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ACTIVE SITES ENVIRONMENTAL MONITORING PROGRAM FY 1992 ANNUAL REPORT

C. M. Morrissey
T. L. Ashwood
D. S. Hicks

(Environmental Sciences Division Publication No. 4002)

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Environmental Sciences Division

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FY 1992 ANNUAL REPORT

C. M. Morrissey, T. L. Ashwood, and D. S. Hicks

Environmental Sciences Division
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ABBREVIATIONS AND ACRONYMS

ACD	Analytical Chemistry Division
ASEMP	Active Sites Environmental Program
DOE	U.S. Department of Energy
ESD	Environmental Sciences Division
FY	fiscal year
HDTF	Hillcut Disposal Test Facility
IT	intratrench
IWMF	Interim Waste Management Facility
LLW	low-level waste
NPDES	National Pollutant Discharge Elimination System
ORNL	Oak Ridge National Laboratory
PWT	perched water table
QA	quality assurance
RCRA	Resource Conservation and Recovery Act
SWO	solid waste operations
SWSA	Solid Waste Storage Area
TMOI	Tumulus I
TMOII	Tumulus II
TOC	total organic carbon
TRU	transuranic
UND	underpad
WOC	White Oak Creek

EXECUTIVE SUMMARY

This report summarizes the activities of the Active Sites Environmental Monitoring Program (ASEMP) from October 1991 through September 1992. Solid Waste Operations and the Environmental Sciences Division established ASEMP in 1989 to provide early detection and performance monitoring at active low-level waste (LLW) disposal sites in Solid Waste Storage Area (SWSA) 6 and transuranic (TRU) waste storage sites in SWSA 5 as required by Chapter II and III of U.S. Department of Energy Order 5820.2A.

The Interim Waste Managenment Facility (IWMF) began operation in December 1991. Monitoring results from the tumulus and IWMF disposal pads continue to indicate that no LLW is leaching from the storage vaults. Storm water falling on the IWMF active pad was collected and transported to the Process Waste Treatment Plant while operators awaited approval of the National Pollutant Discharge Elimination System (NPDES) permit. Several of the recent samples collected from the active IWMF pad had pH levels above the NPDES limit of 9.0 because of alkali leached from the concrete. The increase in gross beta activity has been slight; only 1 of the 21 samples collected contained activity above the 5.0 Bq/L action level.

Automated sample-collection and flow-measurement equipment has been installed at IWMF and is being tested. The flume designed to electronically measure flow from the IWMF pads and underpads is too large to be of practical value for measuring most flows at this site. Modification of this system will be necessary. A CO_2 bubbler system designed to reduce the pH of water from the pads is being tested at IWMF.

A ^3H plume in the shallow groundwater in the tumulus area still exists. Tritium was observed during this reporting period in wells where it was not previously detected. A new plume of ^3H has apparently entered and is moving through the area.

Soil sampling in the tumulus area indicates that no contaminants have been released to the surrounding area during loading operations.

Three of the 44 intratrench (IT) wells around LLW silos accumulated water that contained levels of dissolved gross beta activity above the 5 Bq/L action level during at least one sampling quarter. This was the first indication of elevated gross beta activity for two of these wells (wells 5 and 40). The third well (well 19) has exhibited elevated

gross beta activity during all previous sampling periods. This gross beta activity is primarily of ^{90}Sr, which probably leaches from the silos in the trench. All silos were grouted during the summer of 1992 in order to reduce the potential for waste migration. Evaluation of the effect of grouting for IT well 19 on the gross beta activity of the water has not yet been possible because of the insufficient accumulation of water for sampling. Dissolved gross beta activties in samples from backfill monitoring wells next to the high-range wells, asbestos silos, and fissile wells were below the 5 Bq/L action level. Gross alpha activities in all IT wells and backfill monitoring wells were below the action level of 1 Bq/L.

Some of the IT wells have occasionally shown dissolved ^{60}Co or ^{137}Cs activities above the action levels of 1.5 and 2.5 Bq/L. These activities have generally been accompanied by large counting uncertainties because of the small sample volume. Sampling procedures were modified to collect larger volumes from wells that historically contain ^{60}Co and ^{137}Cs activities above action levels. Data from the new sampling method are being evaluated.

Much less water was collected from the Hillcut Disposal Test Facility (HDTF) during fiscal year (FY) 1992 than in the previous 2 years. This may indicate a leak in the pad-runoff collection system. One sample of water was analyzed and contained no gross alpha, gross beta, or gamma-emitting isotope activities above action levels.

Groundwater and seep monitoring showed that the TRU contaminant plume from the burial trenches in the southwest corner of SWSA 5 North may be larger than previously reported. Groundwater monitoring in the SWSA 5 North area shows the continued presence in well 516 of ^{241}Am and ^{244}Cm concentrations above action levels. Measurable ^{244}Cm was observed for the first time in well 708, which is hydrologically downgradient from, and along strike with, the same group of burial trenches responsible for the ^{244}Cm contamination in well 516. Three other wells in the SWSA 5 North area showed low levels of ^{241}Am or ^{244}Cm during FY 1992.

1. INTRODUCTION

Chapter III of U.S. Department of Energy (DOE) Order 5820.2A (DOE 1988) sets forth requirements for the management of the facilities in Solid Waste Storage Area (SWSA) 6 (Fig. A.1) that were used for the disposal of solid low-level (radioactive) waste (LLW) on or after the date of the order (September 26, 1988). Chapter II of the order covers the transuranic (TRU) waste storage areas in SWSA 5 North (Fig. A.2). Both chapters require environmental monitoring to provide early warning of leaks before those leaks pose a threat to human health or the environment. Chapter III also requires the monitoring of LLW disposal facilities so that their performance can be evaluated. In accordance with this order, the Solid Waste Operations (SWO) Department at Oak Ridge National Laboratory (ORNL) has established an Active Sites Environmental Monitoring Program (ASEMP) that is implemented by staff of the Environmental Sciences Division (ESD) at ORNL.

This report presents the results of ASEMP activities for fiscal year (FY) 1992. The report is divided into two major areas: SWSA 6 [including tumulus pads, Interim Waste Management Facility (IWMF), and other sites] and TRU-waste storage facilities in SWSA 5 North. The monitoring methodology is described in the revised ASEMP program plan (Ashwood et al. 1992b). However, this report presents a summary of the methodology for each major area together with any changes that occurred during the report period. Figures and tables are grouped at the end of the report in Appendix A and B, respectively.

During FY 1992, the program plan was revised to reflect changes in ASEMP approaches that have evolved over the first 2 years of operation (Ashwood et al. 1992b). The revised program plan includes documentation of the procedures used for specific ASEMP tasks. A revised program quality assurance (QA) plan was issued in draft form and serves as the basis for ASEMP activities. The SWSA 5 North activities of the program were scrutinized as part of a DOE audit. The audit findings related to ASEMP and the responses to them are included in Appendix C. The responsibility for monitoring of test casks associated with the Emergency Avoidance Solidification Campaign and the Liquid Waste Solidification Program was transferred from a subcontractor to ASEMP staff at the end of FY 1992. This new task requires further revision of the program plan.

2. SWSA 6 LOW-LEVEL WASTE FACILITIES

SWSA 6 is currently the only operating LLW disposal facility on the Oak Ridge Reservation. Wastes that are certified free of liquids and hazardous wastes are further segregated into low- and high-activity wastes prior to disposal. Low-activity wastes are placed in concrete silos installed in trenches or in concrete vaults on concrete pads aboveground (called tumulus facilities) (Fig. A.1). High-activity wastes are placed either in silos or in steel-lined, concrete-capped auger holes (called high-range wells), depending on the waste form and activity (Fig. A.1). Asbestos waste that cannot be certified free of radioactive contamination is placed in concrete silos below ground. Fissile material is stored in steel-lined wells. During the mid-1980s, high-activity wastes were stored in concrete vaults (similar to tumulus vaults) placed on a concrete pad cut into the side of a hill as a demonstration of this method of disposal. This Hillcut Disposal Test Facility (HDTF) is not an active site, but it is included in ASEMP.

Monitoring activities associated with the SWSA 6 facilities are divided into three major areas: tumulus, including the IWMF; subsurface facilities; and HDTF. Tumulus monitoring activities include pad water monitoring as well as monitoring of water in the underpad area and in the aquitard below the pads. IWMF monitoring thus far includes only pad water. Monitoring at the subsurface facilities includes sampling of the perched water table that develops when shallow storm flow intercepts the silo trenches or the backfill surrounding the high-range wells, asbestos silos, and fissile wells. At HDTF, water that accumulates on the pad or in the underpad area is collected and sampled.

2.1 TUMULUS FACILITIES

The monitoring of water at the tumulus facilities, including IWMF, provides three levels of detection for contaminant release. First, any release from the vaults to the pad surface would be detected in the pad water samples. Second, any contaminants that might seep through the pads would be detected in the underpad water. Third, any contaminant release that passed through the pads and the underpads to the shallow groundwater would be detected in the wells in the area.

Tumulus I was covered by at least a temporary cover

during the entire reporting period. Therefore, the surface of the Tumulus I pad collected little water. Tumulus II remained exposed to the weather while being loaded with vaults. When Tumulus II was fully loaded, tentlike structures covered both the Tumulus I and II pads. Since the completion of these covers in mid-January 1992, water has not accumulated on either pad. Prior to the installation of these semipermanent covers, the tumulus pad drains had been closed in response to concerns over the release of water with high pH and some gross beta and ^3H activity.

Water continues to drain from the underpads of both tumulus pads. This water flows through the monitoring shed and is released to West Tributary. The underpad drainage systems of the two pads are of different designs. Flow through the underpad of Tumulus II is expected, but a plastic liner that should prevent the accumulation of shallow groundwater lies under the Tumulus I underpad. The liner was designed to capture any water that might leak through the pad. Apparently, this lining system is not intact; shallow groundwater infiltrates the underpad collection system and drains to the monitoring shed.

IWMF became operational in December 1991. This facility is similar to the original tumulus pads. Currently, two concrete pads have been constructed. One pad is being loaded with waste-containing vaults, and the loading of waste onto the second pad will begin when the first pad is full. At least four more pads will be constructed as needed.

As a result of concerns over the release of water from the concrete pads with a pH above the National Pollutant Discharge Elimination System (NPDES) permit limit, an automated CO_2 bubbling system is being installed at IWMF. This system is designed to bubble CO_2 into the active pad water when there is flow from the pad if the pH approaches the NPDES limit of 9.0.

2.1.1 Pad Runoff

2.1.1.1 Methodology

The surface drains for all three tumulus facilities remained closed for this reporting period because of concerns over the high pH. Consequently, the pad surface water was sampled directly from the pads and was then pumped to a tanker and transported to the Process Waste Treatment Plant. Samples of this water were analyzed for pH, specific conductance, gross alpha and beta activity, gamma-emitting

radioisotopes, ^3H, and total organic carbon (TOC). No samples have been collected from Tumulus I and II since mid-January 1992 because of the installation of covers over both pads.

The underpad drains from Tumulus I and II continue to be sampled at least quarterly. Water that drains from these underpads flows to separate sumps in the tumulus monitoring shed. Grab samples are collected from the drain pipes that empty into the sumps. These samples are typically analyzed for pH, specific conductance, and radionuclide activities.

The underpad drainage system at IWMF is similar in design to that at Tumulus II. When the IWMF monitoring system is fully operational, water infiltrating the underpads will be allowed to drain freely to the monitoring area. Little water is expected to accumulate under the pads because of an upgradient French drain. This French drain system was designed to divert shallow groundwater away from the pad area.

The monitoring area at IWMF consists of three sumps for the collection of water from the active pad, the inactive pad(s), and the underpads. The water collection system is designed to route water from all three sumps through an H-flume and then to the West Tributary through an NPDES sampling point. Electronic and mechanical equipment allows measurement of flow through the flume and collection of flow-proportional samples of the water being released. This automated monitoring and sampling equipment is not yet in use but is being tested and evaluated. The flume is much too large to measure the normal flow from the pads. Therefore, an alternative means of automating sample collection and monitoring flow is being developed.

2.1.1.2 Tumulus I Results

Although a temporary cover enclosed the Tumulus I pad, some water accumulated on the pad because of cover damage and partial removal of the cover during installation of the new tentlike cover. Ten samples of water were collected from the surface of the pad during this reporting period (Table B.1).

The pH of all ten samples was above the NPDES permitted release level of 9.0. Values for pH ranged from 9.17 to 10.88. Specific conductance values varied between 288 and 1751 μS/cm. TOC data are variable and probably reflect algal growth on the pad.

No samples showed any statistically significant gross

alpha, ^{60}Co, or ^{137}Cs activity. Four samples contained gross beta activity at or above the action level of 5.0 Bq/L (Ashwood and Ashwood 1991). Gross beta activity was generally much lower than during previous reporting periods. Previous samples showed that high concentrations of ^{40}K are almost always associated with the elevated gross beta activity. However, only one sample (TMOI-452) collected during this period showed any ^{40}K actvity (7.0 Bq/L).

About half of the pad surface water samples displayed ^{3}H activity above background levels. This activity was generally lower than that observed during the previous reporting period. The source of this ^{3}H is still unknown.

Data for the Tumulus I underpad and construction base drain samples are reported in Table B.2. These data are incomplete, but they indicate slightly elevated levels of ^{3}H in both locations.

2.1.1.3 Tumulus II Results

Tumulus II remained uncovered until mid-January 1992. Nine samples of water accumulating on this pad were collected before the cover was installed. Data are reported in Table B.2. The pH in five of the samples exceeded 9.0. Specific conductance values ranged from 104 to 387 μS/cm and are consistent with previously reported values. TOC values vary from 1.0 to 31 and probably reflect changes in algal growth on the pad. No samples were reported to have any statistically significant gross alpha, ^{60}Co, or ^{137}Cs activity. Although most of the samples reflected slightly elevated gross beta activity, none of the reported activity exceeded the 5.0 Bq/L action level. Tritium activity above background levels was observed in several of the pad water samples. This activity is variable and is much lower than that observed in the previous reporting period. During that period, a vault containing ^{3}H waste was discovered and moved away from most of the accumulating pad water. This vault remains on the pad and is probably a source of ^{3}H. Data for the Tumulus II underpad water are reported in Table B.2. These data are incomplete but do show elevated ^{3}H activity. This activity may be the result of the ^{3}H groundwater plume in the tumulus area.

2.1.1.4 IWMF Results

Data for surface water from the IWMF pads are presented in Table B.3. Loading of the first pad began in December 1991. One hundred ninety-four vaults were on the pad at the end of September 1992. Twenty grab samples were collected from the active pad, and one was collected from the empty

pad.

The pH has been variable but has shown a generally upward trend as more vaults are loaded onto the pad; four samples have exceeded 9.0. Specific conductance has also generally increased with the loading of the pad. A sample collected from the empty pad had a pH of 8.4 and a specific conductance of only 81 μS/cm. TOC concentrations in the active pad water range from 1.1 to 30 mg/L.

One pad water sample (IWMF-026) and two blank samples (IWMF-011 and -025) were reported by the Analytical Chemistry Division (ACD) of ORNL to have gross alpha activities greater than zero but below the first action level of 1.0 Bq/L. Gross beta activity has shown the same generally increasing trend as that previously observed for the tumulus pads (Ashwood et al. 1991; Wickliff et al. 1991a,b). However, only one sample (IWMF-030) was above the 5.0 Bq/L first action level. One sample (IWMF-018) exhibited both ^{60}Co and ^{137}Cs activities >0. ACD reported that other pad water samples (IWMF-028 and 038) had ^{137}Cs activities >0. ACD also reported ^{137}Cs activity >0 in two blanks (IWMF-025 and 039). The highest activity value for any of these samples was 1.1 Bq/L, well below the action level.

