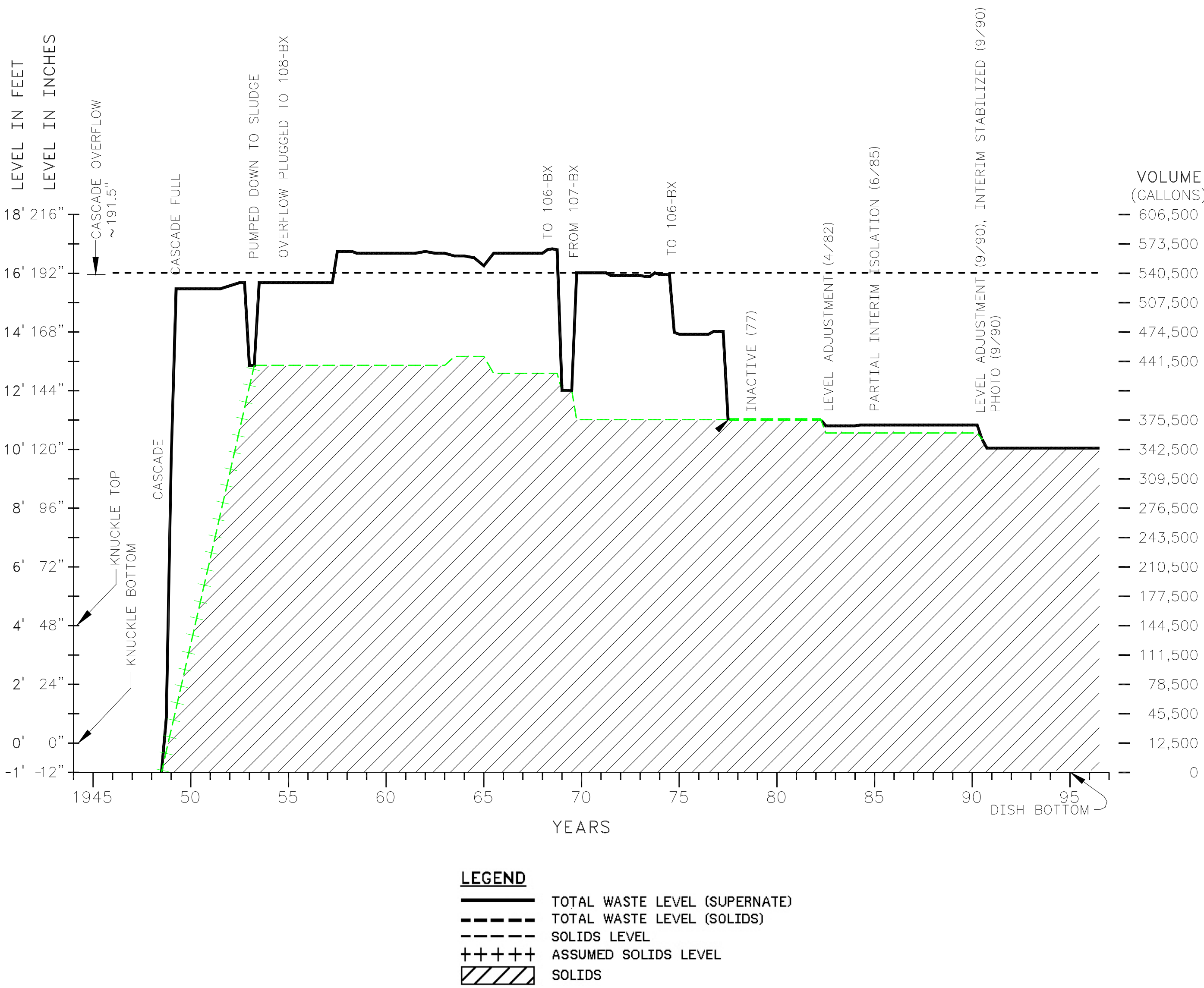
The waste levels remained approximately constant until 1974 when tank BX-107 supernatant liquid was transferred to tank BX-106 for solidification. The remaining liquid was used as evaporator feed in 1977, leaving the tank with residual sludge from 1977 to 1980. In 1977, the tank was decommissioned.

C1.5.2 Tank 241-BX-107 Waste Surface Level

Tank BX-107 was filled to a maximum waste level of 565 kgal in 1957 and remained full through 1968. The tank was pumped down slightly, and then remained above 540 kgal from 1969 through 1974. The current waste level remains constant.

