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Statement of Basis Approval of No Further Action Volume 23 of 30 January 2000, Solid Waste Management Unit 10, Operable Unit 1333, Round 11

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Sandia National Laboratories

**Statement of Basis
Approval of No Further Action
Volume 23 of 30**

January 2000

**Solid Waste Management Unit 10
Operable Unit 1333
Round 11**

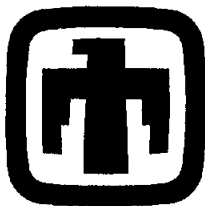
(RCRA Permit No. NM5890110518)

NFA Originally Submitted September 15, 1998 (Chapter 3)
RSI Originally Submitted September 1999

**Environmental
Restoration
Project**



**United States Department of Energy
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3.0 SOLID WASTE MANAGEMENT UNIT 10, BURIAL MOUNDS

3.1 Summary

Sandia National Laboratories/New Mexico (SNL/NM) is proposing a risk-based no further action (NFA) decision for Solid Waste Management Unit (SWMU) 10, Burial Mounds, Operable Unit (OU) 1333. SWMU 10 is an inactive site comprised primarily of soil/debris from construction of bunkers at SWMU 60, from grading operations performed to maintain access to the site, and from salvage operations conducted after explosives testing activities. Primary sources of constituents of concern (COC) for SWMU 10 were depleted uranium (DU), high explosives (HE), and metals associated with accidental detonation of two mock weapons. Other tests conducted at the site may have contributed to contamination at SWMU 10 also, but specific details regarding those tests are unknown. Analytical results indicated that no residual HE compounds are present in the soil/debris mounds or surrounding surface soils (see Section 3.4.4.3). A radiological voluntary corrective measure (VCM) was conducted in 1996 to remove radiological anomalies associated with the soil/debris mounds. A voluntary corrective action (VCA) was conducted in 1998 to remove the vermiculite mound.

Review and analysis of all relevant data indicate that concentrations of COCs at this SWMU are less than applicable risk assessment action levels. Thus, SWMU 10 is being proposed for an NFA decision based upon confirmatory sampling data demonstrating that COCs that may have been released from this SWMU into the environment pose an acceptable level of risk under current and projected future land use, as set forth by Criterion 5 which states, "The SWMU/AOC [area of concern] has been characterized or remediated in accordance with current applicable state or federal regulations, and the available data indicate that contaminants pose an acceptable level of risk under current and projected future land use" (NMED March 1998).

3.2 Description and Operational History

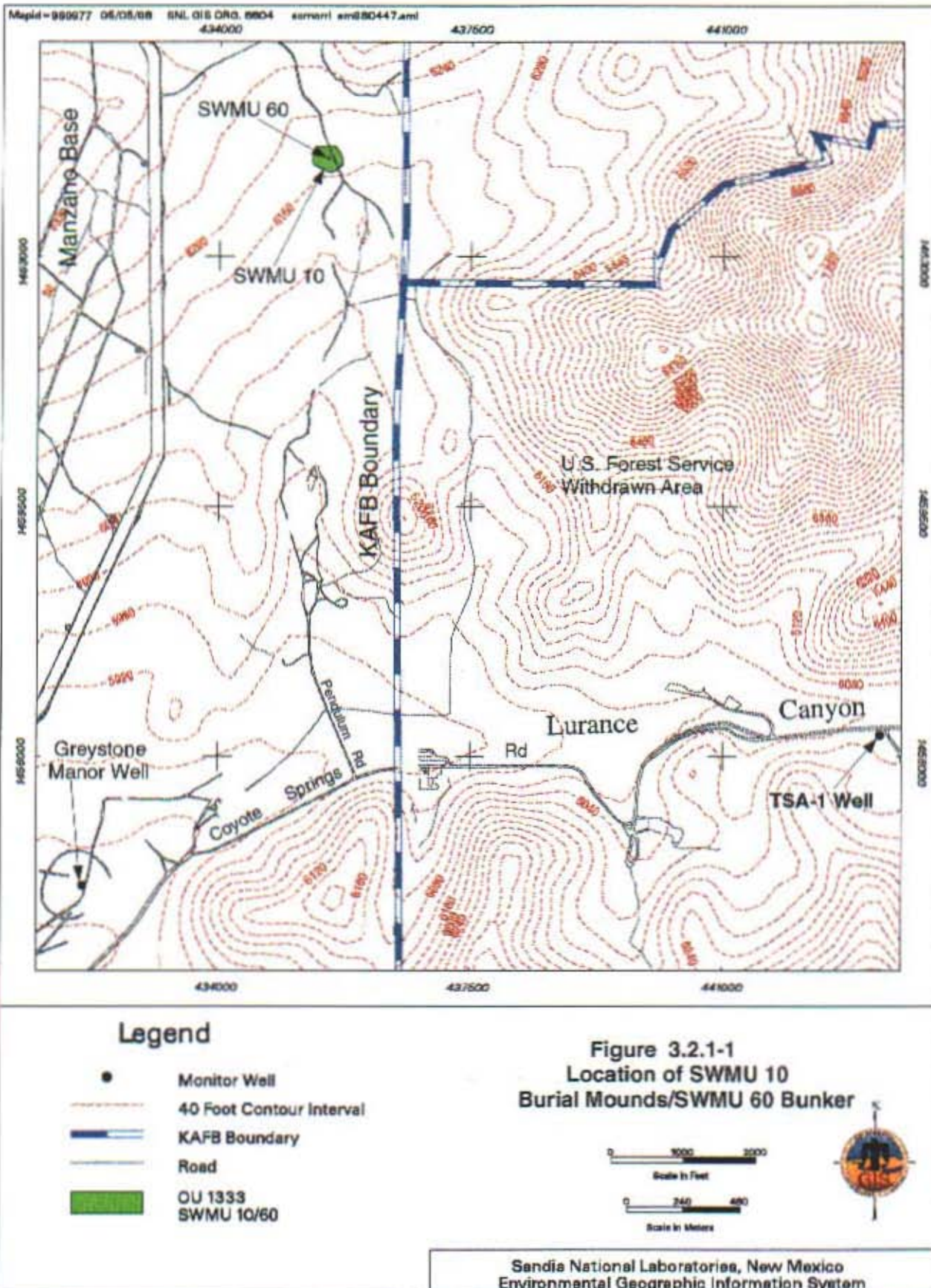
Section 3.2 describes SWMU 10 and discusses its operational history.

3.2.1 Site Description

SWMU 10 (Figure 3.2.1-1) is associated with SWMU 60 and is located near the northeastern corner of Kirtland Air Force Base (KAFB), on federally owned land controlled by KAFB (SNL/NM July 1994a). Access to the general area is by Coyote Springs Road to Pendulum Road and then approximately 1.5 miles north (Gaither Date [Unk]; Oldewage May 1993). The site lies on approximately 2.9 acres at a mean elevation of 6,175 feet above sea level (SNL/NM April 1995).

SWMU 10, Burial Mounds, inactive since the late 1970s, consists of nine soil/debris mounds, one former soil/debris mound removed in April 1996, and a former vermiculite mound removed in May 1998. The former soil/debris mound was removed in conjunction with a radiological

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VCM (Section 3.4.4). The former vermiculite mound was removed as solid waste in a VCA (Section 3.4.5). The site boundary was established based upon the fragmentation radius of DU fragments found in the initial surface gamma radiation survey conducted in October 1993 (RUST Geotech Inc. December 1994).

SWMU 10 lies on Tesajo-Millett stony sandy loams that are underlain by igneous and metamorphic Precambrian rocks (USDA June 1977). Immediate topographic relief around the site is approximately 50 feet (Figure 3.2.1-1). The nearest monitoring wells, the Graystone Manor and TSA-1 Wells, are located approximately 2.2 miles southwest and southeast of SWMU 10, respectively (Figure 3.2.1-1). Groundwater conditions at TSA-1 are probably more representative of conditions at SWMU 10, because SWMU 10 and TSA-1 are east of the Coyote Fault on thin alluvium deposits surrounded by Precambrian rocks (IT May 1994). At TSA-1 well, semiconfined to confined groundwater is encountered in fractured Precambrian bedrock at a depth of 180 feet below ground surface (bgs) (IT May 1994). Local groundwater flow in the vicinity of SWMU 10 may be complicated because of abundant fractures and faults in the area.

For a detailed discussion of the local setting and other information pertaining to SWMU 10, refer to the "RCRA [Resource Conservation and Recovery Act] Facility Investigation Work Plan for Operable Unit 1333, Canyons Test Area" (SNL/NM September 1995).

3.2.2 Operational History

The nine existing soil/debris mounds and one former soil/debris mound comprising SWMU 10 are designated 1 through 10 to simplify discussion in this NFA proposal, and these numbers have no historical basis. The former vermiculite mound, not given a numerical designation, was located directly south of Mound 4 (Wrightson September 1993). Some of the mounds have been removed or modified in conjunction with a radiological VCM and solid waste VCA. Mounds 1 through 7 and Mound 10 are located west of Pendulum Road and the SWMU 60 bunkers (Figure 3.2.2-1). Mounds 8 and 9 are located east of Pendulum Road (Figure 3.2.2-1). Table 3.2.2-1 provides a summary of the mounds and their original area/extent, modifications to the mounds during remediation, and the mounds final configuration.

When most of the mounds were constructed is unknown and cannot be determined through the available historical aerial photographs (SNL/NM August 1994). However, the majority of soil mounds were reportedly in place before January 4, 1979, when the Torch-Activated Burn System (TABS) experiment was conducted at the SWMU 60 control bunker (Kurowski January 1979, Larson August 1994, Larson and Palmieri August 1994a, Larson and Palmieri August 1994b). Interview records confirm that the non-TABS-related soil mounds (i.e., Mounds 1, 2, 4, 7, 8, 9, 10, and part of 6) were probably generated when the SWMU 60 bunkers were constructed and possibly during grading operations in the arroyo channel, which had been used as access to the site (Larson and Palmieri September 1994, Larson August 1994). Mounds 3 and 5 and the south end of Mound 6 consist of sifted material derived from salvage operations that had been conducted after the TABS test. It is believed that the former vermiculite mound west of the bunkers originated from radioactive tracer experiments (osmium-191) that had been conducted in a vermiculite pit prior to the 1979 TABS test (Wrightson September 1993). Interviews confirm that at the conclusion of the tests in the pit the vermiculite was screened by

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Table 3.2.2-1
Summary of Remedial Actions Conducted
On SWMU 10 Soil/Debris Mounds

SWMU 10 Mounds	Original Areal Extent (ft ²)	Remedial Actions Conducted	Present Mound Configurations	Present Areal Extent (ft ²)
Mound 1	680	None	No Change	680
Mound 2	1,298	None	No Change	1,298
Mound 3	979	Radiological VCM Conducted, Mound 3 Completely Dismantled and Radiological Anomalies Removed	Mound 3 Completely Removed, Two Post-VCM Clean Soil Residual Mounds Remain	497 (east) 164 (west)
Mound 4	539	Radiological VCM Conducted, Mound 4 Partially Dismantled and Discrete Radiological Anomalies Removed	Mound 4 and One Post-VCM Clean Soil Residual Mound Remain	274
Mound 5	325	Radiological VCM Conducted, Mound 5 Partially Dismantled and Discrete Radiological Anomalies Removed	Mound 5 and One Post-VCM Clean Soil Residual Mound Remain	142
Mound 6	2,446	Radiological VCM Conducted, Mound 6 Partially Dismantled and Radiological Anomalies Removed Throughout	Southern Portion of Mound 6 Removed. Northern Portion of Mound 6 and One Post-VCM Clean Soil Residual Mound Remain	1,109 (former Mound 6) 1,067 (clean residual)
Mound 7	1,007	None	No Change	1,007
Mound 8	568	None	No Change	568
Mound 9	2,836	None	No Change	2,836
Mound 10	1,013	None	No Change	1,013
Vermiculite Mound	1,070	Solid Waste VCA Conducted, Vermiculite Mound Completely Removed	No Pre- or Post-VCA Residuals from the Vermiculite Mound Remain	0

ft² = Square feet.

SWMU = Solid waste management unit.

VCA = Voluntary Corrective Action.

VCM = Voluntary Corrective Measure.

the shovelful and that no elevated radioactivity was detected (Wrightson September 1993). Part of the former vermiculite mound may have originated when bags of vermiculite were removed from storage in the supply bunker at SWMU 60 (Palmieri November 1994). SWMU 10 has been inactive since the late 1970s (EPA April 1987). Figure 3.2.2-2 presents the actual locations of the ten current and former soil/debris mounds and the former vermiculite mound.

The TABS test was conducted in the SWMU 60 control bunker to investigate the feasibility that remotely burning HE contained in nuclear weapons would not induce an explosion (Kurowski January 1979). However, two mock weapons containing HE, DU, and beryllium detonated (Kurowski January 1979), destroying the control bunker and scattering debris around SWMU 10. Mounds 3 and 5 and the south end of Mound 6 were produced from salvage operations that attempted to recover test materials, DU, and undetonated HE (Larson August 1994, Larson and Palmieri August 1994a). During a survey conducted by SNL/NM Industrial Hygiene and Radiation Protection Operation (RPO) personnel after the TABS test, DU fragments were removed and buried at the mixed waste landfill in Technical Area III (Larson August 1994).

Scrap metal and wood debris are associated with some of the non-TABS soil mounds. However, specific test activities that produced the debris are unknown. One interview record states that containment-type tests were conducted with short half-life radionuclides in the bunker (SWMU 60) north of the Pendulum Site (SWMU 59), and the mounds contain the remnants of these tests (Martz October 1985). Similarly, another interview record states that a test involving a radioactive osmium-191 tracer was conducted in the bunker (SWMU 60) near the Pendulum Site (SWMU 59) (Author [Unk] Date [Unk]a). A test engineer involved in the radioactive tracer experiments stated that osmium tetra oxide was the tracer compound used and that the test involved a vermiculite catch pit located about 100 feet southwest of the bunker (Wrightson September 1993). This implies that the tests were performed in the area of the vermiculite mound rather than in the bunkers (Figure 3.2.2-1). The test engineer also stated that the osmium-191 tracer had a half-life of about 16 days (half-life for osmium-191 is 15.4 days [GE 1989]). Details regarding the test setup and number of tests were not available.

3.3 Land Use

Section 3.3 discusses the current and future proposed land uses for SWMU 10.

3.3.1 Current

SWMU 10 is located within the boundaries of KAFB and is currently an inactive site (Figure 3.3.1-1).

3.3.2 Future/Proposed

SWMU 10 has been recommended for industrial land use in the future (DOE and USAF March 1996). However, the risk associated with SWMU 10 has also been assessed for residential land use because the site is in proximity to private housing developments (see Section 3.5.2.1).

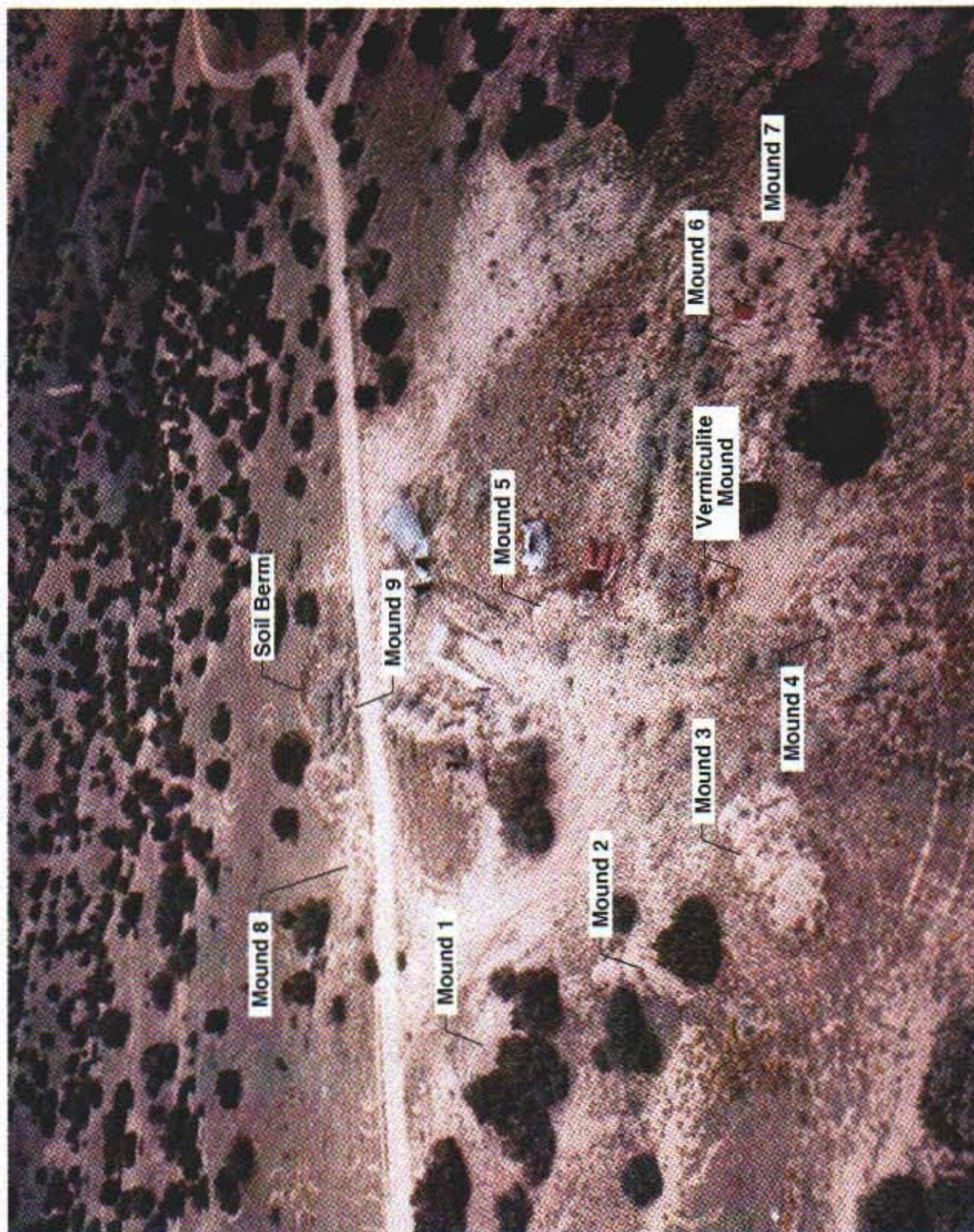
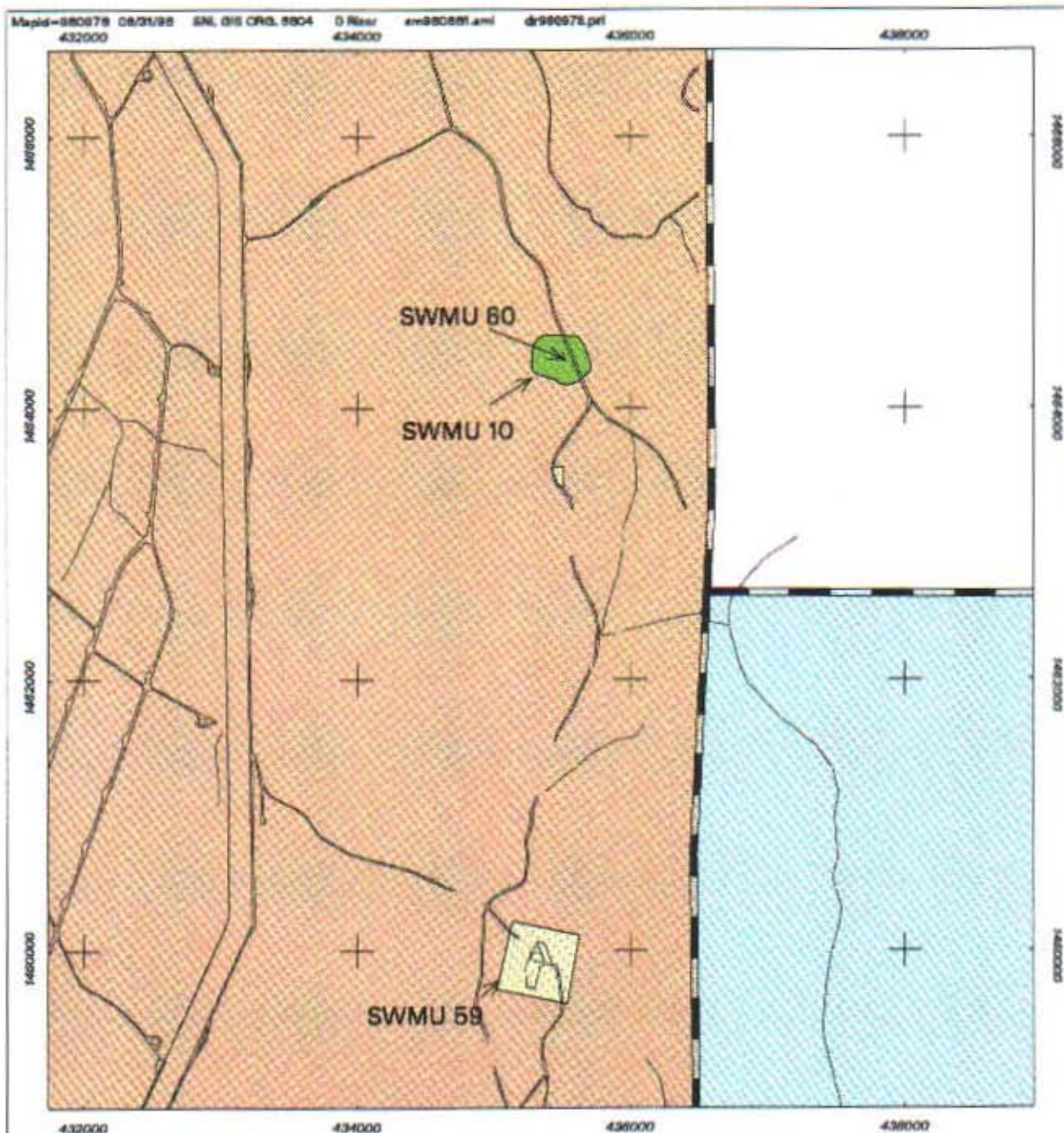


Figure 3.2.2-2 Actual locations of SWMU 10 burial mounds (Mound 10 not shown, located to the right of Mound 7).

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Legend

-  KAFB Boundary
-  Road
-  SWMU 10
-  Other SWMU Sites
-  Recreational Land Use
-  Industrial Land Use

Figure 3.3.1-1
Current Land Use
for SWMU 10



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

3.4 Investigatory Activities

SWMU 10 has been characterized and/or remediated in a series of four investigations and VCM/VCA activities. Section 3.4 discusses these activities.

3.4.1 Summary

SWMU 10 was investigated initially under the U.S. Department of Energy (DOE) Comprehensive Environmental Assessment and Response Program (CEARP) in the mid-1980s in conformance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The investigation included collecting nonsampling data and inspecting the site (Investigation #1). In 1989, preliminary investigations began that included unexploded ordnance (UXO)/HE, radiological, cultural-resources, and sensitive-species surveys and scoping sampling (Investigation #2). A radiological VCM was conducted, followed by confirmatory sampling (Investigation #3). A solid waste VCA was performed at the site to remove a vermiculite mound and was followed by confirmatory sampling (Investigation #4).

3.4.2 Investigation #1—Comprehensive Environmental Assessment and Response Program

3.4.2.1 *Nonsampling Data Collection*

SWMU 10 was first listed as a potential release site based upon the CEARP interviews in 1985. The CEARP Phase I draft report (DOE September 1987) stated that several burial mounds are located in the bunker area (SWMU 60) north of the Pendulum Site (SWMU 59). During the preliminary site investigation, it was observed that scrap metal and small pieces of shrapnel protruded from some of the mounds, that HE were on the surface, and that the mounds contained debris (such as DU, radioactive tracers [osmium-191], beryllium, lead, and/or HE) derived from various explosives testing activities (DOE September 1987).

3.4.2.2 *Sampling Data Collection*

No samples were collected at SWMU 10 during the CEARP.

3.4.2.3 *Data Gaps*

No confirmation samples were obtained during the CEARP to confirm whether hazardous materials or wastes were stored or released to the surrounding environment.

3.4.2.4 *Results and Conclusions*

The CERCLA finding under the CEARP was positive for Federal Facility Site Discovery and identification findings, preliminary assessment, and preliminary site investigation, but insufficient information was available to calculate a Hazard Ranking System score for the SWMU.

3.4.3 Investigation #2—SNL/ER Preliminary Investigations

3.4.3.1 *Nonsampling Data Collection*

This section describes the nonsampling investigation data collected at SWMU 10.

3.4.3.1.1 *Background Review*

A background review was conducted in order to collect available and relevant information regarding SWMU 10. Sources included interviews with SNL/NM staff and contractors familiar with the site's operational history and reviews of existing site records and reports. The study was documented completely and has provided traceable references that sustain the integrity of the NFA proposal. The following sources were used to assist in evaluating SWMU 10.

- Two SNL/NM technical reports on past site TABS testing activities (Kurowski January 1979, SNL/NM February 1979)
- Six historical aerial photographs spanning the years 1951 to 1992 (SNL/NM August 1994)
- Eight interviews with seven current and retired facility personnel (Martz October 1985, Larson and Palmieri September 1994, Larson August 1994, Brouillard June 1994, Larson and Palmieri August 1994a, Larson and Palmieri August 1994b, Palmieri November 1994, Wrightson September 1993)
- Photographs and field notes from numerous site inspections conducted by SNL/NM Environmental Restoration (ER) staff (Author [Unk] Date [Unk]b, Gaither January 1994, Gaither Date [Unk], Gaither November 1992, Author [Unk] Date [Unk]a, Author [Unk] Date [Unk]c, Gaither May 1992, Burton February 1987).

3.4.3.1.2 *UXO/HE Survey*

In September 1993, KAFB Explosive Ordnance Disposal personnel conducted a visual surface survey for UXO/HE on the ground surface of SWMUs 10 and 60. One live ground burst simulator was found and was removed in June 1994. The ordnance debris that were removed included twelve expended smoke grenades, two practice 40-millimeter grenades, three expended smoke pots, five empty White Star parachute containers, one empty homemade booby trap, one empty Molotov Cocktail, various pieces of unidentified rockets, and expended blank 7.6-mm and 5.6-mm ammunition (Young September 1994). It is believed that these materials are associated with KAFB war game operations.

3.4.3.1.3 Radiological Survey(s)

In addition to the DU removal activity after the TABS test in 1979, a 1989 radiation survey of SWMUs 10 and 60 conducted by SNL/NM RPO identified an area of radioactively-contaminated vermiculite. The radioactively-contaminated vermiculite was removed in 1989 and disposed of as radioactive waste. The remaining vermiculite mound was free of radioactive contamination (Gaither January 1994, Minnema and Tucker August 1989, Larson August 1994).

In May 1993, SNL/NM RPO conducted a radiation survey of the road leading to SWMU 10. Adhesive swipes that had been placed on the underside of the vehicle were analyzed and revealed no contamination, nor was airborne radioactivity detected in the dust kicked up by the vehicle (Oldewage May 1993).

In October 1993, RUST Geotech Inc. conducted a Phase I surface gamma radiation survey of SWMUs 10 and 60. The survey was conducted on 6-foot centers and covered 100 percent of the site. The areas of gamma activity greater than 30 percent above natural background (10 to 16 microrentgens per hour [$\mu\text{R/hr}$]) included the following (Figure 3.4.3-1) (SNL/NM September 1997):

- 31 point source and small area source anomalies
- 21 randomly-located soil area source anomalies

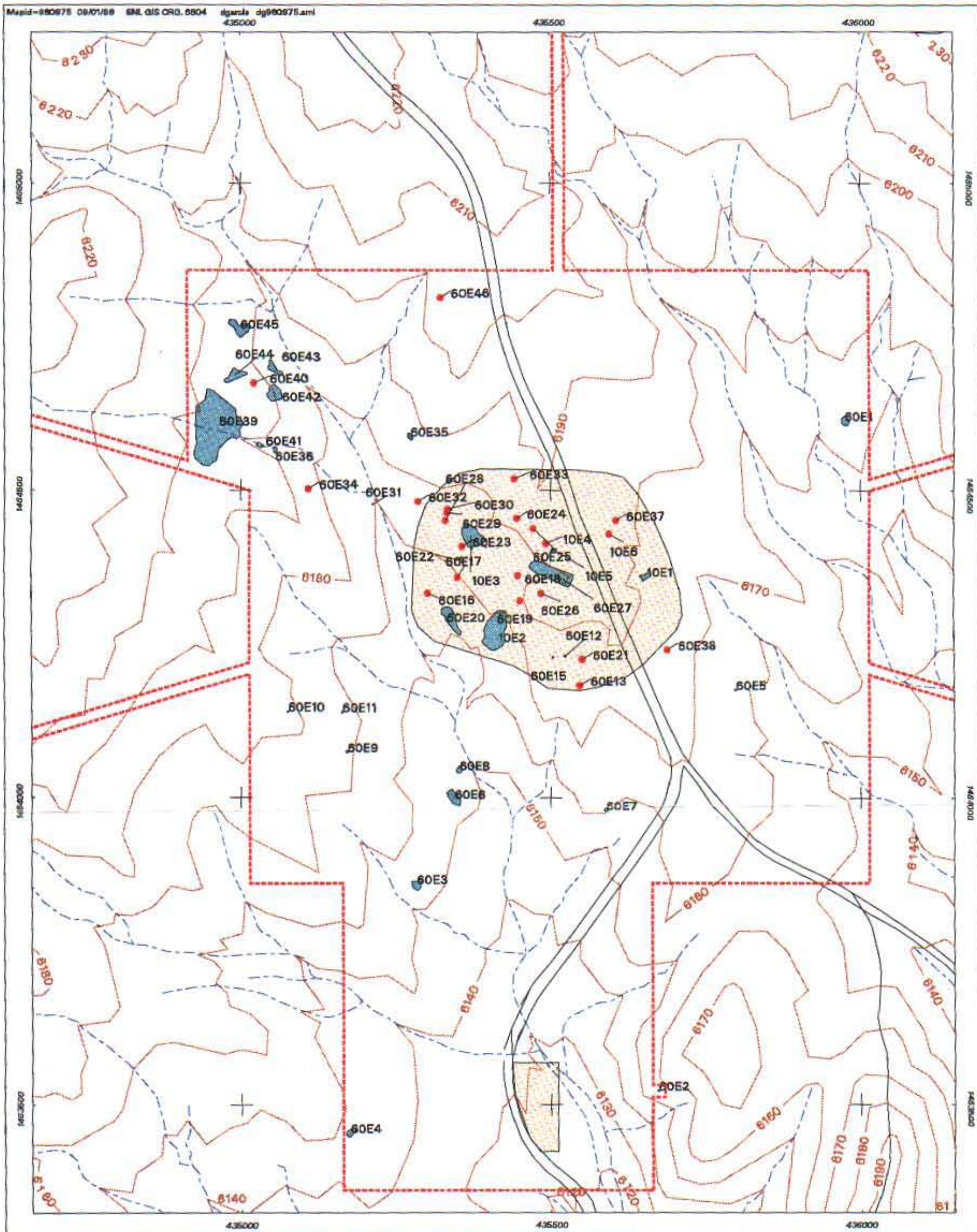
In February 1994, SNL/NM RPO personnel conducted a follow-up beta-gamma radiation survey at SWMUs 10 and 60 (SNL/NM September 1995). None of the measured swipe-sampled anomalies yielded removable contamination above the action levels detailed in DOE Order 5400.1, "General Environmental Protection Program," nor were radiation levels greater than 5 $\mu\text{R/hr}$ at a distance of 1 foot. It is suspected that RUST Geotech anomalies 60E36, 60E39, 60E41, 60E42, 60E43, 60E44, and 60E45, identified in the Phase I survey, resulted from bedrock outcrops of granitic composition (Oldewage February 1994).