Most of the ^{3}H values in the IWMF pad water are very low and probably reflect atmospheric levels. However, at least one of the samples (IWMF-024) appears to have a somewhat elevated ^{3}H activity of 370 Bq/L.

Water has not been allowed to drain from the IWMF underpad. This underpad system is expected to contain very little water because of the influence of the French drain.

2.1.2 Groundwater Monitoring

2.1.2.1 Methodology

Twelve wells designed to monitor the shallow groundwater in the area encircle the tumulus pads (Fig. A.3.). These wells were drilled to auger refusal (typically 20 to 30 ft.) and are screened to include as much of the zone of permanent groundwater above bedrock as possible (Wickliff et al. 1991b: Appendix C). Eleven of the wells are equipped with dedicated sampling pumps and are sampled quarterly for radiological and field parameters. Well 381 is not included in the sampling program because it was not drilled as part of the tumulus program and is of uncertain construction. Field parameters are measured with the use of a Hydrolab equipped with a flow-through cell. Six of the 11

wells are randomly selected for annual sampling and analysis for cations, anions, TOC, and volatile and semivolatile organics.

2.1.2.2 Results

Analytical results from four rounds of quarterly sampling are presented in Table B.4. Field parameters are very consistent from one sampling period to the next and are within ranges normally encountered in the tumulus area (Ashwood et al. 1991; Wickliff et al. 1991b; Solomon et al. 1988).

All radionuclide activities in the tumulus area groundwater are below action levels. Tritium is the only radionuclide detected in any of the monitoring wells. This ^{3}H plume has been observed for the past several years and was previously detected mainly in wells 1036 and 1039 (Ashwood et al. 1991; Wickliff et al. 1991a,b). However, during this reporting period, increased ^{3}H activity was observed in wells 1037, 1038, 1258, and 1259. Activity in well 1036 increased and then stabilized. Activity in 1039 decreased early in this period and then increased again. These data indicate that the plume is spreading to the southwest and that there is possibly a new ^{3}H source east of the tumulus pads.

Cation and anion data for the monitoring wells are reported in Table B.5. These data are similar to previously reported data (Wickliff et al. 1991b) and contain no unexpected or unusual results.

2.1.3 Soils Sampling

2.1.3.1 Methodology

Samples of surface soil around the tumulus pads are collected to detect any activity released during loading operations. Twelve samples were collected near each monitoring well in the tumulus area and submitted for gross alpha and beta analysis and a gamma scan.

2.1.3.2 Results

Table B.6 reports the results of soil sampling during FY 1992. The large counting errors associated with the gross alpha and gross beta analyses make interpretation of these data difficult. Potassium-40 activity is consistent with previously reported data for soil in the tumulus area (Yager et al. 1989). One sample (1257) showed a low level of ^{60}Co activity. Seven of the 12 samples showed levels of

^{137}Cs that were significantly >0.

2.1.4 Conclusions

Tumulus facilities continue to contain the LLW placed within them. As in previous years, the only anomalies noted in the pad water analyses are the high pH and elevated level of gross beta activity. Both of these parameters have increased as more vaults have been loaded onto the pads. The relevance of these two parameters in relation to the long-term integrity of the tumulus facilities is still not clear. At IWMF, a more detailed investigation of the chemistry of pad water will be conducted in FY 1993 in an effort to understand whether pad water chemistry provides any indication of vault integrity.

Tritium activity in groundwater in the tumulus area continues to be present and has appeared in wells where it was not previously detected. The source(s) of this ^{3}H are not certain. Originally, the effluent from the French drain in the 49-trench area was suspected to be the source. However, 2 years ago the effluent pipe was relocated, and no reduction in ^{3}H activity in tumulus area groundwater has occurred. It is unlikely that the loss of ^{3}H from tumulus vaults has had any effect on this plume.

2.2 LLW SILOS, HIGH-RANGE WELLS, ASBESTOS SILOS, AND FISSILE WELLS

LLW silos in SWSA 6 are generally installed in groups of four within a trench. The relatively high permeability of the backfilled soil can cause an intermittent perched water table as a result of subsurface storm flow. Davis et al. (1989) demonstrated that some of the LLW silos within trenches leak. Therefore, to provide early contaminant detection, 2-in. drive-point monitoring wells with 5-ft screened sections were installed in May 1990 in trenches that previously had no monitoring wells. These wells provide a way to monitor groups of silos for containment failure, leaching of wastes, and contaminant transport. Drive-point wells were also installed in May 1990 in the backfilled soil next to high-range wells, asbestos silos, and fissile wells.

2.2.1 Methodology

The intratrench (IT) wells and backfill monitoring wells are equipped with a weighted sample bottle. Samples are collected quarterly from those wells with sufficient water (usually 100 to 250 mL) and are prepared for analyses

by forcing the sample through a 0.45-μm filter and acidifying the sample to pH<2 with HNO_3. Filters are counted for gamma-emitting isotopes in ESD. ACD analyzes the water samples for gross alpha and gross beta activities and for gamma-emitting isotopes.

2.2.2 Results

The FY 1992 quarterly sampling of IT wells around LLW silos and of wells next to high-range wells (identified as AUG), asbestos silos (C520 and C595), and fissile wells (FIS102 and FIS?) was completed in December 1991 and in March, June, and September 1992. Samples were collected from most of the 44 IT wells around LLW silos, from both wells next to the two asbestos silos, and from both wells next to the two fissile wells. Samples were also collected from eight of the nine wells in the high-range well area.

Gross alpha and gross beta activities in the well samples were below the action levels of 1 and 5 Bq/L, respectively, with the exception of gross beta activities in IT wells 5, 19, and 40 (Tables B.7 and B.8). Activities in the third-quarter samples from IT wells 5 and 40 were the first occurrence of gross beta activities above the action level in these two wells. During the fourth quarter, the gross beta activity in IT well 40 returned to a level below the action level. Analyses of the sample from IT well 5 from the fourth-quarter sampling are not complete. Samples from IT well 19 consistently contain elevated gross beta activities, primarily ^{90}Sr, which probably are a result of leaching from waste in one or more of the silos in the trench (Ashwood et al. 1991, 1992a; Wickliff et al. 1991b). This trench is not an active site under the definition in DOE Order 5820.2A. The silos within the trench were installed with the use of precast concrete drainage pipes obtained from the Clinch River Breeder Reactor Project, and the wastes within the silos were not originally grouted. However, in July 1992 the silos were grouted as part of a measure to reduce the potential for release of radionuclides from the LLW silos. Evaluation of the effectiveness of the grouting effort could not be made because IT Well 19 did not contain sufficient water for sample collection during the third and fourth quarters.

Most of the filtered samples from IT wells and backfill monitoring wells contained ^{137}Cs and ^{60}Co activities below the action levels of 2.5 and 1.5 Bq/L, respectively (Tables B.7 and B.8). However, some ^{137}Cs and ^{60}Co results had associated uncertainties that were greater than the action levels. The large associated uncertainties primarily result from a limited sample volume (i.e., limited to the volume of the

weighted bottle and to the amount of water perched within the trench). Therefore, during the last quarter, sampling methods were modified for those wells that contained ^{60}Co and/or ^{137}Cs activities above the action levels during the past 2 years. These wells were monitored approximately twice a month and will continue to be monitored until a 1-L composite sample can be collected. IT wells 35 and 36, for example, had ^{60}Co values of 0.4 ± 0.6 and 1.4 ± 0.6 Bq/L, respectively, during the third quarter of FY 1992 and values of 0.17 ± 0.1 and -0.01 ± 0.1 Bq/L, respectively, during the fourth quarter, when a 1-L composite sample was collected and analyzed (Table B.7). To effectively determine the presence of trace amounts of contaminants, the sampling procedure may need to be modified for all of the wells.

Although a ^{137}Cs activity above the action level was found in only one filtered sample (IT Well 5), 23 wells had measurable ^{137}Cs activity associated with the particulates retained on the filters (Tables B.7 and B.8). Counting the filters for gamma-emitting radionuclides appears to be an effective method for detecting low levels of contaminants (particularly ^{137}Cs because of its particle-reactive properties). However, the quarterly samples contain variable amounts of sediment. Only two samples (IT Well 13 and AUG 48) contained the combined activity of particulate-^{137}Cs and dissolved-^{137}Cs that exceeded the 2.5 Bq/L action level originally set for the water samples. An action level for particulate-associated ^{137}Cs or ^{60}Co has not been established. The activities of particulate ^{137}Cs appear to be decreasing in IT well 13 and increasing in AUG 48 (next to a high-range well), but these trends are tentative.

2.3 HILLCUT DISPOSAL TEST FACILITY

Runoff from the pad is collected in an above-grade tank (tank No. 1) at the HDTF. The volume of pad runoff was measured weekly during FY 1992. Only one pad runoff sample was collected from tank No. 1 when the tank was near its maximum capacity in March 1992. After the sample was collected, the contents of tank No. 1 were transferred to a holding tank until radionuclide analyses were completed. Gross alpha, gross beta, and gamma-emitting isotope activities were below the action levels. Approximately 3300 L of pad runoff was collected in FY 1992. This is only one-third of the volume collected during the previous 2 years and may indicate a leak in the tank or draining system.

Runoff from the underpad gravel drain is collected in an above-grade tank. A 2-in. flexible hose diverts any groundwater runoff to a holding tank. As in previous years

very little if any runoff occurred from the underpad gravel during FY 1992.

Two wells at HDTF were monitored weekly during the period. The well in the gravel layer around the pad remained dry. The weekly water levels in the well on the pad remained fairly constant, and they indicate that a small amount of standing water (depth ≤ 0.5 in.) remained on the pad except during October 1991 and September 1992.

3. TRU WASTE FACILITIES IN SWSA 5 NORTH

TRU wastes have been stored in SWSA 5 North since 1970 (Shoun 1987). Wastes are stored in a variety of facilities, from unlined trenches to subsurface concrete vaults. Groundwater well 516, immediately downgradient from a group of TRU waste trenches (Fig. A.2), contains gross alpha activity varying from 30 to 150 Bq/L (Ashwood et al. 1990, 1991, 1992a; Wickliff et al. 1991a,b). Curium-244 is the dominant radionuclide, and traces of ^{241}Am have been reported from separate samples. The TRU waste trenches also contain some elemental lead (Stewart et al. 1989). Samples from well 516 do not contain detectable concentrations of volatile organics (Wickliff et al. 1991b), and metal concentrations are below regulatory concern (Ashwood et al. 1991). The trenches are upgradient from White Oak Creek (WOC), which drains most of ORNL and eventually enters the Clinch River. Curium-244 and ^{241}Am have been detected in two seeps (Fig. A.2: WOC 213 and WOC 255) in the bank of WOC (Ashwood et al. 1991). These seeps are along geologic strike from the trenches.

3.1 METHODOLOGY

Fifteen groundwater wells surrounding the TRU-waste storage facilities are sampled quarterly (Ashwood et al. 1992b). Samples are collected after the wells are purged. All samples are filtered through 0.45-μm filters and then acidified to a pH <2 with HNO_3. Prior to October 1990, however, samples were acidified but not filtered. Analytes include gross alpha, gross beta, ^{60}Co, ^{137}Cs, ^{241}Am, and ^{244}Cm. Beginning in FY 1992, ^{3}H analysis was limited to one quarterly sample because ^{3}H is not a contaminant of concern for this site and the ^{3}H data have not provided any insight into the transport of TRU contaminants.

Six seep and two stream locations are sampled quarterly (Ashwood et al. 1992b). Seeps identified as WOC XXX (Fig.

A.2) are located in the bank of WOC; however, only four of those seeps (WOC 160, WOC 175, WOC 213, and WOC 255) are sampled regularly. The remaining two seeps are between SWSA 5 North and WOC. Seep and stream samples are analyzed for the same set of parameters as well samples are, except that seep or stream samples were not analyzed for ^{3}H in FY 1992.

Action levels have been established for gross beta (2 Bq/L), ^{60}Co (1.5 Bq/L), and ^{137}Cs (1 Bq/L) (Ashwood and Ashwood 1991). An action level was not established for gross alpha because gross alpha is not a reliable indicator of TRU contamination at trace levels. Instead, concentrations of ^{241}Am or ^{244}Cm that exceed the associated counting error by a factor of 2 are flagged as potentially contaminated samples. This approach roughly corresponds to a 5% probability that a sample would be flagged as contaminated when it is not.

3.2 RESULTS

3.2.1 Groundwater Wells

Samples were obtained from all wells except well 516 in all four quarters of FY 1992. Because of problems with the pump, well 516 could not be sampled in the second quarter. The third-quarter sampling began in late May and continued into early July because of conflicts between ASEMP sample collection and sample collection by the subcontractor supporting the Environmental Restoration program. Because of miscommunication with the analytical lab, analyses for ^{241}Am and ^{244}Cm were not performed on the second-quarter samples. Results of the fourth-quarter sampling are not expected to be available before the deadline for this report. In future years, fourth-quarter samples will be collected in early August so that results will be available for the annual report. This approach could not be used in FY 1992 because of the length of time required for the third-quarter sampling.

Well 516 continues to contain ^{241}Am and ^{244}Cm concentrations above the action level (Table B.9), but gross beta concentrations were below the action level for the first time since the beginning of the program in FY 1990 (Table B.9).

Wells 519 and 524 contained low but statistically significant levels of ^{241}Am during the third-quarter sampling (Table B.9). Well 716 has contained ^{241}Am and ^{244}Cm above the action level in two of the past three periods reported. None of these wells has a history of gross alpha or ^{241}Am

contamination, and the reported values are low enough (<0.1 Bq/L) that they may represent a statistical anomaly.

Well 521 has contained significant ^{241}Am or ^{244}Cm in each of the past three periods reported here (Table B.9). Moreover, the value reported in August 1991 (0.3 ± 0.09 Bq/L) is too high to be considered a statistical anomaly. This well is near a group of trenches in the northeast corner of SWSA 5 North (Fig. A.2).

Well 708 has contained measurable ^{244}Cm throughout FY 1992, though samples from preceding years did not contain appreciable concentrations of this radionuclide (Table B.9). Well 708 is hydrologically downgradient from and along strike with the same group of burial trenches responsible for the ^{244}Cm contamination in well 516 (Fig. A.2).

No significant gamma-emitting contamination was measured in any wells.

3.2.2 Seeps and Surface Water Samples

Seep and stream samples were collected during all quarters of FY 1992. The seep at WOC 213 did not have sufficient flow for sampling during any of the periods. Seep 5NW 01 was not sampled during the second, third, and fourth quarters because of insufficient flow. The WOC 175 seep was not sampled during the third and fourth quarters because of insufficient flow. The third-quarter sampling was not conducted until late July, and the fourth-quarter sampling was not conducted until October. Fourth-quarter results are not available for this report.

Stream location 5NNT 01 contained ^{241}Am or ^{244}Cm contamination at low but reportable levels throughout FY 1992 (Table B.10). Samples from previous years were not analyzed for specific alpha-emitting isotopes, so no history of contamination is available. Neither of the wells upgradient of this seep (522 and 523) shows gross alpha or TRU contamination.

Stream location 5NST 02 has a history of high gross alpha and gross beta contamination (Table B.10). Samples collected since early FY 1991 demonstrate that the alpha contamination is not caused by TRU isotopes (Table B.10).

The reportable concentration of ^{244}Cm in seep 5NW 01 during the first quarter is low enough to be a statistical anomaly (Table B.10), but further samples from this site are needed to confirm this hypothesis. Furthermore, it should be noted that this seep is along strike with the burial

trenches and the contaminated bank seeps at WOC 255 (Fig. A.2).

The seep at WOC 255 has contained reportable concentrations of ^{244}Cm since analysis for this isotope began in the second quarter of FY 1991 (Table B.10).

No significant gamma-emitting contamination was measured in any seeps.