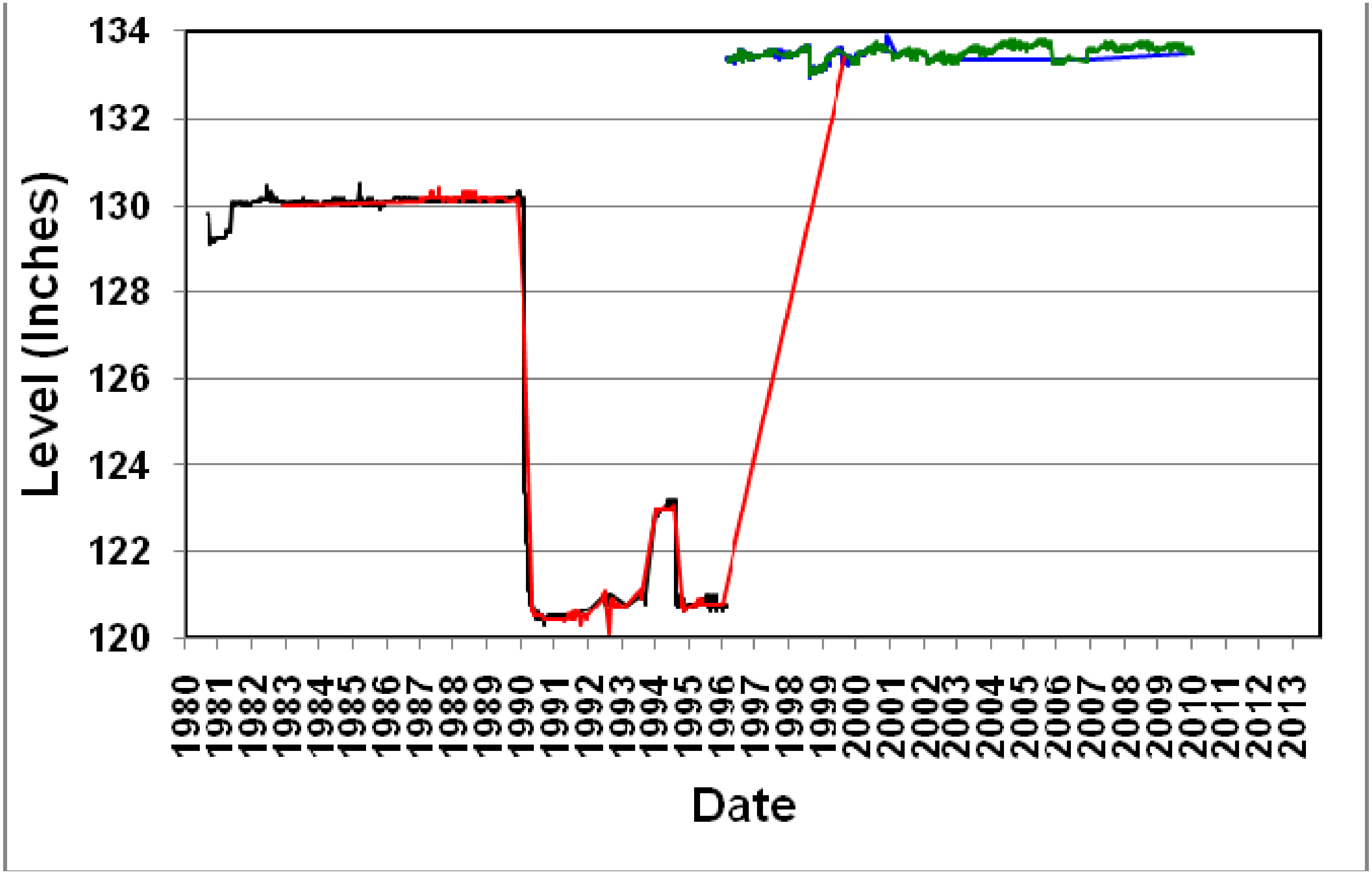
Figure C-13 shows quarterly tank waste surface levels since the tank first received waste.
Figure C-14 shows tank liquid levels from SACS.

Figure C-13. Tank 241-BX-107 Waste Surface Levels



Reference: WHC-SD-WM-ER-349, *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Area*.

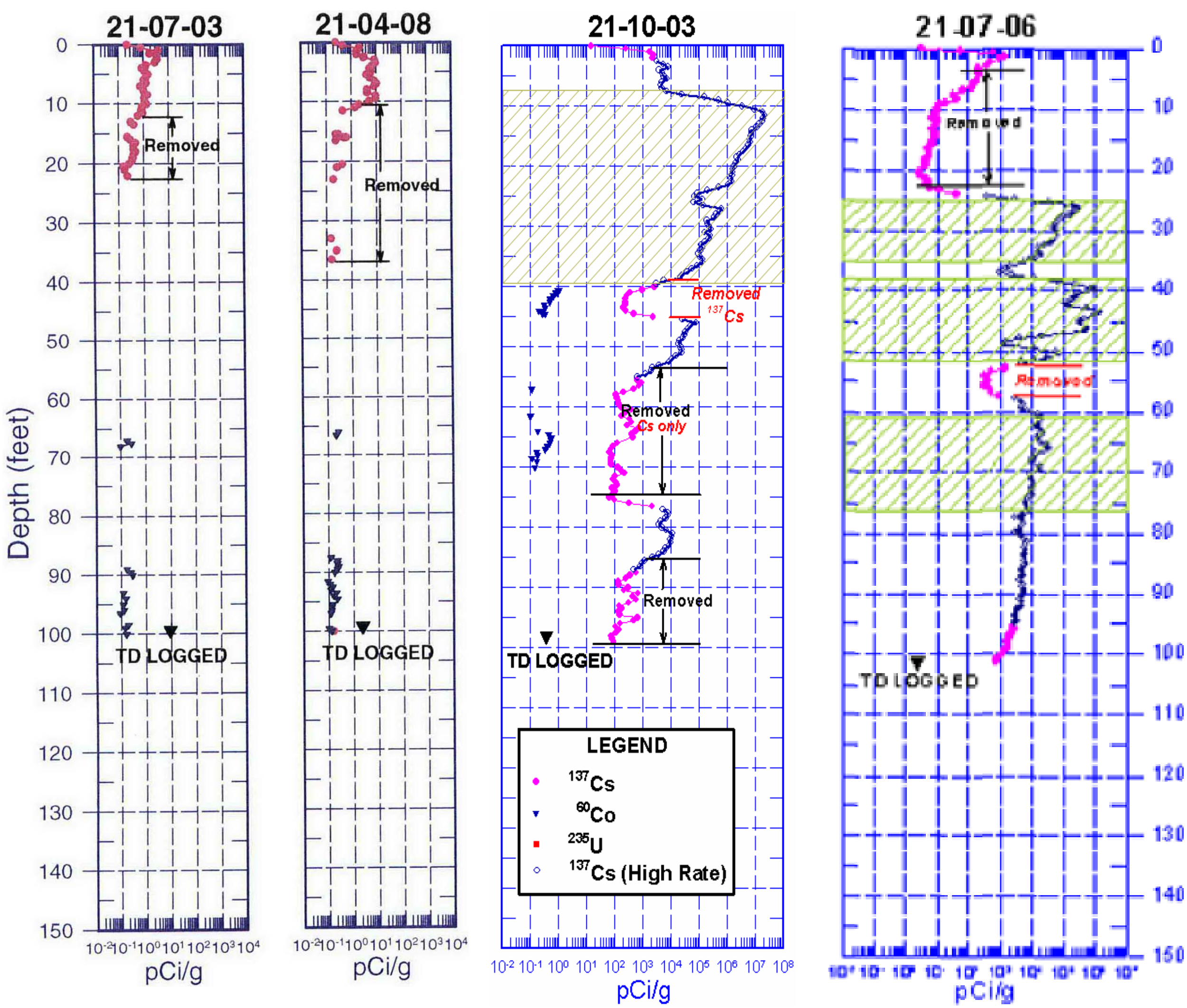
Figure C-14. Tank 241-BX-107 Monitoring Data