The anomalies were analyzed using gamma spectroscopy in March 1995, both in situ and at an off-site laboratory to determine whether they represented natural background or were the result of scattered DU. It was determined that the only DU anomalies within the SWMU 10 boundaries were in Mounds 3 and 6; the radioactive area seen in Mound 7 and other anomalies were of natural origin (i.e., the natural rock and soil types). The anthropogenic anomalies were removed during the VCM conducted in April 1996 (see Section 3.4.4.2.1).

3.4.3.1.4 Cultural-Resources Survey

A cultural-resources survey was conducted as part of the site assessment. One archeological site was identified north of SWMU 10, outside of the site boundary (Hoagland and Dello-Russo February 1995).

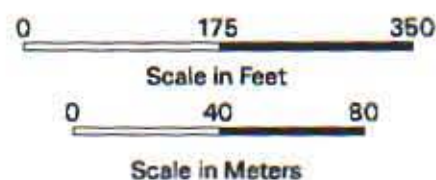
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Legend

- 60E10 Point Source Radiation Anomaly
- 10 Ft Contour
- Road
- Surface Drainage
- Survey Boundary
- SWMU 10/60
- Area Source Radiation Anomaly

Figure 3.4.3-1
Phase I Surface Radiation Survey at
SWMU 10, Burial Mounds



3.4.3.1.5 Sensitive-Species Survey

The site was surveyed for sensitive species on April 26 and May 24, 1994, using parallel transects spaced 100 feet apart (IT February 1995). The area is within piñon-juniper woodland vegetation, with an understory dominated by blue grama. The terrain is rolling, and the soil is coarse to rocky. A small but vigorous population of visnagita cacti was found on a low hill in the southeastern quarter of SWMU 10 near its outer boundary. A single Wright's pincushion cactus was found in the northeastern quarter of the survey area outside of the site boundary.

3.4.3.1.6 Geophysical Survey(s)

No geophysical surveys were performed at SWMU 10.

3.4.3.2 Sampling Data Collection

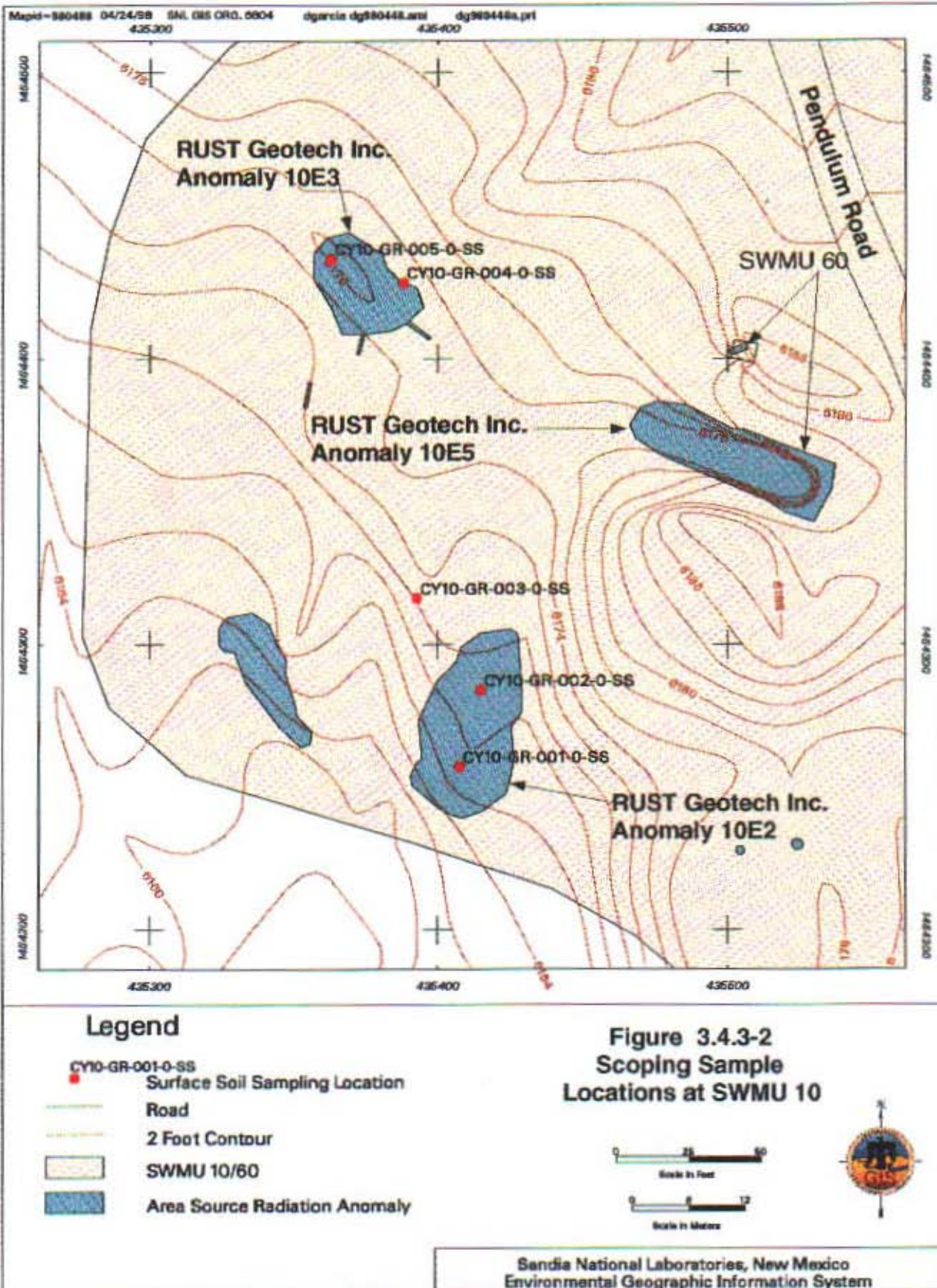
Scoping samples were collected in March 1995 and around SWMU 10 to determine whether radiological anomaly areas also contained RCRA-regulated hazardous constituents (e.g., metals, explosives compounds, etc.). Eight soil samples were collected: four from inside the site boundaries, and four from just outside the boundaries to serve as background samples. Semiquantitative results were produced using x-ray fluorescence and direct current plasma for metals and HE and using gamma spectroscopy for radiological constituents. Gamma spectroscopy revealed elevated anthropogenic radionuclides from four samples from within the site boundary, which were identified for removal during the VCM.

A follow-up scoping sampling was conducted in August 1995, to verify possible metals contamination indicated by the semiquantitative results obtained during the initial scoping sampling effort. Five samples were collected from Mounds 3 and 6 and were analyzed off site for metals and HE compounds using SNL/NM sample collection procedures. Figure 3.4.3-2 shows the follow-up scoping sample locations. Lockheed Analytical Services (LAS) of Las Vegas, Nevada, analyzed the samples for RCRA metals plus beryllium (using EPA Methods 6010/7000 [EPA November 1986]), and for HE (using EPA Method 8330 [EPA November 1986]). No quality assurance (QA)/quality control (QC) samples were collected.

3.4.3.3 Data Gaps

Information gathered from process knowledge, site files, and personal interviews aided in identifying the most likely COCs, the most likely locations of potential COC releases, and the types of analyses to be performed on soil samples. Radiological surveys and scoping sampling further defined the location and extent of contamination that exists at SWMU 10. However, because the need to remove elevated concentrations of radiological contamination was identified, residual contamination levels that would remain after such cleanup activities could not be defined.

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3.4.3.4 *Results and Conclusions*

Table 3.4.3-1 summarizes the off-site metals and HE analysis results for the five surface soil samples collected from Mounds 3 and 6 during follow-up scoping sampling at SWMU 10. Arsenic, barium, and lead were not detected above background concentrations. Mercury, selenium, and silver were not detected above their respective method detection limits (MDL). Beryllium concentrations were significantly elevated above background in both mounds. In addition, cadmium and chromium concentrations were detected above background in both mounds. No HE compounds were detected above practical quantitation limits.

Data Validation

The SNL/NM Sample Management Office reviewed and verified/validated all scoping sampling laboratory results as set forth by "Data Verification/Validation Level 2—DV-2" in Attachment B of Technical Operating Procedure 94-03, Rev. 0 (SNL/NM July 1994b). The verification/validation process confirmed that the data are acceptable for use in this NFA proposal for SWMU 10.

3.4.4 Investigation #3—SNL/NM ER Project Voluntary Corrective Measure and Confirmatory Sampling

3.4.4.1 *Nonsampling Data Collection*

There were no nonsampling data collection activities associated with the VCM and confirmatory sampling at SWMU 10.

3.4.4.2 *Sampling Data Collection*

A VCM was performed in April 1996 to remove all remaining area source gamma radiation anomalies occurring in the soil/debris mounds at SWMU 10. Confirmatory soil sampling was conducted following the VCM to confirm that no RCRA metals (plus beryllium), HE, or gamma-emitting radionuclides remained at the site at concentrations that might pose a level of risk under current and projected future land use.

3.4.4.2.1 *Voluntary Corrective Measures Activities*

Because there were recorded radiation area source anomalies at SWMU 10 that were not addressed during the initial Phase I radiological survey and cleanup (Section 3.4.3.1.3), SNL/NM executed a VCM to remove and dispose of the anomalies. The VCM, conducted in

Table 3.4.3-1
Summary of SWMU 10 Scoping Soil Sampling Metals and HE Analytical Results, August 1995
(Off-site laboratory only)

Sample Attributes			Metals (EPA Methods 6010/7000) ^a (mg/kg)									HE (EPA 8330) ^a (µg/g)
Record Number ^b	ER Sample ID (Figure 3.4.3-2)	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver	
03951	CY10-GR-001-0-SS (Mound 6)	0-0.5	3.7	140	5.1^c	1.2	28	12	ND (0.10) N	ND (0.98)	ND (2.0)	ND (0.25-2.2)
03951	CY10-GR-002-0-SS (Mound 6)	0-0.5	3.8	140	2.1	ND (0.99)	19	11	ND (0.10) N	ND (0.99)	ND (2.0)	ND (0.25-2.2)
03951	CY10-GR-003-0-SS (Mound 6)	0-0.5	3.9	130	1.0	ND (1.0)	13	8.1	ND (0.10) N	ND (1.0)	ND (2.0)	ND (0.25-2.2)
03951	CY10-GR-004-0-SS (Mound 3)	0-0.5	2.8	100	13.0	1.9	29	13	ND (0.10) N	ND (1.0)	ND (2.0)	ND (0.25-2.2)
03951	CY10-GR-005-0-SS (Mound 3)	0-0.5	3.8	170	5.2	1.3	31	12	ND (0.10) N	ND (0.99)	ND (2.0)	ND (0.25-2.2)
SNL/NM Canyons Soil Background 95th UTL or 95th-Percentile Concentrations ^d			9.8	246	0.75	0.64	18.8	18.9	0.055	3.0	<0.5	NA

^aEPA November 1986.

^bAnalysis request/chain-of-custody record.

^cValues in bold exceed background soil concentrations.

^dFrom Zamorski December 1997.

CY = Canyon.

EPA = U.S. Environmental Protection Agency.

ER = Environmental restoration.

ft = Foot (feet).

GR = Grab sample.

HE = High explosives.

ID = Identification.

µg/g = Microgram(s) per gram.

mg/kg = Milligram(s) per kilogram.

N = Matrix spike recovery exceeded acceptance limits.

NA = Not applicable.

ND () = Not detected at or above the project reporting limit for metals (shown in parenthesis) or the practical quantitation limit for HE (range shown in parenthesis).

SNL/NM = Sandia National Laboratories, New Mexico.

SS = Surface soil sample.

SWMU = Solid waste management unit.

UTL = Upper tolerance limit.

April 1996, involved trenching through all of the soil/debris mounds (except Mound 9), screening for radiological anomalies, and removing radioactive fragments and soil as necessary.

It had been shown during previous SWMU 10 radiation surveys (see Section 3.4.3.1.3) that Mounds 1, 2, 7, 8, and 10 have no anomalous radioactive surface contamination. However, during the VCM these mounds were investigated to confirm that no radioactive materials existed beneath the surface. Trenches were excavated through the mounds and the sidewalls and floor, and the areas were scanned for elevated radiation. It was verified that each of these mounds have no radioactive anomalies.

It had also been demonstrated during previous SWMU 10 radiation surveys (see Section 3.4.3.1.3) that Mounds 3 and 6 contained radioactive anomalies. In addition, it was discovered that two other mounds (Mounds 4 and 5) originally thought to have been free of radioactive material did contain radioactive anomalies. All four of these mounds were dissected by trenching, and the excavated materials were systematically screened for radioactive materials (i.e., material that exceeded 1.3 times background radiation readings). The radioactive materials (fragments and soil) were placed into 55-gallon drums for off-site disposal. The segregated clean soil was placed into *clean residual mounds* (Figures 3.4.4-1a and b). SNL/NM Department 7577 (Waste Operations) personnel handled and packaged these materials and secured the waste containers for transport and disposal at Envirocare of Utah (SNL/NM September 1997). A total of one hundred 55-gallon drums and one 30-gallon drum of contaminated soil and two 30-gallon drums of metals fragments were generated during the VCM (SNL/NM September 1997). Only clean soil (gamma radiation reading less than 1.3 times background) was left on site.

Although, because of its large extent and because it was not shown to contain radioactive anomalies, Mound 9 was not trenched during the course of the VCM. It was trenched through the interior to native soil in 3 locations during the subsequent confirmatory sampling investigation conducted in April 1997 (Section 3.4.4.2.2). The results of the VCM are summarized in the report entitled "Final Report, Survey and Removal of Radioactive Surface Contamination at Environmental Restoration Sites, Sandia National Laboratories/New Mexico" (SNL/NM September 1997).

3.4.4.2.2 *Confirmatory Sampling*

SNL/NM conducted confirmatory soil sampling between April and August 1997 to determine whether potential COCs were present at levels exceeding background limits at the site and/or were sufficient to pose a level of risk under current and projected future land uses. The confirmatory soil sampling program was performed in accordance with the rationale and procedures described in the "Sampling and Analysis Plan [SAP] for SWMU 10, Burial Mounds" (SNL/NM January 1997) and in the document of understanding related to the sampling (NMED DOE OB April 1997). Both of these documents were developed in close consultation with New Mexico Environment Department (NMED) DOE Oversight Bureau personnel. All mounds were trenched in multiple locations to the undisturbed soil surface. All samples were grab samples collected using a stainless steel bowl and scoop or trowel, in accordance with ER Field Operating Procedure 94-52 (SNL/NM January 1995). For all sampling activities that included a

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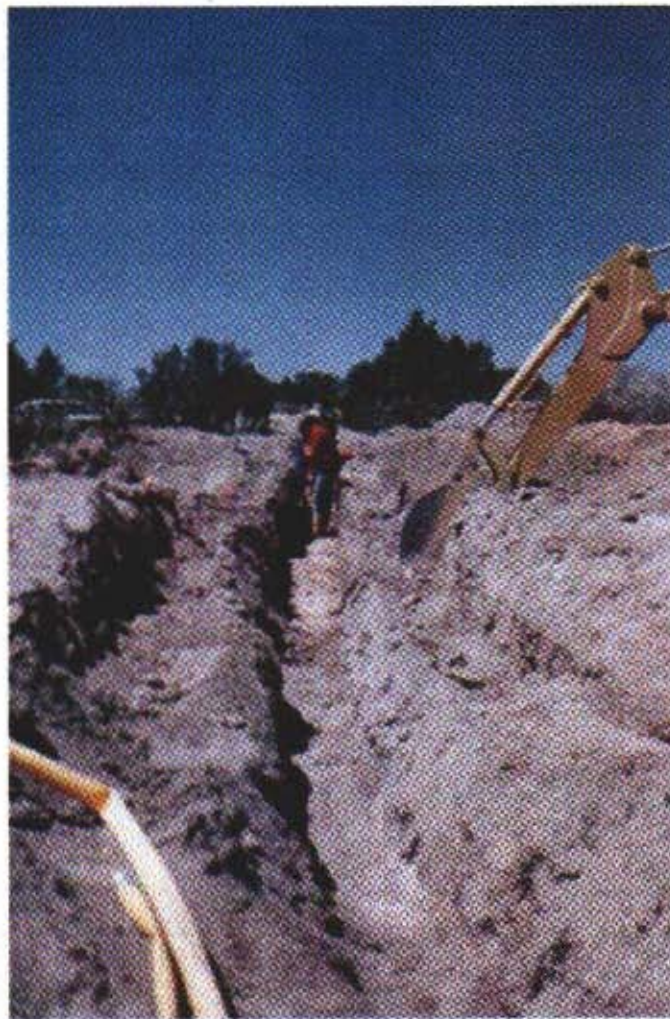


Figure 3.4.4-1a. Longitudinal trench through Mound 6 (north view).



Figure 3.4.4-1b. Layout pad for spreading and screening material from Mound 5 (north view).

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combination of judgmental and random sampling, SNL/NM adhered to the SAP with only minor modification in the field.

The number of trenches excavated at each soil debris mound ranged from one to three depending upon the soil/debris mound size and material consistency. Trench soil samples were collected from the middle of each sidewall and trench bottom beneath the soil/debris mound and native soil interface. Judgmental soil samples were collected from adjacent arroyos (sediment storage areas) and from trenches excavated through the mounds; random samples were collected from the surface in a radial grid pattern representing the fragmentation radius at the point of weapons detonation. Figure 3.4.4-2 shows both the confirmatory sample collection locations in the mounds and the radial grid. Figure 3.4.4-3 shows the confirmatory sample collection locations in the arroyos.

Fifty samples were collected from the mounds at depths of approximately 1 to 2 feet from the top and 1 foot below the bottom of the mound. Seven samples were collected from the arroyos at a depth of 0.5-foot bgs. Seventeen near-surface samples were collected from the radial grid at a depth of 0.5-foot bgs. SNL/NM followed analysis request/chain-of-custody (AR/COC) and sample documentation procedures for all samples collected. All samples were analyzed on site for RCRA metals plus beryllium, HE, and gamma-emitting radionuclides. SNL/NM Department 6684 (ER Chemistry Laboratory) analyzed the samples on site for RCRA metals plus beryllium using EPA Method 6020 (EPA November 1986) and for HE using a micellar electrokinetic chromatograph. SNL/NM Department 7713 (Radiation Protection Sample Diagnostics Laboratory) analyzed the samples on site for radionuclides using gamma spectroscopy. SNL/NM on-site laboratories analyzed QA/QC samples (rinsates and duplicates), which were collected at the rate of 1 in 10. In addition, approximately 15 percent of the samples were split for analysis at an off-site laboratory, including duplicate soil sample analyses. LAS of Las Vegas, Nevada, analyzed the samples for RCRA metals plus beryllium using EPA Method 6010/7000 and for HE using EPA Method 8330 (EPA November 1986).

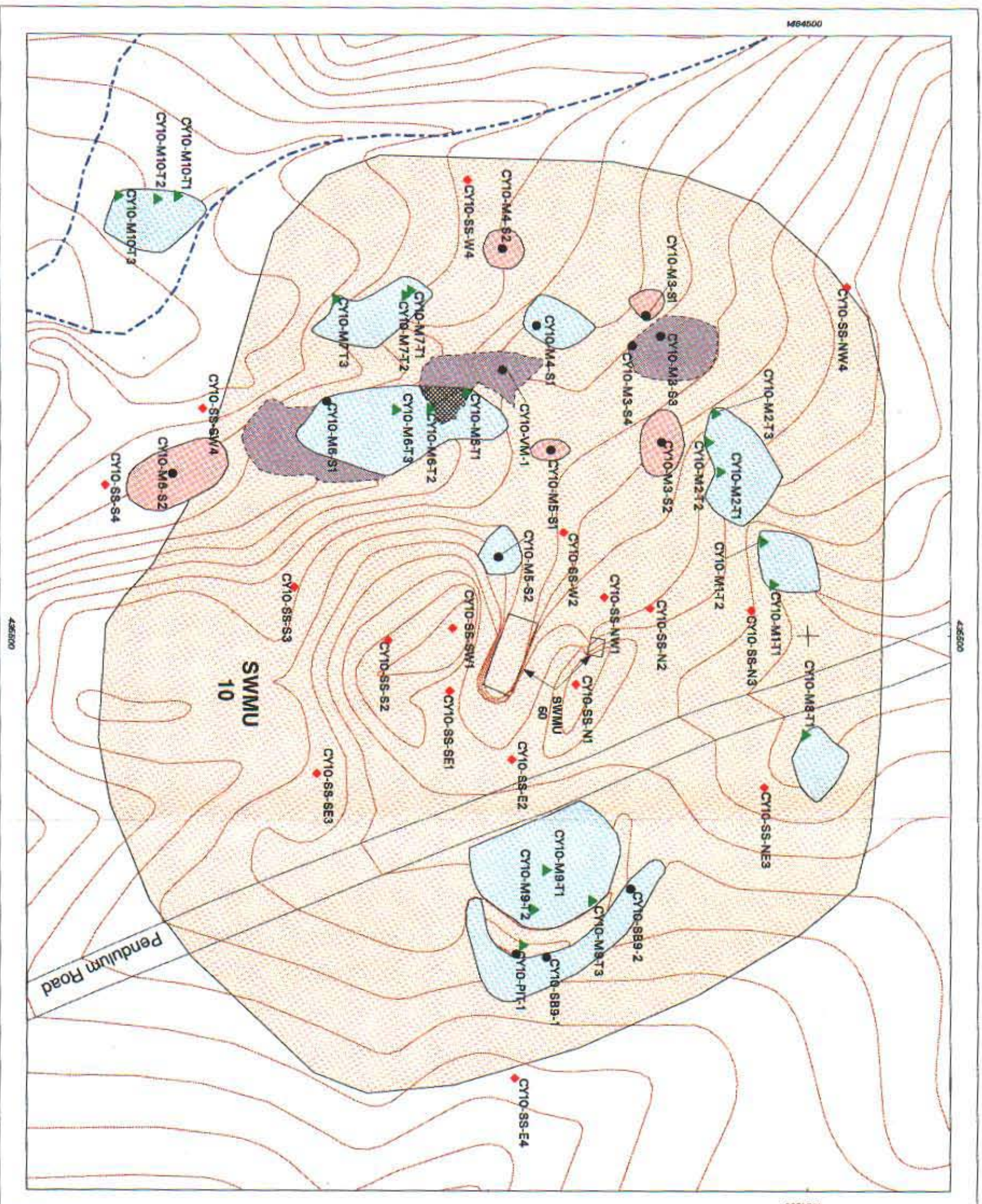
As indicated in Section 3.4.4.4.1, Mound 9 was investigated as part of the confirmatory sampling performed at SWMU 10. The mound was dissected by trenches 3 feet wide by 4 feet deep that were cut approximately north-south, northwest-southeast, and northeast-southwest (approximately 60, 35, and 35 feet long, respectively) (Figure 3.4.4-4). One small piece of oxidized DU (schoepite) was detected in the toe of the southeast-trending trench, but no other DU was detected in any of the trenches through Mound 9.

During the sampling activities conducted at the mounds, a single sample was collected from a surface water collection area located at the base of the soil berm adjacent to Mound 9. Although not intended for surface water collection, accumulation of surface water occurs because of the location of the soil berm relative to the local topography. A sample was collected from this area based on the potential accumulation of surficial contamination migrating in surface water. The sample collected from this area is identified as CY10-PIT-1.

3.4.4.3 *Data Gaps*

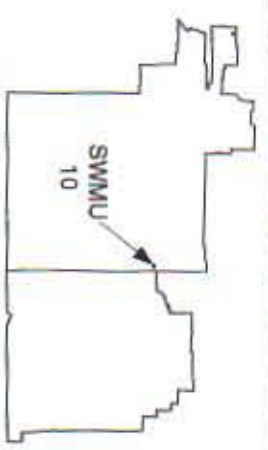
Information gathered from process knowledge, historical site files, and personal interviews aided in identifying the most likely COCs at SWMU 10 and in selecting the types of analyses to be performed on soil samples. Although the history of past releases at the site is incomplete,

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Legend

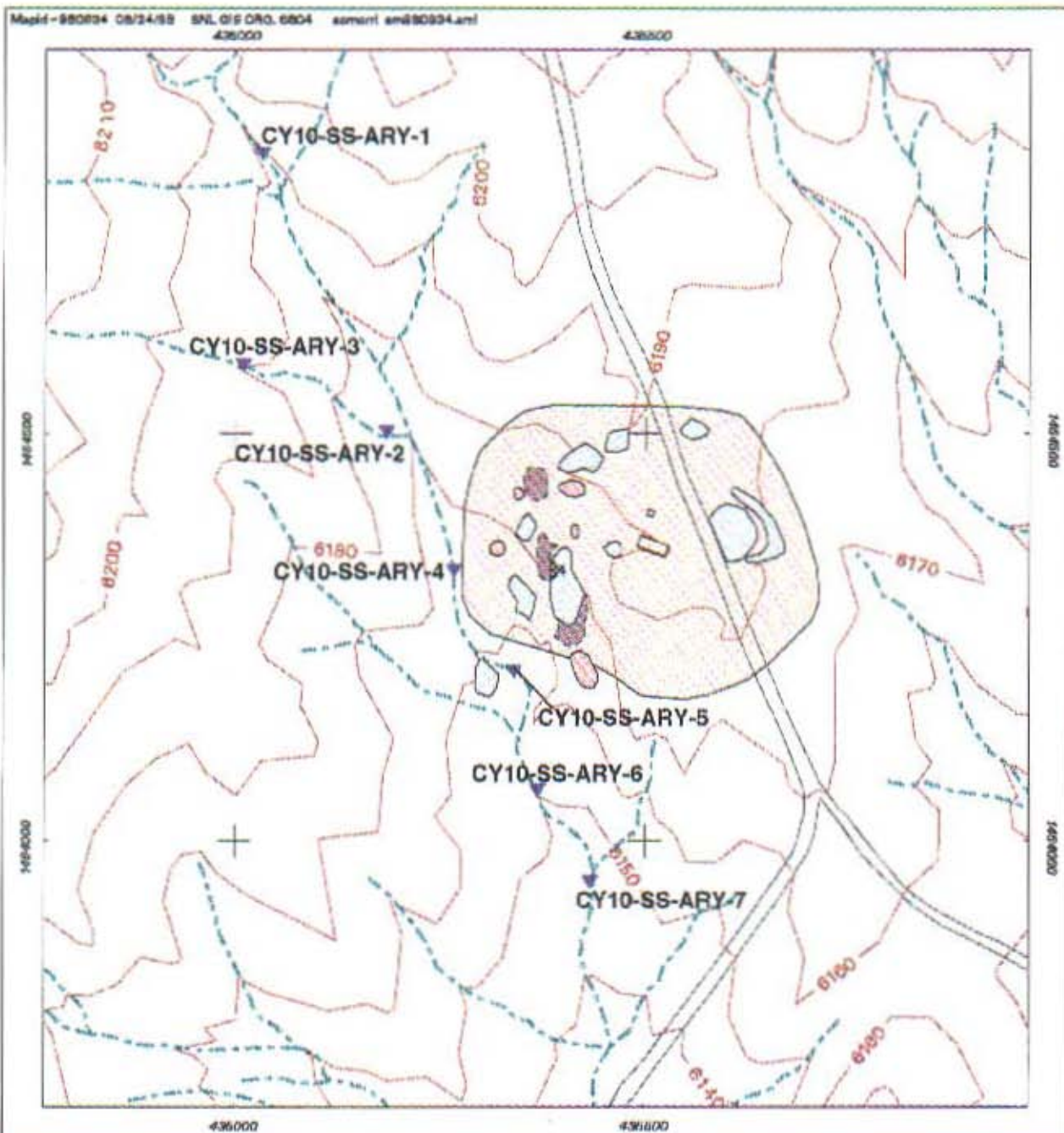
- Surface Sample Location
- ▲ Trench Sample Location
- ◆ Grid Sample Location
- Road
- - - 2 Foot Contour
- - - Surface Drainage
- SWMU 10/60
- Residual Mound (Post - VCM)
- Present Mound (Bunker Construction, Road Grading, TABS Test Recovery Activities)
- Former Mound Location
- Extent of Former Vermiculite Mound beneath Mound 6



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Figure 3.4.4-2
Confirmatory Sample
Locations for the Mounds
and Grid at SWMU 10

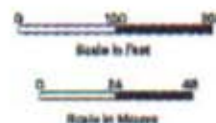
1:600	MAPID = 980976
Unclassified	DRAFT
8Morrison	am808036.jml
	08/05/98



Legend

- Arroyo Sample Location
- Road
- 10 Foot Contour
- Surface Drainage
- SWMU 10/60
- Residual Mound
- Historic Mound/Soil Berm
- Former Mound Location
- Extent of Former Vermiculite Mound beneath Mound 6

Figure 3.4.4-3
Confirmatory Sample Locations
for the Arroyos at SWMU 10



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

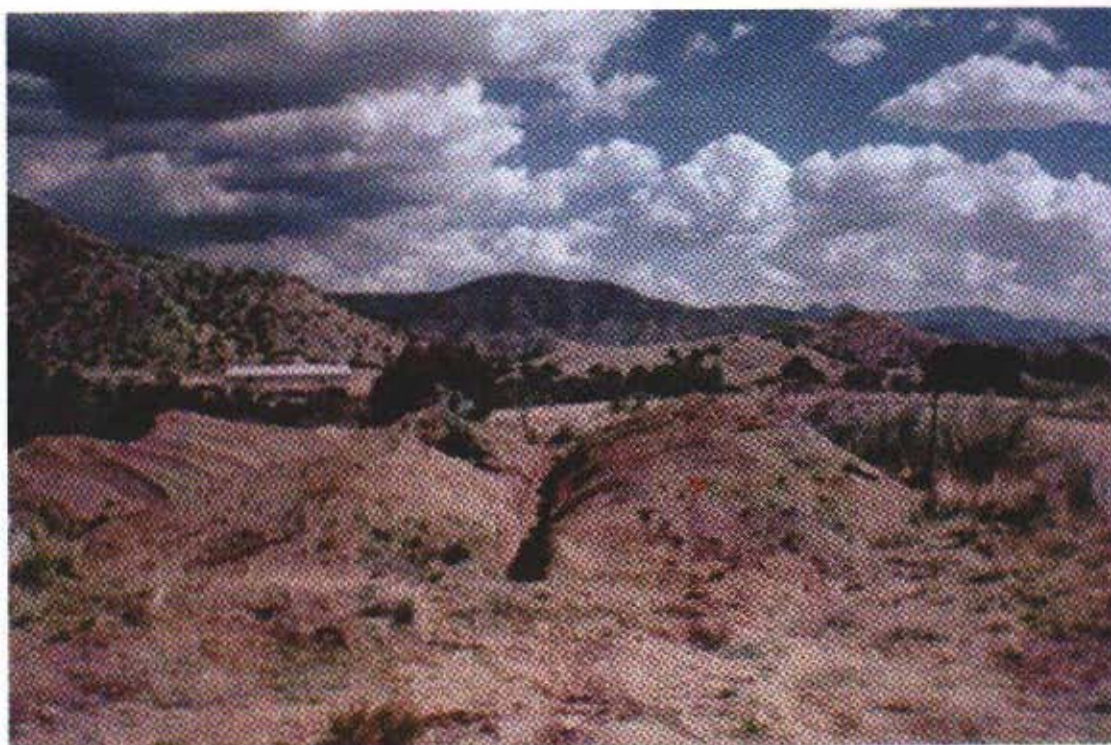


Figure 3.4.4-4. Northwest to southeast trench in Mound 9 (southeast view).