3.3 CONCLUSIONS

The TRU contaminant plume from the burial trenches in the southwest corner of SWSA 5 North (Fig. A.2) apparently is larger than previously reported. Identification of TRU isotopes in wells 708 and 716 and seep 5NW 01 suggests that the plume is broad enough to encompass these three locations. The blips of ^{241}Am measured sporadically in well 513 and seep 5NW 02 may even indicate that the plume may reach these sites under certain hydrologic conditions.

Well 524, and perhaps well 521, is downgradient from the burial trenches in the northeast corner of SWSA 5 North (Fig. A.2). The sporadic TRU contamination seen in these wells may therefore indicate that material is leaching from these trenches. The contamination seen in stream location 5NNT 01 may also originate from these trenches, although the hydrologic connection is somewhat tenuous.

4. ACKNOWLEDGMENTS

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APPENDIX A: FIGURES

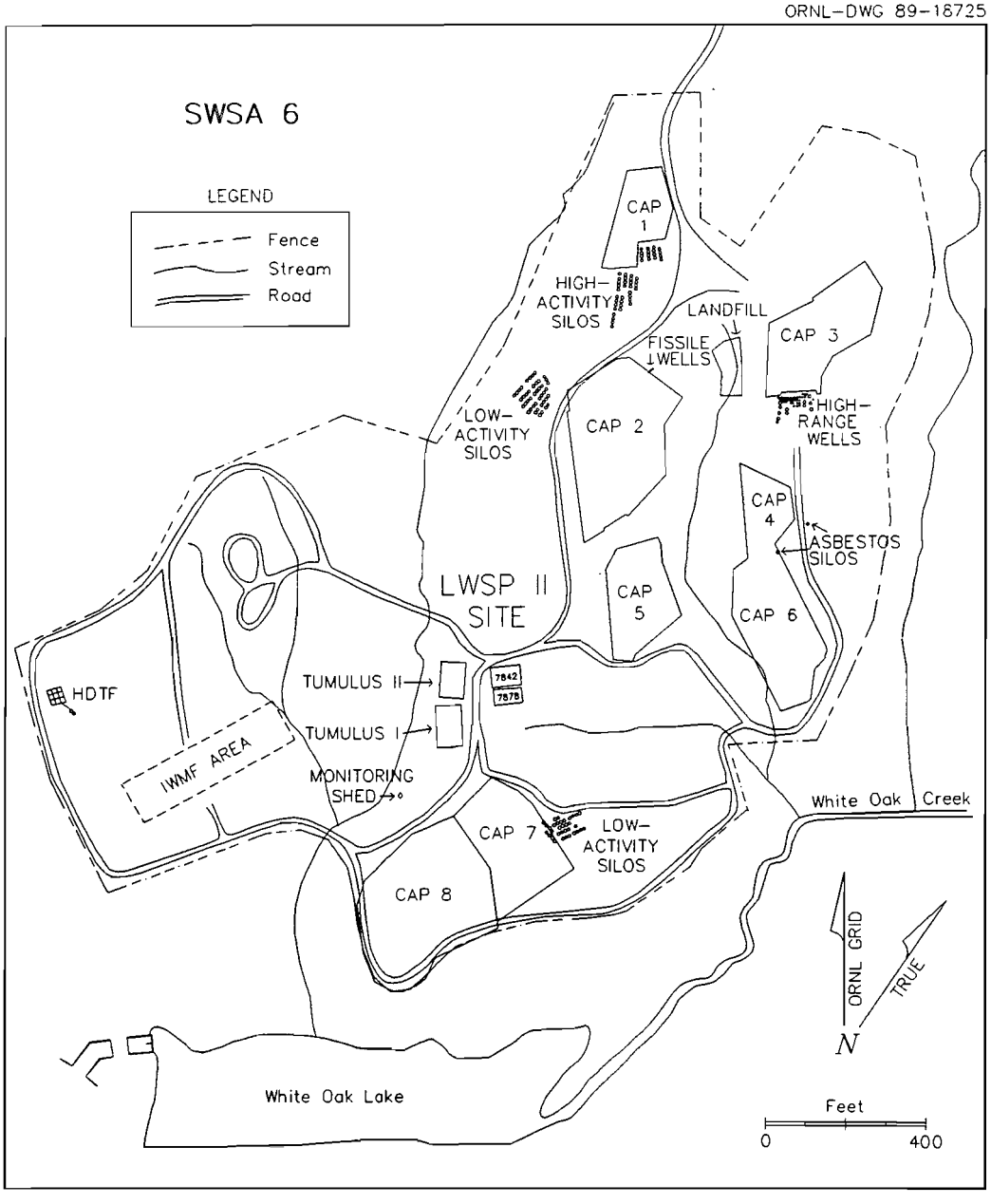

Figure A.1. Active low-level waste disposal sites and other major facilities in Solid Waste Storage Area 6.

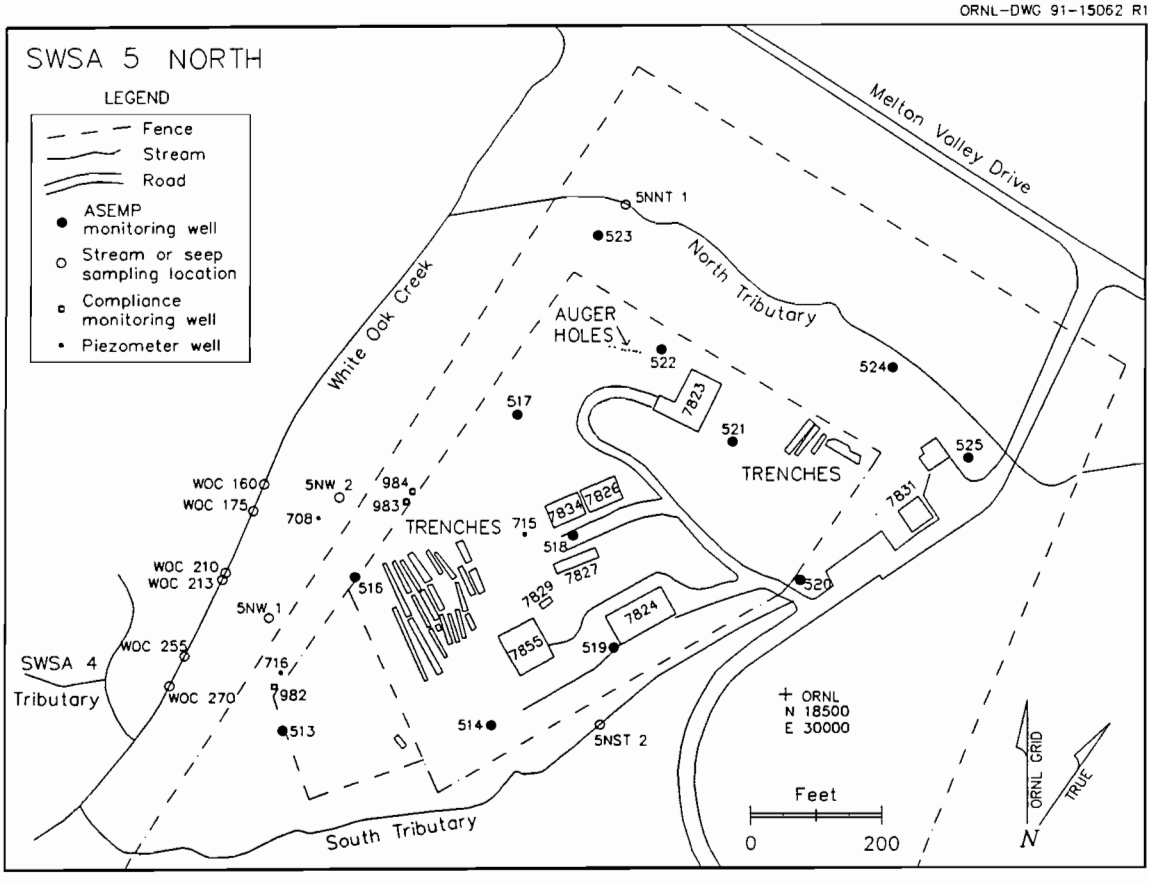

Figure A.2. Transuranic waste storage sites, sampling locations, and major facilities in Solid Waste Storage Area 5 North.

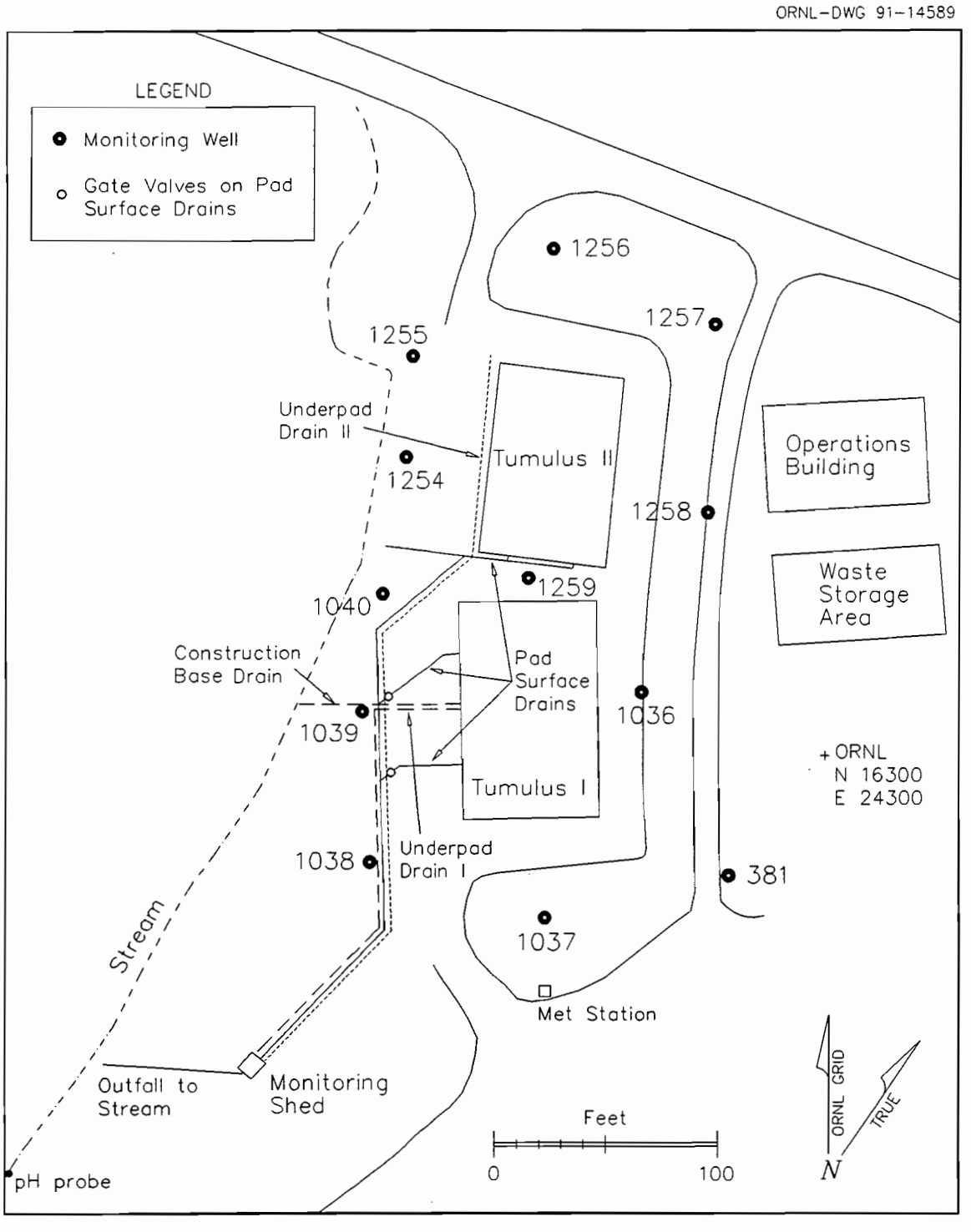

Figure A.3. Tumulus area in Solid Waste Storage Area 6.

APPENDIX B: TABLES

Table B.1. Field parameters and radionuclide concentrations in runoff from tumulus pads[a]

Sample	Date	pH	Specific conductance	Gross Alpha	Gross Beta[b]	^{60}Co	^{137}Cs	^{3}H	TOC[c]
Tumulus I pad water:									
TMOI-452	10/16/91	10.88	758	0.065 ± 0.03	6.3 ± 0.3	−0.01 ± 0.06	0.06 ± 0.09	250 ± 20	43
TMOI-454	11/06/91	10.48	1582	−0.41 ± 0.06	14 ± 2	0.03 ± 0.04	0.01 ± 0.08	−12 ± 10	9.1
TMOI-456	11/11/91	10.29	1751	0.10 ± 0.05	10 ± 1	0.05 ± 0.06	0.12 ± 0.12	1700 ± 50	15
TMOI-458	11/21/91	10.26	42	0.018 ± 0.023	0.48 ± 0.0	−0.05 ± 0.05	−0.06 ± 0.09	120 ± 15	15.3
TMOI-460	12/02/91	9.72	288	0.002 ± 0.018	1.2 ± 0.1	−0.16 ± 0.15	0.37 ± 0.17	240 ± 25	7.6
TMOI-462	12/11/91	9.58	312	0.041 ± 0.02	−0.07 ± 0.20	0.09 ± 0.05	0.12 ± 0.12	690 ± 25	5.6
TMOI-464	12/23/91	9.80	667	0.06 ± 0.07	5.0 ± 0.5	0.02 ± 0.08	−0.01 ± 0.10	620 ± 25	8.1
TMOI-466	12/30/91	9.38	466	0.12 ± 0.07	4.2 ± 0.3	0.02 ± 0.04	0.04 ± 0.07	520 ± 25	6.8
TMOI-468	01/03/92	10.35	302	0.09 ± 0.06	2.0 ± 0.3	−0.19 ± 0.11	−0.03 ± 0.16	40 ± 22	9.5
TMOI-470	01/13/92	9.17	721	0.1 ± 0.0	4.2 ± 0.2	0.07 ± 0.05	−0.04 ± 0.11	900 ± 25	10
Tumulus II pad water:									
TMOII-114	10/16/91	9.15	212	0.074 ± 0.03	1.2 ± 0.1	0.01 ± 0.01	0.03 ± 0.10	770 ± 11	6.7
TMOII-116	11/06/91	9.12	277	0.13 ± 0.07	2.4 ± 0.2	−0.01 ± 0.04	0.03 ± 0.07	−6 ± 50	25
TMOII-118	11/11/91	9.24	387	0.007 ± 0.021	2.5 ± 0.2	−0.04 ± 0.07	−0.01 ± 0.11	2600 ± 50	31
TMOII-120	11/21/91	9.63	347	0.040 ± 0.02	3.0 ± 0.2	−0.09 ± 0.07	0.14 ± 0.10	1700 ± 15	9.9
TMOII-122	12/02/91	8.88	114	0.030 ± 0.022	0.38 ± 0.08	0.09 ± 0.11	0.05 ± 0.17	290 ± 50	1.0
TMOII-124	12/11/91	8.73	312	0.010 ± 0.018	0.71 ± 0.10	−0.01 ± 0.06	−0.02 ± 0.09	1200 ± 18	1.7
TMOII-126	12/23/91	8.63	104	0.01 ± 0.05	1.8 ± 0.3	0.04 ± 0.06	0.01 ± 0.11	−60 ± 25	1.9
TMOII-128	12/30/91	8.31	183	0.013 ± 0.03	1.5 ± 0.2	−0.07 ± 0.04	−0.01 ± 0.07	810 ± 25	2.2
TMOII-130	01/03/92	9.41	130	0.062 ± 0.045	1.0 ± 0.2	0.04 ± 0.04	−0.01 ± 0.10	270 ± 50	2.6

[a] Radionuclide data are in Becquerel/liter, mean ± standard counting error; specific conductance in microsiemens/centimeter; TOC in mg/L.
[b] Gross beta analysis does not include tritium
[c] TOC = total organic carbon

Table B.2. Field parameters and radionuclide concentrations in tumulus underpad drainage[a]

Sample	Date	pH	Specific conductance	Gross Alpha	Gross Beta[b]	^{60}Co	^{137}Cs	^{3}H
Tumulus I construction base drain:								
TMOI–460PWT	12/02/91	7.96	207					560 ± 20
TUM–PWT	06/04/92	7.59		0.002 ± 0.048	0.22 ± 0.18	0.09 ± 0.16	−0.01 ± 0.15	
Tumulus I underpad:								
TMOI–452UND	10/16/91	8.46	877					300 ± 20
TMOI–460UND	12/02/91	8.81	259	0.14 ± 0.05	1.0 ± 0.1	0.13 ± 0.23	−0.40 ± 0.28	160 ± 15
TUMI–UND	07/06/92	7.53		−0.024 ± 0.009	0.54 ± 0.24	−0.01 ± 0.13	0.05 ± 0.11	
TUMI–UND	09/18/92	7.37	815	0.050 ± 0.096	1.8 ± 0.4	0.14 ± 0.10	0.03 ± 0.12	
Tumulus II underpad:								
TMOII–114UND	10/16/91	8.24	599					3100 ± 50
TMOII–122UND	12/02/91	7.51	527	0.054 ± 0.032	0.65 ± 0.10	0.02 ± 0.17	−0.08 ± 0.15	19000 ± 500
TUMII–UND	05/29/92	8.00	450					
TUMII–UND	07/06/92	7.45		0.048 ± 0.093	0.15 ± 0.18	0.01 ± 0.20	0.05 ± 0.20	
TUMII–UND	09/18/92	7.75	568	−0.028 ± 0.053	0.34 ± 0.20	0.02 ± 0.14	−0.01 ± 0.12	

[a] Radionuclide data are in Becquerel/L, mean ± standard counting error; specific conductivity in microsiemens/centimeter; blanks indicate analysis not performed.