C1.5.3 Tank 241-BX-107 Logging and Assessments

Document SD-WM-TI-356 stated that test drilling and auguring in 1974 indicated that the high-level activity in drywell 21-07-06 was associated with a transfer line leak (no specific information or data concerning this leak is available). GJ-HAN-100, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank BX-107* reports that historical information indicates that the sources of the contamination around this tank are surface spills and pipeline and/or tank leaks. Gross gamma-ray logs indicate drywells 21-07-06 and 21-10-03 showed zones of high dead times. Drywell 21-07-03 showed zones of contamination below the base of the tank (Figure C-15). The vertical extent of this contamination could not be determined. The source of this contamination could be a tank leak that originated at any of a number of tanks in the vicinity, or tank BX-107 itself.

Figure C-15. 1997 Tank 241-BX-107 Spectral Gamma Logging Data



Reference: GJO-98-40-TAR/GJO-HAN-19, *Hanford Tank Farms Vadose Zone: BX Tank Farm Report.*

The following occurrence/deviation reports were issued due to liquid level decreases and liquid level increases in tank BX-107.

OR-79-35, *Occurrence Report 79-35 Unplanned Core Drill Contact with 107-BX Tank Liner*

> "Core drilling was in progress and the crew was attempting to remove a drill sample taken at the 89" sludge level. During removal of the latching mechanism, which is used to pull the sample out of the drill rod, the cable broke dropping the latching mechanism to the bottom of the drill rod. Pictures taken after breaking the cable showed that the drill rod had broken during the last drilling activity. While retrieving the broken section of rod it was discovered that an unrecorded 60" segment of drill rod had been attached to the drill string causing the drill bit to come in contact with the tank bottom.
>
> The apparent cause of the additional 60" length of drill rod was a lack of adequate administrative controls for the documentation and addition of drill rod segments.
>
> The permanent corrective action consists of the following administrative controls added to Procedure 200.1.44. "Core Drilling.""

C1.6 TANK 241-BX-109

As of July 2010 SST BX-109 contained 193 kgal (77.6 in.) of waste type TBP sludge material with no supernate (HNF-EP-0182, RPP-RPT-42991, *2009 Auto-TCR for Tank 241-BX-109*). This tank was interim stabilized in 1990 by removing the supernate (HNF-SD-RE-TI-178). There are slight differences in surface levels shown by the current ENRAF which are likely due to an uneven surface. The waste depth is expected to remain relatively constant, as the tank was removed from service in 1976 and declared inactive in 1977. A liquid observation well was installed in January 2003. The liquid observation well neutron probe data indicates that the interstitial liquid level is at or near the solids surface level.

C1.6.1 History

Tank BX-109 went into service in 1950 when 1C supernatant waste was transferred from tank BX-108 via the cascade. From 1953 until 1954, supernatant waste was transferred from tank BX-109 to tank 241-B-106. During the same period, tank BX-109 received waste consisting of 1C and UR process waste (consisting of primarily TBP waste) from U-Plant. Tank BX-109 supernate also cascaded to tank 241-BY-107 during this time period. During 1957, supernate was pumped to tank 241-C-101, scavenged with ferrocyanide, then pumped to tank 241-C-108 for in-tank settling of co-precipitated cesium (scavenging transfer T29).

Tank BX-109 remained static until 1964 when it was sluiced to tank A-102. Tank BX-109 also received supernatant CWP from tank BX-105 during 1964. Late in 1964, tank BX-109 received supernatant CWP from tank C-102. From 1967 to 1969, tank BX-109 received cesium recovery waste from B Plant. From 1968 until 1973, supernate (CSR and/or cesium recovery IX waste) was transferred from tank BX-109 to tank BX-106. The final transfer occurred in 1973, after tank BX-109 received water from an unknown source.

C1.6.2 Tank 241-BX-109 Waste Surface Level

Tank 241-BX-109 was filled to a maximum waste level of 557 kgal in 1968.

Figure C-16 shows quarterly tank waste surface levels since the tank first received waste. Figure C-17 shows tank liquid levels from SACS.

C1.6.3 Tank 241-BX-109 Logging and Assessments

Document SD-WM-TI-356 stated that the dry well remained stable during the report period. GJ-HAN-102, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank BX-109* reports geologic and historical information available from other sources do not identify any active leaks from tank BX-109. However, the data indicate that surface spills have occurred and a subsurface contaminant plume exists in the vicinity of this tank around drywell 21-08-12 (Figure C-18). The contaminant plume may be related to releases near tank BX-109, but it is more likely with tank BX-108. A very small plume was detected at the base of the tank around drywell 21-12-02. The source of this contamination is unknown, but it could be from tank BX-112 or tank BX-109 (GJ-HAN-102).