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analytical data from confirmatory sampling are sufficient to determine whether significant releases of COCs occurred at the site.

3.4.4.4 *Results and Conclusions*

The following sections summarize the analytical results for characterizing the soil mounds, fragmentation area (Grid Sampling), and the arroyo sediment.

3.4.4.4.1 *Soil Mounds*

Tables 3.4.4-1 and 3.4.4-2 list the on- and off-site metal analysis and gamma spectroscopy analysis results, respectively, for the 53 soil samples, 5 split samples, and 5 duplicates collected from the soil mounds during confirmatory sampling at SWMU 10. Table 3.4.4-3 summarizes the HE compounds analyzed for and their respective MDLs. This section summarizes the analytical results.

Metals

Concentrations of arsenic were not detected above the background limit in any of the samples. Concentrations of cadmium and selenium were detected slightly above the background limit in only one sample (CY10-PIT-1D). Concentrations of silver were detected above the nonquantified background limit of <0.5 milligram (mg) per kilogram (/kg) in two samples (CY10-PIT-1 and duplicate).

The beryllium concentration in sample CY10-M3-S1 (3.4 mg/kg) was elevated nearly five times the 0.75 mg/kg background limit but was also observed in the method blank. However, the beryllium concentration in the duplicate of sample CY10-M3-S1 that was analyzed on site was below the background limit. Other samples in which beryllium concentrations were detected above background include CY10-M3-S2, CY10-M6-T3-M, CY10-M6-S2, CY10-M8-T1-B, CY10-M9-T1-M, CY10-M9-T2-B, CY10-M9-T3-M, CY10-PIT-1 (including the split [analyzed off site], duplicate, and split duplicate [analyzed off site]), and CY10-M10-T3-M. The concentration of beryllium in these samples is less than twice the background limit. All other samples contained beryllium at or below the background limit.

Lead concentrations were only slightly above background in sample CY10-PIT-1, including the split (analyzed off site), duplicate, and split duplicate (analyzed off site). All other post-VCA (vermiculite mound removal) samples contained lead at or below the background limit. The mercury concentrations in several samples (including CY10-M1-T2-B, CY10-M2-T1-M, and CY10-PIT-1 [and duplicate]) were estimated to be at levels slightly exceeding the 0.055 mg/kg background concentration limit. Although mercury was not detected in any of the samples analyzed off site, the MDL used for these analyses were above the background limit. Mercury was not detected in the remaining samples and the detection limits were below background.

Concentrations of both barium and chromium were significantly higher than the background limits in several samples collected from locations either within or near the vermiculite mound that existed prior to the VCA. As described in Annex 3-A of this NFA, this outcome is believed

Table 3.4.4-1
Summary of SWMU 10 Confirmatory Soil Sampling Metal Analytical Results, Soil Mounds, April–August 1997

Sample Attributes			Metals (EPA 6010/6020/7000) ^a (mg/kg)								
Record Number ^b	ER Sample ID (Figure 3.4.4-2)	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
06157	CY10-M1-T1-M	0.5–1.0	1.6 J (2.6)	100	0.51 B	0.18	4.6	3.5	ND (0.044)	0.74 J (1.3)	ND (0.044)
06157	CY10-M1-T1-B	0.5–1.0	1.1 J (2.6)	81	0.41 B	0.1 J (0.18)	5.2	2.7	ND (0.044)	0.62 J (1.3)	ND (0.044)
06157	CY10-M1-T2-M	0.5–1.0	1.3 J (2.9)	110	0.5 B	0.099 J (0.2)	20 ^c	3.1	ND (0.049)	0.77 J (1.5)	ND (0.049)
06157	CY10-M1-T2-B	0.5–1.0	1.7 J (3)	180	0.66 B	0.21	37	4.8	0.075 J (0.2) B	1.7	ND (0.05)
06543	CY10-M2-T1-M (Off-site laboratory)	0.5–1.0	3.9	130	0.67 J (0.82)	ND (0.33)	40.	7.9	ND (0.11)	ND (0.66)	ND (0.33)
06157	CY10-M2-T1-M	0.5–1.0	1.8 J (2.8)	140	0.74 B	0.23	21	7.4	0.066 J (0.19) B	1.2 J (1.4)	ND (0.047)
06157	CY10-M2-T1-B	0.5–1.0	1.3 J (2.8)	130	0.58 B	0.15 J (0.18)	8.5	5.9	0.047 J (0.18) B	1 J (1.4)	ND (0.046)
06157	CY10-M2-T2-M	0.5–1.0	1.6 J (2.6)	140	0.65 B	0.2	18	5	ND (0.044)	1.3	ND (0.044)
06157	CY10-M2-T2-B	0.5–1.0	1.6 J (2.9)	120	0.54 B	0.17 J (0.2)	18	5	ND (0.049)	1.2 J (1.5)	ND (0.049)
06157	CY10-M2-T3-M	0.5–1.0	0.71 J (2.4)	75	0.6 B	0.18	15	3.8	ND (0.04)	1 J (1.2)	0.071 J (0.16)
06157	CY10-M2-T3-B	0.5–1.0	1.9 J (2.7)	110	0.56 B	0.19	18	3.6	ND (0.045)	1.2 J (1.3)	ND (0.045)
06157	CY10-M3-S1	0.5–1.0	1.7 J (2.4)	140	3.4 B	0.43	18	7.7	ND (0.04)	1 J (1.2)	0.11 J (0.16)
06157	CY10-M3-S1-D	0.5–1.0	1.3 J (2.6)	87	0.72	0.2	12	4.5	ND (0.044)	0.9 J (1.3)	0.083 J (0.17)
06157	CY10-M3-S2	0.5–1.0	1.8 J (2.8)	130	1	0.31	26	6.6	0.055 J (0.19) B	1.3 J (1.4)	0.1 J (0.19)
06157	CY10-M3-S3	0.5–1.0	1.2 J (2.8)	72	0.54	0.18 J (0.19)	8.3	5	ND (0.047)	0.58 J (1.4)	0.076 J (0.19)
06008	CY10-M3-S4	0.5–1.0	1.9 J (2.6)	99	0.59 B	0.16 J (0.18) B	5.6	6.2	ND (0.044)	0.88 J (1.3)	ND (0.044)
06157	CY10-M4-S1 (Pre-VCA)	0.5–1.0	0.87 J (2.4)	550 E	0.83	0.14 J (0.16)	290 E	6.4	0.064 J (0.16) B	0.69 J (1.2)	0.092 J (0.16)
06543	CY10-M4-S2 (Pre-VCA) (Off-site laboratory)	0.5–1.0	3.7	590	0.68 J (1.0)	ND (0.40)	350	14.	ND (0.11)	ND (0.81)	ND (0.40)
06543	CY10-M4-S2-D (Pre-VCA) (Off-site laboratory)	0.5–1.0	2.9	550	0.57 J (0.93)	ND (0.37)	340	16.	ND (0.11)	0.91 J (0.93)	ND (0.37)
06157	CY10-M4-S2 (Pre-VCA)	0.5–1.0	1.1 J (2.7)	540 E	0.59	0.16 J (0.18)	260 E	12	ND (0.045)	0.62 J (1.4)	0.063 J (0.18)
06157	CY10-M4-S2-D (Pre-VCA)	0.5–1.0	1 J (2.7)	350 E	0.47	0.15 J (0.18)	160	9.8	ND (0.046)	0.62 J (1.4)	0.065 J (0.18)
06566	CY10-VM-1 (Pre-VCA) (Off-site laboratory)	0.5–1.0	3.5	410	0.69 J (0.87)	ND (0.35)	170	27.	ND (0.11)	ND (0.70)	ND (0.35)
06008	CY10-VM-1 (Pre-VCA)	0.5–1.0	ND (0.62)	180 B	0.55 B	0.18 B	72	18	ND (0.041)	0.87 J (1.2)	ND (0.041)
600316	CY10-052698-GR-001-SS (Post-VCA) (Off-site laboratory)		2.69	93.9	0.586	0.164	6.53	6.25	ND (0.173)	0.894	ND (0.031)

Refer to footnotes at end of table.

Table 3.4.4-1 (Continued)
Summary of SWMU 10 Confirmatory Soil Sampling Metal Analytical Results, Soil Mounds, April–August 1997

Sample Attributes			Metals (EPA 6010/6020/7000) ^a (mg/kg)								
Record Number ^b	ER Sample ID (Figure 3.4.4-2)	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
600316	CY10-052698-GR-001-DU (Post-VCA) (Off-site laboratory)		2.64	101	0.490	0.125	7.12	6.90	ND (0.173)	0.779	ND (0.031)
600316	CY10-052698-GR-002-SS (Post-VCA) (Off-site laboratory)		2.79	94.0	0.479	0.146	6.40	5.01	ND (0.173)	0.783	ND (0.031)
06157	CY10-M5-S1	0.5–1.0	1.2 J (3)	97	0.64	0.16 J (0.2)	23	6.1	ND (0.05)	0.96 J (1.5)	ND (0.05)
06157	CY10-M5-S2	0.5–1.0	1.2 J (2.5)	79	0.67 B	0.22 B	15	7.2	ND (0.041)	0.91 J (1.2)	0.049 J (0.16)
06566	CY10-M6-T1-M (Off-site laboratory)	0.5–1.0	4.0	100	0.54 J (1.0)	ND (0.42)	12.	6.4	ND (0.11)	ND (0.84)	ND (0.42)
06008	CY10-M6-T1-M	0.5–1.0	2.7	120	0.5 B	0.15 J (0.18) B	14	6.8	ND (0.046)	0.73 J (1.4)	ND (0.046)
06008	CY10-M6-T1-M-D	0.5–1.0	2.8 J (2.9)	120	0.49 B	0.14 J (0.2) B	6	6.9	ND (0.049)	0.56 J (1.5)	ND (0.049)
06566	CY10-M6-T1-M-D (Off-site laboratory)	0.5–1.0	4.2	120	0.56 J (1.1)	ND (0.42)	15.	7.0	ND (0.11)	ND (0.84)	ND (0.42)
06008	CY10-M6-T1-B	1.0–1.5	1.7 J (3)	92	0.59 B	0.14 J (0.2) B	5.7	6.4	ND (0.049)	0.7 J (1.5)	ND (0.049)
06008	CY10-M6-T2-M	0.5–1.0	1.6 J (2.8)	200	0.73 B	0.24 B	44	16	ND (0.046)	1.3 J (1.4)	0.053 J (0.18) B
06008	CY10-M6-T2-B	1.0–1.5	2.2 J (2.8)	95	0.42 B	0.11 J (0.19) B	4	5.6	ND (0.047)	0.59 J (1.4)	ND (0.047)
06008	CY10-M6-T3-M	0.5–1.0	1.3 J (3)	100	0.78 B	0.29 B	7.1	7.6	ND (0.051)	2.1	0.24 B
06008	CY10-M6-T3-B	1.0–1.5	0.99 J (2.5)	77	0.56 B	0.15 J (0.17) B	7	5.4	ND (0.042)	0.78 J (1.2)	ND (0.042)
06008	CY10-M6-S1	0.5–1.0	1.7 J (2.8)	100	0.53 B	0.15 J (0.19) B	5.9	6.3	ND (0.048)	0.71 J (1.4)	ND (0.048)
06008	CY10-M6-S2	0.5–1.0	1.2 J (2.8)	100	0.82 B	0.24 B	11	8	ND (0.047)	1.2 J (1.4)	0.076 J (0.19) B
06008	CY10-M7-T1-M	0.5–1.0	1.3 J (2.5)	100	0.71 B	0.27 B	16	10	ND (0.042)	1.3	0.073 J (0.17) B
06008	CY10-M7-T1-B	1.0–1.5	0.99 J (2.7)	71	0.64	0.19	14	5.1	ND (0.044)	1.2 J (1.3)	0.053 J (0.18)
06008	CY10-M7-T2-M (Pre-VCA)	0.5–1.0	0.96 J (2.9)	480 E	0.74	0.21	180	7.1	ND (0.048)	0.98 J (1.4)	0.26
06008	CY10-M7-T2-B	1.0–1.5	0.78 J (2.8)	140	0.58	0.16 J (0.19)	45	8.5	ND (0.047)	0.83 J (1.4)	0.072 J (0.19)
06008	CY10-M7-T3-M	0.5–1.0	1.8 J (2.6)	55	0.75	0.28	8.9	12	ND (0.044)	1.5	0.092 J (0.17)
06008	CY10-M7-T3-B	1.0–1.5	0.93 J (2.6)	64	0.58	0.2	6.2	9.2	ND (0.043)	1.3	ND (0.043)
06008	CY10-M8-T1-M	0.5–1.0	2.2 J (2.9)	96	0.52	0.17 J (0.2)	6.4	7.5	ND (0.049)	0.86 J (1.5)	ND (0.049)
06008	CY10-M8-T1-B	1.0–1.5	1 J (2.4)	62	0.78 B	0.43 B	6.7	9.2	ND (0.039)	2	0.1 J (0.16) B
06566	CY10-M9-T1-M (Off-site laboratory)	0.5–1.0	4.0	110	0.71 J (1.0)	ND (0.41)	9.8	7.0	ND (0.11)	ND (0.83)	ND (0.41)
06566	CY10-M9-T1-M-D (Off-site laboratory)	0.5–1.0	3.8	110	0.62 J (1.0)	ND (0.40)	8.8	6.0	ND (0.096)	ND (0.80)	ND (0.40)
06008	CY10-M9-T1-M	0.5–1.0	2.3 J (2.5)	200	0.81 B	0.26 B	7.6	8.4	ND (0.042)	2	ND (0.042)

Refer to footnotes at end of table.

Table 3.4.4-1 (Continued)
Summary of SWMU 10 Confirmatory Soil Sampling Metal Analytical Results, Soil Mounds, April–August 1997

Sample Attributes			Metals (EPA Method 6010/6020/7000) ^a (mg/kg)								
Record Number ^b	ER Sample ID (Figure 3.4.4-2)	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
06008	CY10-M9-T1-M-D	0.5–1.0	1.9 J (2.4)	150	0.73 B	0.19 B	6.4	7.7	ND (0.039)	1.4	ND (0.039)
06008	CY10-M9-T1-B	1.0–1.5	1.4 J (2.4)	130	0.71 B	0.29 B	8	6.4	ND (0.04)	2.2	ND (0.04)
06008	CY10-M9-T2-M	0.5–1.0	2.2 J (2.4)	150	0.75 B	0.23 B	7	10	ND (0.041)	1.6	0.044 J (0.16) B
06008	CY10-M9-T2-B	1.0–1.5	1.7 J (2.4)	140	0.78 B	0.22 B	8.5	7.9	ND (0.04)	1.6	ND (0.04)
06008	CY10-M9-T3-M	0.5–1.0	1.8 J (2.4)	150	1.1 B	0.34 B	9.5	16	ND (0.04)	2	0.055 J (0.16) B
06008	CY10-M9-T3-B	1.0–1.5	1.2 J (2.5)	150	0.62	0.21	5.2	6.6	ND (0.042)	1.3	ND (0.042)
06542	CY10-PIT-1 (Off-site laboratory)	0.5–1.0	8.7	250	1.3	ND (0.46)	18.	20.	ND (0.13)	ND (0.92)	ND (0.46)
06542	CY10-PIT-1D (Off-site laboratory)	0.5–1.0	8.6	250	1.2	ND (0.41)	17.	19.	ND (0.12)	ND (0.81)	ND (0.41)
06159	CY10-PIT-1	0.5–1.0	4.6	230	1.1	0.6	12	20	0.066 J (0.22)	2.9	0.61
06159	CY10-PIT-1D	0.5–1.0	4.6	240 E	1.2	0.65	14	20	0.068 J (0.19)	3.1	0.57
06159	CY10-SB9-1	0.5–1.0	1.4 J (2.3)	96	0.51	0.22	6	6.4	ND (0.038)	1 J (1.1)	ND (0.038)
06159	CY10-SB9-2	0.5–1.0	0.9 J (2.9)	120	0.46	0.25	5.8	4.5	ND (0.048)	1.4	ND (0.048)
06008	CY10-M10-T1-M	0.5–1.0	ND (0.6)	68	0.41	0.083 J (0.16)	2.2 J (2.8)	4.4	ND (0.04)	ND (0.3)	ND (0.04)
06566	CY10-M10-T1-B (Off-site laboratory)	1.0–1.5	4.0	87.	0.67 J (1.1)	ND (0.42)	14.	7.2	ND (0.11)	ND (0.84)	ND (0.42)
06566	CY10-M10-T1-B-D (Off-site laboratory)	1.0–1.5	3.6	71.	0.58 J (1.0)	ND (0.41)	11.	6.5	ND (0.11)	ND (0.82)	ND (0.41)
06008	CY10-M10-T1-B	1.0–1.5	1.4 J (2.5)	100	0.67	0.2	8.8	8.8	ND (0.042)	0.75 J (1.2)	ND (0.042)
06008	CY10-M10-T1-B-D	1.0–1.5	0.96 J (2.6)	67	0.47	0.16 J (0.17)	5.2	5.1	ND (0.044)	0.65 J (1.3)	ND (0.044)
06008	CY10-M10-T2-M	0.5–1.0	1.6 J (2.7)	110	0.71	0.3	8	11	ND (0.045)	0.81 J (1.4)	ND (0.045)
06008	CY10-M10-T2-B	1.0–1.5	0.9 J (2.6)	68 B	0.49 B	0.15 J (0.17) B	5.8	6.9	ND (0.043)	0.39 J (0.13)	ND (0.043)
06008	CY10-M10-T3-M	0.5–1.0	1.8 J (2.6)	140 B	0.87 B	0.3 B	9	10	ND (0.044)	0.83 J (1.3)	0.073 J (0.18) B
06008	CY10-M10-T3-B	1.0–1.5	1.8 J (2.4)	92 B	0.66 B	0.23 B	8.4	8.1	ND (0.041)	0.68 J (1.2)	ND (0.041)
Quality Assurance/Quality Control Samples (all in µg/L)											
06157	CY10-RBA (EB)	NA	ND (0.67)	ND (0.79)	ND (0.022)	ND (0.045)	ND (1.7)	ND (0.34)	ND (0.045)	ND (0.34)	ND (0.045)
06008	CY10-RBC (EB)	NA	ND (3.4)	ND (3.9)	ND (0.11)	ND (0.22)	ND (8.4)	ND (1.7)	ND (0.22)	ND (1.7)	ND (0.22)
06008	CY10-RBD (EB)	NA	ND (3.4)	ND (3.9)	ND (0.11)	ND (0.22)	ND (8.4)	ND (1.7)	ND (0.22)	ND (1.7)	ND (0.22)
06008	CY10-RBE (EB)	NA	ND (3.4)	ND (3.9)	ND (0.11)	ND (0.22)	ND (8.4)	ND (1.7)	ND (0.22)	ND (1.7)	ND (0.22)
SNL/NM Canyons Soil Background 95th UTL or 95th Percentile Concentrations ^c			9.8	246	0.75	0.64	18.8	18.9	0.055	3.0	<0.5

Refer to footnotes at end of table.

Table 3.4.4-1 (Concluded)
Summary of SWMU 10 Confirmatory Soil Sampling Metal Analytical Results, Soil Mounds, April–August 1997

^aEPA Method 6020 (EPA November 1986) used by on-site laboratory and EPA Methods 6010/7000 (EPA November 1986) used by off-site laboratory.

^bAnalysis request/chain of custody record.

^cValues in bold exceed background soil concentrations.

^dFrom Zamorski December 1997.

- B = Associated analyte was also observed in the method blank.
CY = Canyon.
E = The associated concentration was observed above the highest calibration level.
EB = Equipment blank.
EPA = U.S. Environmental Protection Agency.
ER = Environmental Restoration.
ft = Foot (feet).
ID = Identification.
J () = The estimated value reported is either above the method detection limit (MDL) and less than the practical quantification limit (shown in parentheses) for on-site laboratory analyses or above the instrument detection limit and less than the contract required detection limit (shown in parentheses) for off-site laboratory analyses.

- µg/L = Microgram(s) per liter.
mg/kg = Milligram(s) per kilogram.
NA = Not applicable.
ND () = Not detected at or above the MDL, shown in parenthesis.
SNL/NM = Sandia National Laboratories, New Mexico.
SWMU = Solid waste management unit.
UTL = Upper tolerance limit.

Table 3.4.4-2
Summary of SWMU 10 Confirmatory Soil Sampling Gamma Spectroscopy Analysis, Soil Mounds, April–August 1997

Sample Attributes			Activity (pCi/g)							
Record Number ^a	ER Sample ID (Figure 3.4.4-1)	Sample Depth (ft)	Uranium-238		Thorium-232		Uranium-235		Cesium-137	
			Result	Error ^b	Result	Error ^b	Result	Error ^b	Result	Error ^b
06546	CY10-M1-T1-M	0.5–1.0	4.59E+00 ^c	3.91E+00	1.10E+00	5.43E-01	1.19E-01	1.79E-01	3.91E-02	2.76E-02
06546	CY10-M1-T1-B	0.5–1.0	1.36E+00	1.22E+00	1.05E+00	5.02E-01	2.38E-01	1.73E-01	4.43E-02	2.18E-02
06546	CY10-M1-T2-M	0.5–1.0	ND (1.11E+00)	--	1.25E+00	5.90E-01	1.31E-01	1.79E-01	ND (4.70E-02)	--
06546	CY10-M1-T2-B	0.5–1.0	ND (1.68E+00)	--	1.10E+00	5.23E-01	ND (2.35E-01)	--	ND (4.41E-02)	--
06544	CY10-M2-T1-M	0.5–1.0	ND (2.09E+00)	--	1.21E+00	5.57E-01	1.61E-01	1.91E-01	1.32E-01	6.72E-02
06546	CY10-M2-T1-B	0.5–1.0	ND (1.69E+00)	--	1.16E+00	1.03E+00	ND (2.39E-01)	--	ND (2.60E-02)	--
06546	CY10-M2-T2-M	0.5–1.0	ND (1.68E+00)	--	1.10E+00	5.24E-01	ND (2.30E-01)	--	2.60E-01	1.06E-01
06546	CY10-M2-T2-B	0.5–1.0	ND (1.68E+00)	--	1.11E+00	5.28E-01	ND (2.24E-01)	--	5.82E-02	2.49E-02
06546	CY10-M2-T3-M	0.5–1.0	2.06E+00	1.31E+00	1.22E+00	5.67E-01	ND (2.21E-01)	--	ND (4.07E-02)	--
06546	CY10-M2-T3-B	0.5–1.0	ND (1.74E+00)	--	9.41E-01	1.49E+00	ND (1.52E-01)	--	1.58E-02	1.35E-02
06544	CY10-M3-S1	0.5–1.0	8.41E+00	2.22E+00	1.20E+00	5.76E-01	2.91E-01	1.66E-01	2.68E-02	1.75E-02
06544	CY10-M3-S1-D	0.5–1.0	5.92E+00	1.76E+00	1.05E+00	4.86E-01	4.93E-02	7.54E-02	3.30E-02	1.73E-02
06546	CY10-M3-S2	0.5–1.0	7.43E+00	5.44E+00	1.02E+00	4.78E-01	2.25E-01	1.15E-01	2.44E-02	1.93E-02
06546	CY10-M3-S3	0.5–1.0	2.63E+00	3.18E+00	9.66E-01	4.51E-01	1.24E-01	1.23E-01	6.04E-02	2.30E-02
06575	CY10-M3-S4	0.5–1.0	ND (1.70E+00)	--	9.72E-01	4.92E-01	ND (2.31E-01)	--	ND (4.18E-02)	--
06546	CY10-M4-S1	0.5–1.0	ND (3.45E+00)	--	9.25E-01	4.37E-01	ND (2.52E-01)	--	2.69E-02	2.60E-02
06544	CY10-M4-S2	0.5–1.0	ND (1.53E+00)	--	8.60E-01	4.30E-01	ND (2.16E-01)	--	2.04E-01	6.93E-02
06544	CY10-M4-S2-D	0.5–1.0	ND (2.08E+00)	--	7.80E-01	3.75E-01	1.07E-01	1.85E-01	2.49E-01	5.12E-02
03350	CY10-VM-1	0.5–1.0	1.15E+00	9.23E-01	1.22E+00	5.75E-01	1.04E-01	1.76E-01	ND (4.48E-02)	--
06546	CY10-M5-S1	0.5–1.0	ND (3.33E+00)	--	1.13E+00	5.31E-01	ND (2.45E-01)	--	ND (3.30E-02)	--
06546	CY10-M5-S2	0.5–1.0	2.31E+00	1.94E+00	9.37E-01	4.66E-01	ND (2.43E-01)	--	6.26E-02	3.24E-02
03350	CY10-M6-T1-M	0.5–1.0	ND (1.68E+00)	--	8.28E-01	4.01E-01	ND (2.26E-01)	--	ND (4.01E-02)	--
06575	CY10-M6-T1-B	1.0–1.5	ND (1.78E+00)	--	9.79E-01	4.69E-01	ND (2.37E-01)	--	ND (4.34E-02)	--
06575	CY10-M6-T2-M	0.5–1.0	1.55E+00	1.08E+00	9.86E-01	4.85E-01	8.94E-02	9.61E-02	3.74E-02	5.17E-02
06575	CY10-M6-T2-B	1.0–1.5	ND (1.79E+00)	--	8.30E-01	9.92E-01	ND (2.39E-01)	--	ND (4.41E-02)	--
06575	CY10-M6-T3-M	0.5–1.0	1.11E+00	1.74E+00	1.29E+00	6.08E-01	1.20E-01	9.15E-02	3.16E-02	1.68E-02
06575	CY10-M6-T3-B	1.0–1.5	1.48E+00	9.83E-01	8.80E-01	4.34E-01	ND (1.01E-01)	--	ND (4.05E-02)	--
06575	CY10-M6-S1	0.5–1.0	1.17E+00	8.69E-01	1.21E+00	5.70E-01	ND (2.32E-01)	--	2.80E-02	2.12E-02
06575	CY10-M6-S2	0.5–1.0	2.92E+00	--	9.58E-01	4.64E-01	6.81E-02	7.25E-02	ND (4.66E-02)	--
06575	CY10-M7-T1-M	0.5–1.0	ND (1.97E+00)	--	1.46E+00	7.25E-01	ND (2.71E-01)	--	2.99E-01	4.12E-01
06575	CY10-M7-T1-B	1.0–1.5	ND (1.92E+00)	--	1.57E+00	7.44E-01	8.72E-02	1.02E-01	5.43E-02	2.58E-02
06575	CY10-M7-T2-M	0.5–1.0	ND (1.31E+00)	--	1.21E+00	5.79E-01	1.60E-01	1.88E-01	5.38E-01	9.45E-02
06575	CY10-M7-T2-B	1.0–1.5	ND (1.61E+00)	--	9.40E-01	4.57E-01	ND (2.28E-01)	--	6.37E-02	2.64E-02
06575	CY10-M7-T3-M	0.5–1.0	ND (1.92E+00)	--	1.43E+00	6.71E-01	ND (2.64E-01)	--	ND (5.05E-02)	--
06575	CY10-M7-T3-B	1.0–1.5	ND (1.85E+00)	--	1.47E+00	7.01E-01	ND (2.57E-01)	--	ND (4.75E-02)	--

Refer to footnotes at end of table.