[b] Gross beta analysis does not include tritium

Table B.3. Field parameters and radionuclide concentrations in the IWMF pad water runoff[a]

Sample	Date	pH	Specific conductance	Gross Alpha	Gross Beta[b]	^{60}Co	^{137}Cs	^{3}H	TOC[c]
IWMF[d] pad No. 1 (active pad):									
IWMF−000	12/23/91	8.24	129	0.030 ± 0.039	0.92 ± 0.16	−0.19 ± 0.14	0.03 ± 0.10	−81 ± 17	2.7
IWMF−002	12/30/91	7.89	103	0.052 ± 0.043	0.58 ± 0.13	−0.04 ± 0.10	0.05 ± 0.09	23 ± 14	1.2
IWMF−006	01/03/92	8.36	84	0.067 ± 0.048	0.33 ± 0.12	0.16 ± 0.09	−0.05 ± 0.14	−120 ± 15	1.1
IWMF−008	01/13/92	8.96	172	0.062 ± 0.032	0.45 ± 0.08	0.08 ± 0.08	0.01 ± 0.08		10
IWMF−010	01/23/92	7.10	98	0.073 ± 0.033	0.70 ± 0.10	−0.05 ± 0.13	0.01 ± 0.11	49 ± 12	2.8
IWMF−011	01/23/92			0.40 ± 0.07	0.33 ± 0.07	0.03 ± 0.08	−0.04 ± 0.09		
IWMF−012	02/13/92	6.83	226	0.040 ± 0.028	1.3 ± 0.2	−0.3 ± 1.2	−0.9 ± 1.3	50 ± 13	8
IWMF−013	02/13/92			0.058 ± 0.033	0.21 ± 0.07	0.6 ± 1.0	−0.4 ± 1.2		
IWMF−014	02/18/92	9.18	241	0.040 ± 0.031	1.2 ± 0.1	−0.1 ± 1.1	1.1 ± 1.0	63 ± 13	5.3
IWMF−015	02/18/92			−0.004 ± 0.015	0.04 ± 0.06	0.6 ± 0.6	1.5 ± 0.9		
IWMF−016	03/06/92	7.18	229	0.054 ± 0.030	2.0 ± 0.2	−0.2 ± 0.9	−0.4 ± 0.9	51 ± 13	30
IWMF−017	03/06/92			−0.014 ± 0.020	−0.07 ± 0.07	0.05 ± 0.37	0.04 ± 0.38		
IWMF−018	03/18/92	7.83	261	0.014 ± 0.024	1.4 ± 0.2	1.1 ± 0.2	1.1 ± 0.4	25 ± 12	12
IWMF−019	03/18/92			0.014 ± 0.020	0.01 ± 0.07	0.3 ± 0.8	0.5 ± 0.6		
IWMF−020	03/26/92	6.95	273	−0.007 ± 0.020	0.82 ± 0.10	0.10 ± 0.06	−0.05 ± 0.11	13 ± 20	5.8
IWMF−021	03/26/92			0.023 ± 0.021	0.14 ± 0.06	0.27 ± 0.08	0.08 ± 0.11		
IWMF−022	05/07/92	6.67	314	0.016 ± 0.023	2.9 ± 0.2	0.08 ± 0.11	−0.05 ± 0.13	82 ± 14	
IWMF−023	05/07/92			0.026 ± 0.027	−0.07 ± 0.05	0.12 ± 0.15	0.12 ± 0.15		
IWMF−024	05/29/92	8.33	258	0.052 ± 0.036	3.2 ± 0.2	−0.04 ± 0.08	−0.04 ± 0.08	370 ± 20	33
IWMF−025	05/29/92			0.54 ± 0.10	0.67 ± 0.10	0.15 ± 0.04	0.15 ± 0.04		
IWMF−026	06/09/92	8.14	363	0.30 ± 0.08	1.8 ± 0.2	−0.07 ± 0.10	−0.07 ± 0.10	[e]	4.40
IWMF−027	06/09/92			0.053 ± 0.032	0.38 ± 0.08	0.09 ± 0.10	0.09 ± 0.10		

Table B.3 (continued)

Sample	Date	pH	Specific conductance	Gross Alpha	Gross Beta[b]	^{60}Co	^{137}Cs	^{3}H	TOC[c]
IWMF-028	06/19/92	8.10	393	−0.005 ± 0.030	2.1 ± 0.2	0.23 ± 0.11	0.23 ± 0.11	55 ± 15	4.68
IWMF-029	06/19/92			0.024 ± 0.031	−0.05 ± 0.06	0.07 ± 0.08	0.07 ± 0.08		
IWMF-030	06/30/92	9.41	539	0.07 ± 0.11	6.9 ± 0.6	0.11 ± 0.13	0.11 ± 0.13	170 ± 20	26
IWMF-031	06/30/92			0.10 ± 0.10	0.13 ± 0.33	0.12 ± 0.06	0.12 ± 0.06		
IWMF-032	08/03/92	8.97	285	0.054 ± 0.045	2.0 ± 0.2	0.01 ± 0.08	0.15 ± 0.09		3.6
IWMF-034	08/13/92	8.78	337	0.034 ± 0.030	2.0 ± 0.2	0.01 ± 0.09	0.01 ± 0.09	42 ± 13	4.0
IWMF-035	08/13/92			−0.019 ± 0.020	0.10 ± 0.07	0.05 ± 0.07	0.05 ± 0.07		
IWMF-036	08/17/92	9.61	421	0.031 ± 0.028	2.9 ± 0.2	−0.03 ± 0.11	−0.03 ± 0.11	62 ± 14	4.2
IWMF-037	08/17/92			0.014 ± 0.020	0.04 ± 0.05	−0.03 ± 0.07	−0.03 ± 0.07		
IWMF-038	08/24/92	8.84	354	0.012 ± 0.035	2.1 ± 0.2	0.14 ± 0.06	0.14 ± 0.06	130 ± 15	3.9
IWMF-039	08/24/92			0.12 ± 0.06	0.30 ± 0.11	0.23 ± 0.07	0.23 ± 0.07		
IWMF-040	09/18/92	9.65	302	0.08 ± 0.05	2.4 ± 0.2	0.03 ± 0.08	0.05 ± 0.08	56 ± 13	7.2
IWMF-041	09/18/92			0.019 ± 0.034	−0.02 ± 0.07	0.07 ± 0.12	0.08 ± 0.10		
IWMF-042	09/22/92	8.98	274	−0.004 ± 0.023	4.5 ± 0.2	0.16 ± 0.08	0.06 ± 0.12	62 ± 13	4.1
IWMF pad #2 (inactive pad):									
IWMF2-000	09/18/92	8.40	81					25 ± 25	2.4

[a] Radionuclide data are in Becquerel/liter, mean ± standard counting error; specific conductance in microsiemens/centimeter.
[b] Gross beta analysis does not include tritium
[c] TOC = total organic carbon; data in milligrams/liter.
[d] IWMF = Interim Waste Management Facility; odd sample numbers are blanks
[e] Sample bottle broken during analysis.

Table B.4. Field parameters and radionuclide concentrations in tumulus area monitoring wells[a]

Well	Date	pH	Specific conductance	Gross alpha	Gross beta[b]	^{60}Co	^{137}Cs	Tritium
1036	09/26/91	6.4	353	0.15 ± 0.05	0.40 ± 0.08	0.8 ± 0.8	−0.3 ± 1.2	11000 ± 500
1037	09/26/91	5.1	199	0.054 ± 0.032	0.29 ± 0.09	0.8 ± 1.0	−1.4 ± 1.4	470 ± 20
1038	09/26/91	6.1	687	0.078 ± 0.042	0.28 ± 0.09	0.6 ± 1.0	0.3 ± 1.2	170 ± 15
1039	09/26/91	6.2	625	0.13 ± 0.04	0.21 ± 0.07	0.5 ± 1.1	0.8 ± 1.0	510 ± 20
1040	09/26/91	6.5	377	0.094 ± 0.040	0.20 ± 0.08	−0.8 ± 1.4	−0.9 ± 1.3	70 ± 15
1254	09/26/91	6.9	367	0.17 ± 0.05	0.16 ± 0.07	1.5 ± 1.0	−0.1 ± 1.3	40 ± 13
1255	09/26/91	6.8	413	0.089 ± 0.041	0.29 ± 0.08	0.3 ± 1.3	−0.9 ± 1.4	110 ± 15
1256	09/26/91	6.2	659	0.19 ± 0.05	0.21 ± 0.07	−0.28 ± 0.17	−0.01 ± 0.12	150 ± 15
1257	09/26/91	6.7	414	0.096 ± 0.043	0.11 ± 0.08	0.06 ± 0.09	0.06 ± 0.10	160 ± 15
1258	09/26/91	6.0	289	0.031 ± 0.028	0.09 ± 0.08	−0.9 ± 1.4	−2.0 ± 1.4	130 ± 15
1259	09/26/91	5.5	213	0.15 ± 0.05	0.03 ± 0.06	−3.0 ± 1.7	0.4 ± 1.2	18 ± 25
1036	01/15/92	6.1	304	0.027 ± 0.025	0.09 ± 0.08	0.13 ± 0.13	0.04 ± 0.15	14000 ± 500
1037	01/15/92	5.5	121	0.038 ± 0.027	0.16 ± 0.07	−0.08 ± 0.15	0.07 ± 0.11	5600 ± 50
1038	01/15/92	6.4	617	0.030 ± 0.026	0.07 ± 0.06	0.17 ± 0.10	0.08 ± 0.11	260 ± 20
1039	01/15/92	6.2	552	0.031 ± 0.027	0.12 ± 0.07	0.02 ± 0.09	−0.02 ± 0.08	320 ± 20
1040	01/15/92	6.4	341	−0.017 ± 0.013	−0.07 ± 0.08	0.05 ± 0.17	0.04 ± 0.16	0 ± 16
1254	01/15/92	6.6	279	0.026 ± 0.024	0.09 ± 0.06	0.04 ± 0.12	0.02 ± 0.13	−83 ± 15
1255	01/15/92	6.3	483	−0.005 ± 0.018	0.10 ± 0.07	−0.13 ± 0.22	−0.09 ± 0.16	51 ± 17
1256	01/15/92	6.5	621	−0.017 ± 0.014	0.04 ± 0.06	0.16 ± 0.11	−0.03 ± 0.14	140 ± 20
1257	01/15/92	6.5	166	0.007 ± 0.022	0.08 ± 0.07	0.05 ± 0.09	−0.02 ± 0.07	130 ± 20
1258	01/15/92	6.8	167	0.079 ± 0.036	0.16 ± 0.08	0.01 ± 0.17	0.03 ± 0.14	320 ± 20
1259	01/15/92	5.9	46	0.062 ± 0.032	0.12 ± 0.06	−0.08 ± 0.13	−0.01 ± 0.13	71 ± 17
1036	04/06/92	6.4	349	−0.030 ± 0.005	0.25 ± 0.07	0.01 ± 0.11	0.09 ± 0.10	14000 ± 500
1037	04/06/92	5.4	134	−0.005 ± 0.018	−0.07 ± 0.05	0.2 ± 0.1	0.04 ± 0.09	2700 ± 50

Table B.4 (continued)

Well	Date	pH	Specific conductance	Gross alpha	Gross beta[b]	^{60}Co	^{137}Cs	Tritium
1038	04/06/92	6.2	441	0.002 ± 0.018	0.22 ± 0.08	−0.07 ± 0.12	0.07 ± 0.11	580 ± 20
1039	04/06/92	6.4	577	0.039 ± 0.028	0.07 ± 0.07	0.02 ± 0.12	−0.06 ± 0.12	460 ± 20
1040	04/06/92	6.5	326	−0.022 ± 0.005	0.04 ± 0.07	0.02 ± 0.15	0.12 ± 0.13	66 ± 14
1254	04/06/92	7.0	370	0.038 ± 0.027	0.21 ± 0.07	−0.05 ± 0.14	−0.02 ± 0.12	−19 ± 12
1255	04/06/92	6.8	401	0.008 ± 0.022	0.07 ± 0.07	0.01 ± 0.18	0.1 ± 0.1	100 ± 15
1256	04/06/92	6.4	669	0.082 ± 0.035	0.13 ± 0.07	0.02 ± 0.18	0.16 ± 0.15	180 ± 15
1257	04/06/92	6.6	499	0.007 ± 0.022	0.08 ± 0.07	0.05 ± 0.09	−0.02 ± 0.07	160 ± 15
1258	04/06/92	6.0	296	0.073 ± 0.037	0.12 ± 0.07	0.06 ± 0.31	−0.27 ± 0.32	510 ± 20
1259	04/06/92	5.6	167	−0.013 ± 0.019	0.14 ± 0.08	−0.09 ± 0.15	−0.09 ± 0.13	250 ± 15
1036	07/21/92	6.6	326	0.072 ± 0.037	0.15 ± 0.07	−0.10 ± 0.14	−0.05 ± 0.12	14000 ± 500
1037	07/21/92	5.9	128	0.034 ± 0.025	−0.02 ± 0.06	0.02 ± 0.08	0.07 ± 0.06	2300 ± 50
1038	07/17/92	4.9	521	−0.024 ± 0.005	0.64 ± 0.13	0.22 ± 0.10	0.17 ± 0.13	1300 ± 50
1039	07/17/92	6.3	483	0.07 ± 0.05	0.05 ± 0.08	−0.05 ± 0.08	−0.01 ± 0.07	1200 ± 50
1040	07/16/92	6.8	347	0.063 ± 0.033	0.25 ± 0.07	−0.06 ± 0.18	0.12 ± 0.18	84 ± 21
1254	07/16/92	7.2	348	0.13 ± 0.05	0.29 ± 0.07	0.17 ± 0.08	−0.06 ± 0.18	9 ± 14
1255	07/16/92	7.2	371	0.058 ± 0.030	0.23 ± 0.07	0.10 ± 0.14	0.10 ± 0.11	110 ± 15
1256	07/21/92	6.5	690	0.092 ± 0.039	0.10 ± 0.06	0.21 ± 0.17	0.01 ± 0.16	230 ± 15
1257	07/21/92	7.0	396	0.083 ± 0.038	0.14 ± 0.06	−0.22 ± 0.29	0.03 ± 0.24	170 ± 15
1258	07/21/92	6.5	262	0.062 ± 0.032	0.02 ± 0.06	0.04 ± 0.15	0.18 ± 0.15	690 ± 25
1259	07/21/92	5.5	164	0.096 ± 0.038	0.14 ± 0.06	−0.01 ± 0.06	0.02 ± 0.05	340 ± 20

[a] Radionuclide data are in Becquerel/liter, mean ± standard counting error; specific conductance in microsiemens/centimeter.
[b] Gross beta analysis does not include tritium.