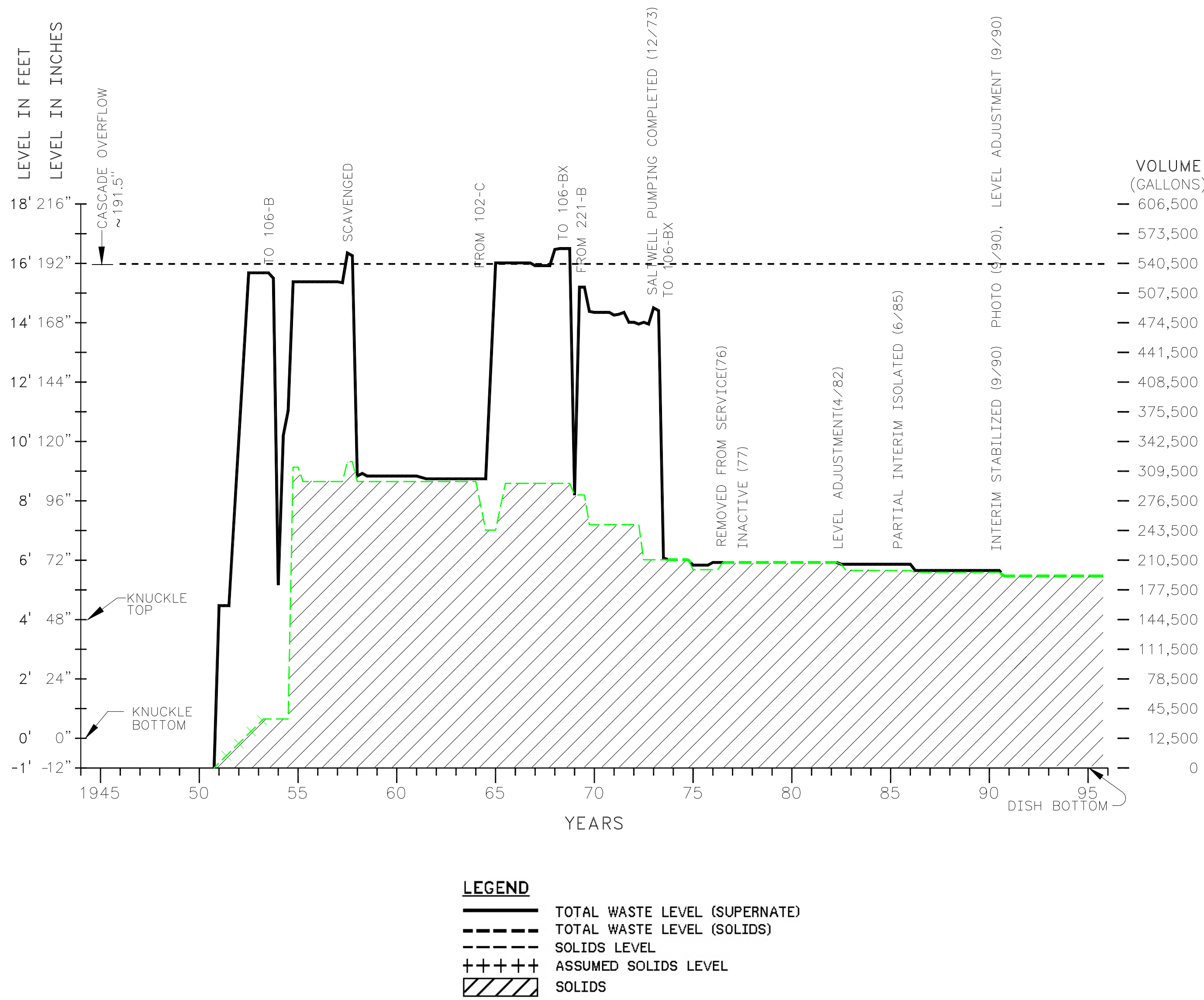
C1.7 TANK 241-BX-112

As of July 2010 SST BX-112 contained 164 kgal (67.2 in.) of waste type 1C sludge material with 1 kgal of supernate (HNF-EP-0182, RPP-RPT-42994, *2009 Auto-TCR for Tank 241-BX-112*). This tank was interim stabilized in 1990 (HNF-SD-RE-TI-178). The January 2001 ENRAF surface level measurement is consistent with the October 1, 2004 measurement. Tank BX-112 was removed from service in 1978, and the tank was saltwell pumped in 1983.

C1.7.1 History

Tank BX-112 is third in a cascade series beginning with tanks BX-110 and BX-111 in the 241-BX Tank Farm and cascading into tank BY-110 in the 241-BY Tank Farm. Tank BX-112 began receiving 1C waste from B Plant operations cascading from tank BX-111 in 1951. The cascade continued until 1952 when all the tanks in the cascade were filled. During 1953, supernatant waste was pumped from tank BX-112 to the 216-B-039 crib. Tank BX-112 received waste in 1954 from a transfer of supernatant waste from tank 241-B-105. Historical records indicate that the waste from tank 241-B-105 was 242-B Evaporator saltcake waste.

Figure C-16. Tank 241-BX-109 Waste Surface Levels



Reference: WHC-SD-WM-ER-349, *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Area*.