Table 3.4.4-2 (Concluded)
Summary of SWMU 10 Confirmatory Soil Sampling Gamma Spectroscopy Analysis, Soil Mounds, April–August 1997

Sample Attributes			Activity (pCi/g)							
Record Number ^a	ER Sample ID (Figure 3.4.4-1)	Sample Depth (ft)	Uranium-238		Thorium-232		Uranium-235		Cesium-137	
			Result	Error ^b	Result	Error ^b	Result	Error ^b	Result	Error ^b
06575	CY10-M8-T1-M	0.5–1.0	8.40E-01	9.11E-01	9.67E-01	5.00E-01	ND (2.36E-01)	--	ND (4.12E-02)	--
06575	CY10-M8-T1-B	1.0–1.5	ND (3.73E+00)	--	1.13E+00	5.24E-01	ND (2.72E-01)	--	ND (3.60E-02)	--
03350	CY10-M9-T1-M-D	0.5–1.0	ND (1.73E+00)	--	1.09E+00	6.57E-01	ND (2.45E-01)	--	ND (4.51E-02)	--
06575	CY10-M9-T1-M	0.5–1.0	ND (3.45E+00)	--	1.10E+00	5.86E-01	ND (2.51E-01)	--	2.65E-02	1.38E-02
06575	CY10-M9-T1-B	1.0–1.5	ND (3.51E+00)	--	1.15E+00	5.18E-01	ND (2.59E-01)	--	ND (3.49E-02)	--
06575	CY10-M9-T2-B	1.0–1.5	1.66E+00	9.51E-01	1.01E+00	1.10E+00	2.34E-01	1.53E-01	2.42E-02	1.47E-02
06570	CY10-M9-T2-U	0.5–1.0	3.47E+00	1.01E+00	1.05E+00	5.02E-01	ND (2.25E-01)	--	ND (4.48E-02)	--
06575	CY10-M9-T3-M	0.5–1.0	ND (3.43E+00)	--	1.09E+00	5.17E-01	ND (2.50E-01)	--	ND (3.31E-02)	--
06575	CY10-M9-T3-B	1.0–1.5	ND (3.39E+00)	--	9.90E-01	4.61E-01	ND (2.45E-01)	--	2.20E-02	1.72E-02
06544	CY10-PIT-1	0.5–1.0	ND (3.15E+00)	--	2.29E+00	1.04E+00	1.39E-01	1.30E-01	3.36E-01	7.47E-02
06544	CY10-PIT-1-D	0.5–1.0	ND (2.35E+00)	--	2.27E+00	1.06E+00	3.03E-01	2.38E-01	ND (3.73E-02)	--
06546	CY10-SB9-1	0.5–1.0	ND (3.70E+00)	--	1.00E+00	4.68E-01	ND (2.69E-01)	--	1.36E-01	4.13E-02
06546	CY10-SB9-2	0.5–1.0	ND (2.88E+00)	--	1.14E+00	5.65E-01	ND (2.14E-01)	--	ND (2.92E-02)	--
06575	CY10-M10-T1-M	0.5–1.0	5.48E-01	6.39E-01	6.68E-01	3.26E-01	ND (1.89E-01)	--	ND (3.54E-02)	--
03350	CY10-M10-T1-B	0.5–1.0	ND (1.59E+00)	--	1.06E+00	4.99E-01	ND (2.22E-01)	--	ND (4.01E-02)	--
06575	CY10-M10-T2-M	0.5–1.0	ND (4.06E+00)	--	1.34E+00	8.73E-01	ND (2.98E-01)	--	ND (3.94E-02)	--
06575	CY10-M10-T2-B	1.0–1.5	ND (3.38E+00)	--	1.02E+00	4.78E-01	ND (2.44E-01)	--	ND (3.16E-02)	--
06575	CY10-M10-T3-M	0.5–1.0	ND (1.61E+00)	--	1.00E+00	4.99E-01	ND (2.24E-01)	--	ND (4.25E-02)	--
06575	CY10-M10-T3-B	1.0–1.5	ND (1.41E+00)	--	1.00E+00	4.72E-01	ND (2.06E-01)	--	ND (3.89E-02)	--
Quality Assurance/Quality Control Samples (all in pCi/mL)										
06546	CY10-RBA (EB)	NA	ND (1.73E+00)	--	ND (1.56E-01)	--	ND (1.60E-01)	--	ND (2.24E-02)	--
06575	CY10-RBC (EB)	NA	ND (9.68E-01)	--	ND (1.79E-01)	--	ND (1.53E-01)	--	ND (3.15E-02)	--
06575	CY10-RBD (EB)	NA	ND (2.01E+00)	--	ND (1.73E-01)	--	ND (1.77E-01)	--	ND (2.60E-02)	--
06575	CY10-RBE (EB)	NA	ND (7.98E-01)	--	ND (1.58E-01)	--	ND (1.42E-01)	--	ND (2.52E-02)	--
Background Soil Activity, Lower Canyons ^d			2.31	NA	1.03	NA	0.16	NA	1.55	NA

^aAnalysis request/chain of custody record.^bTwo standard deviations about the mean detected activity.^cValues in bold exceed background soil activity.^dFrom Dinwiddie September 1997.

CY = Canyon.
 EB = Equipment blank.
 ER = Environmental Restoration.
 ft = Foot (feet).
 ID = Identification.
 NA = Not applicable.

ND () = Not detected at or above the minimum detectable activity, shown in parenthesis.
 pCi/g = Picocurie(s) per gram.
 pCi/mL = Picocurie(s) per milliliter.
 SNL/NM = Sandia National Laboratories, New Mexico.
 SWMU = Solid waste management unit.
 -- = Error not calculated for nondetectable results.

Table 3.4.4-3
Summary of HE Analysis Detection Limits
Used for SWMU 10 Confirmatory Soil Sampling, April—August 1997

HE Compounds	Analysis Detection Limits	
	On-Site Analyses by MEKC (mg/kg)	Off-Site Analyses by EPA Method 8330 ^a (µg/g)
1,3,5-trinitrobenzene	0.093–0.12	0.070
1,3-dinitrobenzene	0.065–0.085	0.10
2,4,6-trinitrotoluene	0.25–0.33	0.11
2,4-dinitrotoluene	0.21–0.28	0.16
2,6-dinitrotoluene	0.25–0.33	0.19
2-amino-4,6-dinitrotoluene	0.11–0.14	0.13
2-nitrotoluene	0.13–0.17	0.070
3-nitrotoluene	0.13–0.17	0.16
4-amino-2,6-dinitrotoluene	0.093–0.12	0.055
4-nitrotoluene	0.11–0.14	0.17
HMX	0.11–0.14	0.42
Nitrobenzene	0.15–0.19	0.15
Pentaerythritol tetranitrate	0.3–0.39	NA
RDX	0.16–0.2	0.19
Tetryl	NA	0.34

^aEPA November 1986.

EPA = U.S. Environmental Protection Agency.

HE = High explosives.

HMX = 1,3,5,7-tetranitro-1,3,5,7-tetrazacyclooctane.

MEKC = Micellar electrokinetic chromatography.

mg/kg = Milligrams per kilogram.

NA = Not applicable.

RDX = 1,3,5-trinitro-1,3,5-triazacyclohexane.

SWMU = Solid waste management unit.

Tetryl = 2,4,6-trinitrophenylmethylnitramine.

µg/g = Microgram(s) per gram.

to be a result of the chemical composition of vermiculite, which was present in the sample matrices, rather than an indication of environmental contamination. However, barium slightly exceeded background at sample locations not necessarily within or near the former vermiculite mound (CY10-PIT-1 split and split duplicate). Chromium exceeded background in one or more samples collected from Mounds 1 through 7, including sample location CY10-PIT-1.

Radionuclides

Table 3.4.4-2 presents a summary of the on-site gamma spectroscopy results for the 50 soil samples and 4 duplicate samples collected during confirmatory sampling at SWMU 10. Annex 3-B contains complete results of the gamma spectroscopy analyses. Gamma activity from uranium-238 is equivalent to or exceeds the 2.31 picocuries per gram (pCi/g) background limit in samples CY10-M1-T1-M, CY10-M3-S1 and duplicate, CY10-M3-S2, CY10-M3-S3, CY10-M5-S2, CY10-M6-S2, and CY10-M9-T2-U. The detected uranium-238 activity ranged from 0.55 pCi/g to 8.41 pCi/g. The uranium-238 activity is residual from the mock weapon detonation. Gamma activity from uranium-238 was not detected in 13 other samples in which the minimum detectable activity (MDA) exceeded the background concentration.

Thorium-232 is a long-lived thorium series indicator for contamination (Miller June 1998). Gamma activity from thorium-232 exceeded background in 31 samples. Thirty-one out of fifty soil samples only slightly exceeded background, sample CY10-PIT-1 and the duplicate were about twice the background activity.

Gamma activity resulting from uranium-235 was detected equivalent to or slightly above the 0.16 pCi/g background limit in samples CY10-M1-T1-B, CY10-M2-T1-M, CY10-M3-S2, CY10-M3-S3, CY10-M6-T3-B, CY10-M7-T2-M, and CY10-M9-T2-B. Gamma activity from uranium-235 was also detected above background in sample CY10-M3-S1 but not in the duplicate sample CY10-M3-S1-D. Conversely, gamma activity from uranium-235 was detected above background in the duplicate sample CY10-PIT-1-D but not in sample CY10-PIT-1. Gamma activity resulting from cesium-137 was not detected above the 1.55 pCi/g background limit in any of the samples collected.

Explosives

During confirmatory sampling at SWMU 10, a total of 50 soil samples, 12 split samples, and 6 duplicate samples were collected from the soil mounds and analyzed for HE. Results of the analyses indicate that HE compounds were not detected in any of the samples. Table 3.4.4-3 shows the detection limits used for HE analyses by both on- and off-site laboratories.

3.4.4.4.2 *Fragmentation Area—Grid Soil Sampling*

Tables 3.4.4-4 and 3.4.4-5 summarize the on- and off-site metals analysis and gamma spectroscopy analysis results, respectively, for the 17 soil samples and 1 duplicate sample collected from the radial grid pattern covering the fragmentation area during confirmatory sampling at SWMU 10. Table 3.4.4-3 lists the HE compounds analyzed for and their respective

Table 3.4.4-4
Summary of SWMU 10 Confirmatory Soil Sampling Metal Analytical Results, Grid Sampling, April–August 1997

Sample Attributes			Metals (EPA Methods 6010/6020/7000) ^a (mg/kg)								
Record Number ^b	ER Sample ID (Figure 3.4.4-2)	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
06158	CY10-SS-N2	0.5–1.0	1.4 J (2.7)	76 B	0.79 B^c	0.28 B	7.3	9.2	ND (0.045)	1.3	0.05 J (0.18) B
06158	CY10-SS-N3	0.5–1.0	1.7 J (2.7)	87 B	0.92 B	0.24 B	7.5	16	ND (0.046)	1.4	ND (0.046)
06158	CY10-SS-NE1	0.5–1.0	1.3 J (2.5)	140 B	0.77 B	0.25 B	7.4	9	ND (0.042)	1.4	ND (0.042)
06158	CY10-SS-NE3	0.5–1.0	1.2 J (2.6)	110 B	0.73 B	0.26 B	5.3	6.7	ND (0.043)	1.5	0.046 J (0.17) B
06158	CY10-SS-E2	0.5–1.0	1.6 J (2.3)	99 B	0.62 B	0.2 B	7.4	7.5	ND (0.039)	0.58 J (1.2)	ND (0.039)
06158	CY10-SS-E4	0.5–1.0	3.5	110 B	0.69 B	0.26 B	9.6	30	ND (0.039)	0.95 J (1.3)	ND (0.039)
06158	CY10-SS-SE1	0.5–1.0	ND (0.67)	76 B	0.6 B	0.21 B	4.6	6	ND (0.045)	0.94 J (1.3)	ND (0.045)
06158	CY10-SS-SE3	0.5–1.0	1 J (2.7)	120 B	0.82 B	0.26 B	5.3	7.1	ND (0.046)	1.7	ND (0.046)
06158	CY10-SS-S2	0.5–1.0	1.3 J (2.7)	100	0.68 B	0.22 B	17	8.8	ND (0.045)	1.2 J (1.4)	0.052 J (0.18) B
06567	CY10-SS-S3 (Off-site laboratory)	0.5–1.0	4.7	120	0.82 J (0.98)	ND (0.39)	12.	9.8	ND (0.11)	ND (0.78)	ND (0.39)
06567	CY10-SS-S3-D (Off-site laboratory)	0.5–1.0	3.5	91.	0.65 J (0.93)	ND (0.37)	13.	7.9	ND (0.11)	ND (0.75)	ND (0.37)
06158	CY10-SS-S4	0.5–1.0	1.9 J (2.3)	160	0.95 B	0.26 B	8.6	12	ND (0.039)	1 J (1.2)	0.062 J (0.16) B
06158	CY10-SS-SW1	0.5–1.0	0.89 J (2.3)	73	0.72 B	0.21 B	5.4	7	ND (0.038)	1.1 J (1.2)	ND (0.038)
06158	CY10-SS-SW4	0.5–1.0	2.7	140	0.94 B	0.26 B	10	10	ND (0.046)	1 J (1.4)	ND (0.046)
06158	CY10-SS-W2	0.5–1.0	0.86 J (2.3)	75	0.73 B	0.26 B	7.1	7.4	ND (0.039)	1.2	0.066 J (0.16) B
06158	CY10-SS-W4	0.5–1.0	1 J (2.7)	83	0.71	0.24	7.2	8.7	ND (0.045)	1.1 J (1.4)	0.1 J (0.18)
06158	CY10-SS-NW1	0.5–1.0	1.4 J (2.8)	110	0.71	0.22	9.6	8.1	ND (0.046)	1.1 J (1.4)	ND (0.046)
06158	CY10-SS-NW4	0.5–1.0	0.76 J (2.6)	44	0.83	0.32	5	7.9	ND (0.044)	0.91 J (1.3)	0.17
Quality Assurance/Quality Control Sample (in µg/L)											
06158	CY10-RBG (EB)	NA	ND (3.4)	ND (3.9)	ND (0.11)	ND (0.22)	ND (8.4)	ND (1.7)	ND (0.22)	ND (1.7)	ND (0.22)
SNL/NM Canyons Soil Background 95th UTL or 95th-Percentile Concentrations ^d			9.8	246	0.75	0.64	18.8	18.9	0.055	3.0	<0.5

^aEPA Method 6020 (EPA November 1986) used by on-site laboratory and EPA Methods 6010/7000 (EPA November 1986) used by off-site laboratory.

^bAnalysis request/chain of custody record.

^cValues in bold exceed background soil concentrations.

^dFrom Zamorski December 1997.

B = Associated analyte was also observed in the method blank.

CY = Canyon.

D = Duplicate.

EB = Equipment blank.

EPA = U.S. Environmental Protection Agency.

ER = Environmental Restoration.

ft = Foot (feet).

ID = Identification.

J () = The estimated value reported is either above the method detection limit (MDL) and less than the practical quantification limit (shown in parenthesis) for on-site laboratory analyses or above the instrument detection limit and less than the contract required detection limit (shown in parenthesis) for off-site laboratory analyses.

µg/L = Microgram(s) per liter.

mg/kg = Milligram(s) per kilogram.

NA = Not applicable.

ND () = Not detected above the MDL (shown in parenthesis).

SNL/NM = Sandia National Laboratories, New Mexico.

SS = Surface soil sample.

SWMU = Solid waste management unit.

UTL = Upper tolerance limit.

Table 3.4.4-5
Summary of SWMU 10 Confirmatory Soil Sampling Gamma Spectroscopy Analysis, Grid Sampling, April–August 1997

Sample Attributes			Activity (pCi/g)							
Record Number ^a	ER Sample ID (Figure 3.4.4-2)	Sample Depth (ft)	Uranium-238		Thorium-232		Uranium-235		Cesium-137	
			Result	Error ^b	Result	Error ^b	Result	Error ^b	Result	Error ^b
06569	CY10-SS-N2	0.5–1.0	1.16E+00	1.01E+00	1.07E+00^c	5.25E-01	ND (2.26E-01)	--	2.61E-02	1.89E-02
06569	CY10-SS-N3	0.5–1.0	ND (1.43E+00)	--	1.20E+00	5.80E-01	ND (2.30E-01)	--	9.10E-02	3.95E-02
06569	CY10-SS-NE1	0.5–1.0	ND (1.52E+00)	--	9.88E-01	6.63E-01	ND (2.15E-01)	--	ND (3.82E-02)	--
06569	CY10-SS-NE3	0.5–1.0	ND (1.52E+00)	--	8.71E-01	4.18E-01	ND (2.13E-01)	--	1.28E-01	5.72E-02
06569	CY10-SS-E2	0.5–1.0	ND (1.82E+00)	--	1.39E+00	6.67E-01	ND (2.45E-01)	--	2.81E-02	3.75E-02
06569	CY10-SS-E4	0.5–1.0	ND (1.62E+00)	--	8.36E-01	4.07E-01	ND (2.19E-01)	--	ND (4.21E-02)	--
06569	CY10-SS-SE1	0.5–1.0	ND (1.25E+00)	--	ND (2.17E-01)	--	ND (2.75E-01)	--	2.22E-02	2.29E-02
06569	CY10-SS-SE3	0.5–1.0	ND (1.61E+00)	--	1.33E+00	6.19E-01	ND (2.51E-01)	--	ND (4.73E-02)	--
06569	CY10-SS-S2	0.5–1.0	ND (1.47E+00)	--	1.05E+00	4.89E-01	ND (2.09E-01)	--	2.07E-02	1.33E-02
06568	CY10-SS-S3	0.5–1.0	ND (3.66E+00)	--	1.13E+00	5.26E-01	ND (2.66E-01)	--	3.51E-02	2.18E-02
06569	CY10-SS-S4	0.5–1.0	2.12E+00	1.66E+00	1.18E+00	5.55E-01	ND (2.20E-01)	--	ND (4.02E-02)	--
06569	CY10-SS-SW1	0.5–1.0	ND (1.54E+00)	--	1.05E+00	4.92E-01	ND (2.12E-01)	--	1.04E-01	1.98E-01
06569	CY10-SS-SW4	0.5–1.0	ND (1.49E+00)	--	1.08E+00	6.43E-01	ND (2.01E-01)	--	2.83E-02	1.78E-02
06569	CY10-SS-W2	0.5–1.0	1.73E+00	1.01E+00	1.07E+00	5.13E-01	ND (1.45E-01)	--	3.33E-02	1.89E-02
06569	CY10-SS-W4	0.5–1.0	ND (1.60E+00)	--	1.06E+00	5.09E-01	ND (2.26E-01)	--	1.15E-01	7.55E-02
06569	CY10-SS-NW1	0.5–1.0	ND (1.60E+00)	--	1.10E+00	5.17E-01	ND (2.27E-01)	--	5.19E-02	2.44E-02
06569	CY10-SS-NW4	0.5–1.0	ND (1.41E+00)	--	7.31E-01	3.72E-01	ND (1.91E-01)	--	4.44E-02	2.67E-02
Background Soil Activity, Lower Canyons ^d			2.31	NA	1.03	NA	0.16	NA	1.55	NA
Quality Assurance/Quality Control Sample (in pCi/mL)										
06569	CY10-RBG (EB)	NA	ND (8.96E-01)	--	ND (1.54E-01)	--	ND (1.46E-01)	--	ND (2.90E-02)	--

^aAnalysis request/chain of custody record.

^bTwo standard deviations about the mean detected activity.

^cValues in bold exceed background soil activity.

^dFrom Dinwiddie September 1997.

CY = Canyon.

EB = Equipment blank.

ER = Environmental Restoration.

ft = Foot (feet).

ID = Identification.

NA = Not applicable.

ND () = Not detected at or above the minimum detectable activity, shown in parentheses.

pCi/g = Picocurie(s) per gram.

pCi/mL = Picocurie(s) per milliliter.

SNL/NM = Sandia National Laboratories, New Mexico.

SS = Surface soil sample.

SWMU = Solid waste management unit.

-- = Error not calculated for nondetectable results.

MDLs. This section summarizes the analytical results from the grid sampling in the fragmentation area.

Metals

Concentrations of arsenic, barium, cadmium, chromium, and selenium were not detected above background concentrations in any samples. Silver does not have a quantified background concentration. However, the maximum reported silver concentration is 0.61 mg/kg. Mercury was not detected in any of the 18 samples analyzed. However, samples CY10-SS-S3 and CY10-SS-S3-D were analyzed for mercury at the off-site laboratory, which used a detection limit of 0.11 mg/kg which exceeded the 0.055 mg/kg background limit. Lead concentration levels were elevated above the 18.9 mg/kg background limit in one sample (CY10-SS-E4). No other samples contained lead concentrations above background. Beryllium concentration levels were slightly elevated above the 0.75 mg/kg background limit in 8 of the 18 samples collected. However, none of the samples containing elevated beryllium concentrations were above 1.0 mg/kg.

Radionuclides

Table 3.4.4-5 summarizes the on-site gamma spectroscopy results for the 17 soil samples collected during confirmatory sampling at SWMU 10. Annex 3-B contains complete results of the gamma spectroscopy analyses. Gamma activity from uranium-238 does not exceed the 2.31 pCi/g background limit in any samples. However, the MDA used in the analysis of sample CY10-SS-S3 did exceed the background activity.

Thorium-232 is a long-lived thorium series indicator for contamination (Miller June 1998). Gamma activity from thorium-232 exceeded background limits in 12 samples. However, in each instance the background activity was exceeded only slightly.

Gamma activity resulting from uranium-235 was not detected in any of the 17 samples that were collected; however, the detection limits used for 16 of those samples were above the 0.16 pCi/g background level. Because gamma activity from uranium-238 and thorium-234 (Annex 3-B) were below background limits, it is reasonable to infer that uranium-235 also does not exceed background limits in these samples. In addition, the MDA for uranium-235 was still several orders of magnitude less than a projected preliminary remediation goal (PRG) for that isotope, so there is no human health or environmental concern. Gamma activity resulting from cesium-137 was not detected above the 1.55 pCi/g background limit in any of the samples collected.

Explosives

During confirmatory sampling at SWMU 10, a total of 17 surface soil samples and 1 duplicate sample were collected from the radial grid pattern and analyzed for HE. Results of the analyses show that HE compounds were not detected in the samples. Table 3.4.4-3 shows the detection limits used for HE analyses by both on- and off-site laboratories.

3.4.4.4.3 Arroyo Sediment Sampling

Tables 3.4.4-6 and 3.4.4-7 summarize the on- and off-site metals analysis and gamma spectroscopy analysis results, respectively, for the seven soil samples and one duplicate sample collected from the arroyo sediments during confirmatory sampling at SWMU 10. Table 3.4.4-3 summarizes the HE compounds analyzed for and their respective MDLs. A summary of the analytical results for all arroyo sediment samples are described below.

Metals

Concentrations of arsenic, barium, cadmium, lead, and selenium were not detected above background limits in any samples. Silver does not have a quantified background limit. However, the maximum reported silver concentration is 0.17 mg/kg. Mercury was not detected in any of the eight samples analyzed. However, samples CY10-SS-ARY-2 and the duplicate for CY10-SS-ARY-2 were analyzed for mercury at the off-site laboratory, which used a detection limit of 0.11 mg/kg, which exceeded the 0.055 mg/kg background limit. It was estimated that beryllium was slightly above the 0.75 mg/kg background limit in the sample duplicate for CY10-SS-ARY-2. No other samples contained beryllium above background.

Concentrations of chromium were elevated above the 18.8 mg/kg background limit in samples CY10-SS-ARY-2, the duplicate for CY10-SS-ARY-2, and CY10-SS-ARY-4. These sample locations are immediately adjacent to the former vermiculite mound. This outcome is believed to be a result of the chemical composition of vermiculite, which was present in the sample matrices, rather than an indication of environmental contamination (see Annex 3-A).

Radionuclides

Table 3.4.4-7 summarizes the on-site gamma spectroscopy results for the seven soil samples collected during confirmatory sampling at SWMU 10. Annex 3-B contains complete results of the gamma spectroscopy analyses. Gamma activity from uranium-238 for sample CY10-SS-ARY-4 was 7.51 pCi/g which exceeded the 2.31 pCi/g background activity limit. In addition, the MDA used in the analysis of sample CY10-SS-ARY-2 exceeded the background activity limit.

Thorium-232 is a long-lived thorium series indicator for contamination (Miller June 1998). Gamma activity from thorium-232 exceeded background limits in five samples. However, in each instance the background limits were exceeded only slightly.

Gamma activity resulting from uranium-235 was not detected above the 0.16 pCi/g background activity limit. However, the MDAs for six of the seven samples were above the background activity limit. Because gamma activity from uranium-238 was below background activity limits in six samples, it is reasonable to infer that uranium-235 also does not exceed background activity limits in those six samples. In addition, the MDA for uranium-235 was still several orders of magnitude less than a projected PRG for that isotope, so there is no human health or environmental concern. Gamma activity resulting from cesium-137 was not detected above the 1.55 pCi/g background limit in any of the samples collected.

Table 3.4.4-6
Summary of SWMU 10 Confirmatory Soil Sampling Metal Analytical Results, Arroyos, April–August 1997

Sample Attributes			Metals (EPA Methods 6010/6020/7000) ^a (mg/kg)								
Record Number ^b	ER Sample ID (Figure 3.4.4-3)	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
06158	CY10-SS-ARY-1	0.5–1.0	0.76 J (2.6)	73	0.61	0.16 J (0.17)	5.5	8.6	ND (0.043)	0.34 J (1.3)	ND (0.043)
06567	CY10-SS-ARY-2 (Off-site laboratory)	0.5–1.0	7.0	66.	0.72 J (0.99)	0.63 J (0.99)	46. ^c	13.	ND (0.10)	2.9	ND (0.40)
06567	CY10-SS-ARY-2-D (Off-site laboratory)	0.5–1.0	5.2	69.	0.76 J (0.98)	ND (0.39)	27.	9.8	ND (0.10)	2.0	ND (0.39)
06158	CY10-SS-ARY-3	0.5–1.0	0.93 J (2.5)	55	0.65	0.21	7.6	4.9	ND (0.042)	0.72 J (1.3)	0.07 J (0.17)
06158	CY10-SS-ARY-4	0.5–1.0	1.6 J (2.4)	59	0.7	0.3	30	12	ND (0.04)	0.83 J (1.2)	0.1 J (0.16)
06158	CY10-SS-ARY-5	0.5–1.0	0.9 J (2.7)	66 B	0.56 B	0.19 B	9.1	8.2	ND (0.045)	0.48 J (1.3)	ND (0.045)
06158	CY10-SS-ARY-6	0.5–1.0	0.82 J (2.3)	59 B	0.56 B	0.18 B	6.9	8.8	ND (0.038)	0.38 J (1.1)	ND (0.038)
06158	CY10-SS-ARY-7	0.5–1.0	ND (0.58)	30 B	0.3 B	0.11 J B (0.15)	4.4	5.5	ND (0.038)	0.36 J (1.2)	ND (0.038)
Quality Assurance/Quality Control Samples (all in µg/L)											
06158	CY10-RBF (EB)	NA	ND (3.4)	ND (3.9)	ND (0.11)	ND (0.22)	ND (8.4)	ND (1.7)	ND (0.22)	ND (1.7)	ND (0.22)
SNL/NM Canyons Soil Background 95th UTL or 95th Percentile Concentration ^d			9.8	246	0.75	0.64	18.8	18.9	0.055	3.0	<0.5

^aEPA Method 6020 (EPA November 1986) used by on-site laboratory and EPA Methods 6010/7000 (EPA November 1986) used by off-site laboratory.

^bAnalysis request/chain of custody record.

^cValues in bold exceed background soil concentrations.

^dFrom Zamorski December 1997.

ARY = Arroyo.

B = Associated analyte was also observed in the method blank.

CY = Canyon.

D = Duplicate.

EB = Equipment blank.

EPA = U.S. Environmental Protection Agency.

ER = Environmental Restoration.

ft = Foot (feet).

ID = Identification.

J () = The estimated value reported is either above the method detection limit (MDL) and less than the practical quantification limit (shown in parenthesis) for on-site laboratory analyses or above the instrument detection limit and less than the contract required detection limit (shown in parenthesis) for off-site laboratory analyses.

µg/L = Microgram(s) per liter.

mg/kg = Milligram(s) per kilogram.

NA = Not applicable.

ND () = Not detected at or above the MDL, shown in parenthesis.

SNL/NM = Sandia National Laboratories, New Mexico.

SS = Surface soil sample.

SWMU = Solid waste management unit.

UTL = Upper tolerance limit.

Table 3.4.4-7
Summary of SWMU 10 Confirmatory Soil Sampling Gamma Spectroscopy Analysis, Arroyos, April–August 1997

Sample Attributes			Activity (pCi/g)							
Record Number ^a	ER Sample ID (Figure 3.4.4-3)	Sample Depth (ft)	Uranium-238		Thorium-232		Uranium-235		Cesium-137	
			Result	Error ^b	Result	Error ^b	Result	Error ^b	Result	Error ^b
06569	CY10-SS-ARY-1	0.5–1.0	9.43E-01	1.84E+00	1.04E+00^c	5.02E-01	ND (2.17E-01)	--	1.22E-01	3.71E-02
06568	CY10-SS-ARY-2	0.5–1.0	ND (3.82E+00)	--	1.62E+00	7.51E-01	ND (2.81E-01)	--	1.30E-01	1.10E-01
06569	CY10-SS-ARY-3	0.5–1.0	ND (2.12E+00)	--	1.61E+00	7.48E-01	ND (2.98E-01)	--	5.77E-02	3.32E-02
06569	CY10-SS-ARY-4	0.5–1.0	7.51E+00	1.74E+00	1.24E+00	5.78E-01	ND (2.39E-01)	--	ND (4.13E-02)	--
06569	CY10-SS-ARY-5	0.5–1.0	ND (1.20E+00)	--	1.06E+00	5.00E-01	ND (2.16E-01)	--	1.12E-01	1.06E-01
06569	CY10-SS-ARY-6	0.5–1.0	ND (1.53E+00)	--	9.40E-01	4.49E-01	1.15E-01	8.04E-02	8.08E-02	2.62E-02
06569	CY10-SS-ARY-7	0.5–1.0	ND (1.44E+00)	--	8.56E-01	4.74E-01	ND (2.02E-01)	--	1.99E-02	1.33E-02
Background Soil Activity, Lower Canyons ^d			2.31	NA	1.03	NA	0.16	NA	1.55	NA
Quality Assurance/Quality Control Samples (all in pCi/mL)										
06569	CY10-RBF (EB)	NA	ND (8.86E-01)	--	ND (1.67E-01)	--	ND (1.42E-01)	--	ND (2.67E-02)	--

^aAnalysis request/chain of custody record.

^bTwo standard deviations about the mean detected activity.

^cValues in bold exceed background soil activity.

^dFrom Dinwiddie September 1997.

ARY = Arroyo

CY = Canyon.

EB = Equipment blank.

ER = Environmental Restoration.

ft = Foot (feet).

ID = Identification.

NA = Not applicable.

ND () = Not detected at or above the minimum detectable activity, shown in parentheses.

pCi/g = Picocurie(s) per gram.

pCi/mL = Picocurie(s) per milliliter.

SNL/NM = Sandia National Laboratories, New Mexico.

SS = Surface soil sample.

SWMU = Solid waste management unit.

-- = Error not calculated for nondetectable results.

Explosives

During confirmatory sampling at SWMU 10, a total of seven soil samples and one duplicate sample were collected from the arroyo sediments and analyzed for HE. Results of the analyses indicate that no HE compounds were detected in the samples. Table 3.4.4-3 shows the detection limits used for HE analyses by both on- and off-site laboratories.

3.4.4.4.4 *Quality Assurance/Quality Control Results*

Data quality were assessed by reviewing the field QA/QC results and validating the laboratory QA/QC results for all analyses. This section summarizes the data quality assessment.

Metals

Table 3.4.4-1, Table 3.4.4-4, and Table 3.4.4-6 present results of the analysis of metals QA/QC samples collected during confirmatory sampling at SWMU 10. All QA/QC analyses were performed on site. QA/QC samples consisted of six equipment blanks (CY10-RBA, CY10-RBC, CY10-RBD, CY10-RBE, CY10-RBF, and CY10-RBG). Results of the analyses indicate that no metals were detected in the equipment blanks.