Table B.5. Tumulus monitoring wells cation and anion data[a]

Well	Date	Ba	Ca	Fe	Mg	Mn	Na	Ni	Si	Sr	Zn	Cl	NO_3	SO_4	F
1036	04/06/92	0.23	56	<0.05	7.7	0.0028	5.0	0.005	7.6	0.092	<0.005	4.3	1.6	8.5	0.3
1037	04/09/92	0.038	7.4	<0.05	10	0.014	<5.0	0.11	13	0.024	<0.005	1.8	1.4	9.9	<0.2
1038	04/09/92	0.1	84	0.071	18	0.051	5.1	0.061	8.3	0.16	<0.005	2.4	<0.5	35.8	<0.2
1039	04/06/92	0.055	100	<0.05	14	0.012	7.0	0.017	6.7	0.15	<0.005	3.2	<0.5	41.6	<0.2
1040	04/06/92	0.08	57	<0.05	14	0.0014	<5.0	0.029	6.8	0.096	<0.005	3.4	<0.5	9.5	<0.2
1254	04/07/92	0.12	61	<0.05	7.9	0.0073	5.8	<0.004	10	0.26	0.034	2.4	<0.5	17.1	<0.2
1255	04/07/92	0.15	68	<0.05	8.2	0.011	<5.0	<0.004	8.3	0.24	0.018	5.2	<0.5	14.9	<0.2
1256	04/28/92	0.28	120	<0.05	15	0.013	<5.0	<0.004	7.2	0.22	0.011	0.8	<0.5	0.8	<0.2
1257	04/28/92	0.24	71	<0.05	9.6	0.024	<5.0	<0.004	8.4	0.12	<0.005	3.8	0.7	10.4	<0.2
1258	04/09/92	0.21	52	<0.05	3.9	0.0017	<5.0	<0.004	7.9	0.082	<0.005	4.6	5.9	2.5	<0.2
1259	04/07/92	0.12	20	<0.05	3.5	0.01	8.5	<0.004	8.5	0.047	0.013	3.7	2.5	5.7	<0.2

[a] All data in milligrams per liter.

Table B.6. Radionuclide concentrations in tumulus area soil samples[a]

Sample	Date	Gross alpha	Gross beta	^{60}Co	^{137}Cs	^{40}K
1036N	01/22/92	1600 ± 500	1500 ± 650	2.2 ± 1.9	1.1 ± 2.2	840 ± 40
1036S	01/22/92	690 ± 275	300 ± 340	1.9 ± 1.7	7.1 ± 1.4	390 ± 30
1037	01/22/92	250 ± 240	1200 ± 600	0.9 ± 2.0	11 ± 1.5	470 ± 25
1038	01/22/92	570 ± 1550	550 ± 195	−1.1 ± 2.5	9.9 ± 1.8	250 ± 30
1039	01/22/92	2100 ± 550	700 ± 550	−0.2 ± 2.4	4.8 ± 1.4	580 ± 35
1040	01/22/92	1400 ± 500	1800 ± 600	0.4 ± 1.8	−1.1 ± 2.5	590 ± 35
1254	01/22/92	720 ± 345	1600 ± 1200	0.2 ± 2.4	3.5 ± 1.4	590 ± 40
1255	01/22/92	620 ± 200	1200 ± 350	−0.2 ± 2.4	5.3 ± 2.0	610 ± 40
1256	01/22/92	360 ± 155	1500 ± 600	−1.5 ± 2.9	0.9 ± 3.0	750 ± 45
1257	01/22/92	1200 ± 400	1200 ± 450	3.4 ± 1.6	3.3 ± 1.8	630 ± 40
1258	01/22/92	630 ± 345	2000 ± 650	0.2 ± 2.6	8.3 ± 1.7	330 ± 35
1259	01/22/92	300 ± 135	1300 ± 300	1.9 ± 1.7	−1.2 ± 1.9	490 ± 30

[a] All data are in Becquerel per kilogram, mean ± standard error.

Table B.7. FY 1992 radionuclide data from intratrench wells near low–level waste silos in Solid Waste Storage Area 6[a]

Well No.	Date	Gross alpha	Gross beta	^{60}Co	^{137}Cs	Particulate ^{137}Cs[b]
4	12/20/91	0.19 ± 0.07	0.60 ± 0.15	0.1 ± 0.5	−0.04 ± 0.4	
4	03/04/92	0.033 ± 0.034	0.29 ± 0.09	0.5 ± 0.7	−0.4 ± 0.9	
4	06/04/92	0.049 ± 0.035	0.24 ± 0.10	0.9 ± 0.8	0.1 ± 0.7	
5	12/20/91	0.05 ± 0.06	1.2 ± 0.2	0.4 ± 0.9	0.1 ± 0.9	1.3 ± 0.2
5	03/04/92	0.13 ± 0.07	0.23 ± 0.15	−0.2 ± 1.4	−0.7 ± 1.4	
5	06/04/92	0.12 ± 0.11	5.2 ± 0.5	−0.3 ± 3.2	3.3 ± 2.9	
6	12/20/91	0.056 ± 0.040	1.2 ± 0.2	−0.1 ± 0.6	0.5 ± 0.6	
6	03/17/92	0.039 ± 0.032	0.44 ± 0.09	1.2 ± 0.7	0.1 ± 0.7	
6	06/04/92	0.13 ± 0.04	0.90 ± 0.10	0.6 ± 0.5	−0.1 ± 0.6	0.11 ± 0.02
6	08/31/92	0.15 ± 0.07	1.5 ± 0.2	−0.3 ± 1.2	−0.9 ± 1.5	0.08 ± 0.14
7	12/20/91	0.015 ± 0.043	1.1 ± 0.2	0.5 ± 0.5	−0.1 ± 0.6	
7	03/17/92	0.080 ± 0.050	0.57 ± 0.18	1.7 ± 1.1	0.5 ± 1.4	
8	12/20/91	0.010 ± 0.026	0.99 ± 0.15	0.3 ± 0.9	0.4 ± 0.7	
8	03/17/92	0.12 ± 0.05	0.99 ± 0.12	−0.1 ± 1.1	0.4 ± 0.9	0.19 ± 0.07
8	06/04/92	0.14 ± 0.05	1.0 ± 0.1	1.3 ± 0.8	−1.0 ± 1.2	1.06 ± 0.42
10	12/20/91	−0.011 ± 0.023	0.39 ± 0.11	−0.1 ± 0.8	−0.1 ± 0.6	
10	06/04/92	0.001 ± 0.046	0.62 ± 0.17	−1.7 ± 2.1	0.8 ± 1.5	
10	08/28/92	0.12 ± 0.07	1.1 ± 0.2	−1.7 ± 1.9	0.8 ± 1.3	
11	12/20/91	0.035 ± 0.041	0.55 ± 0.12	−0.3 ± 0.7	−0.04 ± 0.46	
11	03/04/92	0.010 ± 0.025	0.19 ± 0.12	−0.4 ± 1.0	−0.8 ± 0.8	
11	06/04/92	0.10 ± 0.04	0.23 ± 0.07	−0.8 ± 1.1	−0.4 ± 0.8	
11	08/28/92	0.057 ± 0.033	0.38 ± 0.09	−0.7 ± 1.4	0.3 ± 1.3	

Table B.7 (continued)

Well No.	Date	Gross alpha	Gross beta	^{60}Co	^{137}Cs	Particulate $^{137}Cs^{b}$
12	12/20/91	0.056 ± 0.033	0.22 ± 0.07	−0.4 ± 1.0	−0.1 ± 0.8	
12	03/04/92	0.046 ± 0.043	0.10 ± 0.12	0.4 ± 1.2	−0.4 ± 1.1	
13	12/20/91	0.004 ± 0.029	2.4 ± 0.2	1.4 ± 0.5	0.5 ± 0.8	3.1 ± 0.6
13	03/04/92	0.19 ± 0.10	2.0 ± 0.3	−3.9 ± 3.6	−0.1 ± 2.6	1.2 ± 0.2
13	08/28/92	0.56 ± 0.18	4.3 ± 0.4	−1.3 ± 2.8	1.0 ± 2.1	0.56 ± 0.53
15	12/20/91	0.052 ± 0.043	0.14 ± 0.11	−0.1 ± 1.0	0.3 ± 0.7	
15	03/04/92	0.06 ± 0.05	0.21 ± 0.11	0.2 ± 0.8	0.3 ± 0.7	
15	06/04/92	0.003 ± 0.019	−0.04 ± 0.07	−1.7 ± 1.3	0.1 ± 1.0	0.12 ± 0.09
15	08/28/92	0.063 ± 0.036	0.47 ± 0.09	−0.2 ± 1.4	0.4 ± 1.1	0.11 ± 0.04
16	06/04/92	0.039 ± 0.050	0.18 ± 0.13	−1.2 ± 1.8	0.5 ± 1.3	
17	12/20/91	−0.024 ± 0.005	0.41 ± 0.12	−0.3 ± 0.7	0.2 ± 0.5	
17	03/04/92	0.065 ± 0.034	0.68 ± 0.10	−0.2 ± 0.6	0.30 ± 0.44	
17	06/04/92	−0.005 ± 0.026	0.80 ± 0.14	1.4 ± 1.1	0.3 ± 1.1	
18	12/20/91	0.09 ± 0.06	1.0 ± 0.2	−0.3 ± 0.5	0.25 ± 0.39	0.06 ± 0.04
19	12/20/91	0.081 ± 0.042	29 ± 0.5	−0.3 ± 1.0	0.7 ± 0.8	0.5 ± 0.2
19	03/04/92	0.030 ± 0.029	73 ± 1	0.8 ± 0.8	0.6 ± 0.7	
20	12/20/91	−0.006 ± 0.029	0.81 ± 0.15	−0.1 ± 0.8	−0.1 ± 0.8	
20	03/04/92	0.075 ± 0.045	0.20 ± 0.10	1.2 ± 0.6	0.6 ± 0.8	0.12 ± 0.04
20	08/28/92	0.30 ± 0.18	4.5 ± 0.6	0.3 ± 3.9	−1.3 ± 4.3	
21	03/04/92	0.003 ± 0.024	1.6 ± 0.2	−0.4 ± 0.9	1.1 ± 0.5	
21	08/28/92	0.56 ± 0.26	3.6 ± 0.7	−1 ± 5.5	1 ± 5.0	

Table B.7 (continued)

Well No.	Date	Gross alpha	Gross beta	^{60}Co	^{137}Cs	Particulate $^{137}Cs^{b}$
22	12/20/91	0.70 ± 0.14	4.2 ± 0.3	1.3 ± 0.5	0.5 ± 0.7	0.13 ± 0.13
22	03/04/92	0.041 ± 0.040	0.18 ± 0.10	0.7 ± 0.7	0.4 ± 0.6	
22	06/04/92	0.130 ± 0.060	0.29 ± 0.11	0.86 ± 0.49	−0.5 ± 0.6	
22	08/28/92	0.053 ± 0.027	0.36 ± 0.08	0.1 ± 1.4	−0.4 ± 1.4	0.16 ± 0.07
23	12/20/91	0.038 ± 0.039	1.3 ± 0.2	0.6 ± 0.9	−0.3 ± 0.9	
23	03/04/92	0.058 ± 0.042	0.27 ± 0.11	−0.5 ± 0.8	0.5 ± 0.7	
23	06/04/92	0.016 ± 0.041	0.52 ± 0.17	1.4 ± 1.3	−0.3 ± 1.5	
24	12/20/91	−0.005 ± 0.028	0.24 ± 0.10	1.1 ± 0.8	−0.6 ± 0.8	
24	03/04/92	0.053 ± 0.032	0.17 ± 0.09	0.7 ± 0.5	0.1 ± 0.6	
25	12/20/91	0.07 ± 0.05	0.46 ± 0.14	0.1 ± 1.0	−0.2 ± 0.9	
25	03/04/92	0.044 ± 0.043	0.16 ± 0.10	−0.5 ± 0.8	0.98 ± 0.47	0.07 ± 0.04
25	06/04/92	−0.049 ± 0.010	0.51 ± 0.21	1.3 ± 1.5	−2.1 ± 1.8	
25	08/28/92	0.041 ± 0.029	0.20 ± 0.08	−0.8 ± 1.6	−0.1 ± 1.3	0.04 ± 0.03
26	12/20/91	0.022 ± 0.040	0.33 ± 0.11	1.1 ± 0.5	0.4 ± 0.6	
		±	±	±	±	
27−A	12/20/91	0.043 ± 0.030	0.14 ± 0.08	0.7 ± 0.8	−0.9 ± 0.8	
27−B	12/20/91	0.041 ± 0.033	0.11 ± 0.08	1.0 ± 0.7	1.8 ± 0.7	
27	03/17/92	0.084 ± 0.050	0.38 ± 0.12	0.3 ± 0.7	−0.2 ± 0.6	
27	06/08/92	0.016 ± 0.024	0.25 ± 0.07	1.2 ± 0.6	0.2 ± 0.6	
27	08/31/92	0.067 ± 0.034	2.1 ± 0.2	−0.7 ± 1.6	−0.2 ± 1.3	
28	12/20/91	−0.005 ± 0.017	0.67 ± 0.09	0.6 ± 0.7	−0.3 ± 0.9	
29	06/08/92	0.14 ± 0.09	1.7 ± 0.25	3.0 ± 1.7	0.8 ± 1.5	

Table B.7 (continued)