Figure C-17. Tank 241-BX-109 Monitoring Data

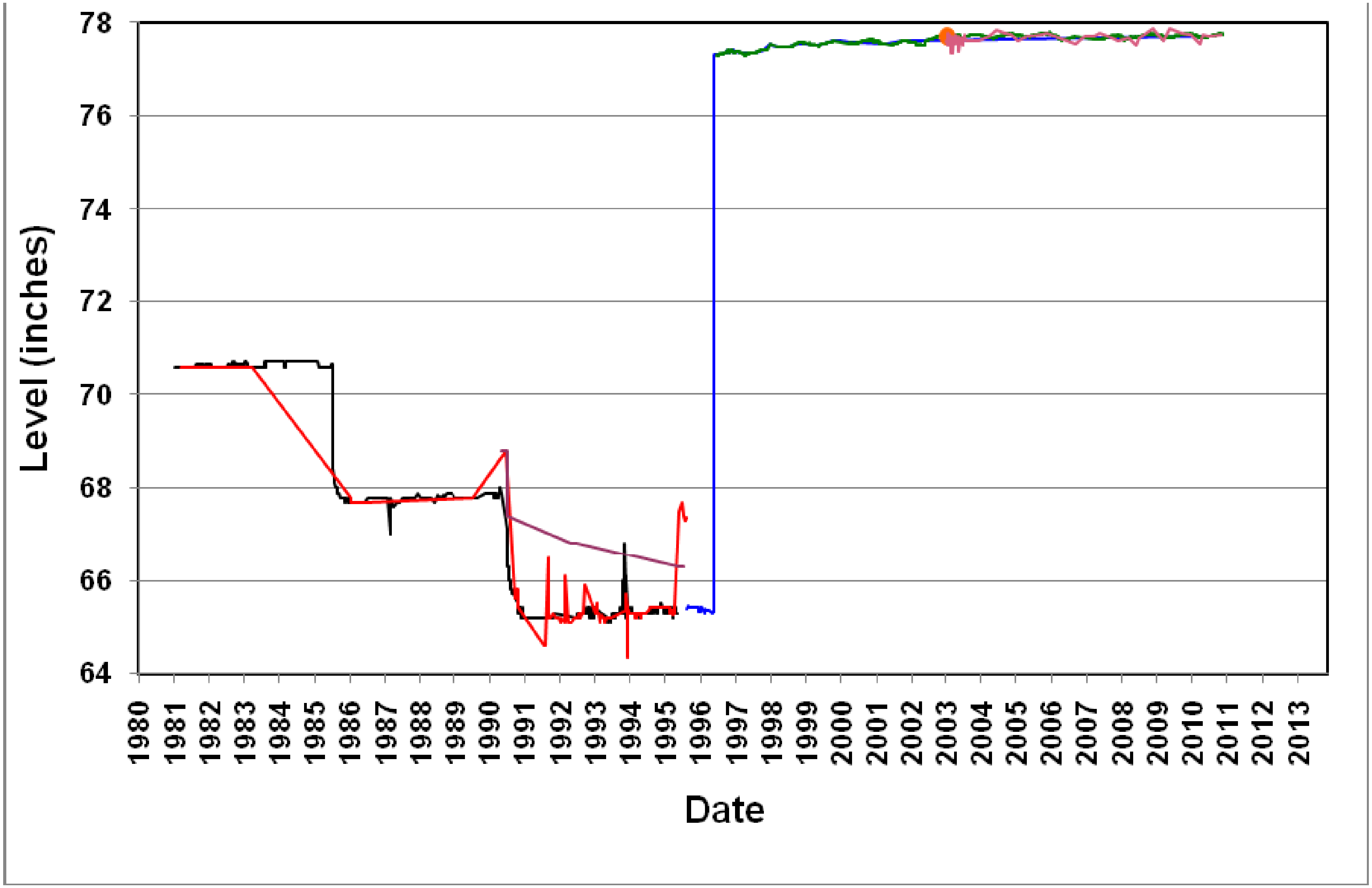
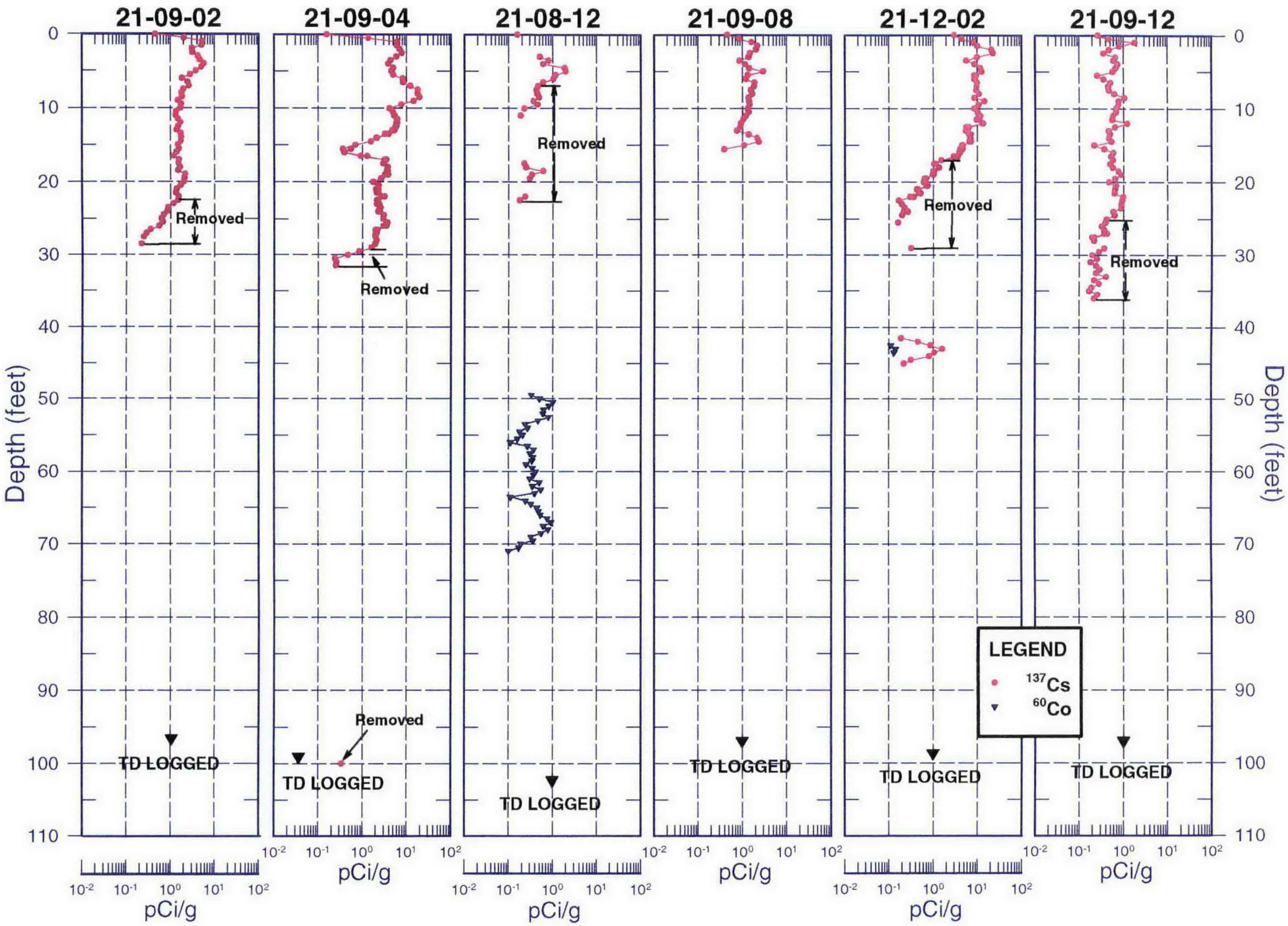