Eight duplicate samples (CY10-M3-S1-D, CY10-M4-S2-D, CY10-M6-T1-M-D, CY10-M9-T1-M-D, CY10-PIT-1D, CY10-M10-T1-B-D, CY10-SS-S3-D, and CY10-SS-ARY-2-D) were collected during confirmatory sampling at SWMU 10 and were analyzed on site for metals. Variability in the concentration levels of metals in certain duplicate samples and the equivalent primary samples was observed. Results for sample CY10-M3-S1-D indicated lower concentrations of barium, beryllium, cadmium, chromium, and lead than reported for the primary sample. However, similar variability resulted in the corresponding split samples for CY10-M3-S1 and CY10-M3-S1-D that were sent to the off-site laboratory. Results for samples CY10-M4-S2-D and CY10-M6-T1-M-D indicated significantly lower concentrations of chromium than reported for the primary samples. This variability was not reproduced in the split samples for CY10-M4-S2 and CY10-M4-S2-D, and CY10-M6-T1-M and CY10-M6-T1-D that were sent to the off-site laboratory. The concentration levels of metals in all other duplicate samples were comparable to those detected in the equivalent primary samples.

Twelve split samples (CY10-M2-T1-M, CY10-M4-S2, CY10-M4-S2-D, CY10-VM-1, CY10-M6-T1-M, CY10-M6-T1-M-D, CY10-M9-T1-M, CY10-M9-T1-M-D, CY10-PIT-1, CY10-PIT-1D, CY10-M10-T1-B, and CY10-M10-T1-B-D) were collected during confirmatory sampling at SWMU 10 and were verification analyzed off site for metals. Arsenic concentrations were substantially higher in all split samples. Chromium concentrations were also higher in several split samples, however, it is believed that this is caused by variations in the amount of vermiculite in the sample matrices (see Annex 3-A). Because of the higher MDL in the off-site analyses, metals such as cadmium, mercury, selenium, and silver were typically not detected in the off-site samples.

Relative percent differences (RPD) were calculated for metals detected in samples with an associated duplicate that were both analyzed by the same laboratory (Table 3.4.4-8). In general, the metals analyses had acceptable RPDs less than 25 percent. Arsenic RPDs were slightly above acceptable limits in two samples. Five of fourteen samples for barium and four of the fourteen samples for chromium exceeded the acceptable RPD. Three lead analyses exceeded 25 percent. However, the RPDs presented in Table 3.4.4-8 are typical of data for uncontaminated soil and are therefore acceptable.

Radionuclides

Tables 3.4.4-2, 3.4.4-5, and 3.4.4-7 present analytical results of radionuclides in QA/QC samples collected during confirmatory sampling at SWMU 10. All QA/QC analyses were performed on site. QA/QC samples consisted of six equipment blanks (CY10-RBA, CY10-RBC, CY10-RBD, CY10-RBE, CY10-RBF, and CY10-RBG). Results of the analyses indicate that no radionuclides were detected in the equipment blanks.

Four duplicate soil samples (CY10-M3-S1-D, CY10-M4-S2-D, CY10-M9-T1-M-D, and CY10-PIT-1-D) were collected during confirmatory sampling at SWMU 10 and were analyzed on site for radionuclides using gamma spectroscopy. Activities of radionuclides in the duplicate samples were comparable to those detected in the equivalent primary samples.

High Explosives

Results of the analysis of HE in the QA/QC samples that were collected during confirmatory sampling at SWMU 10 are not presented. However, six equipment blanks (CY10-RBA, CY10-RBC, CY10-RBD, CY10-RBE, CY10-RBF, and CY10-RBG) were included in the QA/QC samples. All QA/QC analyses were performed on site. Results of the analyses indicated that no HE were detected in the equipment blanks at MDLs ranging from 16 to 72 µg/L.

Eight duplicate samples (CY10-M3-S1-D, CY10-M4-S2-D, CY10-M6-T1-M-D, CY10-M9-T1-M-D, CY10-PIT-1D, CY10-M10-T1-B-D, CY10-SS-S3-D, and CY10-SS-ARY-2-D) were collected during post-VCM confirmatory sampling at SWMU 10 and were analyzed on site for HE. Results of the analyses indicate that no HE were detected in the sample duplicates.

Twelve split samples (CY10-M2-T1-M, CY10-M4-S2, CY10-M4-S2-D, CY10-VM-1, CY10-M6-T1-M, CY10-M6-T1-M-D, CY10-M9-T1-M, CY10-M9-T1-M-D, CY10-PIT-1, CY10-PIT-1D, CY10-M10-T1-B, and CY10-M10-T1-B-D) were collected during post-VCM confirmatory sampling at SWMU-10 and were verification analyzed off site for HE. Results of the analyses indicate that no HE were detected in the split samples.

Data Validation

SNL/NM Department 7713 Radiation Protection Sample Diagnostics (RPSD) reviewed all gamma spectroscopy results according to "Laboratory Data Review Guidelines,"

Table 3.4.4-8
Summary of SWMU 10 Field-Duplicate Relative Percent Differences

Sample Attributes		Relative Percent Differences								
Record Number ^a	ER Sample ID	Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
Mound										
06157	CY10-M3-SI CY10-M3-SI-D (On-site laboratory)	NC ^a	46.7	NC ^a	73.0	40.0	52.5	NC ^b	NC ^a	NC ^a
06543	CY10-M4-S2 CY10-M4-S2-D (Off-site laboratory)	24.2	7.0	NC ^a	NC ^b	2.9	13.3	NC ^b	NC ^b	NC ^b
06157	CY10-M4-S2 CY10-M4-S2-D (On-site laboratory)	NC ^a	42.7	22.6	NC ^a	47.6	20.2	NC ^b	NC ^a	NC ^a
06566	CY10-M6-T1-M CY10-M6-T1-M-D (Off-site laboratory)	4.9	18.1	NC ^a	NC ^b	22.2	8.9	NC ^b	NC ^b	NC ^b
06008	CY10-M6-T1-M CY10-M6-T1-M-D (On-site laboratory)	3.6	0.0	NC ^a	NC ^a	8.0	1.5	NC ^b	NC ^a	NC ^b
06566	CY10-M9-T1-M CY10-M9-T1-M-D (Off-site laboratory)	5.1	0.0	NC ^a	NC ^b	10.8	15.4	NC ^b	NC ^b	NC ^b
06008	CY10-M9-T1-M CY10-M9-T1-M-D (On-site laboratory)	NC ^a	28.6	NC ^a	NC ^a	17.1	8.7	NC ^b	35.3	NC ^b
06542	CY10-PIT-1 CY10-PIT-1-D (Off-site laboratory)	1.2	0.0	8.0	NC ^b	8.0	5.1	NC ^b	NC ^b	NC ^b
06159	CY10-PIT-1 CY10-PIT-1-D (On-site laboratory)	0.0	4.3	8.7	8.0	15.4	0.0	NC ^a	6.7	6.8
06566	CY10-M10-T1-B CY10-M10-T1-B-D (Off-site laboratory)	10.5	20.3	NC ^a	NC ^b	24.0	10.2	NC ^b	NC ^b	NC ^b
06008	CY10-M10-T1-B CY10-M10-T1-B-D (On-site laboratory)	NC ^a	39.5	35.1	NC ^a	51.4	53.2	NC ^b	NC ^a	NC ^b

Refer to footnotes at end of table.

Table 3.4.4-8 (Concluded)
Summary of SWMU 10 Field-Duplicate Relative Percent Differences

Sample Attributes		Relative Percent Differences								
Record Number ^a	ER Sample ID	Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
Grid										
06567	CY10-SS-S3 CY10-SS-S3-D (Off-site laboratory)	29.3	27.5	NC ^a	NC ^b	8.0	21.5	NC ^b	NC ^b	NC ^b
Arroyo										
06567	CY10-SS-ARY-2 CY10-SS-ARY-2-D (Off-site laboratory)	29.5	4.4	NC ^a	NC ^b	52.1	28.1	NC ^b	36.7	NC ^b
Former Vermiculite Mound										
600316	CY10-052698-GR-001-SS CY10-052698-GR-001-DU (Off-site laboratory) (Post-VCA)	1.9	7.3	17.8	27.0	8.6	9.9	NC ^a	13.7	NC ^a

^aAnalysis request/chain of custody record.

ARY = Arroyo

CY = Canyon.

D = Duplicate Analysis.

EPA = U.S. Environmental Protection Agency.

ER = Environmental Restoration.

ID = Identification.

M = Mound

NC^a = Not calculated, both original sample and duplicate were estimated values.

NC^b = Not calculated, at least one of the original sample or duplicate were nondetects.

NC^c = Not calculated, associated analyte was also observed in the method blank.

SWMU = Solid waste management unit.

Procedure No. RPSD-02-11, Issue No. 2 (SNL/NM July 1996). In addition, all off-site laboratory results were reviewed and verified/validated according to "Data Verification/Validation Level 3—DV-3" in Attachment C of the Technical Operating Procedure 94-03, Rev. 0 (SNL/NM July 1994b). Annex 3-C summarizes off-site data validation results. The verification/validation process confirmed that the data are acceptable for use in this NFA proposal for SWMU 10.

3.4.5 Investigation #4 SNL/NM ER Project Voluntary Corrective Action (Solid Waste Removal) and Confirmatory Sampling

3.4.5.1 *Nonsampling Data Collection*

No nonsampling data collection activities were associated with the VCA and the confirmatory sampling activities.

3.4.5.2 *Sampling Data Collection*

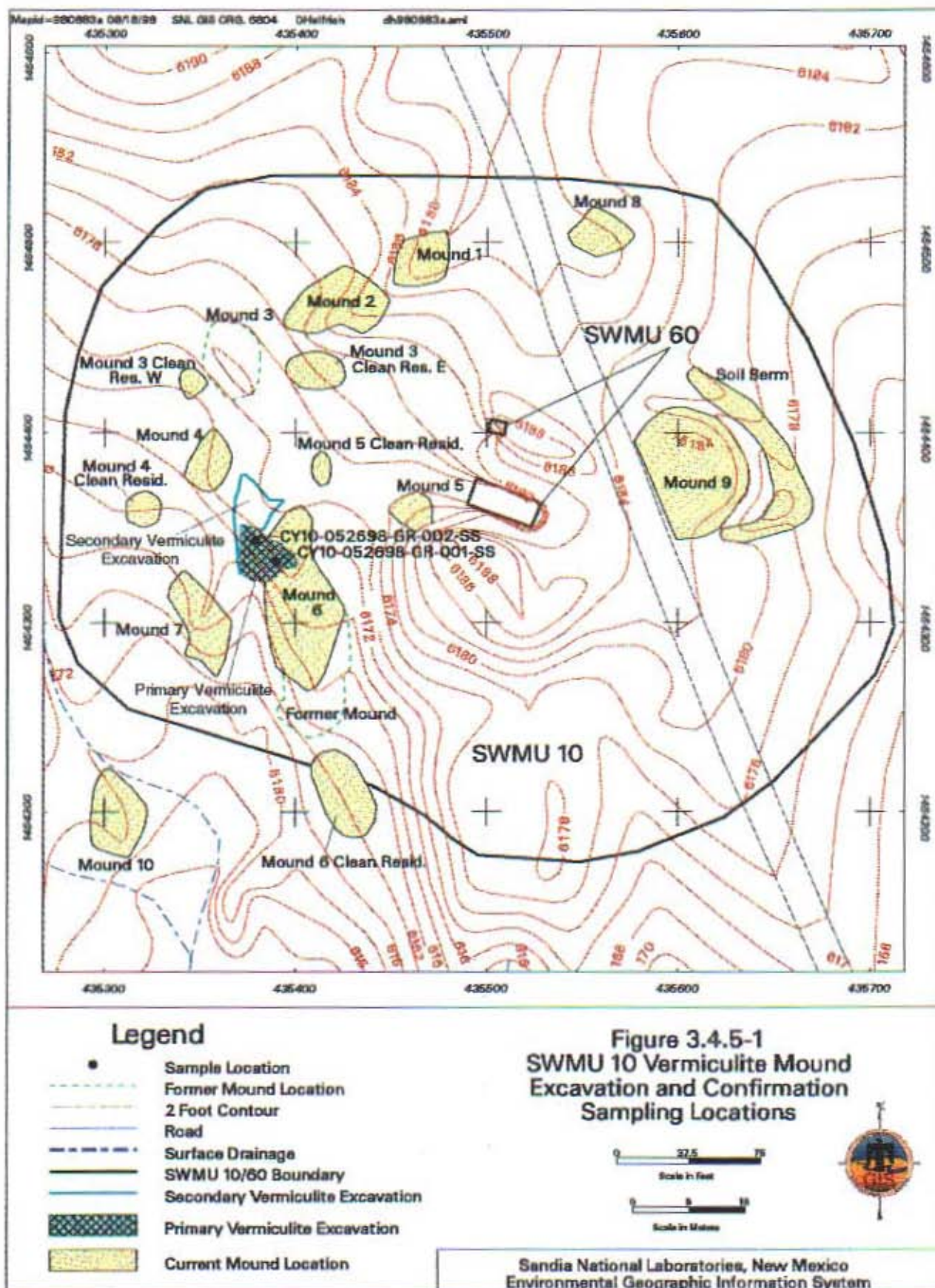
A VCA was performed in May 1998 to remove the vermiculite mound from SWMU 10. Confirmatory sampling was conducted to confirm that no RCRA metals associated with vermiculite remained at the site at concentrations that might pose a level of risk under current and projected future land uses.

3.4.5.2.1 *Voluntary Corrective Action Activities*

A VCA (solid waste removal) was conducted in May 1998 to remove the vermiculite mound. Vermiculite, a naturally occurring mineral, has been shown to contain significant concentrations of chromium and barium (see Annex 3-A). Although toxicity characteristic leaching procedure analysis indicates that the chemical properties of vermiculite are such that the barium and chromium are not accessible to the environment (see Annex 3-A), it was determined that the material (60 cubic yards [yd³]) should be removed from the site. The material excavated (Figure 3.4.5-1) was subsequently disposed of as RCRA Subtitle D solid waste using standard SNL/NM-approved waste disposal protocols.

3.4.5.2.2 *Confirmatory Sampling*

On May 26, 1998, two soil samples (CY10-052698-GR-001 and CY10-052698-GR-002) were collected from beneath the former vermiculite mound location. In addition, one duplicate soil sample was collected (CY10-052698-GR-001-DU). Figure 3.4.5-1 shows sample locations. SNL/NM followed AR/COC and sample documentation procedures for all samples collected. The samples were analyzed for RCRA metals plus beryllium using EPA Method 6010A (EPA November 1986). Mercury was analyzed using EPA Method 7471 (EPA November 1986). All analyses were performed by General Engineering Laboratories in Charleston, South Carolina. The laboratory results were reviewed and verified/validated according to "Data Verification/Validation Level 3—DV3 in Attachment C of the Technical Operating Procedure 94-03, Rev. 0 (SNL/NM July 1994b). All confirmatory sampling data are acceptable for use in this NFA proposal for SWMU 10.



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3.4.5.3 Data Gaps

There are no data gaps related to characterization of SWMU 10.

3.4.5.4 Results and Conclusions

All metals concentrations in the confirmatory soil samples were below the background limits (Table 3.4.4-1). The removal of 60 yd³ of vermiculite and vermiculite/soil mixture successfully eliminated the primary source of vermiculite from SWMU 10.

3.5 Site Conceptual Model

This section describes the conceptual model for SWMU 10 and summarizes the nature and extent of contamination and the environmental fate of COCs.

3.5.1 Nature and Extent of Contamination

The COCs at SWMU 10 are metals and radionuclides associated primarily with accidental detonation of two mock weapons. Other tests conducted at the site may have contributed to contamination at SWMU 10 also, but the specific materials involved with those tests are unknown. Table 3.5.1-1 summarizes the COCs for SWMU 10.

Fifty-three environmental samples were collected from the soil/debris mounds. In addition, 17 environmental samples were collected from the fragmentation area (radial grid pattern), and seven environmental samples were collected from the arroyos. Whether any metal or radiological COC exceeded the background concentration limit in any sample was the determining factor in designating potential contaminants. In the case of nondetectable results, the MDL (for metals) or MDA (for radionuclides) was compared to the background concentration limit. As a result, metal COCs included barium, beryllium, cadmium, chromium, lead, mercury, selenium, and silver. Based on an extensive investigation into the chemical composition of natural vermiculite (see Annex 3-A), it is believed that significantly elevated barium and chromium concentrations are attributable to vermiculite present at the site prior to conducting the VCA. Therefore, no pre-VCA samples from the former vermiculite mound or vicinity were included to define the nature and extent of contamination. Radiological COCs included uranium-238, uranium-235, and thorium-232. Table 3.5.1-1 lists the COCs and the sample locations where the COCs exceed the maximum background concentration limits.

Metal COCs that exceed background limits typically occur as isolated *hot spots* of one or two different COCs with no particular COC associations or as areas that could be delineated as contaminated. However, sample location CY10-PIT-1 (the surface water accumulation area, see Section 3.4.4.2.2) did contain several metal COCs slightly above background concentration limits. Radionuclide COCs associated with DU (uranium-238) were detected above background limits where VCM activities were conducted at Mounds 3 and 6. All other occurrences of radionuclide COCs above background concentration limits were sporadic. It is expected that no metal or radionuclide COCs are bgs at any location within SWMU 10, because the release

**Table 3.5.1-1
Summary of COCs for SWMU 10**

COC Type	Number of Samples	COCs Greater Than Background	Maximum Background Limit/Canyons ^a (mg/kg except where noted)	Maximum Concentration (mg/kg except where noted)	Average Concentration ^b (mg/kg except where noted)	Sampling Locations Where Background Concentration Exceeded ^c
Inorganic nonradiological	76 environmental, 6 duplicates, 7 splits	Ba	246	250	109	CY10-PIT-1 (split) CY10-PIT-1D (duplicate)
		Be	0.75	3.4 B	0.70	CY10-M3-S1 CY10-M3-S2 CY10-M6-T3-M CY10-M6-S2 CY10-M8-T1-B CY10-M9-T1-M CY10-M9-T2-B CY10-M9-T3-M CY10-PIT-1 (plus duplicate & split) CY10-M10-T3-M CY10-SS-N2 CY10-SS-N3 CY10-SS-NE1 CY10-SS-SE3 CY10-SS-S3 CY10-SS-S4 CY10-SS-SW4 CY10-SS-NW4 CY10-SS-ARY-2-D
		Cd	0.64	0.65	0.25	CY10-PIT-1D
		Cr	18.8	46	12.0	CY10-M1-T2-M CY10-M1-T2-B CY10-M2-T1-M CY10-M2-T1-M (split) CY10-M3-S2 CY10-M5-S1 CY10-M6-T2-M CY10-M7-T2-B CY10-SS-ARY-2 CY10-SS-ARY-2-D CY10-SS-ARY-4
		Pb	18.9	30	8.3	CY10-PIT-1 (plus duplicate & splits) CY10-SS-E4

Refer to footnotes at end of table.

Table 3.5.1-1 (Continued)
Summary of COCs for SWMU 10

COC Type	Number of Samples	COCs Greater Than Background	Maximum Background Limit/Canyons ^a (mg/kg except where noted)	Maximum Concentration (mg/kg except where noted)	Average Concentration ^b (mg/kg except where noted)	Sampling Locations Where Background Concentration Exceeded ^c
		Hg	0.055	ND (0.075 J)	0.059	CY10-M1-T2-B CY10-M2-T1-M (plus split) CY10-M6-T1-M CY10-M6-T1-M-D CY10-M9-T1-M CY10-M9-T1-M-D CY-M10-T1-B CY10-M10-T1-B-D CY10-PIT-1 (plus duplicate and splits) All off-site analyses ^d
		Se	3.0	3.1	1.1	CY10-PIT1D
		Ag	<0.5	0.61	0.11	CY10-PIT-1 CY10-PIT-1D
Radiological	70 environmental, 3 duplicates	U-238	2.31 pCi/g	8.41 pCi/g	Not calculated ^e	CY10-M1-T1-M CY10-M3-S1 CY10-M3-S1-D CY10-M3-S2 CY10-M3-S3 CY10-M5-S2 CY10-M6-S2 CY10-M9-T2-U CY10-SS-ARY-4 Mound Samples Arroyo Sample ^g
		Th-232	1.03 pCi/g	2.29 pCi/g	Not calculated	CY10-M1-T1-M CY10-M1-T1-B CY10-M1-T2-M CY10-M1-T2-B CY10-M2-T1-M CY10-M2-T1-B CY10-M2-T2-M CY10-M2-T2-B CY10-M2-T3-M CY10-M3-S1 CY10-M3-S1-D CY10-M5-S1 CY10-M6-T3-M CY10-M6-S1 CY10-M7-T1-M CY10-M7-T1-B CY10-M7-T2-M CY10-M7-T3-M CY10-M7-T3-B CY10-M7-T3-M CY10-M8-T1-B CY10-M9-T1-M-D CY10-M9-T1-M CY10-M9-T1-B CY10-M9-T2-U CY10-M9-T3-M CY10-PIT-1 CY10-PIT-1-D CY10-SB9-2 CY10-M10-T1-B CY10-M10-T2-M Grid Samples ^h Arroyo Samples ⁱ

Refer to footnotes at end of table.

Table 3.5.1-1 (Concluded)
Summary of COCs for SWMU 10

COC Type	Number of Samples	COCs Greater Than Background	Maximum Background Limit/Canyons ^a (mg/kg except where noted)	Maximum Concentration (mg/kg except where noted)	Average Concentration ^b (mg/kg except where noted)	Sampling Locations Where Background Concentration Exceeded ^c
		U-235	0.16	0.303 pCi/g	Not calculated	CY10-M1-T1-B CY10-M2-T1-M CY10-M3-S1 CY10-M3-S2 CY10-M3-S3 CY10-M6-T3-M CY10-M9-T2-B CY10-PIT-1-D Grid Samples ^d Arroyo Samples ^k Mound Samples ^l

^aFrom SNL/NM December 1997 (metals) and Dinwiddie September 1997 (radionuclides).

^bAverage concentration includes all samples, duplicates, and splits. For nondetectable results, the detection limit is used to calculate the average.

^cFor radionuclide COCs, sampling locations are only reported where detected activities exceed background. Nondetectable activities, where the minimum detectable activity exceeds background, are not listed.

^dThe detection limits used in the off-site analyses for mercury were above the background concentration limit.

^eAn average minimum detectable activity is not calculated due to the variability in instrument counting error and the number of reported nondetectable activities.

^fEleven mean detected activities for nondetect results from mound samples exceeded the maximum background limit.

^gOne mean detected activity for nondetect results from arroyo samples exceeded the maximum background limit.

^hAll grid samples exceed background for thorium-232 except CY10-SS-NE1, NE3, E4, SE1, and NW1.

ⁱAll Arroyo samples exceeded background for thorium-232 except CY10-SS-ARY-6 and 7.

^jSixteen mean detected activities for nondetect results from grid samples exceeded the maximum background limit.

^kSix mean detected activities for nondetect results from arroyo samples exceeded the maximum background limit.

^lThirty-two mean detected activities for nondetect results from mound samples exceeded the maximum background limit.

B = Associate analyte was also observed in the method blank.

COC = Constituent of concern.

ND () = Not detected at or above the method detection limit or the minimum detectable activity, shown in parenthesis.

mg/kg = Milligram(s) per gram.

pCi/g = Picocurie(s) per gram.

SNL/NM = Sandia National Laboratories/New Mexico.

SWMU = Solid waste management unit.

mechanism at the site was primarily caused by dispersion from explosives and salvage operations that produced aboveground soil/debris mounds.

3.5.2 Environmental Fate

Primary sources of COCs for SWMU 10 were DU, HE, and metals associated with accidental detonation of two mock weapons (Figure 3.5.2-1). Other tests conducted at the site may have contributed to contamination at SWMU 10 also, but specific details regarding those tests are unknown. It is believed that the soil/debris mounds were formed as the result of grading operations for site access, from construction of the SWMU 60 bunker, and from salvage operations conducted after the detonation of the mock weapons. Analytical results indicated that no residual HE compounds are present in the soil/debris mounds or surrounding surface soils (see Section 3.4.4.3). A radiological VCM was conducted in 1996 to remove radiological anomalies associated with the soil/debris mounds. A VCA was conducted in 1998 to remove the vermiculite mound.

Table 3.5.1-1 lists potential COCs for SWMU 10. Based upon the nature and extent of contamination at the site (Section 3.5.1), metal COCs occur sporadically around the site at concentrations higher than the maximum background concentrations. Radionuclide COCs occur in the residual mounds at concentrations higher than the maximum background activities at several locations where remediation was conducted (specifically Mound 3 and 6). Sample location CY10-PIT-1 has been shown to contain both metal and radionuclide COCs consistently above background concentration limits. Excluding those areas specifically mentioned above, the majority of the potential COCs are present in concentrations just slightly exceeding the maximum background limits. All potential COCs were retained in the conceptual model and evaluated in the human health and ecological risk assessments.

Since radiation anomalies were removed from the site, the secondary source of COCs is residual metals and radionuclides in the soil/debris mounds and surface soil. No historical testing activities have been conducted at SWMU 10 that resulted in the presence of COCs below the surface soil. The secondary release mechanisms at SWMU 10 are, therefore, limited to suspension and/or dissolution of COCs in surface-water runoff and percolation to the vadose zone, direct contact with soil (radionuclides only), dust emissions, and uptake of COCs in the soil by biota (Figure 3.5.2-1). The depth to groundwater at the site (at approximately 180 feet bgs) precludes migration of COCs to the aquifer. The pathways to receptors are surface water, soil water, air, and soil (radionuclides). Biota are also a pathway through food chain transfers. Annex 3-D provides additional discussion of the fate and transport of COCs at SWMU 10.

The current and future land use for SWMU 10 is industrial (DOE and USAF March 1996). However, because the site is close to private housing developments, a residential land use is also considered. For all applicable pathways, the exposure route for the receptor is dermal contact and ingestion/inhalation. In addition, the receptor could be exposed by external irradiation from radionuclides in soil. Only external irradiation and ingestion of soil are considered major exposure routes for the receptor. Potential biota receptors include flora and fauna at the site. Similar to the human receptor, external irradiation and ingestion of soil are considered major exposure routes for biota, in addition to ingesting COCs through food chain transfers or indirect uptake. Annex 3-D provides additional discussion of the exposure routes and receptors at SWMU 10.

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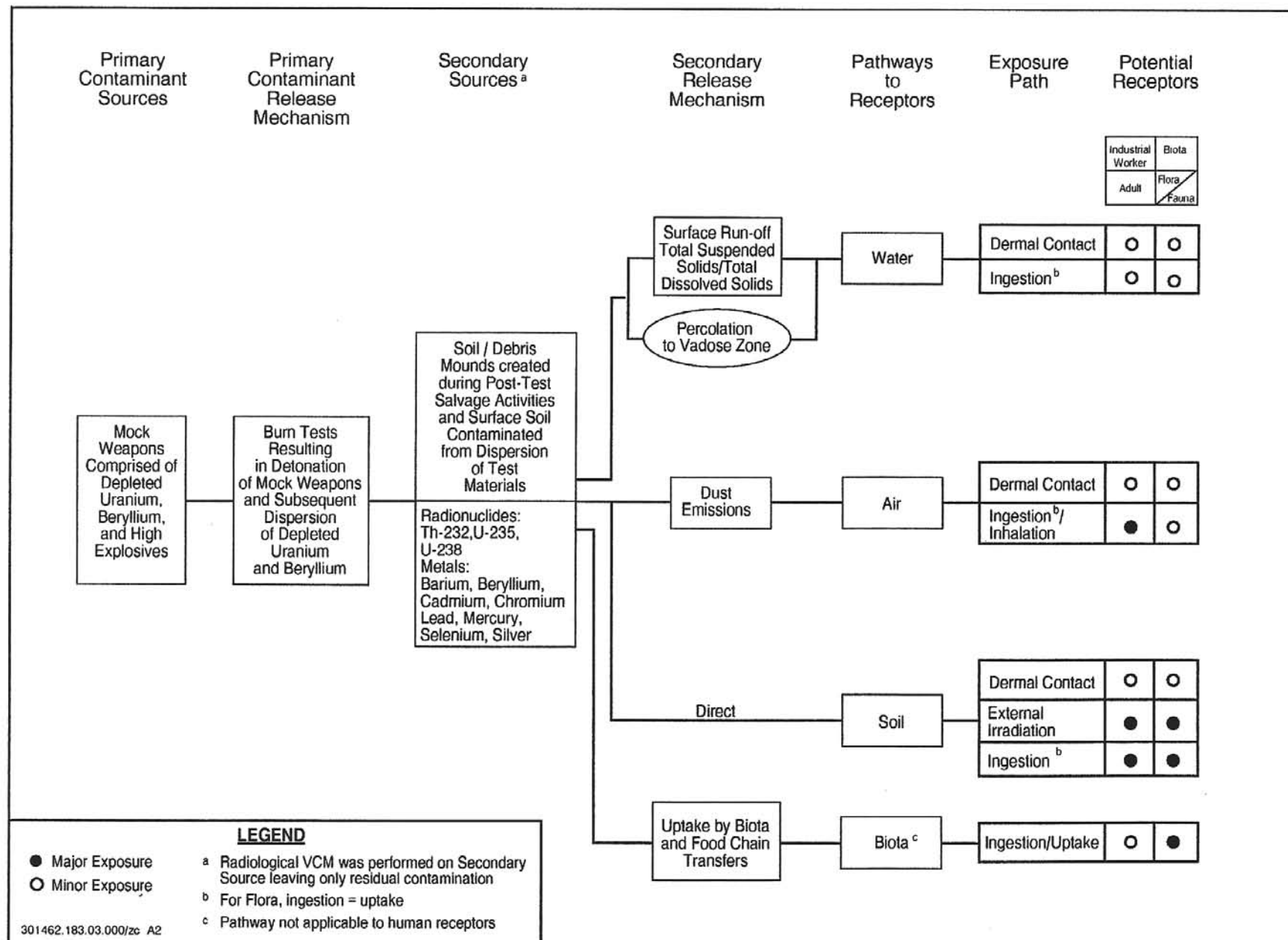


Figure 3.5.2-1
Conceptual Model Flow Diagram for SWMU 10, Burial Mounds

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3.6 Site Assessments

The site assessment process for SWMU 10 includes risk screening assessments and risk baseline assessments for both human health risk and ecological risk. This section briefly summarizes the site assessment results. Annex 3-D provides details of the site assessment.

3.6.1 Summary

The site assessment concludes that SWMU 10 does not have potential to affect human health under an industrial land-use scenario. After consideration of the uncertainties of related available data and modeling assumptions, ecological risks associated with SWMU 10 were found to be very low. Section 3.6.2 briefly describes and Annex 3-D provides detailed descriptions of the site assessments.