Well No.	Date	Gross alpha	Gross beta	^{60}Co	^{137}Cs	Particulate ^{137}Cs[b]
30	12/20/91	−0.012 ± 0.018	0.14 ± 0.07	0.4 ± 0.6	0.6 ± 0.5	0.09 ± 0.05
30	03/17/92	0.26 ± 0.08	0.26 ± 0.10	0.3 ± 0.7	−0.5 ± 0.7	0.08 ± 0.06
30	06/08/92	−0.006 ± 0.023	0.26 ± 0.08	0.2 ± 1.4	−0.9 ± 1.3	
31	12/20/91	0.033 ± 0.024	0.29 ± 0.08	0.3 ± 0.8	0.2 ± 0.7	0.3 ± 0.1
31	03/17/92	0.09 ± 0.06	0.29 ± 0.11	0.6 ± 0.6	1.3 ± 0.5	
31	06/08/92	0.016 ± 0.023	0.28 ± 0.07	−0.1 ± 0.8	−0.3 ± 0.7	
31	09/23/92	0.080 ± 0.037	0.24 ± 0.08	−0.01 ± 0.08	0.18 ± 0.05	
32	12/20/91	0.003 ± 0.018	0.80 ± 0.11	1.2 ± 0.6	−0.3 ± 0.6	0.3 ± 0.2
32	03/17/92	0.056 ± 0.029	0.24 ± 0.07	0.1 ± 0.9	0.3 ± 1.2	0.19 ± 0.06
32	06/08/92	0.081 ± 0.037	0.51 ± 0.09	1.6 ± 0.4	−0.1 ± 0.6	1.18 ± 0.23
33	12/20/91	0.13 ± 0.07	0.62 ± 0.15	2.5 ± 0.9	2.2 ± 0.8	
35	12/20/91	−0.033 ± 0.006	1.9 ± 0.2	−0.7 ± 1.0	0.1 ± 0.9	0.04 ± 0.07
35	03/17/92	−0.008 ± 0.016	0.29 ± 0.08	1.6 ± 1.0	1.0 ± 1.2	
35	06/08/92	0.035 ± 0.025	0.37 ± 0.08	0.4 ± 0.6	−0.2 ± 0.6	0.16 ± 0.03
35	09/23/92	0.036 ± 0.030	0.64 ± 0.09	0.17 ± 0.10	0.11 ± 0.12	0.20 ± 0.09[c]
36	12/20/91	−0.005 ± 0.018	0.33 ± 0.08	1.5 ± 0.4	0.2 ± 0.7	0.10 ± 0.06
36	03/17/92	0.000 ± 0.023	0.32 ± 0.09	2.4 ± 0.9	−1.0 ± 1.6	
36	06/08/92	0.48 ± 0.08	0.56 ± 0.08	1.4 ± 0.6	−0.1 ± 0.8	0.23 ± 0.06
36	09/23/92	0.026 ± 0.029	0.46 ± 0.09	−0.01 ± 0.1	0.06 ± 0.08	0.16 ± 0.05
38	12/30/91	0.026 ± 0.030	2.70 ± 0.15	0.5 ± 0.7	0.1 ± 0.8	
38	03/17/92	0.008 ± 0.023	2.2 ± 0.2	0.3 ± 0.9	0.4 ± 0.7	
38	06/12/92	0.036 ± 0.037	0.82 ± 0.14	−0.2 ± 0.7	−0.1 ± 0.7	
38	09/02/92	−0.049 ± 0.007	1.5 ± 0.2	0.21 ± 0.18	0.01 ± 0.20	

Table B.7 (continued)

Well No.	Date	Gross alpha	Gross beta	^{60}Co	^{137}Cs	Particulate $^{137}Cs^{b}$
39	12/30/91	−0.038 ± 0.006	0.09 ± 0.08	0.1 ± 0.6	0.1 ± 0.6	0.1 ± 0.1
40	12/30/91	0.011 ± 0.031	0.48 ± 0.09	0.7 ± 0.7	0.1 ± 0.6	
40	03/17/92	0.030 ± 0.027	0.13 ± 0.07	−0.1 ± 1.1	0.8 ± 0.7	
40	06/12/92	0.038 ± 0.044	38 ± 1	0.7 ± 0.6	−0.2 ± 0.9	
40	09/02/92	−0.016 ± 0.021	0.42 ± 0.10	−0.9 ± 1.6	−0.7 ± 1.3	
41	12/30/91	−0.010 ± 0.013	0.18 ± 0.07	0.1 ± 1.0	−0.4 ± 1.0	
41	03/17/92	0.012 ± 0.025	0.13 ± 0.07	0.4 ± 0.8	−0.5 ± 0.8	
41	06/12/92	0.09 ± 0.06	0.12 ± 0.09	−0.2 ± 1.2	0.1 ± 1.0	
41	09/02/92	0.05 ± 0.14	1.7 ± 0.8	−1 ± 5.5	−2 ± 5.0	
42	12/30/91	0.020 ± 0.026	0.20 ± 0.07	−0.1 ± 0.7	0.2 ± 0.7	
42	03/17/92	0.019 ± 0.024	0.01 ± 0.07	1.1 ± 0.7	−0.8 ± 0.8	0.06 ± 0.05
42	06/12/92	−0.020 ± 0.004	0.25 ± 0.10	−0.1 ± 0.9	−0.1 ± 0.9	
42	09/02/92	−0.006 ± 0.018	0.19 ± 0.08	0.03 ± 0.12	0.13 ± 0.11	
43	12/30/91	0.028 ± 0.026	0.22 ± 0.09	0.5 ± 0.7	−0.4 ± 0.6	
43	03/17/92	−0.018 ± 0.014	0.02 ± 0.06	0.4 ± 1.0	−0.1 ± 0.8	
43	06/12/92	−0.003 ± 0.037	0.22 ± 0.10	1.2 ± 0.7	0.2 ± 0.7	
43	09/02/92	0.081 ± 0.046	0.06 ± 0.08	0.84 ± 0.40	0.48 ± 0.33	
44	12/30/91	0.039 ± 0.029	0.46 ± 0.09	0.3 ± 0.8	0.5 ± 0.7	
44	03/17/92	0.059 ± 0.035	0.43 ± 0.11	0.6 ± 0.9	−0.2 ± 0.9	0.22 ± 0.16
44	06/12/92	0.11 ± 0.05	1.4 ± 0.1	1.6 ± 0.7	0.6 ± 0.9	
44	09/02/92	−0.026 ± 0.005	0.40 ± 0.10	0.15 ± 0.27	0.16 ± 0.25	
45	03/17/92	0.34 ± 0.13	4.0 ± 0.3	−1.4 ± 1.9	1.7 ± 1.2	
45	09/02/92	0.29 ± 0.19	2.0 ± 0.4	1.1 ± 2.7	−0.2 ± 2.7	

Table B.7 (continued)

Well No.	Date	Gross alpha	Gross beta	^{60}Co	^{137}Cs	Particulate ^{137}Cs[b]
46	12/30/91	0.037 ± 0.033	0.27 ± 0.08	0.6 ± 0.6	0.2 ± 0.6	
46	03/17/92	0.017 ± 0.025	0.10 ± 0.07	0.4 ± 0.9	1.0 ± 0.7	
46	06/12/92	0.038 ± 0.031	0.12 ± 0.06	−0.1 ± 0.7	−0.1 ± 0.7	
46	09/02/92	−0.044 ± 0.037	0.21 ± 0.15	0.8 ± 1.2	0.4 ± 1.1	
47	12/30/91	0.016 ± 0.046	3.1 ± 0.3	−0.1 ± 1.7	0.4 ± 1.4	

[a] All data are in Becquerel per liter, mean ± standard error. Boldface indicates value exceeds action level.
[b] Results below detectable activity of about 1 Becquerel per liter except when reported.
[c] Average of duplicate counts.

Table B.8. FY 1992 radionuclide data for water collected from wells next to high–range wells, asbestos silos, and fissile wells[a]

Well No.	Date	Gross alpha	Gross beta	^{60}Co	^{137}Cs	Particulate ^{137}Cs[b]
AUG 48–A	12/30/91	−0.013 ± 0.020	1.4 ± 0.1	0.3 ± 1.0	2.3 ± 0.6	0.9 ± 0.1
AUG 48–B	12/30/91	0.014 ± 0.028	0.65 ± 0.11	−0.9 ± 0.9	0.6 ± 0.7	0.7 ± 0.2
AUG 48–A	03/24/92	0.020 ± 0.026	0.22 ± 0.07	0.1 ± 1.3	−0.7 ± 1.2	1.4 ± 0.2[c]
AUG 48–B	03/24/92	0.032 ± 0.028	0.13 ± 0.07	0.7 ± 0.5	0.1 ± 0.6	1.7 ± 0.2
AUG 48	06/12/92	0.10 ± 0.06	0.58 ± 0.13	−0.1 ± 0.6	−0.03 ± 0.50	2.2 ± 0.4[c]
AUG 49	12/30/91	−0.005 ± 0.018	0.13 ± 0.07	0.3 ± 0.8	0.3 ± 0.5	
AUG 49	03/24/92	0.071 ± 0.037	0.09 ± 0.08	0.5 ± 1.2	0.1 ± 1.4	
AUG 49	06/12/92	0.025 ± 0.045	0.21 ± 0.12	0.3 ± 1.0	−0.1 ± 0.8	
AUG 50	12/30/91	0.064 ± 0.038	0.27 ± 0.08	−0.8 ± 1.0	0.3 ± 1.0	
AUG 50	03/24/92	0.016 ± 0.023	0.07 ± 0.06	−0.7 ± 1.3	−0.2 ± 1.2	0.1 ± 0.1
AUG 50	06/12/92	0.017 ± 0.025	−0.07 ± 0.07	0.1 ± 0.7	−0.5 ± 0.6	
AUG 51	12/30/91	0.014 ± 0.041	0.20 ± 0.15	1.7 ± 1.3	−0.5 ± 1.4	
AUG W536	12/30/91	−0.006 ± 0.024	0.35 ± 0.08	0.9 ± 0.6	−0.3 ± 0.7	
AUG W536	03/24/92	0.10 ± 0.04	0.25 ± 0.08	−1.1 ± 1.5	−0.8 ± 1.4	
AUG W540	12/30/91	0.035 ± 0.032	0.40 ± 0.09	0.6 ± 0.4	−0.4 ± 0.6	
AUG W540	03/24/92	0.086 ± 0.040	0.31 ± 0.08	−0.5 ± 0.9	−0.6 ± 0.9	
AUG W559	03/24/92	0.055 ± 0.033	0.18 ± 0.08	0.9 ± 0.5	−0.2 ± 0.7	
AUG W572	12/30/91	−0.011 ± 0.015	0.53 ± 0.10	0.6 ± 0.6	0.2 ± 0.60	
AUG W572	03/24/92	−0.010 ± 0.014	0.10 ± 0.06	0.2 ± 0.9	−0.2 ± 0.8	

Table B.8 (continued)

Well No.	Date	Gross alpha	Gross beta	^{60}Co	^{137}Cs	Particulate ^{137}Cs[b]
C520	12/30/91	0.035 ± 0.025	0.16 ± 0.07	0.9 ± 0.6	0.2 ± 0.5	
C520	03/24/92	0.000 ± 0.023	0.22 ± 0.09	0.38 ± 0.44	0.3 ± 0.7	0.2 ± 0.1
C520	06/12/92	0.003 ± 0.020	0.16 ± 0.07	0.1 ± 1.5	1.0 ± 1.5	
C520	09/03/92	−0.02 ± 0.05	0.28 ± 0.18	−0.2 ± 1.7	0.6 ± 1.2	
C595	12/30/91	0.068 ± 0.035	0.18 ± 0.08	−0.3 ± 1.0	0.6 ± 0.8	0.2 ± 0.2
C595	03/24/92	0.020 ± 0.026	0.51 ± 0.10	0.9 ± 1.0	0.6 ± 0.7	0.2 ± 0.1[c]
C595	06/12/92	0.069 ± 0.040	0.48 ± 0.09	−0.8 ± 1.7	−0.5 ± 1.7	1.04 ± 0.32
C595	09/03/92	0.04 ± 0.06	0.15 ± 0.15	−0.3 ± 1.5	0.4 ± 1.3	
FIS 102	12/30/91	−0.018 ± 0.014	0.52 ± 0.09	0.1 ± 0.6	0.20 ± 0.48	
FIS 102	03/24/92	−0.015 ± 0.012	0.20 ± 0.07	0.8 ± 0.9	−1.6 ± 1.5	
FIS 102	06/12/92	0.003 ± 0.020	0.34 ± 0.07	1.0 ± 0.6	0.2 ± 0.7	
FIS 102	09/23/92	0.008 ± 0.024	0.36 ± 0.08	0.12 ± 0.08	0.03 ± 0.08	0.08 ± 0.02
FIS ?	12/30/91	0.090 ± 0.038	0.15 ± 0.07	0.67 ± 0.47	0.74 ± 0.43	
FIS ?	03/24/92	0.000 ± 0.021	0.13 ± 0.07	−1.1 ± 1.7	0.2 ± 1.1	0.2 ± 0.1
FIS ?	06/12/92	0.028 ± 0.026	0.16 ± 0.07	1.0 ± 1.1	0.1 ± 1.2	0.14 ± 0.09
FIS ?	09/03/92	0.22 ± 0.09	0.57 ± 0.19	0.20 ± 0.09	0.06 ± 0.10	0.07 ± 0.03[c]

[a] All data are in Becquerel per liter, mean ± standard error.
[b] Results below detectable activity of about 1 Becquerel per liter except when reported.
[c] Average of duplicate counts.

Table B.9. Radionuclide concentrations in SWSA 5 North wells from November 1989 through July 1992[a]

Sample date	Gross alpha	^{241}Am	^{244}Cm	Gross beta[b]	^{60}Co	^{137}Cs	Tritium
			Well 513				
29 Nov 89	0.068 ± 0.034			0.19 ± 0.06	0.4 ± 1.7	0.7 ± 1.9	
27 Mar 90[c]	0.05 ± 0.04			0.14 ± 0.05	<0.35	<0.35	60 ± 17.5
18 Jun 90[c]	0.012 ± 0.02			0.09 ± 0.04	<0.55	<0.55	
13 Aug 90	−0.12 ± 0.03			0.1 ± 0.8			
06 Dec 90	0.02 ± 0.02			0.01 ± 0.06	−0.08 ± 0.115	−0.08 ± 0.095	25 ± 17.5
22 Mar 91	0.17 ± 0.05	0.003 ± 0.07	−0.004 ± 0.002	0.54 ± 0.095	<0.1	<0.1	45 ± 17
04 Sep 91	−0.029 ± 0.001	0.002 ± 0.01	−0.017 ± 0.009	0.13 ± 0.095	−0.3 ± 0.55	−0.4 ± 0.55	43 ± 20.5
16 Dec 91	0.068 ± 0.049	0.008 ± 0.008	0.07 ± 0.011	−0.01 ± 0.1	0.03 ± 0.195	−0.06 ± 0.24	47 ± 13
09 Mar 92	0.026 ± 0.023			0.2 ± 0.075	−1.5 ± 1.35	0.7 ± 1.05	
24 Jun 92	0.011 ± 0.04	−0.002 ± 0.014	0.01 ± 0.007	0.09 ± 0.06	0.05 ± 0.05	0.058 ± 0.048	
			Well 514				
29 Nov 89	0.053 ± 0.031			0.26 ± 0.065	−4 ± 3.75	−1.4 ± 2.3	
22 Mar 90[c]	0.01 ± 0.02			0.12 ± 0.04	<0.35	<0.35	66 ± 17.5
14 Jun 90[c]	0.005 ± 0.02			0.20 ± 0.05	<0.55	<0.55	
29 Aug 90	0.02 ± 0.22			0.4 ± 0.85			
15 Nov 90	0.035 ± 0.036			0.04 ± 0.105	0.06 ± 0.155	0.12 ± 0.125	33 ± 17
15 Mar 91	0.032 ± 0.023	0.004 ± 0.002	−0.005 ± 0.002	0.27 ± 0.07	<0.1	0.07 ± 0.03	49 ± 17
23 Aug 91	−0.011 ± 0.024	−0.06 ± 0.065	−0.18 ± 0.045	−0.041 ± 0.078	0.6 ± 0.75	0.3 ± 0.8	63 ± 20.5
06 Dec 91	0.12 ± 0.06	0.001 ± 0.06	0.000 ± 0.003	0.28 ± 0.125	−0.5 ± 0.9	−0.5 ± 0.9	
27 Feb 92	0.029 ± 0.030			0.00 ± 0.065	−0.2 ± 0.9	0.1 ± 0.8	31 ± 12.5
28 May 92	0.022 ± 0.038	0.007 ± 0.005	−0.002 ± 0.002	−0.08 ± 0.085	0.27 ± 0.135	0.06 ± 0.165	

Table B.9 (continued)