Figure C-18. 1997 Tank 241-BX-109 Spectral Gamma Logging Data



Reference: GJO-98-40-TAR/GJO-HAN-19, *Hanford Tank Farms Vadose Zone: BX Tank Farm Report*.

In 1955, liquid waste from tank BX-112 was sent to the 242-B Evaporator with the same amount returned as 242-B Evaporator saltcake waste. The next transfer occurred in 1964 when cladding waste (CW) was transferred from tank C-102 to tank BX-112. In 1968, tank BX-112 received flush water, and a supernate transfer was made to tank BX-106. Waste from cesium recovery operations in B Plant was received by tank BX-112 during 1969. Waste was transferred from tank BX-112 to tank BY-102 in late 1969. Another transfer of waste from tank BX-112 occurred in 1974 to tank BX-105. In 1977, waste was transferred to tank A-102 from tank BX-112, and waste was also received from tank A-102. In 1978, tank A-102 again received waste from tank BX-112.

C1.7.2 Tank 241-BX-112 Waste Surface Level

Tank BX-112 was filled to a maximum waste level of 552 kgal in 1969. The liquid level in tank BX-112 stayed relatively constant with a waste volume of 546 kgal (above the cascade level) from the end of 1964 into 1968. Since 1993 the surface level in the tank appears to be decreasing gradually. There have been no occurrence reports on this slow decrease in the waste surface level. 1990 photographs show standing supernate in the tank and indicate that the ENRAF may be gradually penetrating the sludge layer.

Figure C-19 shows quarterly tank waste surface levels since the tank first received waste. Figure C-20 shows tank liquid levels from SACS.

C1.7.3 Tank 241-BX-112 Logging and Assessments

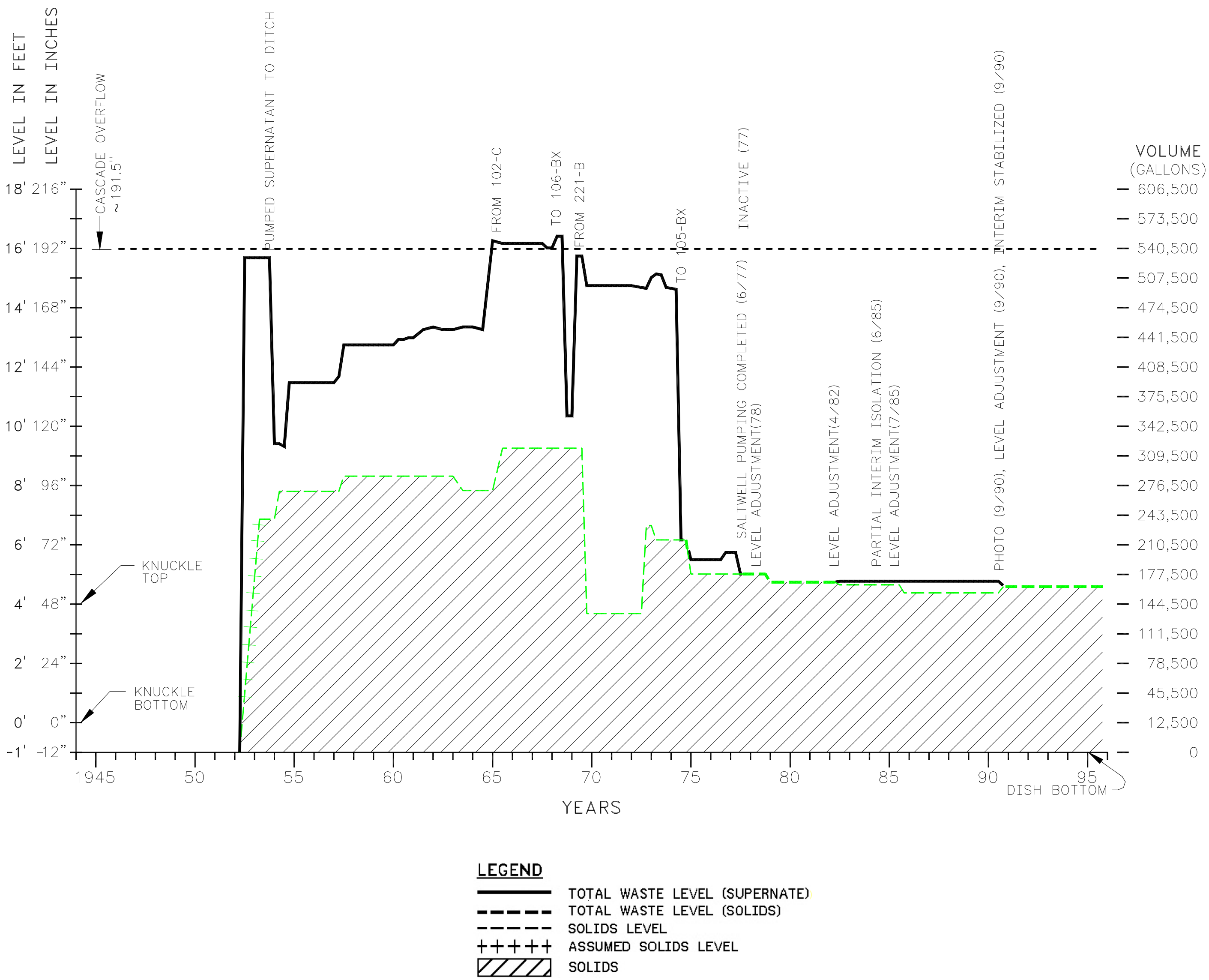
Document SD-WM-TI-356 noted that surface level decreases did not exceed the criterion. GJ-HAN-105, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank BX-112* reports geologic and historical information available from other sources do not identify any apparent leaks from tank BX-112. However, the data indicate that surface spills have occurred and a small subsurface contaminant plume exists below the bottom elevation of this tank (Figure C-21). The source of that plume may be a release from tank BX-109 or it may have originated from surface contamination. The exact source cannot be determined at this time.