3.6.2 Screening Assessments

Risk screening assessments were performed for both human health risk and ecological risk for SWMU 10. The following discusses the results.

3.6.2.1 Human Health

SWMU 10 has been recommended for industrial land use; however, based upon recommendations from the Citizen's Advisory Board, a residential land use is also considered (DOE and USAF March 1996). Annex 3-D provides a complete discussion of the risk assessment process, results, and uncertainties. Because COCs are present in concentrations or activities greater than background levels, it was necessary to perform a health risk assessment analysis for the site. Besides COC metals, this assessment included any volatile organic compounds or semivolatile organic compounds detected above their reporting limits and any radionuclide compounds either detected above background levels and/or MDAs. The risk assessment process provides a quantitative evaluation of the potential adverse human health effects caused by constituents in the site's soil. The Risk Assessment Report calculated the hazard index (HI) and excess cancer risk for both an industrial land-use and residential land-use setting. The excess cancer risk from nonradiological COCs and the radiological COCs is not additive (EPA 1989).

The HI calculated for SWMU 10 nonradiological COCs is 0.01 for an industrial land-use setting, which is less than the numerical standard of 1.0 suggested by risk assessment guidance (EPA 1989). Incremental risk is determined by subtracting risk associated with background from potential nonradiological COC risk. Since the background HI is 0.0 the incremental HI is also 0.01. The total excess cancer risk for SWMU 10 nonradiological COCs is $1\text{E-}7$ for an industrial land-use setting. Guidance from the NMED indicates that excess lifetime risk of developing cancer by an individual must be less than $1\text{E-}6$ for Class A and B carcinogens and less than $1\text{E-}5$ for Class C carcinogens (NMED March 1998). The total excess cancer risk is driven by chromium, total. Chromium, total, is assumed to be chromium VI (most conservative) which is

a Class A carcinogen. Thus, the excess cancer risk for this site is below the suggested acceptable risk value of $1\text{E-}6$. The incremental excess cancer risk for SWMU 10 is $1\text{E-}7$.

The incremental total effective dose equivalent (TEDE) for radionuclides for an industrial land-use setting for SWMU 10 is 3.8 millirems per year (mrem/yr), which is well below the recommended dose limit of 15 mrem/yr found in EPA's OSWER Directive No. 9200.4-18 and reflected in a document entitled "Sandia National Laboratories/New Mexico Environmental Restoration Project—RESRAD Input Parameter Assumptions and Justification" (February 1998). The incremental excess cancer risk for radionuclides is $5.5\text{E-}5$ for an industrial land-use scenario, which is much less than risk values calculated from naturally occurring radiation and from intakes considered background concentration values.

The HI calculated for SWMU 10 nonradiological COCs is 2 for a residential land-use setting, which is above the numerical standard of 1.0 suggested by risk assessment guidance (EPA 1989). Incremental risk is determined by subtracting risk associated with background from potential nonradiological COC risk. The incremental HI is 0.15. The excess cancer risk for SWMU 10 nonradiological COCs is $2\text{E-}7$ for a residential land-use setting. Guidance from the NMED indicates that excess lifetime risk of developing cancer by an individual must be less than $1\text{E-}6$ for Class A and B carcinogens and less than $1\text{E-}5$ for Class C carcinogens (NMED March 1998). Thus, the excess cancer risk for this site is below the suggested acceptable risk value of $1\text{E-}6$. The incremental excess cancer risk for SWMU 10 is $2\text{E-}7$.

The incremental TEDE for radionuclides for a residential with loss of institutional control, land-use setting for SWMU 10 is 6.8 mrem/yr, which is well below the recommended dose limit of 75 mrem/yr found in "Sandia National Laboratories/New Mexico Environmental Restoration Project—RESRAD Input Parameter Assumptions and Justification" (February 1998). The incremental excess cancer risk for radionuclides is $1.1\text{E-}4$ for a residential land-use scenario, which is much less than risk values calculated from naturally occurring radiation and from intakes considered background concentration values. The report concludes that SWMU 10 does not have potential to affect human health under either an industrial or a residential land-use scenario.

3.6.2.2 Ecological

An ecological screening assessment that corresponds with the screening procedures in the EPA's Ecological Risk Assessment Guidance for Superfund (EPA 1997) was performed as set forth by the NMED Risk-Based Decision Tree (NMED March 1998). An early step in the evaluation is to compare COC concentration levels and to identify potentially bioaccumulative constituents. This is presented in Annex 3-D, Sections III and VI and Sections VII.2 and VII.3. This methodology requires developing a site conceptual model and food web model as well as selecting ecological receptors. Each of these items is presented in the "Predictive Ecological Risk Assessment Methodology for SNL/NM ER Program, Sandia National Laboratories/New Mexico" (IT July 1998) and will not be duplicated here. The screen also includes the estimation of exposure and ecological risk.

Tables 14, 15, 16, and 17 of Annex 3-D present the results of the ecological risk assessment screen. Site-specific information was incorporated into the screening assessment when such data were available. Hazard quotients greater than unity were originally predicted; however,

closer examination of the exposure assumptions revealed an overestimation of risk primarily attributed to exposure concentration (maximum COC concentration was used in the estimation of risk) and exposure setting (area use factors of one were assumed), background risk, quality of analytical data, and the use of detection limits as exposure concentrations. Based upon evaluation of these uncertainties, ecological risks associated with this site are expected to be very low.

3.6.3 Baseline Risk Assessments

This section discusses the baseline risk assessments for human health risk and ecological risk.

3.6.3.1 Human Health

Based upon the fact that human health results of the screening assessment summarized in Section 3.6.2.1 indicate that SWMU 10 does not have potential to affect human health under an industrial or residential land-use scenario, a baseline human health risk assessment is not required for SWMU 10.

3.6.3.2 Ecological

Based upon the screening assessment summarized in Section 3.6.2.2, a baseline ecological risk assessment is not required for SWMU 10.

3.6.4 Other Applicable Assessments

No other applicable assessments have been performed at SWMU 10.

3.7 No Further Action Proposal

SWMU 10 is proposed for an NFA decision based upon all the supporting information in this chapter. The rationale and criterion for the NFA proposal is provided below.

3.7.1 Rationale

Based upon field investigation data and the human health risk assessment analysis, an NFA is being recommended for SWMU 10 for the following reason: No COCs (metals and radionuclides) were present in concentrations considered hazardous to human health for an industrial or a residential land-use scenario.

3.7.2 Criterion

Based upon the evidence provided above, SWMU 10 is proposed for an NFA decision in conformance with Criterion 5 (NMED March 1998), which states that "The SWMU/AOC has been characterized or remedied in accordance with current applicable state or federal regulations and that available data indicate that contaminants pose an acceptable level of risk under current and projected future land use."

REFERENCES

Author [Unk] Date [Unk]a. Notes collected for SWMU 10, Sandia National Laboratories, Albuquerque, New Mexico.

Author [Unk] Date [Unk]b. Notes collected for SWMU 10. SWMU 60-63: Pendulum Site Mounds (No. 1-3) and Burial Area; SWMU 64: Scrap Metal Yard at Pressure Vessel Test Site, Sandia National Laboratories, Albuquerque, New Mexico.

Author [Unk] Date [Unk]c. Notes collected for SWMU 10, Sandia National Laboratories, Albuquerque, New Mexico.

Brouillard, L., June 1994. Interview conducted for the Environmental Restoration Project, Department 7585, ER7585/1333/010/INT/95-004, Sandia National Laboratories, Albuquerque, New Mexico. June 29, 1994.

Burton, C.W. (Sandia National Laboratories/New Mexico). Memorandum to W.D. Burnett (Sandia National Laboratories/New Mexico), Albuquerque, New Mexico. February 26, 1987.

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ANNEX 3-A
Vermiculite Composition and Source Evaluation



February 18, 1998

Project No. 301462.183.03

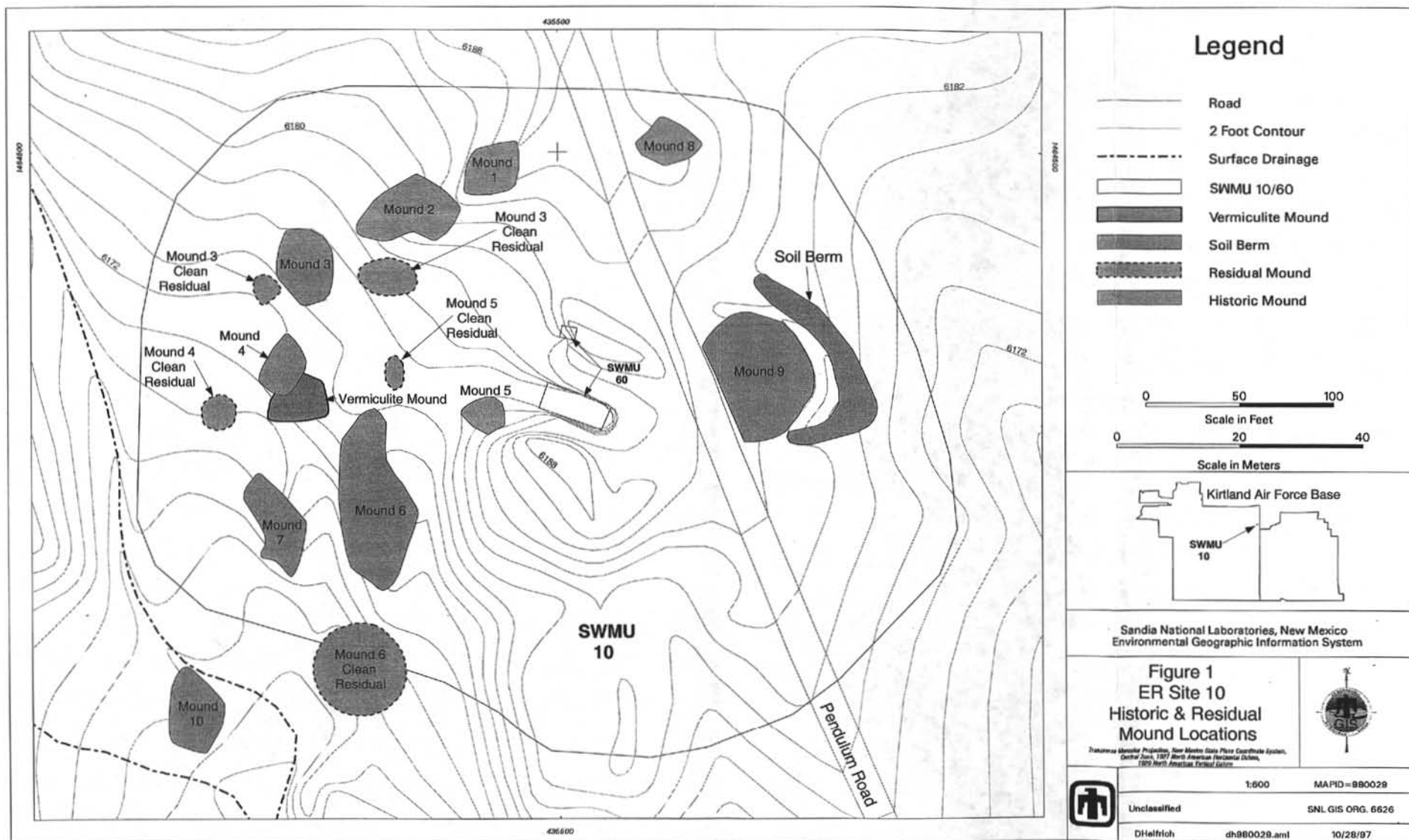
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Background Information on Vermiculite Chemistry as Relating to
Environmental Assessment Activities at ER Site 10

Dear Ms. Young:

A Voluntary Corrective Measure (VCM) was undertaken at Sandia National Laboratories/New Mexico (SNL/NM) Environmental Restoration (ER) Site 10 between 1995 and 1996 to remove depleted uranium fragments that resulted from experiments conducted at the site in the late 1970s. The VCM successfully removed depleted uranium contamination from ER Site 10 (SNL/NM September 1997a). Confirmatory sampling for RCRA-regulated metals identified several locations where barium and chromium concentrations in the soil were significantly elevated above background concentrations. This outcome was unexpected because neither barium or chromium were known to have been managed at the site. After further review the locations of the elevated barium and chromium concentrations were found to occur in the proximity of the Vermiculite Mound located at the site. The Vermiculite Mound (Figure 1) appears to be the primary source of elevated barium and chromium concentrations in soil samples from ER Site 10. The remaining issue regarding the ER Site 10 vermiculite concerned whether the barium and chromium were being released to the surrounding environment from (1) the natural vermiculite product or (2) from elevated metals potentially absorbed onto the vermiculite during ER Site 10 activities. To resolve this issue, IT was requested to obtain and compare virgin vermiculite product similar to the vermiculite found at ER Site 10.

The origin of vermiculite product found at ER Site 10 is uncertain. Efforts to review historical records and interview former site workers were unsuccessful in determining the source of vermiculite used at Sandia National Laboratories in the late 1970s. Research into vermiculite production, which was primarily domestic in the 1970s, narrowed the possible sources to two mining regions: Libby, Montana, and South Carolina. The Libby, Montana production accounted for approximately two-thirds (one-quarter million tons per year) of all domestic production. The South Carolina deposits accounted for approximately one-third of the annual production (Jercinovic, 1997). A vermiculite sample could not be obtained from Libby, Montana, as production from this location has terminated and no current stockpiles exist. However, published data on the Libby vermiculite ore was obtained, reviewed, and is presented herein. A vermiculite sample from South Carolina was obtained and analyzed for total metals. This letter report describes the chemical composition of vermiculite and compares laboratory analyses performed on



vermiculite samples from ER Site 10 and South Carolina relative to the potential for environmental contamination at ER Site 10.

Introduction

Vermiculite is the mineralogical name applied to a group of hydrated trioctahedral ferromagnesian aluminosilicate minerals that possess a platy or micaceous structure. The mineral in natural form has the size and shape of mica while possessing the ion exchange properties of zeolites and some clays. Vermiculite is an important industrial mineral that is commercially mined.

Vermiculite Production

The production of commercial domestic vermiculite began in 1915 from a mine near Hecla, Colorado, that proved to be unsuccessful. The vermiculite mine started by the Zonolite Company at Libby Montana in 1921 was the first successful venture (Perry, 1948). The Libby deposit was the oldest and largest domestic mine producing vermiculite during the period 1921 to 1990. It had been developed and enlarged for almost 70 years until it was closed in 1990 due to the presence of asbestos in the remaining ore (Berg, 1997). Vermiculite has also been mined for short periods of time in other states including Colorado, Nevada, North Carolina, Wyoming, and Texas. Current production in the United States is restricted to mines in South Carolina, Virginia, and Montana. Production of vermiculite outside of the United States is predominantly from Phalabowra, Republic of South Africa (Potter, 1996; USGS, 1997).

Properties

An unusual and useful property of vermiculite is its ability to greatly expand when heated. Within the internal structure of vermiculite is a layer of loosely bound water molecules, which when rapidly heated, transform into steam causing the vermiculite particles to increase in volume. The expansion, or "exfoliation" occurs in a direction perpendicular to the cleavage, forming accordion-shaped grains. The worm-like appearance of the expanded grains is the origin of the name vermiculite, which means "to breed worms." The increase in bulk volume is 8 to 12 times, but individual flakes may expand by a factor as high as 30.

Additional properties of vermiculite include low density, rot-resistance, nontoxic, nonflammable, chemically inert, biologically inert, insoluble in water, high absorptive capacity for water, nonabrasive, odorless, nonirritant, and low thermal conductivity. Commercial uses include thermal insulation, sound insulation, packing material, as an additive to cement and plaster, and as an additive to potting and greenhouse soil (Hindman, 1996).

Mineralogy and Crystal Chemistry of Vermiculite

Vermiculite, along with micas, chlorites, and clay minerals, is a member of the phyllosilicate family. The prominent feature of the crystal structure of the phyllosilicate family is an indefinitely extended sheet of silica and alumina tetrahedra linked together in a two-dimensional hexagonal array, much like a honeycomb (Berry and Mason, 1959). This tetrahedral layer is bonded to a parallel octahedral layer composed of hydroxyl ions (OH⁻) and divalent or trivalent oxides, commonly MgO or Al₂O₃. These tetrahedral and octahedral layers, plus interlayers of cations and/or water molecules, form the basic building blocks of phyllosilicate minerals.

Commercial deposits of vermiculite $[(\text{Mg,Ca})_{0.3}(\text{Mg,Fe,Al})_3(\text{Al,Si})_4\text{O}_{10}(\text{OH})_2 \cdot 8\text{H}_2\text{O}]$ are formed by the near-surface weathering of mafic igneous or metamorphic rocks containing a high content of large grains of biotite $[\text{KFe}_3(\text{AlSi}_3\text{O}_{10})(\text{OH})_2]$ or iron-rich phlogopite $[\text{K}(\text{Mg,Fe})_3(\text{AlSi}_3\text{O}_{10})(\text{OH})_2]$ micas. Typical major oxide compositions of various vermiculite samples from Libby, Montana, and Phalabowra, South Africa, are shown in Table 1.

Table 1
Major Oxide Analyses of Vermiculite
(in weight percentage)

Major Oxides	Commercial Vermiculite Source			
	Libby, MT ^a	Libby, MT ^a	Libby, MT ^b	Phalabowra, SA ^c
SiO ₂	35.57	35.43	41.0	38.0 to 49.0
Al ₂ O ₃	11.47	11.30	18.0	12.0 to 17.5
TiO ₂	1.06	0.91	NA	0 to 1.5
Cr ₂ O ₃	0.18	0.26	NA	0 to 0.5
Fe ₂ O ₃	7.49	6.65	7.0	5.4 to 9.3
FeO	0.34	0.27	NA	0 to 1.2
NiO	0.02	0.01	NA	NA
MnO	0.06	0.05	NA	0.1 to 0.3
MgO	22.57	23.56	21.0	20.0 to 23.5
CaO	0.73	0.39	1.0	0.7 to 1.5
SrO	0.01	0.01	NA	NA
BaO	0.10	0.03	NA	NA
Na ₂ O	0.00	0.00	NA	0 to 0.8
K ₂ O	0.96	0.14	1.0	5.2 to 7.9
H ₂ O	19.12	20.73	11.0	5.2 to 11.5

^aBoettcher, 1996.

^bPerry, 1948.

^cMandoval, 1997.

NA = Not applicable.

The structure of biotite and phlogopite consists of tetrahedral-octahedral-tetrahedral sequences separated by a layer of potassium. When biotite or phlogopite is altered to vermiculite, the interlayer changes from potassium ions sitting on the surface of the silicate sheets, to hydrated units of calcium or magnesium ions surrounded by closely held water molecules. An example of a specific vermiculite formula would be $\text{Mg}_3(\text{Al,Si})_4(\text{OH})_2 \cdot 4.5\text{H}_2\text{O}[\text{X}]_{0.35}$ where [X] represents the exchangeable Ca or Mg ions in the interlayer.

Numerous substitutions of ions at various sites within the structure can occur, yielding a highly variable chemical composition. Trivalent cations such as Fe^{+3} and Cr^{+3} can substitute for Al^{+3} in the tetrahedral layer; divalent cations such as Fe^{+2} , Ca^{+2} , and Ba^{+2} can substitute for Mg^{+2} in the octahedral layer; and monovalent anions such as F^- and Cl^- can substitute for OH^- in the octahedral layer. An even greater

number of substitution possibilities exists within the exchangeable cation layer, which gives vermiculite its high cation exchange capacity (Hurlbut and Klein, 1977).

The ability to exchange one ion for another depends on the bond strength, which varies for each type of structural site. For instance, an ion such as Cr^{+3} that is substituting for Al^{+3} in a tetrahedral site is not easily exchangeable, whereas an ion such as K^{+} in the interlayer site is much more easily exchangeable. This can be seen in Table 2, which provides the Cr_2O_3 , BaO , K_2O , and Na_2O contents of some biotite and vermiculite samples. An investigation of the origin of the Libby, Montana, vermiculite deposit

Table 2
Chromium, Barium, Potassium, and Sodium Contents of Biotite and Vermiculite Samples from Libby, Montana
(From Boettcher, 1966)

Mineral	Location	Cr_2O_3 (ppm)	BaO (ppm)	K_2O (ppm)	Na_2O (ppm)
Biotite	Libby, MT	2,300	4,500	100,000	2,600
Biotite	Libby, MT	2,500	3,500	100,500	2,300
Vermiculite	Libby, MT	1,800	1,000	9,600	0
Vermiculite	Libby, MT	2,600	300	1,400	0

(Boettcher, 1966) provided chemical analyses of both unaltered biotites as well as biotites altered to vermiculite from the same biotite pyroxenite pluton. The Cr_2O_3 content remained roughly unchanged throughout the natural weathering process, indicating the stability of Cr in the tetrahedral-octahedral layer. The BaO content decreased by about a factor of four during the weathering process, suggesting that some of the Ba was located in the exchangeable sites. Potassium and sodium are known to preferentially occupy the exchangeable sites in biotite (Hurlbut and Klein, 1977). Potassium decreased in concentration by over an order of magnitude, and sodium was completely removed during the weathering process.

Comparison of ER Site 10 Soil and Vermiculite Analyses

A total of 96 confirmatory soil samples were obtained at ER Site 10. Attachment 1 of this letter report contains a summary of laboratory results for the confirmatory soil samples, as well as site maps depicting sample locations. Table 3 is a subset of Attachment 1 and presents laboratory results for selected ER Site 10 soil samples obtained near the Vermiculite Mound, which contained the highest Ba and Cr concentrations and exceeded the range of local background concentrations ($\text{Ba} = 246 \text{ mg/kg}$, $\text{Cr} = 19 \text{ mg/kg}$). Table 3 also presents laboratory results for a relatively pure sample of vermiculite from the Vermiculite Mound (sample CY10-Vermiculite) and a virgin vermiculite product sample obtained from Enoree, South Carolina. While the two vermiculite samples contain significantly higher concentrations of

Table 3
Comparison of Analytical Results for Vermiculite and Selected ER Site 10 Environmental Samples

Sample Attributes			Total Metals (EPA 6010/7000)* (mg/kg)								
COC Number	ER Sample ID	Sample Depth (ft)	Arsenic	Barium	Cadmium	Chromium	Hexavalent Chromium	Lead	Mercury	Selenium	Silver
Selected ER Site 10 Environmental Sample Analysis Results											
06543	CY10-M4-S2 (off-site laboratory)	0.5-1.0	3.7	590	ND (0.40)	350	NT	14.	ND (0.11)	ND (0.81)	ND (0.40)
06543	CY10-M4-S2-D (off-site laboratory)	0.5-1.0	2.9	550	ND (0.37)	340	NT	16.	ND (0.11)	0.91 J (0.93)	ND (0.37)
06157	CY10-M4-S1	0.5-1.0	0.87 J (2.4)	550 E	0.14 J (0.16)	290 E	NT	6.4	0.064 J (0.16) B	0.69 J (1.2)	0.092 J (0.16)
06157	CY10-M4-S2	0.5-1.0	1.1 J (2.7)	540 E	0.16 J (0.18)	260 E	NT	12	ND (0.045)	0.62 J (1.4)	0.063 J (0.18)
06157	CY10-M4-S2-D	0.5-1.0	1 J (2.7)	350 E	0.15 J (0.18)	160	NT	9.8	ND (0.046)	0.62 J (1.4)	0.065 J (0.18)
06566	CY10-VM-1 (off-site laboratory)	0.5-1.0	3.5	410	ND (0.35)	170	NT	27.	ND (0.11)	ND (0.70)	ND (0.35)
06008	CY10-VM-1	0.5-1.0	ND (0.62)	180 B	0.18 B	72	NT	18	ND (0.041)	0.87 J (1.2)	ND (0.041)
06008	CY10-M7-T2-M	0.5-1.0	0.98 J (2.9)	480 E	0.21	180	NT	7.1	ND (0.048)	0.98 J (1.4)	0.26
06008	CY10-M7-T2-B	1.0-1.5	0.78 J (2.8)	140	0.16 J (0.19)	45	NT	8.5	ND (0.047)	0.83 J (1.4)	0.072 J (0.19)
06008	CY10-M6-T2-M	0.5-1.0	1.6 J (2.8)	200	0.24 B	44	NT	16	ND (0.046)	1.3 J (1.4)	0.053 J (0.18) B
06567	CY10-SS-ARY-2 (Off-site laboratory)	0.5-1.0	7.0	66.	0.63 J (0.99)	46.	NT	13.	ND (0.10)	2.9	ND (0.40)
06567	CY10-SS-ARY-2-D (Off-site laboratory)	0.5-1.0	5.2	69.	ND (0.39)	27.	NT	9.8	ND (0.10)	2.0	ND (0.39)
06158	CY10-SS-ARY-4	0.5-1.0	1.6 J (2.4)	59	0.3	30	NT	12	ND (0.04)	0.83 J (1.2)	0.1 J (0.16)
Vermiculite Sample Analysis Results											
510251	South Carolina Vermiculite	NA	ND (0.32)	1700	ND (0.070)	590	ND (0.10)	2.8	ND (0.050)	ND (0.16)	ND (0.11)
06194	CY10-Vermiculite	0-0.5	ND (0.16)	1540	ND (0.070)	749	ND (0.10)	21.3	ND (0.050)	ND (0.16)	ND (0.11)
TCLP Metals (1311/6010/7470)* (mg/L)											
			ND (0.0021)	5.9	0.0032J (0.020)	0.064	NA	0.16J (0.40)	ND (0.00010)	0.0096J (1.0)	0.0083J (0.040)
SNL/NM Canyons Surface Soil Background UTL or 95 th Percentile Concentrations ^b			9.8	246	0.64	18.8	NA	18.9	0.055	3.0	<0.5

*EPA November 1986.

^bSNL/NM September 1997b.

ARY = Arroyo.

B = Associated analyte was also observed in the method blank.

COC = Chain of custody record.

CY = Canyon.

E = The associated concentration was observed above the highest calibration level.

EPA = U.S. Environmental Protection Agency.

ER = Environmental restoration.

ID = Identification

J () = The estimated value reported is above the method detection limit (MDL) and less than the practical quantification limit, shown in parenthesis.

mg/kg = Milligram(s) per kilogram.

mg/L = Milligram(s) per liter.

NA = Not applicable.

ND () = Not detected above the MDL, shown in parentheses.

NT = Not tested.

SS = Surface soil sample.

TCLP = Toxicity characteristic leaching procedure.

both Ba and Cr than the selected ER Site 10 soil samples, all samples were characterized with a ratio of barium to chromium of approximately 2 to 3. No other metals are elevated relative to background concentrations. This result supports the position that vermiculite is the primary source of elevated Ba and Cr concentrations in soil samples from ER Site 10. Additionally, since the virgin vermiculite product is chemically identical to the vermiculite contained at ER Site 10, we conclude that the vermiculite itself, and not any absorbed contaminants, is the source of barium and chromium in the surrounding environmental samples.

Figure 2 shows a cross-plot of the concentrations of Ba (x-axis) and Cr (y-axis) from the 96 ER Site 10 soil samples and sample CY10-Vermiculite. A linear regression ($r^2 = 0.93$) of the data is plotted as a line that passes through the background values and the pure vermiculite sample. The close correlation between Ba and Cr suggests that samples with concentrations that exceed background have some variable percentage of vermiculite present.

Additional chemical testing of the ER Site 10 vermiculite was performed to verify the state of the chromium and the potential for release of metals under more natural weathering conditions. The vermiculite sample from ER Site 10 (CY10-Vermiculite) was also analyzed for hexavalent chromium, which was not detected (<0.1 ppm) in the sample (Table 3). This result is expected because Cr is restricted to the trivalent state in vermiculite. A split of the same sample was also subjected to a TCLP test to determine the leachability of the Ba and Cr (Table 3). Chromium was a factor of 78 below the EPA limit of 5 mg/L, and Ba was a factor of 17 below the EPA limit of 100 mg/L. These results indicate that the Ba and Cr are not leachable from the vermiculite matrix, and that the vermiculite present at the site does not have a toxic characteristic as defined by the EPA.

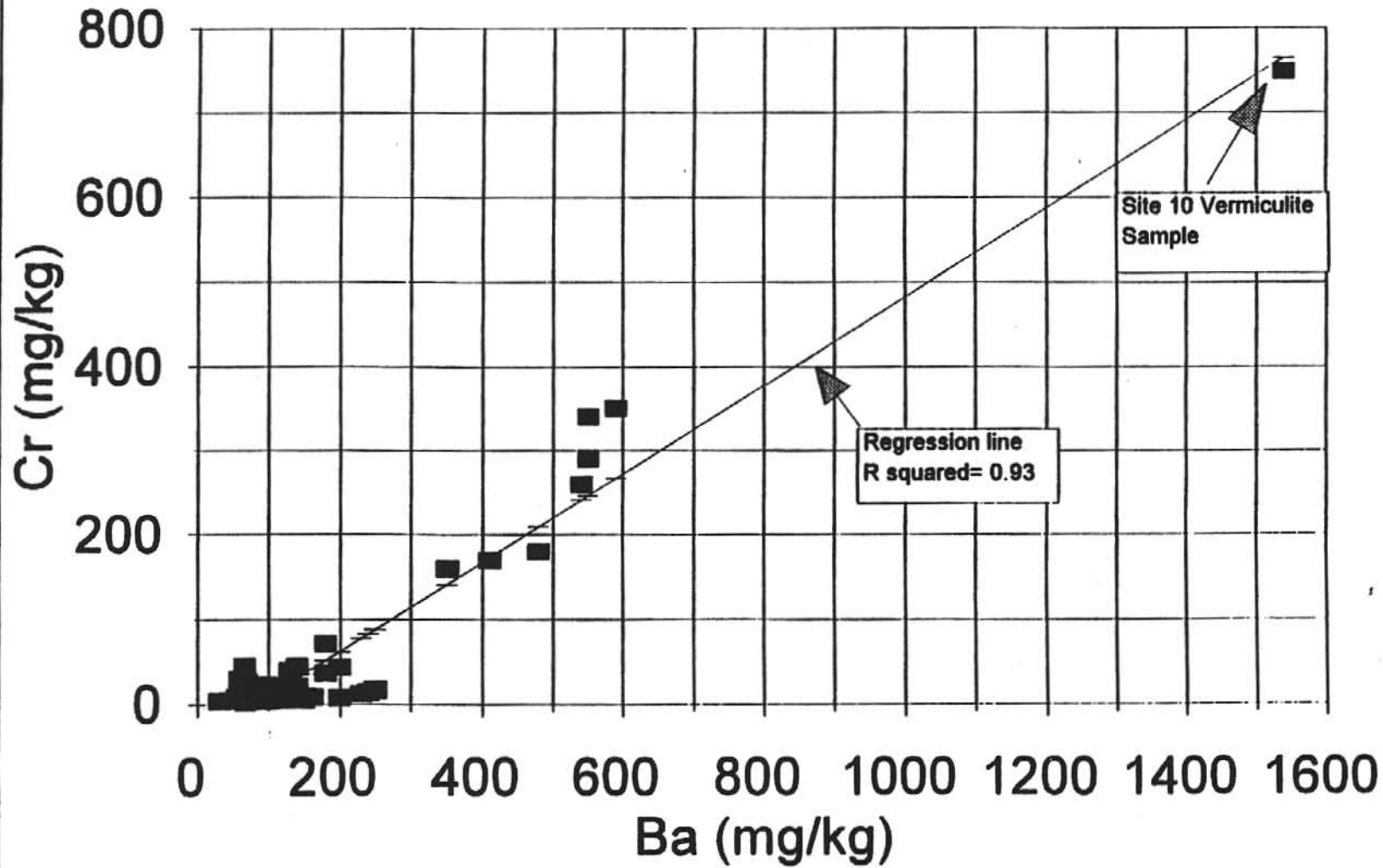
Conclusions

Vermiculite can be the source of elevated Ba and Cr concentrations in ER Site 10 confirmatory soil samples only if the composition of those samples include some fraction of vermiculite within the matrix. Consequently, a reasonable explanation must exist for the presence of vermiculite at the locations of elevated Ba and Cr concentrations in confirmatory soil samples. A review of laboratory results for the confirmatory soil samples (Attachment 1) indicates the locations of elevated Ba and Cr concentrations occur in the immediate vicinity of the Vermiculite Mound. There are several likely causes for vermiculite to have become transported from the Vermiculite Mound to these nearby locations. The most probable scenario involves natural transport mechanisms such as wind and rain. In addition to natural transport mechanisms, environmental investigation activities conducted at the site may also have resulted in the spread of vermiculite. During these investigation activities access within the site frequently involved heavy equipment, vehicles, and site workers moving directly past the vermiculite mound. As a result, the presence of vermiculite in soils surrounding the Vermiculite Mound can be visually observed at the site.