Sample date	Gross alpha	^{241}Am	^{244}Cm	Gross beta[b]	^{60}Co	^{137}Cs	Tritium
			Well 516				
29 Nov 89	**170** ± 10		**140** ± 5	**13** ± 1.5	0.15 ± 0.085	0.01 ± 0.095	
28 Mar 90	**79** ± 3	**5.53** ± 0.21	**71.1** ± 2.7		0.8 1.2	1.1 1.05	40 ± 17
26 Jun 90[c]	**9.3** ± 0.23		±	**2.68** ± 0.14	<0.55	<0.55	
26 Jul 90	**120** ± 5	**0.66** ± 0.025	**43** ± 0.5				
16 Aug 90	**110** ± 5			**7.3** ± 0.35			
13 Nov 90	**38** ± 1	**1.7** ± 0.25		**2.2** ± 0.25	−0.02 ± 0.295	0.14 ± 0.22	51 ± 12
22 Mar 91	**210** ± 5	**7** ± 0.5	−0.004 ± 0.002	**15** ± 0.5	0.07 ± 0.05	0.08 ± 0.05	35 ± 16.5
04 Sep 91	**46** ± 1	**0.99** ± 0.115	−0.017 ± 0.009	**3.8** ± 0.2	0.6 ± 0.7	0.7 ± 0.6	−49 ± 19
18 Dec 91	**24** ± 0.5	**0.62** ± 0.03	**0.07** ± 0.011	1.6 ± 0.15	−0.01 ± 0.38	−0.01 ± 0.3	36 ± 13
30 Jun 92	**14** ± 0.5	**0.18** ± 0.02		0.99 ± 0.145	0.1 ± 0.105	0.07 ± 0.1	
			Well 517				
29 Nov 89	−0.21 ± 0.04			−3 ± 0.7	−1.1 ± 2.9	0.9 ± 2.1	
06 Mar 90[c]	−0.001 ± 0.006			0.22 ± 0.05	<2.5	<2.5	54 ± 17.5
14 Jun 90[c]	−0.002 ± 0.01			0.09 ± 0.03	<0.55	<0.55	
29 Aug 90	0.09 ± 0.23			0.1 ± 0.9			
15 Nov 90	0.023 ± 0.041			0.28 ± 0.11	−0.11 ± 0.165	0.05 ± 0.15	37 ± 17
20 Mar 91	0.00 ± 0.029	−0.008 ± 0.01	−0.007 ± 0.008	0.31 ± 0.075	<0.1	<0.1	19 ± 16.5
30 Aug 91	0.004 ± 0.029	−0.02 ± 0.05	−0.045 ± 0.045	0.51 ± 0.11	−1 ± 2.05	0.2 ± 1.35	9 ± 20
10 Dec 91	0.05 ± 0.05	0.001 ± 0.008	−0.003 ± 0.006	0.07 ± 0.115	1.2 ± 0.6	0.1 ± 0.75	
27 Feb 92	−0.019 ± 0.02			0.24 ± 0.085	0.37 ± 0.125	0.16 ± 0.485	35 ± 13
08 Jun 92[c]	0.019 ± 0.047	0.008 ± 0.0065	−0.008 ± 0.002	0.18 ± 0.105	−0.02 ± 0.175	−0.02 ± 0.155	

Table B.9 (continued)

Sample date	Gross alpha	^{241}Am	^{244}Cm	Gross beta[b]	^{60}Co	^{137}Cs	Tritium
			Well 518				
29 Nov 89	0.028 ± 0.024			0.13 ± 0.055	1.4 ± 0.85	−1.2 ± 2.1	
23 Mar 90[c]	0.004 ± 0.01			0.09 ± 0.04	<0.35	<0.35	64 ± 17.5
14 Jun 90[c]	0.013 ± 0.01			0.08 ± 0.04	<0.55	<0.55	
29 Aug 90	0.03 ± 0.02			0.11 ± 0.05			
09 Dec 90	0.14 ± 0.05			0.32 ± 0.08	0.08 ± 0.14	0.05 ± 0.155	22 ± 18
15 Mar 91	0.04 ± 0.034	−0.002 ± 0.006	−0.009 ± 0.003	0.34 ± 0.08	<0.1	<0.1	31 ± 16.5
29 Aug 91	0.026 ± 0.028	0.09 ± 0.07	−0.12 ± 0.05	0.25 ± 0.08	0.3 ± 0.55	0.23 ± 0.42	68 ± 20.5
10 Dec 91	0.12 ± 0.065	0.03 ± 0.010	0.002 ± 0.007	0.37 ± 0.115	1.5 ± 0.7	0.2 ± 0.8	
27 Feb 92	0.024 ± 0.028			0.30 ± 0.15	−0.6 ± 0.95	0.1 ± 0.85	40 ± 13
01 Jun 92	0.06 ± 0.05	−0.004 ± 0.006	−0.001 ± 0.003	−0.11 ± 0.065	−0.21 ± 0.29	0.03 ± 0.195	
			Well 519				
29 Nov 89	−0.21 ± 0.04			0.078 ± 0.0475	−0.4 ± 2.35	−0.9 ± 2.1	
23 Mar 90[c]	−0.001 ± 0.006			0.08 ± 0.04	<0.35	<0.35	56 ± 17.5
13 Jun 90[c]	−0.002 ± 0.01			0.17 ± 0.04	<0.55	<0.55	
29 Aug 90	0.09 ± 0.23			0.06 ± 0.05			
15 Nov 90	0.023 ± 0.041			0.30 ± 0.11	0.05 ± 0.14	0.18 ± 0.135	27 ± 17
14 Mar 91	0 ± 0.029			0.15 ± 0.065	<0.1	<0.1	23 ± 16.5
29 Aug 91	0.004 ± 0.029	0.03 ± 0.095	−0.2 ± 0.085	−0.06 ± 0.07	−1.3 ± 2.4	1.2 ± 2.1	22 ± 20
06 Dec 91	0.05 ± 0.05	−0.007 ± 0.007	−0.013 ± 0.003	0.23 ± 0.11	−0.7 ± 0.85	0.5 ± 0.75	
27 Feb 92	−0.019 ± 0.02			0.24 ± 0.08	−0.1 ± 0.9	−0.1 ± 0.9	18 ± 12.5
28 May 92	0.019 ± 0.047	0.013 ± 0.006	0.009 ± 0.005	0.07 ± 0.095	0.15 ± 0.15	0.09 ± 0.125	

Table B.9 (continued)

Sample date	Gross alpha	^{241}Am	^{244}Cm	Gross beta[b]	^{60}Co	^{137}Cs	Tritium
			Well 520				
29 Nov 89	0.02 ± 0.025			0.05 ± 0.07	0.08 ± 0.175	0.01 ± 0.165	
22 Mar 90[c]	0.01 ± 0.02			0.08 ± 0.04	<0.35	<0.35	76 ± 17.5
13 Jun 90[c]	0.007 ± 0.02			0.10 ± 0.04	<0.55	<0.55	
30 Aug 90	0.32 ± 0.32			0.80 ± 0.85			
12 Nov 90	0.05 ± 0.055			0.08 ± 0.10	0.12 ± 0.09	0.02 ± 0.09	36 ± 12
20 Mar 91	0.021 ± 0.027	−0.004 ± 0.005	−0.007 ± 0.002	0.19 ± 0.065	<0.1	<0.1	26 ± 16.5
28 Aug 91	0.09 ± 0.042	0.08 ± 0.06	−0.12 ± 0.035	0.21 ± 0.08	−2.4 ± 2.8	0.2 ± 0.6	9 ± 20
13 Dec 91	−0.005 ± 0.027	0.002 ± 0.008	−0.012 ± 0.006	0.20 ± 0.10	−1.4 ± 0.8	−0.6 ± 0.85	
05 Mar 92	0.014 ± 0.025			0.10 ± 0.07	1.1 ± 0.8	−0.4 ± 1.05	23 ± 12.5
10 Jun 92	0.12 ± 0.04	0.015 ± 0.019	**0.11** ± 0.02	0.14 ± 0.06	0.01 ± 0.1	0.02 ± 0.09	
			Well 521				
29 Nov 89	0.014 ± 0.012			0.64 ± 0.05	0.08 ± 0.125	0.2 ± 0.07	
23 Mar 90[c]	0.004 ± 0.017			0.21 ± 0.05	<0.35	<0.35	28 ± 17
18 Jun 90[c]	0.01 ± 0.01			0.13 ± 0.04	<0.55	<0.55	
30 Aug 90	−0.15 ± 0.035			1.2 ± 0.9			
05 Dec 90	0.00 ± 0.05			0.12 ± 0.075	0.04 ± 0.12	−0.04 ± 0.12	−45 ± 16.5
20 Mar 91	−0.10 ± 0.13			0.9 ± 0.6	<0.1	<0.1	7 ± 16
30 Aug 91	0.84 ± 0.405	0.08 ± 0.075	**0.30** ± 0.09	1.1 ± 0.75	−1.6 ± 2.95	−1.4 ± 2.65	13 ± 20
12 Dec 91	0.16 ± 0.13	**0.062** ± 0.014	0.002 ± 0.01	0.28 ± 0.23	0.3 ± 0.8	−0.1 ± 0.85	
05 Mar 92	0.10 ± 0.10			−0.09 ± 0.145	0.05 ± 0.475	−0.13 ± 0.485	3 ± 12
28 May 92	−0.06 ± 0.012	0.006 ± 0.006	**0.015** ± 0.005	1.4 ± 0.035	−0.05 ± 0.1	−0.07 ± 0.1	

Table B.9 (continued)

Sample date	Gross alpha	^{241}Am	^{244}Cm	Gross beta[b]	^{60}Co	^{137}Cs	Tritium
			Well 522				
29 Nov 89	0.01 ± 0.010			0.39 ± 0.045	−0.03 ± 0.095	0.04 ± 0.095	
08 Mar 90[c]	−0.01 ± 0.02			0.23 ± 0.05	<2.5	<2.5	32 ± 17
18 Jun 90[c]	0.007 ± 0.03			0.28 ± 0.06	<0.55	<0.55	
31 Aug 90	0.02 ± 0.23			−1.4 ± 0.5			
20 Mar 91	0.044 ± 0.031	0.006 ± 0.005	0.007 ± 0.004	0.08 ± 0.07	<0.3	<0.1	−9 ± 15.5
02 Aug 91	0.035 ± 0.03	0.014 ± 0.031	0.048 ± 0.029	0.18 ± 0.075	−0.4 ± 1.8	1.8 ± 0.8	−28 ± 14.5
12 Dec 91	0.024 ± 0.044	0.013 ± 0.013	−0.006 ± 0.010	0.18 ± 0.1	−0.5 ± 0.85	−0.5 ± 0.8	
05 Mar 92	−0.018 ± 0.018			0.17 ± 0.085	−1 ± 1.35	−0.3 ± 1.2	−18 ± 11.5
08 Jun 92	0.017 ± 0.042	−0.01 ± 0.006	−0.007 ± 0.005	0.14 ± 0.105	0.08 ± 0.04	0.08 ± 0.05	
			Well 523				
29 Nov 89	0.083 ± 0.038			1.9 ± 0.15	0.4 ± 0.08	1.1 ± 0.1	
15 Mar 90[c]	0.01 ± 0.02			0.28 ± 0.05	<0.35	<0.35	80 ± 18
19 Jun 90[c]	0.008 ± 0.02			0.16 ± 0.04	<0.55	<0.55	
31 Aug 90	−0.14 ± 0.035			0.6 ± 0.85			
15 Nov 90	0.15 ± 0.085			0.22 ± 0.18	0.1 ± 0.095	−0.04 ± 0.09	55 ± 17.5
25 Mar 91	0.032 ± 0.028	0.003 ± 0.002	0.006 ± 0.004	0.26 ± 0.075	<0.1	<0.1	66 ± 17.5
05 Sep 91	−0.006 ± 0.017	−0.079 ± 0.042	−0.004 ± 0.046	−0.01 ± 0.08	0.3 ± 1.5	0.9 ± 1	15 ± 20
19 Dec 91	0.026 ± 0.034	−0.013 ± 0.006	−0.003 ± 0.0055	0.06 ± 0.15	−0.04 ± 0.38	−0.57 ± 0.3	52 ± 13
18 Mar 92	−0.016 ± 0.016			−0.03 ± 0.06	0.8 ± 0.8	−0.2 ± 1.1	45 ± 13
02 Jul 92	0.05 ± 0.003	−0.004 ± 0.006	−0.0074 ± 0.0046	0.26 ± 0.12	0.03 ± 0.09	0.1 ± 0.065	

Table B.9 (continued)

Sample date	Gross alpha	^{241}Am	^{244}Cm	Gross beta[b]	^{60}Co	^{137}Cs	Tritium
			Well 524				
29 Nov 89	0.014 ± 0.012			0.87 ± 0.055	0.1 ± 0.145	0.09 ± 0.145	
15 Mar 90[c]	0.01 ± 0.01			0.54 ± 0.07	<0.35	<0.35	300 ± 20
19 Jun 90[c]	0.001 ± 0.01			0.22 ± 0.05	<0.55	<0.55	
31 Aug 90	0.02 ± 0.25			0.2 ± 1			
15 Nov 90	−0.01 ± 0.028			0.35 ± 0.115	−0.02 ± 0.12	0.04 ± 0.12	370 ± 22.5
26 Mar 91	0.021 ± 0.027			3 ± 0.15	<0.1	<0.1	180 ± 20
05 Sep 91	0.018 ± 0.024	−0.014 ± 0.015	0.01 ± 0.012	0.14 ± 0.075	1.6 ± 0.75	−2 ± 2.45	240 ± 25
19 Dec 91	0.053 ± 0.044	0.048 ± 0.0115	0.011 ± 0.005	0.37 ± 0.115	0.42 ± 0.12	−0.34 ± 0.485	220 ± 15
18 Mar 92	−0.008 ± 0.017			2.2 ± 0.15	−1 ± 1.4	−1.2 ± 1.3	100 ± 15
02 Jul 92	−0.008 ± 0.003	0.017 ± 0.0065	0.004 ± 0.004	0.78 ± 0.16	0.08 ± 0.125	0.07 ± 0.105	
			Well 525				
29 Nov 89	0.018 ± 0.012			0.32 ± 0.04	0.05 ± 0.135	0.08 ± 0.11	
22 Mar 90[c]	0.002 ± 0.014			0.19 ± 0.05	<0.35	<0.35	20 ± 17
13 Jun 90[c]	0.015 ± 0.02			0.11 ± 0.04	<0.55	<0.55	
29 Aug 90	−0.21 ± 0.04			−0.9 ± 0.9			
13 Nov 90	0.05 ± 0.065			0.17 ± 0.13	−0.06 ± 0.12	0.11 ± 0.105	2 ± 10
14 Mar 91	0.015 ± 0.022			0.18 ± 0.085	<0.1	0.067 ± 0.033	9 ± 16
05 Sep 91	0.02 ± 0.029	−0.01 ± 0.02	0.014 ± 0.021	0.15 ± 0.08	0.4 ± 1.35	0.2 ± 0.95	−30 ± 19
13 Dec 91	0.10 ± 0.055	0.017 ± 0.010	−0.013 ± 0.004	0.17 ± 0.095	0.8 ± 0.8	0.1 ± 0.75	
05 Mar 92	−0.008 ± 0.022			0.15 ± 0.09	0.2 ± 1.1	0.9 ± 1	−2 ± 12
15 Jun 92	0.023 ± 0.038	0.004 ± 0.006	0.000 ± 0.003	0.07 ± 0.105	0.1 ± 0.075	0.04 ± 0.085	

Table B.9 (continued)