The following occurrence/deviation reports were issued due to liquid level decreases and liquid level increases in tank BX-112.

ARHCO Occurrence Report 74-26, *Significant Liquid Level Decrease – Tank 241-112-BX*

> "Study of the photographs of the tank interior after pumpdown did not reveal the presence of tar rings nor of any conditions suggesting potential for leakage. The liquid level data is variable and the dry well data does not suggest a leak. The tank is considered sound but will remain inactive unless required for additional waste storage space when it would be filled under controlled conditions. This would include incremental filling and increased dry well monitoring. A salt well will not be installed."

Figure C-19. Tank 241-BX-112 Waste Surface Levels



Reference: WHC-SD-WM-ER-349, *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Area*.

Figure C-20. Tank 241-BX-112 Monitoring Data

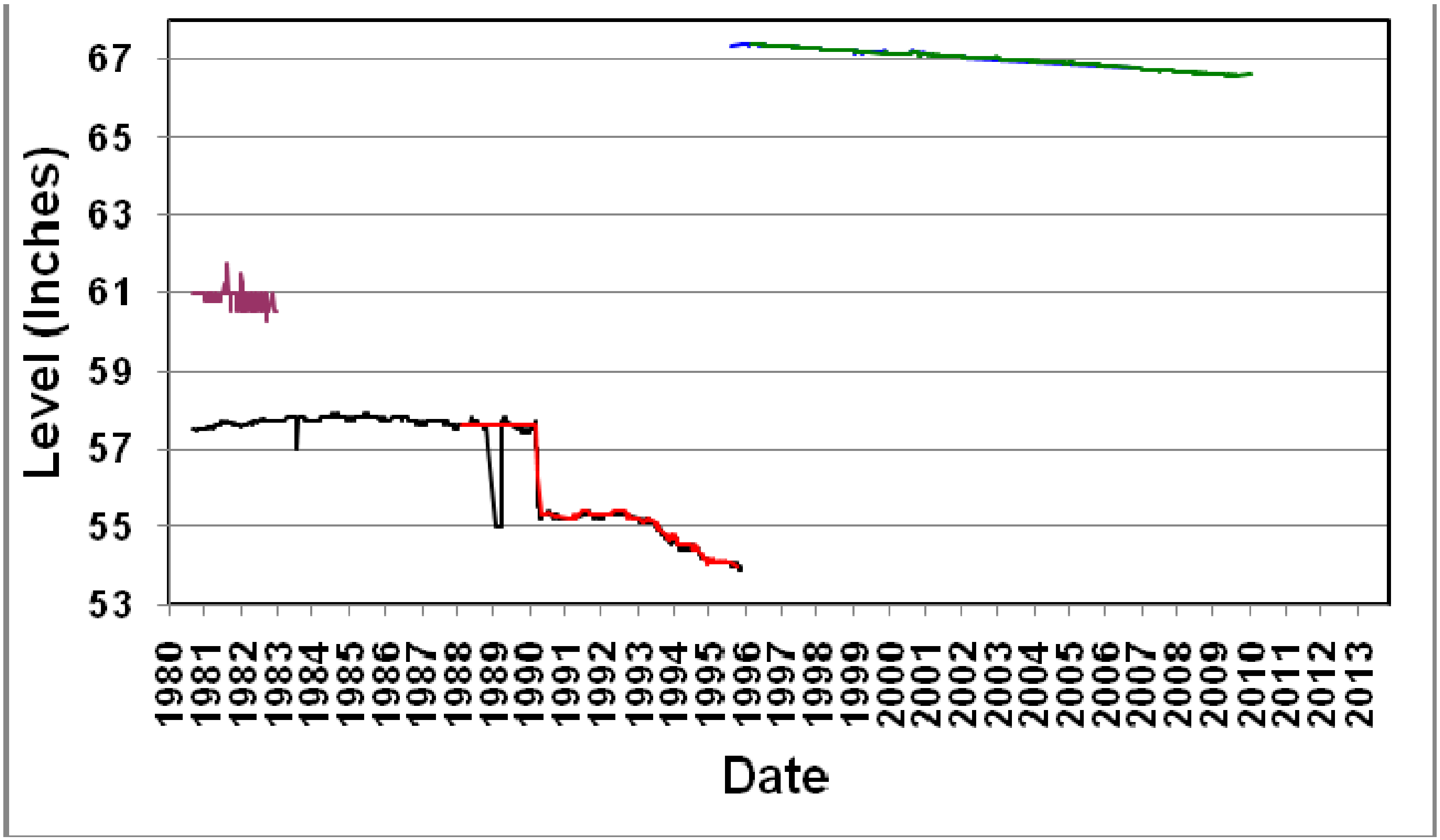
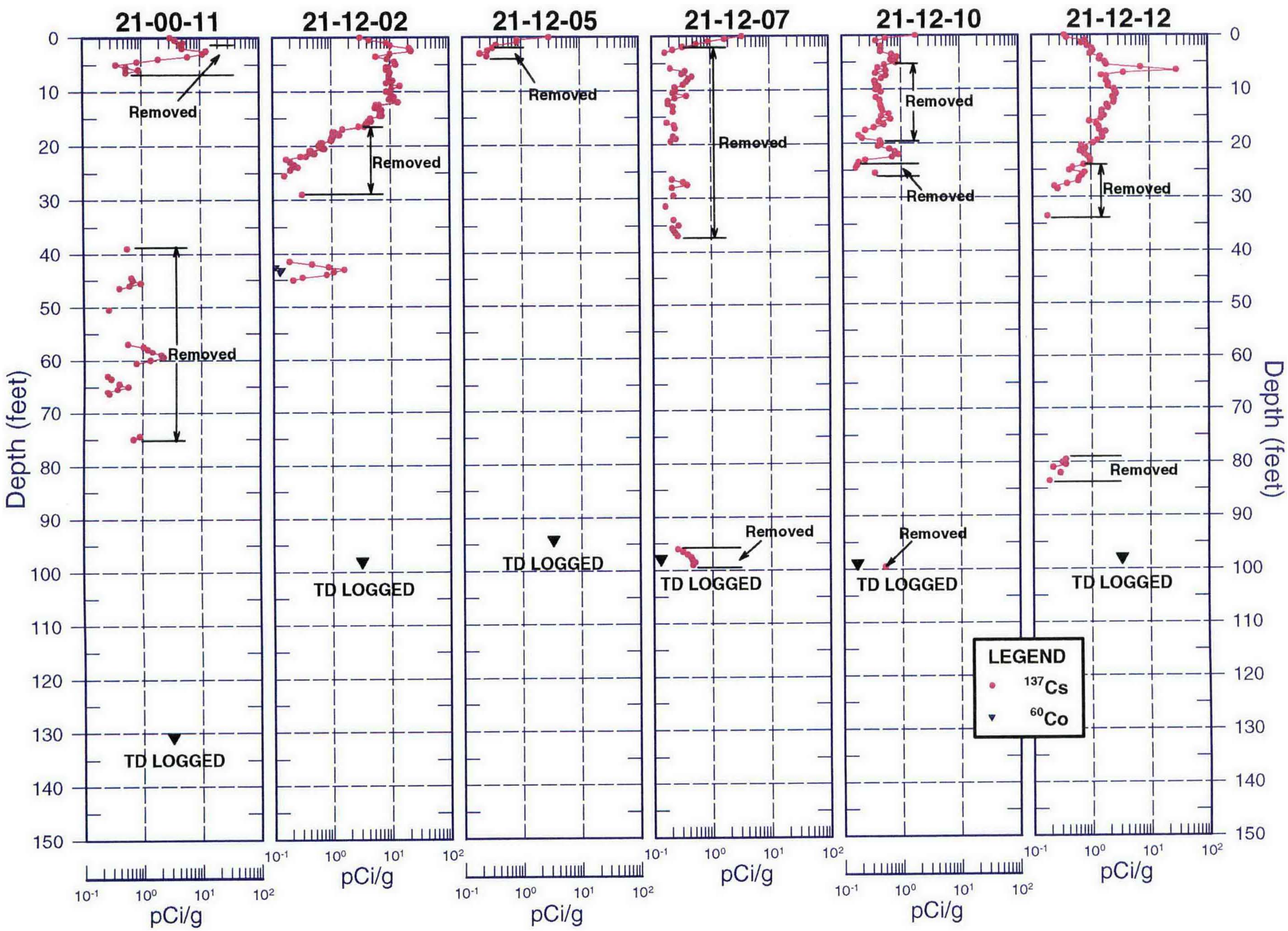


Figure C-21. 1997 Tank 241-BX-112 Spectral Gamma Logging Data



Reference: GJO-98-40-TAR/GJO-HAN-19, *Hanford Tank Farms Vadose Zone: BX Tank Farm Report*.

OR-77-66, *Occurrence Report 77-66 Liquid Level Decrease in Tank 112-BX*

> "The apparent cause of this criterion violation is a failure to readjust the baseline for the tank following scheduled maintenance of the FIC plummet on April 19, 1977. Before the maintenance, the measurement was 70.7 inches. Immediately following maintenance, the liquid level measurement was 68.7 inches. The baseline should have been changed at this time.
>
> An investigation of recent liquid level data sheets brought the FIC maintenance record to the attention of the Tank Farm Surveillance staff. The baseline has been changed to 68.7 inches."

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