Based on the information presented within this letter report the following conclusions can be justified:

- Vermiculite has migrated from the vermiculite mound as a result of natural transport mechanisms (wind and rain) and environmental investigation activities conducted at the site;

Figure 2
Chromium and Barium in Site 10 Soils



- Barium and chromium were not managed at ER Site 10 as a result of past experiments conducted at the site;
- Vermiculite is the primary source of elevated barium and chromium concentrations in soil samples from ER Site 10;
- Chromium is not present within the vermiculite matrix in the toxic hexavalent state;
- Chromium and barium are not leachable from the vermiculite matrix; and
- Vermiculite from ER Site 10 does not have a toxic characteristic as defined by EPA.

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Ms. Sharissa Young

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February 18, 1998

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Respectfully submitted,

IT CORPORATION



Devon Jercinovic
Task Manager

DJ:dlr

Attachment 1—Summary of Laboratory Results from Metals Analyses for ER Site 10 Soil Samples

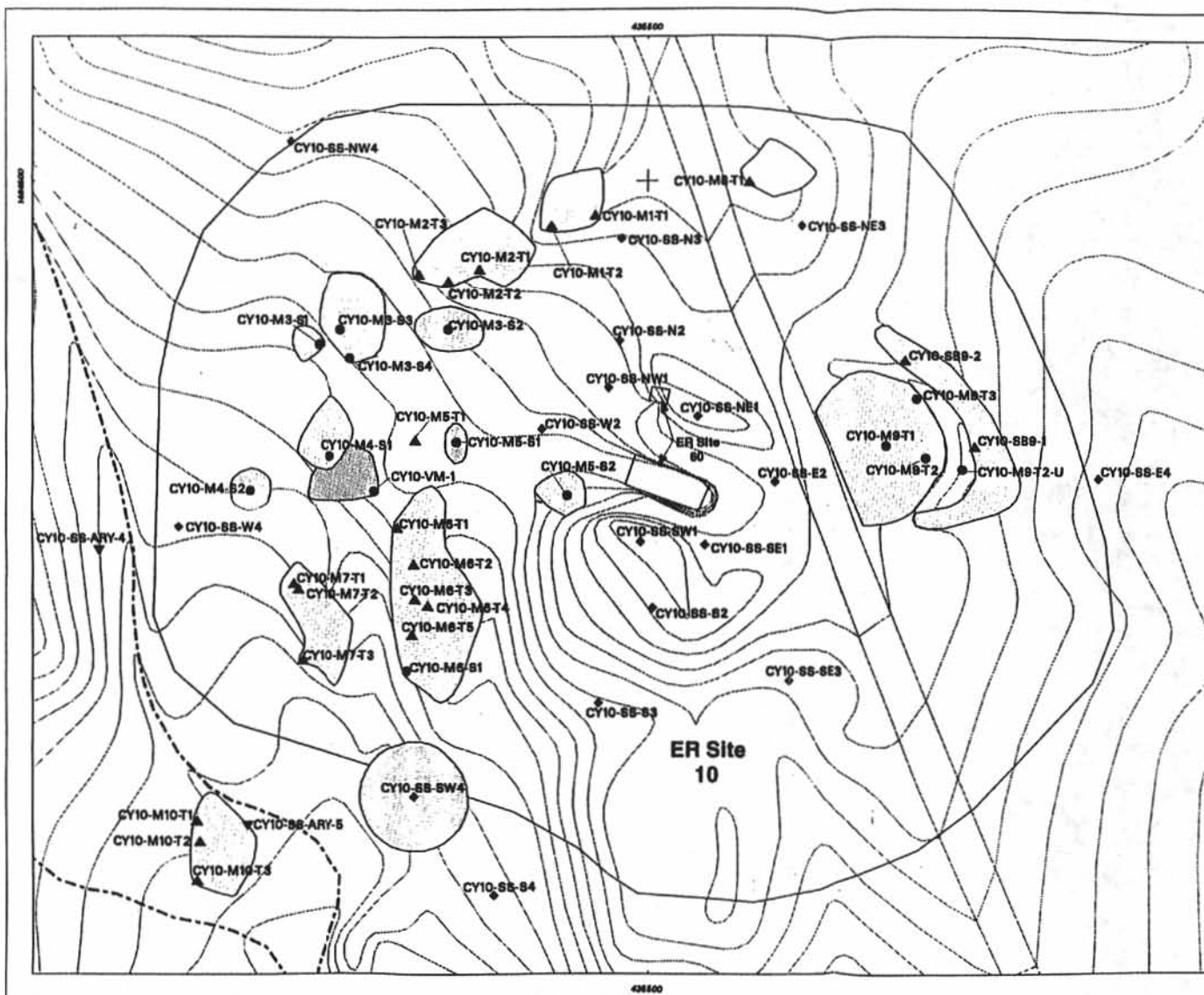
Attachment 2—Published Vermiculite References

Attachment 3—Telephone Records with Vermiculite Consultants

Attachment 4—Vermiculite Information Collected from the Internet

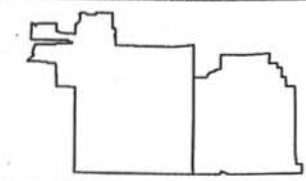
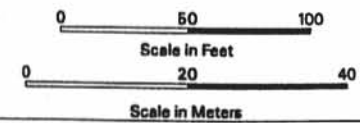
ATTACHMENT 1

SUMMARY OF LABORATORY RESULTS FROM METALS ANALYSES FOR ER SITE 10 SOIL SAMPLES



Legend

- Sample Location (GPS'd 10-20-97)
- ▲ Trench Sample Location
- ▼ Arroyo Sample Location
- ◆ Grid Sample Location
- Road
- 2 Foot Contour
- - - Surface Drainage
- ER Site 10/60
- Vermiculite Mound
- Residual Mound
- Historic Mound



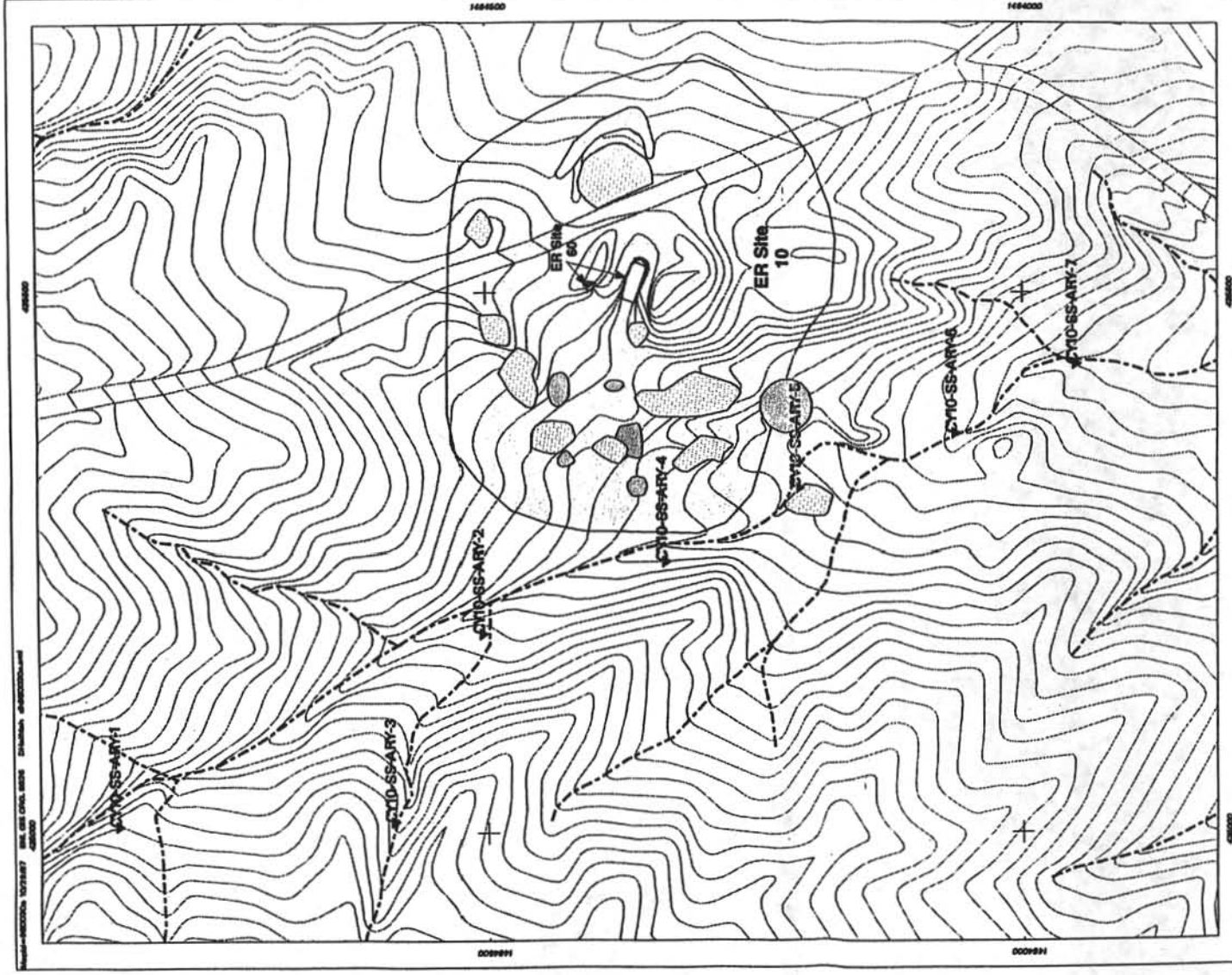
Sandia National Laboratories, New Mexico
Environmental Geographic Information System

ER Site 10 Trench & Grid Sample Locations

Transverse Quarter Projection, New Mexico State Plane Coordinate System,
Central Zone, 1983 North American Horizontal Datum,
1983 North American Vertical Datum



1:500	MAPID=980030
Unclassified	DRAFT SNL GIS ORG. 8826
DHelfrich	dh980030.sml 10/29/97



Legend

▼ Arroyo Sample Location

— Road

— 2 Foot Contour

- - - Surface Drainage

ER Site 10/60

Vermiculite Mound

Residual Mound

Historic Mound

ER Site 10 Arroyo Sample Locations



Table 3-2
Summary of ER Site 10 Confirmatory Soil Sampling Metal Analytical Results, Soil Mounds, April–August 1997

Sample Attributes			Metals (EPA 6010/6020/7000) ^{a,b} (mg/kg)								
COC Number	ER Sample ID (Figure 3-4)	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
06157	CY10-M1-T1-M	0.5–1.0	1.6 J (2.6)	100	0.51 B	0.18	4.6	3.5	ND (0.044)	0.74 J (1.3)	ND (0.044)
06157	CY10-M1-T1-B	0.5–1.0	1.1 J (2.6)	81	0.41 B	0.1 J (0.18)	5.2	2.7	ND (0.044)	0.62 J (1.3)	ND (0.044)
06157	CY10-M1-T2-M	0.5–1.0	1.3 J (2.9)	110	0.5 B	0.099 J (0.2)	20	3.1	ND (0.049)	0.77 J (1.5)	ND (0.049)
06157	CY10-M1-T2-B	0.5–1.0	1.7 J (3)	180	0.66 B	0.21	37	4.8	0.075 J (0.2) B	1.7	ND (0.05)
06543	CY10-M2-T1-M (Off-site laboratory)	0.5–1.0	3.9	130	0.67 J (0.82)	ND (0.33)	40	7.9	ND (0.11)	ND (0.66)	ND (0.33)
06157	CY10-M2-T1-M	0.5–1.0	1.6 J (2.6)	140	0.74 B	0.23	21	7.4	0.066 J (0.19) B	1.2 J (1.4)	ND (0.047)
06157	CY10-M2-T1-B	0.5–1.0	1.3 J (2.6)	130	0.58 B	0.15 J (0.18)	8.5	5.9	0.047 J (0.18) B	1 J (1.4)	ND (0.046)
06157	CY10-M2-T2-M	0.5–1.0	1.6 J (2.6)	140	0.65 B	0.2	18	5	ND (0.044)	1.3	ND (0.044)
06157	CY10-M2-T2-B	0.5–1.0	1.6 J (2.9)	120	0.54 B	0.17 J (0.2)	18	5	ND (0.049)	1.2 J (1.5)	ND (0.049)
06157	CY10-M2-T3-M	0.5–1.0	0.71 J (2.4)	75	0.6 B	0.16	15	3.8	ND (0.04)	1 J (1.2)	0.071 J (0.16)
06157	CY10-M2-T3-B	0.5–1.0	1.9 J (2.7)	110	0.56 B	0.19	18	3.6	ND (0.045)	1.2 J (1.3)	ND (0.045)
06157	CY10-M3-S1	0.5–1.0	1.7 J (2.4)	140	3.4 B	0.43	18	7.7	ND (0.04)	1 J (1.2)	0.11 J (0.16)
06157	CY10-M3-S1-D	0.5–1.0	1.3 J (2.6)	87	0.72	0.2	12	4.5	ND (0.044)	0.9 J (1.3)	0.083 J (0.17)
06157	CY10-M3-S2	0.5–1.0	1.6 J (2.6)	130	1	0.31	26	6.6	0.055 J (0.19) B	1.3 J (1.4)	0.1 J (0.19)
06157	CY10-M3-S3	0.5–1.0	1.2 J (2.6)	72	0.54	0.16 J (0.19)	8.3	5	ND (0.047)	0.58 J (1.4)	0.076 J (0.16)
06008	CY10-M3-S4	0.5–1.0	1.9 J (2.6)	99	0.59 B	0.16 J (0.18) B	5.6	6.2	ND (0.044)	0.88 J (1.3)	ND (0.044)
06157	CY10-M4-S1	0.5–1.0	0.67 J (2.4)	550 E	0.83	0.14 J (0.16)	290 E	6.4	0.064 J (0.16) B	0.69 J (1.2)	0.092 J (0.16)
06543	CY10-M4-S2 (Off-site laboratory)	0.5–1.0	3.7	590	0.66 J (1.0)	ND (0.40)	350	14	ND (0.11)	ND (0.81)	ND (0.40)
06543	CY10-M4-S2-D (Off-site laboratory)	0.5–1.0	2.9	550	0.57 J (0.93)	ND (0.37)	340	16	ND (0.11)	0.91 J (0.93)	ND (0.37)
06157	CY10-M4-S2	0.5–1.0	1.1 J (2.7)	540 E	0.59	0.16 J (0.18)	260 E	12	ND (0.045)	0.62 J (1.4)	0.083 J (0.16)
06157	CY10-M4-S2-D	0.5–1.0	1 J (2.7)	350 E	0.47	0.15 J (0.18)	160	9.8	ND (0.046)	0.62 J (1.4)	0.085 J (0.16)
06566	CY10-VM-1 (Off-site laboratory)	0.5–1.0	3.5	410	0.69 J (0.87)	ND (0.35)	170	27	ND (0.11)	ND (0.70)	ND (0.35)
06008	CY10-VM-1	0.5–1.0	ND (0.62)	180 B	0.55 B	0.18 B	72	18	ND (0.041)	0.87 J (1.2)	ND (0.041)

Table 3-2 (Continued)
Summary of ER Site 10 Confirmatory Soil Sampling Metal Analytical Results, Soil Mounds, April–August 1997

Sample Attributes			Metals (EPA 8010/6020/7000) ^{a,b} (mg/kg)								
COC Number	ER Sample ID (Figure 3-4)	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
06157	CY10-M5-S1	0.5–1.0	1.2 J (3)	97	0.64	0.16 J (0.2)	23	6.1	ND (0.05)	0.96 J (1.5)	ND (0.05)
06157	CY10-M5-S2	0.5–1.0	1.2 J (2.5)	79	0.67 B	0.22 B	15	7.2	ND (0.041)	0.91 J (1.2)	0.049 J (0.16)
06566	CY10-M6-T1-M (Off-site laboratory)	0.5–1.0	4.0	100	0.54 J (1.0)	ND (0.42)	12.	6.4	ND (0.11)	ND (0.84)	ND (0.42)
06566	CY10-M6-T1-M-D (Off-site laboratory)	0.5–1.0	4.2	120	0.56 J (1.1)	ND (0.42)	15.	7.0	ND (0.11)	ND (0.84)	ND (0.42)
06008	CY10-M6-T1-M	0.5–1.0	2.7	120	0.5 B	0.15 J (0.18) B	14	6.8	ND (0.046)	0.73 J (1.4)	ND (0.046)
06008	CY10-M6-T1-M-D	0.5–1.0	2.8 J (2.9)	120	0.49 B	0.14 J (0.2) B	6	6.9	ND (0.049)	0.56 J (1.5)	ND (0.049)
06008	CY10-M6-T1-B	1.0–1.5	1.7 J (3)	92	0.59 B	0.14 J (0.2) B	5.7	6.4	ND (0.049)	0.7 J (1.5)	ND (0.049)
06008	CY10-M6-T2-M	0.5–1.0	1.6 J (2.8)	200	0.73 B	0.24 B	44	16	ND (0.046)	1.3 J (1.4)	0.053 J (0.18) B
06008	CY10-M6-T2-B	1.0–1.5	2.2 J (2.6)	95	0.42 B	0.11 J (0.19) B	4	5.8	ND (0.047)	0.59 J (1.4)	ND (0.047)
06008	CY10-M6-T3-M	0.5–1.0	1.3 J (3)	100	0.78 B	0.29 B	7.1	7.8	ND (0.051)	2.1	0.24B
06008	CY10-M6-T3-B	1.0–1.5	0.99 J (2.5)	77	0.56 B	0.15 J (0.17) B	7	5.4	ND (0.042)	0.76 J (1.2)	ND (0.042)
06008	CY10-M6-S1	0.5–1.0	1.7 J (2.6)	100	0.53 B	0.15 J (0.19) B	5.9	6.3	ND (0.046)	0.71 J (1.4)	ND (0.046)
06008	CY10-M6-S2	0.5–1.0	1.2 J (2.6)	100	0.62 B	0.24 B	11	8	ND (0.047)	1.2 J (1.4)	0.076 J (0.19) B
06008	CY10-M7-T1-M	0.5–1.0	1.3 J (2.5)	100	0.71 B	0.27 B	16	10	ND (0.042)	1.3	0.073 J (0.17) B
06008	CY10-M7-T1-B	1.0–1.5	0.99 J (2.7)	71	0.64	0.19	14	5.1	ND (0.044)	1.2 J (1.3)	0.053 J (0.18)
06008	CY10-M7-T2-M	0.5–1.0	0.96 J (2.9)	480 E	0.74	0.21	180	7.1	ND (0.046)	0.96 J (1.4)	0.26
06008	CY10-M7-T2-B	1.0–1.5	0.76 J (2.8)	140	0.58	0.16 J (0.19)	45	8.5	ND (0.047)	0.83 J (1.4)	0.072 J (0.19)
06008	CY10-M7-T3-M	0.5–1.0	1.8 J (2.6)	55	0.75	0.28	6.9	12	ND (0.044)	1.5	0.092 J (0.17)
06008	CY10-M7-T3-B	1.0–1.5	0.93 J (2.8)	64	0.58	0.2	6.2	9.2	ND (0.043)	1.3	ND (0.043)
06008	CY10-M8-T1-M	0.5–1.0	2.2 J (2.9)	96	0.52	0.17 J (0.2)	6.4	7.5	ND (0.049)	0.86 J (1.5)	ND (0.049)
06008	CY10-M8-T1-B	1.0–1.5	1 J (2.4)	62	0.78 B	0.43 B	6.7	9.2	ND (0.039)	2	0.1 J (0.16) B
06566	CY10-M9-T1-M (Off-site laboratory)	0.5–1.0	4.0	110	0.71 J (1.0)	ND (0.41)	9.8	7.0	ND (0.11)	ND (0.83)	ND (0.41)
06566	CY10-M9-T1-M-D (Off-site laboratory)	0.5–1.0	3.8	110	0.62 J (1.0)	ND (0.40)	8.8	6.0	ND (0.096)	ND (0.80)	ND (0.40)
06008	CY10-M9-T1-M	0.5–1.0	2.3 J (2.5)	200	0.81 B	0.26 B	7.6	8.4	ND (0.042)	2	ND (0.042)
06008	CY10-M9-T1-M-D	0.5–1.0	1.9 J (2.4)	150	0.73 B	0.19 B	6.4	7.7	ND (0.039)	1.4	ND (0.039)
06008	CY10-M9-T1-B	1.0–1.5	1.4 J (2.4)	130	0.71 B	0.29 B	8	6.4	ND (0.04)	2.2	ND (0.04)
06008	CY10-M9-T2-M	0.5–1.0	2.2 J (2.4)	150	0.75 B	0.23 B	7	10	ND (0.041)	1.6	0.044 J (0.16) B
06008	CY10-M9-T2-B	1.0–1.5	1.7 J (2.4)	140	0.78 B	0.22 B	8.5	7.9	ND (0.04)	1.6	ND (0.04)
06008	CY10-M9-T3-M	0.5–1.0	1.8 J (2.4)	150	1.1 B	0.34 B	9.5	16	ND (0.04)	2	0.055 J (0.16) B
06008	CY10-M9-T3-B	1.0–1.5	1.2 J (2.5)	150	0.62	0.21	5.2	6.6	ND (0.042)	1.3	ND (0.042)

Table 3-2 (Continued)
Summary of ER Site 10 Confirmatory Soil Sampling Metal Analytical Results, Soil Mounds, April–August 1997

Sample Attributes		Metals (EPA 6010/6020/7000) (mg/kg)									
COC	ER Sample ID (Figure 3-4)	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
06542	CY10-PIT-1 (Off-site laboratory)	0.5-1.0	6.7	250	1.3	ND (0.46)	18.	20.	ND (0.13)	ND (0.92)	ND (0.46)
06542	CY10-PIT-1D (Off-site laboratory)	0.5-1.0	6.6	250	1.2	ND (0.41)	17.	19.	ND (0.12)	ND (0.61)	ND (0.41)
06159	CY10-PIT-1 (Off-site laboratory)	0.5-1.0	4.6	230	1.1	0.6	12	20	0.066 J (0.22)	2.9	0.61
06159	CY10-PIT-1D	0.5-1.0	4.6	240 E	1.2	0.65	14	20	0.066 J (0.19)	3.1	0.57
06159	CY10-SBS-1	0.5-1.0	1.4 J (2.3)	96	0.51	0.22	6	6.4	ND (0.038)	1 J (1.1)	ND (0.038)
06159	CY10-SBS-2	0.5-1.0	0.9 J (2.9)	120	0.46	0.25	5.6	4.5	ND (0.046)	1.4	ND (0.046)
06008	CY10-M10-T1-M	0.5-1.0	ND (0.6)	66	0.41	0.083 J (0.16)	2.2 J (2.6)	4.4	ND (0.04)	ND (0.3)	ND (0.04)
06566	CY10-M10-T1-B (Off-site laboratory)	1.0-1.5	4.0	67.	0.67 J (1.1)	ND (0.42)	14.	7.2	ND (0.11)	ND (0.64)	ND (0.42)
06566	CY10-M10-T1-B-D (Off-site laboratory)	1.0-1.5	3.6	71.	0.58 J (1.0)	ND (0.41)	11.	6.5	ND (0.11)	ND (0.62)	ND (0.41)
06008	CY10-M10-T1-B	1.0-1.5	1.4 J (2.5)	100	0.67	0.2	6.6	6.6	ND (0.042)	0.75 J (1.2)	ND (0.042)
06008	CY10-M10-T1-B-D	1.0-1.5	0.96 J (2.6)	67	0.47	0.16 J (0.17)	5.2	5.1	ND (0.044)	0.65 J (1.3)	ND (0.044)
06008	CY10-M10-T2-M	0.5-1.0	1.6 J (2.7)	110	0.71	0.3	6	11	ND (0.045)	0.81 J (1.4)	ND (0.045)
06008	CY10-M10-T2-B	1.0-1.5	0.9 J (2.6)	66 B	0.49 B	0.15 J (0.17) B	5.6	6.9	ND (0.043)	0.39 J (0.13)	ND (0.043)
06008	CY10-M10-T3-M	0.5-1.0	1.6 J (2.6)	140 B	0.67 B	0.3 B	9	10	ND (0.044)	0.63 J (1.3)	0.073 J (0.16) B
06008	CY10-M10-T3-B	1.0-1.5	1.6 J (2.4)	92 B	0.66 B	0.23 B	6.4	6.1	ND (0.041)	0.68 J (1.2)	ND (0.041)
Quality Assurance/Quality Control Samples (all in µg/L)											
06157	CY10-RBA (EB)	NA	ND (0.67)	ND (0.79)	ND (0.022)	ND (0.045)	ND (1.7)	ND (0.34)	ND (0.045)	ND (0.34)	ND (0.045)
06008	CY10-RBC (EB)	NA	ND (3.4)	ND (3.9)	ND (0.11)	ND (0.22)	ND (6.4)	ND (1.7)	ND (0.22)	ND (1.7)	ND (0.22)
06008	CY10-RBD (EB)	NA	ND (3.4)	ND (3.9)	ND (0.11)	ND (0.22)	ND (6.4)	ND (1.7)	ND (0.22)	ND (1.7)	ND (0.22)
06008	CY10-RBE (EB)	NA	ND (3.4)	ND (3.9)	ND (0.11)	ND (0.22)	ND (6.4)	ND (1.7)	ND (0.22)	ND (1.7)	ND (0.22)
SNL/NM Canyons Surface Soil Background UTL or 95 th Percentile Concentrations			9.8	246	0.75	0.64	16.6	16.9	0.055	3.0	<0.5

Table 3-2 (Concluded) Summary of ER Site 10 Confirmatory Soil Sampling Metal Analytical Results, Soil Mounds, April-August 1997

*EPA November 1986.

*EPA Method 6020 used by on-site laboratory and EPA Methods 6010/7000 used by off-site laboratory.

*SNL/NM September 1997b.

B = Associated analyte was also observed in the method blank.

COC = Chain of custody record.

CY = Canyon.

E = The associated concentration was observed above the highest calibration level.

EB = Equipment blank.

EPA = U.S. Environmental Protection Agency.

ER = Environmental Restoration.

ft = Feet.

ID = Identification.

J () = The estimated value reported is either above the method detection limit (MDL) and less than the practical quantification limit (shown in parenthesis) for on-site laboratory analyses or above the instrument detection limit and less than the contract required detection limit (shown in parenthesis) for off-site laboratory analyses.

µg/L = Micrograms per liter.

mg/kg = Milligrams per kilogram.

NA = Not applicable.

ND () = Not detected above the MDL (shown in parenthesis).

UTL = Upper tolerance limit.

Table 3-5
Summary of ER Site 10 Confirmatory Soil Sampling Metal Analytical Results, Grid Sampling, April–August 1997

Sample Attributes			Metals (EPA 8010/6020/7000) ^{a,b} (mg/kg)								
COC Number	ER Sample ID (Figure 3-4)	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
06158	CY10-SS-N2	0.5–1.0	1.4 J (2.7)	76 B	0.79 B	0.28 B	7.3	9.2	ND (0.045)	1.3	0.05 J (0.18) B
06158	CY10-SS-N3	0.5–1.0	1.7 J (2.7)	67 B	0.92 B	0.24 B	7.5	16	ND (0.046)	1.4	ND (0.046)
06158	CY10-SS-NE1	0.5–1.0	1.3 J (2.5)	140 B	0.77 B	0.25 B	7.4	9	ND (0.042)	1.4	ND (0.042)
06158	CY10-SS-NE3	0.5–1.0	1.2 J (2.6)	110 B	0.73 B	0.26 B	5.3	6.7	ND (0.043)	1.5	0.046 J (0.17) B
06158	CY10-SS-E2	0.5–1.0	1.6 J (2.3)	99 B	0.62 B	0.2 B	7.4	7.5	ND (0.039)	0.58 J (1.2)	ND (0.039)
06158	CY10-SS-E4	0.5–1.0	3.5	110 B	0.69 B	0.26 B	9.6	30	ND (0.039)	0.95 J (1.3)	ND (0.039)
06158	CY10-SS-SE1	0.5–1.0	ND (0.67)	76 B	0.6 B	0.21 B	4.6	6	ND (0.045)	0.94 J (1.3)	ND (0.045)
06158	CY10-SS-SE3	0.5–1.0	1 J (2.7)	120 B	0.92 B	0.26 B	5.3	7.1	ND (0.046)	1.7	ND (0.046)
06158	CY10-SS-S2	0.5–1.0	1.3 J (2.7)	100	0.66 B	0.22 B	17	8.8	ND (0.045)	1.2 J (1.4)	0.052 J (0.18) B
06567	CY10-SS-S3 (Off-site laboratory)	0.5–1.0	4.7	120	0.62 J (0.98)	ND (0.39)	12.	9.6	ND (0.11)	ND (0.76)	ND (0.39)
06567	CY10-SS-S3-D (Off-site laboratory)	0.5–1.0	3.5	91.	0.65 J (0.93)	ND (0.37)	13.	7.9	ND (0.11)	ND (0.75)	ND (0.37)
06158	CY10-SS-S4	0.5–1.0	1.9 J (2.3)	160	0.95 B	0.26 B	6.6	12	ND (0.039)	1 J (1.2)	0.062 J (0.16) B
06158	CY10-SS-SW1	0.5–1.0	0.89 J (2.3)	73	0.72 B	0.21 B	5.4	7	ND (0.038)	1.1 J (1.2)	ND (0.038)
06158	CY10-SS-SW4	0.5–1.0	2.7	140	0.94 B	0.26 B	10	10	ND (0.046)	1 J (1.4)	ND (0.046)
06158	CY10-SS-W2	0.5–1.0	0.66 J (2.3)	75	0.73 B	0.26 B	7.1	7.4	ND (0.039)	1.2	0.066 J (0.16) B
06158	CY10-SS-W4	0.5–1.0	1 J (2.7)	63	0.71	0.24	7.2	6.7	ND (0.045)	1.1 J (1.4)	0.1 J (0.18)
06158	CY10-SS-NW1	0.5–1.0	1.4 J (2.6)	110	0.71	0.22	9.6	6.1	ND (0.046)	1.1 J (1.4)	ND (0.046)
06158	CY10-SS-NW4	0.5–1.0	0.76 J (2.6)	44	0.83	0.32	5	7.9	ND (0.044)	0.91 J (1.3)	0.17
Quality Assurance/Quality Control Sample (in µg/L)											
06158	CY10-RBG (EB)	NA	ND (3.4)	ND (3.9)	ND (0.11)	ND (0.22)	ND (6.4)	ND (1.7)	ND (0.22)	ND (1.7)	ND (0.22)
SNL/NM Canyons Surface Soil Background UTL or 95 th Percentile Concentrations ^c			9.8	246	0.75	0.64	16.6	16.9	0.055	3.0	<0.5

Refer to footnotes at end of table.