Sample date	Gross alpha	^{241}Am	^{244}Cm	Gross beta[b]	^{60}Co	^{137}Cs	Tritium
			Well 708				
06 Dec 90	0.01 ± 0.02			0.1 ± 0.06	0.07 ± 0.105	0.15 ± 0.06	220 ± 20
22 Mar 91	0.022 ± 0.021	−0.002 ± 0.003	−0.002 ± 0.003	0.26 ± 0.07	<0.1	<0.1	120 ± 20
04 Sep 91	−0.043 ± 0.026	0.005 ± 0.003	0.00 ± 0.05	0.11 ± 0.09	0.7 ± 1.05	0.89 ± 0.415	−6 ± 19.5
16 Dec 91	0.005 ± 0.036	0.01 ± 0.006	**0.15** ± 0.015	0.26 ± 0.115	0.09 ± 0.38	0.15 ± 0.35	56 ± 13.5
11 Mar 92	−0.014 ± 0.004			0.01 ± 0.07	0.1 ± 0.8	0.2 ± 0.105	
24 Jun 92	0.044 ± 0.026	0.012 ± 0.009	**0.075** ± 0.013	0.15 ± 0.06	−0.01 ± 0.105	0.03 ± 0.08	
			Well 715				
15 Nov 90	0.026 ± 0.034			0.6 ± 0.12	−0.09 ± 0.17	−0.03 ± 0.14	10 ± 16.5
15 Mar 91	0.076 ± 0.039	0.008 ± 0.009	−0.004 ± 0.006	0.34 ± 0.075	<0.1	<0.1	42 ± 16.5
29 Aug 91	0.029 ± 0.034	0.002 ± 0.002	0.004 ± 0.003	0.19 ± 0.075	−2 ± 2.4	−0.8 ± 2.45	21 ± 20
10 Dec 91	0.024 ± 0.031	0.003 ± 0.011	0.003 ± 0.011	0.37 ± 0.11	0.4 ± 0.8	0.2 ± 0.8	
27 Feb 92	0.00 ± 0.02			0.17 ± 0.075	−0.7 ± 1.2	0.6 ± 1	26 ± 12.5
01 Jun 92	0.038 ± 0.027	0.006 ± 0.0145	0.005 ± 0.005	0.16 ± 0.065	0.17 ± 0.105	−0.17 ± 0.145	

Table B.9 (continued)

Sample date	Gross alpha	^{241}Am	^{244}Cm	Gross beta[b]	^{60}Co	^{137}Cs	Tritium
			Well 716				
06 Dec 90	0.04 ± 0.03			0.27 ± 0.08	0.11 ± 0.095	0.09 ± 0.1	−30 ± 17
22 Mar 91	0.026 ± 0.03			0.059 ± 0.01	<0.1	<0.1	−20 ± 15.5
04 Sep 91	0.15 ± 0.06	**0.067** ± 0.015	**0.039** ± 0.012	0.83 ± 0.115	0.8 ± 0.65	0.2 ± 1.35	−70 ± 37
16 Dec 91	0.52 ± 0.36	0.01 ± 0.007	**0.022** ± 0.005	1.1 ± 0.3	0.5 ± 0.7	−0.2 ± 0.8	
09 Mar 92	0.085 ± 0.048			0.66 ± 0.11	1.6 ± 0.9	0.1 ± 1.1	
24 Jun 92	0.09 ± 0.065	0.007 ± 0.0065	0.002 ± 0.004	0.28 ± 0.115	0.23 ± 0.05	0.04 ± 0.12	

[a] All results are in Becquerel/liter, mean ± standard counting error. Blanks indicate analysis not performed. Samples collected prior to October were acidified but not filtered. Samples collected beginning in October 1991 were filtered prior to acidification. Boldface indicates value exceeds action level.

[b] Gross beta analysis does not include tritium.

[c] Gross alpha/beta analyses were performed in Health and Safety Research Division counters after sample preparation in Environmental Sciences Division (ESD). Values for these analyses are typically lower than values from analyses performed in Analytical Chemistry Division. Gamma scans were performed in the ESD counting room.

Table B.10. Radionuclide concentrations in SWSA 5 North seeps from March 1990 through July 1992[a]

Sample date	Gross alpha	^{241}Am	^{244}Cm	Gross beta[b]	^{60}Co	^{137}Cs	Tritium
			5NN 01				
07 Mar 90[c]	−0.004 ± 0.026			0.14 ± 0.05	<2.5	<2.5	52 ± 17.5
26 Jun 90[c]	0.02 ± 0.03			0.23 ± 0.05	<2.5	<2.5	
12 Nov 90	0.05 ± 0.12			0.07 ± 0.13	−0.01 ± 0.21	0.01 ± 0.21	
16 Apr 91	0.014 ± 0.021			0.26 ± 0.07	<0.1	<0.1	
12 Dec 91	0.14 ± 0.045	0.001 ± 0.007	**0.028** ± 0.0095	0.28 ± 0.09	−0.02 ± 0.06	−0.01 ± 0.06	
29 Apr 92	0.19 ± 0.05	0.013 ± 0.012	**0.13** ± 0.02	1.8 ± 0.15	0.01 ± 0.09	0.03 ± 0.075	
28 Jul 92	0.02 ± 0.035	**0.01** ± 0.004	0.005 ± 0.0035	0.63 ± 0.12	−0.08 ± 0.2	0.03 ± 0.175	
			5NS 02				
07 Mar 90[c]	3.93 ± 0.5			**3.45** ± 0.29	<2.5	<2.5	970 ± 30
12 Nov 90	2.6 ± 0.6	0.038 ± 0.04	−0.028 ± 0.015	**2.1** ± 0.5	−0.02 ± 0.27	0.08 ± 0.22	760 ± 50
16 Apr 91	0.54 ± 0.6			0.76 ± 0.095	<0.1	<0.1	
12 Dec 91	13 ± 0.5	−0.001 ± 0.0065	−0.01 ± 0.006	**16** ± 0.5	−0.03 ± 0.16	0.02 ± 0.145	
29 Apr 92	6.8 ± 0.3	−0.08 ± 0.345	0.14 ± 0.16	**8.8** ± 0.25	−0.01 ± 0.125	0.11 ± 0.08	
28 Jul 92	1.0 ± 0.1	0.047 ± 0.0375	−0.011 ± 0.0185	1.5 ± 0.15	−0.01 ± 0.12	0.05 ± 0.095	
			5NW 01				
07 Mar 90[c]	0.11 ± 0.12			0.58 ± 0.14	<2.5	<2.5	610 ± 25
19 Dec 90	0.17 ± 0.09			0.27 ± 0.12	<0.5	<0.5	
15 Jan 91	0.07 ± 0.09			0.31 ± 0.23	−0.03 ± 0.31	−0.01 ± 0.3	39 ± 17.5
16 Apr 91					<0.1	<0.1	
12 Dec 91	0.067 ± 0.034	−0.002 ± 0.0065	**0.018** ± 0.008	0.16 ± 0.07	0.11 ± 0.215	0.08 ± 0.215	

Table B.10 (continued)

Sample date	Gross alpha	^{241}Am	^{244}Cm	Gross beta[b]	^{60}Co	^{137}Cs	Tritium
			5NW 02				
07 Mar 90[c]	0.04 ± 0.11			0.11 ± 0.1	<2.5	<2.5	350 ± 20
19 Dec 90	0.12 ± 0.08			0.4 ± 0.14	<0.5	0.126 ± 0.119	
15 Jan 91	−0.02 ± 0.01			0.02 ± 0.16	0.23 ± 0.27	0.11 ± 0.45	220 ± 20
16 Apr 91					<0.1	<0.1	
12 Dec 91	0.12 ± 0.04	0.008 ± 0.065	−0.006 ± 0.005	0.12 ± 0.065	0.06 ± 0.13	−0.04 ± 0.13	
29 Apr 92	0.044 ± 0.042	0.046 ± 0.016	−0.011 ± 0.01	0.11 ± 0.1	0.02 ± 0.085	0.29 ± 0.055	
28 Jul 92	0.05 ± 0.029	0.008 ± 0.008	−0.007 ± 0.003	0.14 ± 0.06	0.02 ± 0.225	−0.08 ± 0.25	
			WOC 160				
19 Dec 90	0.12 ± 0.08			0.47 ± 0.14	<0.5	<0.5	
15 Jan 91	0.03 ± 0.07			0.12 ± 0.2	0.40 ± 0.27	0.8 ± 2.5	170 ± 20
16 Apr 91					<0.1	<0.1	
09 Sep 91[d]	0.34 ± 0.095	0.056 ± 0.036	−0.009 ± 0.021	1.5 ± 0.2	0.30 ± 0.85	0.10 ± 0.60	
09 Sep 91[d]	0.45 ± 0.11	−0.011 ± 0.023	−0.025 ± 0.011	1.5 ± 0.2	1.3 ± 0.7	−0.10 ± 1.35	
12 Dec 91	0.14 ± 0.045	0.001 ± 0.007	0.028 ± 0.0095	0.28 ± 0.075	0.21 ± 0.135	0.04 ± 0.155	
29 Apr 92	0.19 ± 0.05	0.013 ± 0.012	0.13 ± 0.02	0.35 ± 0.105	0.2 ± 0.55	0.50 ± 0.50	
28 Jul 92	0.02 ± 0.035	0.01 ± 0.004	0.005 ± 0.0035	0.6 ± 0.125	0.08 ± 0.085	−0.06 ± 0.10	
			WOC 175				
19 Dec 90	0.09 ± 0.07			0.8 ± 0.18	<0.5	<0.5	
15 Jan 91	−0.01 ± 0.05			0.25 ± 0.19	0.19 ± 0.59	0.12 ± 0.62	200 ± 20
16 Apr 91					<0.3	<0.1	
12 Dec 91	0.15 ± 0.045	−0.002 ± 0.012	−0.002 ± 0.004	0.29 ± 0.08	0.03 ± 0.135	0.15 ± 0.09	
29 Apr 92	0.073 ± 0.048	0.002 ± 0.01	0.009 ± 0.006	0.34 ± 0.105	−0.04 ± 0.13	−0.01 ± 0.115	

Table B.10 (continued)

Sample date	Gross alpha	^{241}Am	^{244}Cm	Gross beta[b]	^{60}Co	^{137}Cs	Tritium
			WOC 255				
19 Dec 90	0.27 ± 0.11			0.31 ± 0.13	<0.5	<0.5	
15 Jan 91	0.99 ± 0.31	0.04 ± 0.06	**0.79** ± 0.18	0.06 ± 0.17	0.01 ± 0.15	0.03 ± 0.13	33 ± 17.5
16 Apr 91					<0.1	<0.1	
09 Sep 91[d]	0.31 ± 0.09	0.011 ± 0.031	−0.004 ± 0.032	0.49 ± 0.145	0.10 ± 1	0.80 ± 0.75	
09 Sep 91[d]	0.32 ± 0.095	−0.001 ± 0.023	**0.084** ± 0.032	0.22 ± 0.135	−0.20 ± 1.15	−0.10 ± 1.05	
12 Dec 91	0.32 ± 0.065	0.009 ± 0.005	**0.18** ± 0.02	0.25 ± 0.07	−0.04 ± 0.1	0.01 ± 0.1	
29 Apr 92	0.35 ± 0.09	−0.03 ± 0.05	**0.32** ± 0.055	0.26 ± 0.11	−0.02 ± 0.185	0.12 ± 0.16	
28 Jul 92	0.17 ± 0.07	0.01 ± 0.014	0.22 ± 0.03	0.21 ± 0.095	0.09 ± 0.23	0.10 ± 0.175	

[a] All results are in Becquerel/liter, mean ± standard counting error. Blanks indicate analysis not performed. Samples collected prior to October were acidified but not filtered. Samples collected beginning in October 1991 were filtered prior to acidification. Boldface indicates value exceeds action level.

[b] Gross beta analysis does not include tritium.

[c] Gross alpha/beta analyses were performed in Health and Safety Research Division counters after sample preparation in Environmental Sciences Division (ESD). Values for these analyses are typically lower than values from analyses performed in Analytical Chemistry Division. Gamma scans were performed in the ESD counting room.

[d] Duplicate samples.

APPENDIX C:

ASEMP-RELATED FINDINGS OF DOE SURVEILLANCE IN SWSA 5 NORTH

MARTIN MARIETTA

Internal Correspondence

MARTIN MARIETTA ENERGY SYSTEMS, INC.

April 22, 1992

D. F. Hall

Response to DOE Surveillance of Solid Waste Operations at ORNL

I have reviewed the draft report from DOE on the subject surveillance. Following are responses to the ASEMP[1] deficiencies noted in section 3.1.9 of the draft report.

EOA-92-03-18-B: No gross alpha or beta action levels are used for certain operational samples.

> This deficiency primarily concerns operational samples collected by Soild Waste Operations personnel from sumps in four buildings at SWSA 5 North. It is my understanding that you will address the deficiencies associated with those samples. However, the discussion following this deficiency also includes a misinterpretation by the surveillance team of the ASEMP action levels for SWSA 5 North—specifically the lack of an action level for gross alpha contamination. As discussed in the ASEMP program plan (ORNL/M-1793) and the ASEMP action level report (ORNL/M-1569), no gross alpha action level was established for SWSA 5 North because we no longer use gross alpha as a screening tool for SWSA 5 North. The gross alpha analysis is not sufficiently sensitive to detect the presence of transuranic isotopes (i.e., ^{241}Am and ^{244}Cm) at concentrations that are found in some SWSA 5 North samples (e.g., <0.1 Bq/L). All ASEMP samples are now analyzed for ^{241}Am and ^{244}Cm, and the presence of these isotopes above detection limits is used as a screen to determine whether further action is required.

EOA-92-03-18-D: The logbooks for groundwater and surface water sampling activities are not formally controlled.

> The original program plan did not require that field notebooks be formally controlled. The current revision of the plan, which was issued in February 1992, includes a requirement for formal control of all technical notebooks. Notebooks in current use are officially registered through Laboratory Records and are maintained in accordance with ESD and ORNL procedures.

EOA-92-03-18-E: Numerous Groundwater Monitoring Summary Sheets did not include required and essential data.

> See response to EQA-92-03-18-H.

[1] ASEMP = Active Sites Environmental Monitoring Program.

EQA-92-03-18-F: Operational monitoring wells are not being purged as required.

Our purging procedure requires that most SWSA 5 North wells be pumped dry, allowed to recover overnight, and sampled the following day. This deficiency refers to those few wells that are sufficiently productive that they cannot be pumped dry. One to three well volumes should be purged from these wells, depending upon how long it takes to stabilize the parameters of temperature, pH, and conductivity; sampling should occur immediately after purging. For the most recent quarterly sampling, this procedure was not followed by the field technician, and the wells were sampled the day following purging. It is unlikely that this problem will adversely affect the quality of the data from these wells, but we will note the nonconformance when reporting the data.

The training program identified in the response to EQA-92-03-18-H will address this issue. Routine surveillances by the program manager, as identified in the most recent draft of the program QA plan, will also be used to ensure that procedures are followed.

EQA-92-03-18-G: The identification of the sampler is not documented on the groundwater data sheets or the field logbooks.

See response to EQA-92-03-18-H.

EQA-92-03-18-H: The review system for ASEP [*sic*] data is inadequate.

This deficiency reflects the nature of the technical notebooks in use prior to the latest revision of the program plan. At the time of the original plan, the ASEMP was viewed as an operational monitoring program with little requirement for the rigorous data control typical of compliance monitoring. To a large extent, we still view the program in that light, and the current QA plan, which carries a QA level designation of III, reflects that approach. Nevertheless, we recognize that greater control over the acquisition and recording of data is necessary, and the current program plan and the most recent draft of the QA plan both address this issue.

A training program for all ASEMP staff will be conducted during the third quarter of FY 1992. This training will include all procedural requirements of the program plan and all aspects of the QA plan. In addition, the the most recent draft of the QA plan includes surveillances by the program manager of all sampling activities.

I hope that these responses adequately address the issues raised by the surveillance team. We appreciate the surveillance team's efforts because they helped us identify areas where improvement is needed. Please call me if you have any questions.

Tom L. Ashwood

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