Table 3-5 (Concluded)
Summary of ER Site 10 Confirmatory Soil Sampling Metal Analytical Results, Grid Sampling, April–August 1997

*EPA November 1986.

*EPA Method 6020 used by on-site laboratory and EPA Methods 6010/7000 used by off-site laboratory.

*SNL/NM September 1997b.

B = Associated analyte was also observed in the method blank.

COC = Chain of custody record.

CY = Canyon.

D = Duplicate.

EB = Equipment blank.

EPA = U.S. Environmental Protection Agency.

ER = Environmental Restoration.

ft = Feet.

ID = Identification.

J () = The estimated value reported is either above the method detection limit (MDL) and less than the practical quantification limit (shown in parenthesis) for on-site laboratory analyses or above the instrument detection limit and less than the contract required detection limit (shown in parenthesis) for off-site laboratory analyses.

µg/L = Micrograms per liter.

mg/kg = Milligrams per kilogram.

NA = Not applicable.

ND () = Not detected above the MDL (shown in parenthesis).

SS = Surface soil sample.

UTL = Upper tolerance limit.

Table 3-7
Summary of ER Site 10 Confirmatory Sediment Sampling Metal Analytical Results, April–August 1997

Sample Attributes			Metals (EPA 6010/6020/7000) ^{a,b} (mg/kg)								
COC Number	ER Sample ID (Figure 3-5)	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
06158	CY10-SS-ARY-1	0.5–1.0	0.76 J (2.6)	73	0.61	0.16 J (0.17)	5.5	6.6	ND (0.043)	0.34 J (1.3)	ND (0.043)
06567	CY10-SS-ARY-2 (Off-site laboratory)	0.5–1.0	7.0	66	0.72 J (0.99)	0.63 J (0.99)	46	13	ND (0.10)	2.9	ND (0.40)
06567	CY10-SS-ARY-2-D (Off-site laboratory)	0.5–1.0	5.2	69	0.76 J (0.98)	ND (0.39)	27	9.8	ND (0.10)	2.0	ND (0.39)
06158	CY10-SS-ARY-3	0.5–1.0	0.93 J (2.5)	55	0.65	0.21	7.6	4.9	ND (0.042)	0.72 J (1.3)	0.07 J (0.17)
06158	CY10-SS-ARY-4	0.5–1.0	1.6 J (2.4)	59	0.7	0.3	30	12	ND (0.04)	0.63 J (1.2)	0.1 J (0.16)
06158	CY10-SS-ARY-5	0.5–1.0	0.9 J (2.7)	66 B	0.56 B	0.19 B	9.1	6.2	ND (0.045)	0.48 J (1.3)	ND (0.045)
06158	CY10-SS-ARY-6	0.5–1.0	0.62 J (2.3)	59 B	0.56 B	0.18 B	6.9	6.8	ND (0.038)	0.36 J (1.1)	ND (0.038)
06158	CY10-SS-ARY-7	0.5–1.0	ND (0.58)	30 B	0.3 B	0.11 J B (0.15)	4.4	5.5	ND (0.038)	0.36 J (1.2)	ND (0.038)
Quality Assurance/Quality Control Samples (all in µg/L)											
06158	CY10-RBF (EB)	NA	ND (3.4)	ND (3.9)	ND (0.11)	ND (0.22)	ND (6.4)	ND (1.7)	ND (0.22)	ND (1.7)	ND (0.22)
SNL/NM Canyons Surface Soil Background UTL or 95 th Percentile Concentration ^c			9.6	246	0.75	0.64	18.8	18.9	0.055	3.0	<0.5

^aEPA November 1986.

^bEPA Method 6020 used by on-site laboratory and EPA Methods 6010/7000 used by off-site laboratory.

^cSNL/NM September 1997b.

ARY = Arroyo.

B = Associated analyte was also observed in the method blank.

COC = Chain of custody record.

CY = Canyon.

D = Duplicate.

EB = Equipment blank.

EPA = U.S. Environmental Protection Agency.

ER = Environmental Restoration.

ft = Feet.

ID = Identification.

J () = The estimated value reported is either above the method detection limit (MDL) and less than the practical quantification limit (shown in parenthesis) for on-site laboratory analyses or above the instrument detection limit and less than the contract required detection limit (shown in parenthesis) for off-site laboratory analyses.

µg/L = Micrograms per liter.

mg/kg = Milligrams per kilogram.

NA = Not applicable.

ND () = Not detected above the MDL (shown in parenthesis).

SS = Surface soil sample.

UTL = Upper tolerance limit.

ATTACHMENT 2

PUBLISHED VERMICULITE REFERENCES

VERMICULITE

By Michael J. Potter

Vermiculite is a mica-like mineral that has the ion-exchange properties of zeolites and some clays. Beneficiation of vermiculite ore yields concentrate that is typically 90% vermiculite and 10% grit or rock. When a particle of vermiculite is heated rapidly to about 900 °C, the normally flat plate expands as much as twentyfold into an accordionlike, lightweight particle. This forms the basis for much of the commercial application of this mineral (Hindman, 1996).

Production

The total of U.S. vermiculite concentrate sold and used was withheld to avoid disclosing company proprietary data. The amount of exfoliated vermiculite sold and used was 135,000 metric tons compared with 130,000 tons in 1995. Domestic production data for vermiculite were derived by the U.S. Geological Survey (USGS) from two separate voluntary surveys—one for domestic mine-mill operations and the other for exfoliating plants. Of the four known mine-mill operations, data were obtained for two operations, representing a response rate of 50%. Production for the two nonrespondents was estimated by the USGS based on previous years' production levels and estimates. Of the 19 known active exfoliating plants, data were obtained from 16 for a response rate of 84%. Output for the three nonrespondents was estimated by the USGS by using previous years' production levels.

Domestic producers of vermiculite concentrate were W.R. Grace & Co. from its operation at Encore, SC, Virginia Vermiculite Ltd. with operations near Woodruff, SC, and in Louisa County, VA, and Patterson Vermiculite Co. near Enoree, SC.

U.S. output of exfoliated vermiculite from 15 known companies came from 19 plants in 11 States. (See table 3). Of these plants, four in four States were operated by W.R. Grace. The largest producing States of exfoliated vermiculite were estimated to be, in descending order of output sold and used, South Carolina, Ohio, Pennsylvania, Arizona, Illinois, Arkansas, New Jersey, and Florida.

Prices

Yearend prices for U.S. vermiculite concentrate, ex-plant, bulk, converted to dollars per metric ton ranged from \$143 to \$220. For South African material, crude, bulk, f.o.b. barge, Gulf Coast, converted to dollars per metric ton, prices ranged from \$127 to \$209 (Industrial Minerals, 1996).

World Review

Table 5 lists approximations of rated annual capacity for vermiculite concentrate plants as of December 31. Because actual capacity data were generally not available, capacities for most countries were considered to be equal to their highest production levels during the past 5 years.

In South Africa, the decrease in output of vermiculite concentrate was reportedly because of unusually high rainfall in the first quarter. Another factor was the delay in commissioning the new fluidized bed drying furnaces at Palabora Mining Co. Ltd., the world's largest producer (Palabora Mining Co. Ltd., 1996).

Dinidza Vermiculite Mining (Pvt.) Ltd. in Zimbabwe continued with an expansion program to increase concentrate production to 1,000 tons per month by July 1996 (Hindman, 1996).

Outlook

The largest enduse of vermiculite in recent years has been in potting soils and other horticultural and fertilizer products. Vermiculite also is used in building boards, such as plaster board, some lightweight wallboard, and various refractory board products. Potential new applications of vermiculite include detoxification of water and soil, nuclear waste containment and removal, and industrial spill containment and cleanup.

With the absence of large particle-sized vermiculite production in the United States and the use of imported concentrates to fill this void, there has been substantial interest in developing new vermiculite sources in the Western United States (Hindman, 1996).

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¹Prior to January 1996, published by U.S. Bureau of Mines.

TABLE 1
SALIENT VERMICULITE STATISTICS 1/

(Thousand metric tons and thousand dollars)

	1992	1993	1994	1995	1996
United States:					
Sold and used by producers:					
Concentrate 2/	190	190	177	171	W
Exfoliated	140	140	130	130	135
Value	\$45,900	\$46,700	\$43,600	\$39,400	\$45,300
Average value 3/	\$328	\$338	\$335	\$306	\$334
Exports to Canada e/	8	7	7	6	8
Imports for consumption e/	40	30	30	30	48
World: Production 4/	456	490	484	482 r/	266

e/ Estimated. r/ Revised. W Withheld to avoid disclosing company proprietary data.

1/ Data are rounded to three significant digits.

2/ Values are withheld to avoid disclosing company proprietary data.

3/ Based on unrounded data.

4/ Excludes production by countries for which data were not available.

TABLE 2
EXFOLIATED VERMICULITE
SOLD AND USED IN THE UNITED STATES, BY END USE 1/

(Metric tons)

	1995	1996
Aggregates:		
Concrete 2/	11,700	16,900
Plaster	1,400	3,220
Premixes 3/	W	W
Total	W	W
Insulation:		
Loose-fill	W	W
Block	14,200	12,000
Other 3/	W	W
Total	33,600	27,100
Agricultural:		
Horticultural	26,800	26,500
Soil conditioning	14,500	19,700
Fertilizer carrier e/	30,400	29,300
Total e/	71,700	75,500
Other 4/	W	W
Grand total	130,000	135,000

e/ Estimated. W Withheld to avoid disclosing company proprietary data; included in "Total" and/or "Grand total."

1/ Data rounded to three significant digits; may not add to totals shown.

2/ Includes acoustic, fireproofing, and texturizing uses.

3/ Includes high-temperature and packing insulation and sealants.

4/ Includes various industrial, etc., uses not specified.

TABLE 3
ACTIVE VERMICULITE EXFOLIATION
PLANTS IN THE UNITED STATES IN 1996

Company	County	State
A-Tops Corp.	Beaver	Pennsylvania
W. R. Grace & Co., Construction Products Div.	Jefferson	Alabama
Do.	Maricopa	Arizona
Do.	Broward	Florida
Do.	Greenville	South Carolina
Palmetto Vermiculite Co., Inc.	Spartanburg	Do.
Patterson Vermiculite Co.	Laurens	Do.
P.V.P. Industries	Trumbull	Ohio
The Schundler Co.	Middlesex	New Jersey
O.M. Scott & Sons	Union	Ohio
Southwest Vermiculite Co., Inc.	Bernalillo	New Mexico
Strong-Lite Products Corp.	Jefferson	Arkansas
Strong Products Corporation	La Salle	Illinois
Thermic Refractories, Inc.	Macoupin	Do.
Thermo-O-Rock, Inc.	Maricopa	Arizona
Do.	Washington	Pennsylvania
Verlite Co.	Hillsborough	Florida
Vermiculite Industrial Corp.	Allegheny	Pennsylvania
Vermiculite Products, Inc.	Harris	Texas

TABLE 4
VERMICULITE: WORLD PRODUCTION, BY COUNTRY 1/ 2/

(Metric tons)

Country	1992	1993	1994	1995	1996 e/
Argentina	-	38	32 r/	44 r/	50
Brazil	11,615	14,541	16,000	17,000 r/ e/	17,000
Egypt e/	500	500	500	500	500
India	1,609	1,485	1,903 r/	1,688 r/	1,750
Japan e/	15,000	15,000	15,000	15,000	15,000
Kenya	2,291	1,961	1,110 r/ e/	457 r/	500
Mexico	125	134	300	225 r/	225
Russia e/	60,000	50,000	40,000	40,000	30,000
South Africa	170,399	211,143	223,478	221,748	186,082 3/
United States (sold and used by producers) 4/	190,000	190,000	177,000	171,000	W
Zimbabwe	4,300	5,032	8,184	13,742 r/	15,000
Total	456,000	490,000	484,000	482,000 r/	266,000 5/

e/ Estimated. r/ Revised. W Withheld to avoid disclosing company proprietary data; not included in "Total."

1/ World totals, U.S. data, and estimated data are rounded to three significant digits; may not add to totals shown.

2/ Excludes production by countries for which data are not available and for which general information is inadequate for formulation of reliable estimates. Table includes data available through July 22, 1997.

3/ Reported figure.

4/ Concentrate.

5/ Excludes U.S. data.

TABLE 5
WORLD VERMICULITE ANNUAL
PRODUCTION CAPACITY
DECEMBER 31, 1996

(Thousand metric tons)

Country	Rated capacity 1/ 2/
North America:	
Mexico	(3/)
United States	190
Total	190
South America:	
Argentina	(3/)
Brazil	17
Total	17
Europe:	
Russia e/	60
Africa:	
Egypt e/	1
Kenya	2
South Africa	223
Total	226
Asia:	
India	2
Japan e/	15
Total	17
World total	510

e/ Estimated.

1/ Includes capacity at operating plants as well as at plants on standby basis.

2/ Excludes countries for which data were not available.

3/ Less than 1/2 unit.

Montana's changing industrial minerals industry

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Abstract

Talc production in Montana has expanded from a modest beginning in the early 1940s to around 400,000 short tons of annual production in recent years, making Montana the leading talc-producing state. Barretts Minerals, Inc. (owned by Minerals Technologies, Inc.) and Luzenac America (owned by RTZ) are the current producers. Bentonite is mined in the extreme southeastern corner of the state by the American Colloid Company and processed in their plant at Colony, Wyoming. In 1982, Continental Lime constructed their Indian Creek plant near Townsend and in 1991, expanded its capacity to 1000 short tons of lime per day with the addition of a second kiln. Basin Electric completed a lime plant at Frannie, Wyoming in 1993 that uses limestone from the Warren quarry just across the border in Montana. In 1995, Cominco American began mining almandine garnet for the abrasive and filter bed markets from dredge tailings along Alder Creek in southwestern Montana. Increased demand for decorative stone for local and out-of-state markets has resulted in numerous independent operations providing stone ranging from Precambrian gneiss to field stone. Interest continues in the development of two vermiculite deposits in southwestern Montana: one near Dillon and the other near Hamilton. Clinoptilolite, from the Grasshopper Creek zeolite deposit near Dillon, is being evaluated for various applications. American Gem has acquired many sapphire deposits in western Montana with plans to produce heat-treated sapphires for mass markets and Gem River is developing a sapphire deposit in southwestern Montana.

Introduction

As with all industries, the industrial minerals industry in Montana is continually changing. The rate of change of this industry in Montana has increased in the last decade with changes in ownership, new mines and plants, and closures. The purpose of this paper is to document some of these changes for selected commodities before this information is lost. For a more complete list of Montana's deposits of industrial miner-

als with brief descriptions of the geologic settings of these deposits, see Berg (1990). Because there are generally less than three producers of a specific mineral commodity in Montana, the U.S. Bureau of Mines has not released production figures (to protect individual producers' confidentiality) for most of these commodities mined in Montana.

Mineral commodities with current production

Garnet

The newest industrial mineral operation in Montana is the recovery of almandine garnet from dredge tailings remaining from the placer mining of gold in Alder Gulch, 50 miles (80 km) southeast of Butte (No. 1, Figure 1). Between 1899 and 1922, over 2 million ounces of gold were mined from placer deposits along

Alder Gulch (Dippold, 1996). The source of the alluvium in Alder Gulch is metamorphic rock of Archean age exposed in the surrounding mountains. Amphibolite, hornblende gneiss, quartzofeldspathic gneiss, and less abundant schist have provided garnet to the alluvial deposits. The dredge tailings in Alder Gulch, which are more than 36 feet (11 m) thick, are reported to contain 4.5% almandine garnet and 0.03 gram/tonne

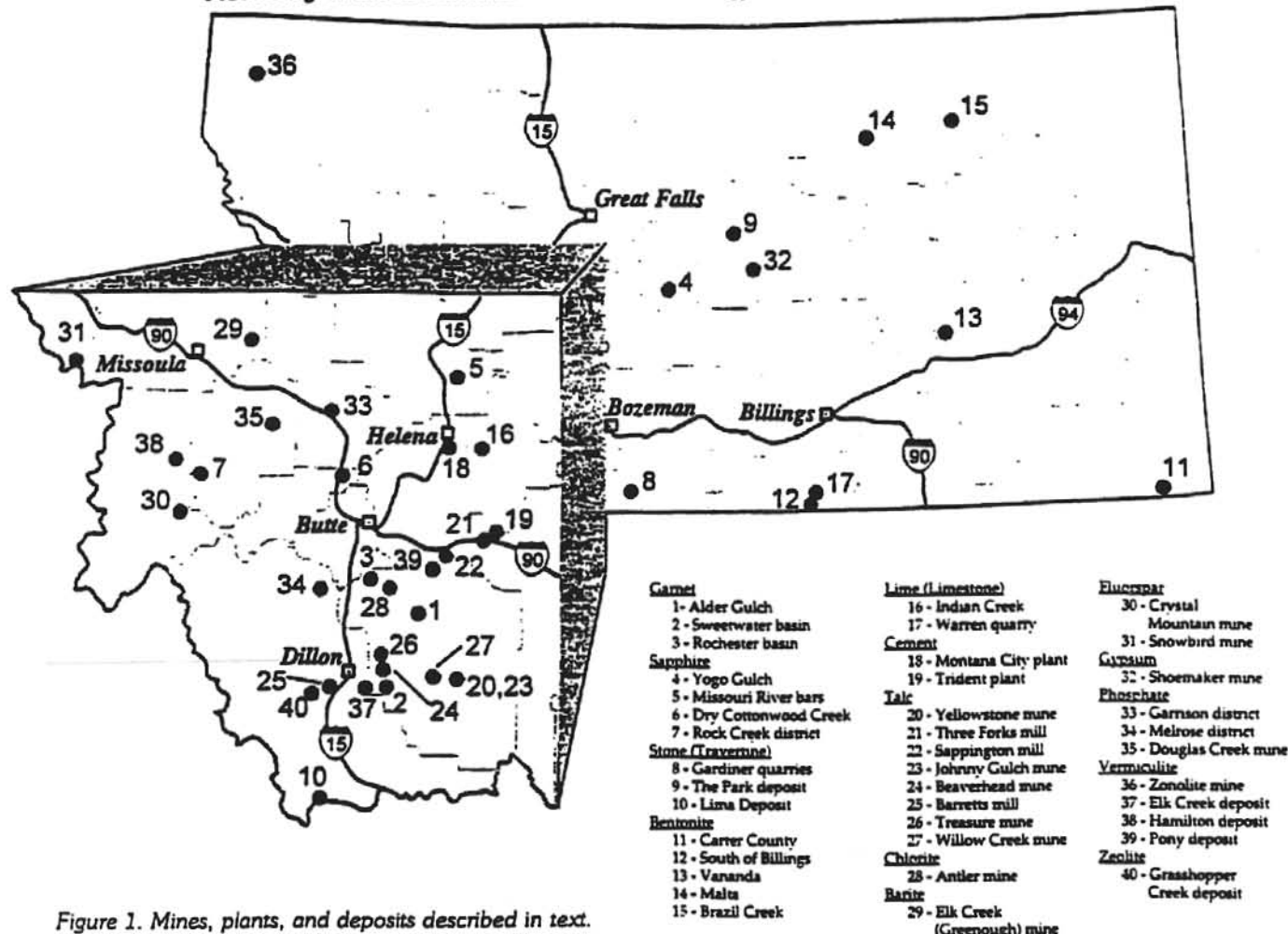


Figure 1. Mines, plants, and deposits described in text.

of gold (Austin, 1994). In the spring of 1995, Cominco American, Inc. began construction of a facility to recover garnet and gold. They will sell a product that consists of 90% almandine and in specific size fractions ranging from 6 mesh (3.4 mm) down to 150 mesh (0.1 mm) for the filter bed and abrasive markets, including abrasive jet cutting. The construction phase of this development has been completed and production is now beginning. Because of health concerns, the use of quartz in sandblasting is now prohibited in some states which has caused an increase in the demand for garnet by this industry.

Sweetwater Garnet, Inc. of Absolute Resources has announced plans to begin mining almandine garnet from an alluvial deposit in the Sweetwater basin 14 miles (22 km) southeast of Dillon (No. 2, Figure 1). This deposit is reported to contain 8% garnet which was derived from erosion of Precambrian metamorphic rocks exposed in the Ruby Range surrounding this basin. Sweetwater Garnet plans to construct a facility at the deposit for initial processing to be followed by further processing at a plant situated near Dillon. Garnet is also concentrated in Rochester basin, 25 miles (40 km) southeast of Butte (No. 3, Figure 1).

Sapphire

Within the last two years the sapphire industry in Montana has changed dramatically with the involvement of two new companies, American Gem, Inc. and Gem River. Montana has a long history of sapphire production beginning in about 1896 with mining of the famous blue stones from the Yogo deposit 45 miles (72 km) southwest of Lewistown in central Montana (No. 4, Figure 1). Sapphires were mined from a lamprophyre dike of Tertiary age until 1929 (Zeihen, 1987). Since then several companies have either mined sapphires from the Yogo dike and associated placers, or investigated and promoted the development of these deposits. Sapphire International Corporation began mining sapphires from this dike in about 1970. Roncor Inc. is currently recovering sapphires from some of the previously mined material. In 1984, Vortex Mining discovered a new occurrence of sapphires within a mile of the now inactive American mine in an altered lamprophyre dike similar to the Yogo dike. Vortex is now mining at another site less than 600 feet (200 m) from the American mine. The Yogo deposit is the only developed sapphire deposit in Montana that produces a blue stone of consistent color.

In addition to the Yogo deposit, there are three other major sapphire deposits in Montana, all placer deposits and all without a recognized bedrock source. Stones from these deposits differ in color from those mined from the Yogo deposit; these deposits generally yield stones that are pale shades of blue to green; and stones from each deposit show a variety of shades. Large concentrations of sapphires occur in the so-called "bars" along the Missouri River, east of Helena (No. 5, Figure 1). Probably the largest of these deposits of terrace gravel is the Eldorado Bar, which was extensively sampled by American Gem in 1994. French Bar and Spokane Bar, also along the Missouri River, have been mined for sapphires. Fee digging open to the public has been a major activity for these deposits. Farther west, 15 miles (24 km) north of Butte, sapphire deposits along Dry Cottonwood Creek have received recent attention (No. 6, Figure 1). In 1995, American Gem, Inc. mined sapphires from their holdings along Dry Cottonwood Creek and Gem River was involved in developing their property, also along Dry Cottonwood Creek.

Alluvial deposits of sapphire occur in several tributaries of Rock Creek in the Sapphire Range, 60 miles (100 km) northwest of Butte, (No. 7, Figure 1). For many years buckets of sapphire-bearing gravel from the Gem Mountain deposit were sold to the public. In 1995, American Gem mined this deposit commercially and in 1996 reported that they had mined 1.56 million carats of sapphires from their Gem Mountain and Dry Cottonwood Creek deposits. Sapphires mined from these deposits are heat treated to enhance their color. In a study of more than 75,000 stones from the Rock Creek deposit, it was found that 65 to 70% of the stones were susceptible to heat treatment, changing to attractive blues and yellows from pale shades of blue and green (Emmett and Douthit, 1993). With the successful heat treatment of pale sapphires from the western Montana deposits, new markets have been developed for the commercial mining of these deposits. In addition to these deposits, there are five other alluvial occurrences of sapphires in western Montana (Zeihen, 1987).

Stone

Over 80 years ago, most Montana cities had a local stone quarry and quite possibly a brick plant using local clays. Because of large capital costs and improved quality standards, these industries have largely vanished from the local level. The last brick plant to operate in the state was Lovell Clay Products' plant in Billings which was closed in the late 1970s. During the past 30 years sandstone, limestone, quartzite, dolo-

mitic siltstone, argillite, and a variety of volcanic rocks have been quarried in Montana. However, the only stone producer that has been in continuous operation is Livingston Marble and Granite who, contrary to their name, quarry and finish travertine from their quarries at Gardiner 40 miles (64 km) south of Livingston (No. 8, Figure 1). This firm has been in continuous production for 40 years. Livingston Marble and Granite quarries various colors of travertine, ranging from white to ochre, from which they make tiles, ashlar, and custom-fabricated pieces at their Livingston plant. There are two other large deposits of travertine in Montana: one in the central part of the state, about 12 miles (20 km) north of Lewistown, and the other along the Idaho-Montana border, 50 miles (80 km) southwest of Dillon (Nos. 9 and 10, respectively, Figure 1). Neither deposit is now being quarried, but travertine has been quarried from the deposit southwest of Dillon for fabrication of facing by an Idaho producer.

In recent years there has been a substantial increase in numbers of independent stone producers. Argillite in the Prichard Formation of the Proterozoic Belt Supergroup is quarried at numerous localities in northwestern Montana. This tan-to-brown argillite can be split into thin slabs to provide attractive stone for patios, floors, and facing. Much of this stone is marketed outside Montana. Water-worn cobbles and boulders, largely of metamorphic rocks found in alluvial deposits in western Montana and known in the market as river rock, are now in demand. Boulders, some large enough to weigh 5 tons, are sold for landscaping. Loose blocks of sandstone of Cretaceous age (field stone) are collected in central Montana and sold for facing. Lichen-covered sandstone (moss rock) also is sold for facing. The current market is largely for stone with natural-appearing or weathered surfaces.

Bentonite

Bentonite has been commercially mined from at least five localities in Montana. The most important locality for continuous production and also for total production is in the extreme southeastern corner of the state in Carter County. American Colloid mines bentonite (No. 11, Figure 1) that is processed at their plant near Colony, Wyoming. These deposits are at the western edge of the very important Black Hills bentonite district. Bentonite is mined from beds in the Belle Fourche Shale, of Cretaceous age. Bentonite from these deposits has been used in pelletizing taconite iron ore, bonding foundry molding sand, oil well drilling mud, pet litter, and engineering applications such as pond lining.

Bentonite also is mined by Wyo-Ben, Inc. from beds in the Thermopolis Shale of Cretaceous age close to the Wyoming border 50 miles (80 km) south of Billings (No. 12, Figure 1).

Most other bentonite deposits that have been mined in Montana are in the Bearpaw Shale, also of Cretaceous age. This formation is exposed over large areas of eastern and central Montana. In 1966, Hallet Minerals Company began mining bentonite from the Vananda deposit situated 20 miles (32 km) northwest of Forsyth (No. 13, Figure 1), in an area well described by the names of the two local creeks, Froze-to-Death and Starved-to-Death Creeks. After partial drying in a rotary kiln, the bentonite was shipped to Minnesota for pelletizing taconite iron ore. Mining bentonite from this deposit was discontinued in 1978.

In the same year (1978) American Colloid began construction of a plant near Malta to process bentonite mined from beds in the Bearpaw Shale, south of Malta (No. 14, Figure 1). Bentonite mined from these beds was used in drilling mud and in pelletizing taconite iron ore. Production of bentonite by the Malta plant continued until 1986, when production was discontinued because of diminishing markets and an unfavorable tax situation.

In the late 1960s, an 18-mile (29-km)-long railroad spur was constructed from the Great Northern Railroad main line to the Brazil Creek bentonite deposit, 18 miles (29 km) southwest of Glasgow (No. 15, Figure 1). This bentonite deposit, also in the Bearpaw Shale, was initially developed by the Ashland Chemical Company, then acquired by the Archer Daniels Midland Company, and finally by Federal Bentonite, who closed this drying facility in 1980. The market for this bentonite was mainly the taconite pelletizing industry.

Lime

In 1982, Continental Lime began producing lime at their Indian Creek plant northwest of Townsend approximately 30 miles (48 km) southeast of Helena (No. 16, Figure 1). Limestone is quarried from the Mission Canyon Formation of the Madison Group of Mississippian age. Addition of a second kiln in 1991 doubled the capacity of this plant to 1000 short tons of lime per day. Lime from this plant is used for flue gas desulphurization, processing metalliferous ores, and in the production of precipitated calcium carbonate (PCC) for the paper industry. A lime hydrator was added in 1994 to hydrate lime for use in asphalt. Continental Lime is owned by Graymont.

In 1993, Basin Electric Cooperative constructed a lime plant at Frannie, Wyoming, just across the Montana border, to supply lime for flue gas desulphurization at the company's coal-fired generating plants. Limestone is quarried at Warren, Montana, 50 miles (80 km) south of Billings (No. 17, Figure 1), and trucked 8 miles (13 km) to their Frannie plant, now operated by Dakota Lime, a division of Basin Electric. The quarry is in limestone of the Madison Group and also supplies limestone to Holly Sugar Corporation's plants at Sidney, Montana and Torrington, Wyoming, and Western Sugar Company's Lovell, Wyoming and Scottsbluff, Nebraska plants. The limestone is used to produce lime for the processing of sugar beets.

Cement

Montana has two cement plants supplying both local and out-of-state markets. Ash Grove Cement West, Inc. operates a cement plant at Montana City, 5 miles (8 km) southeast of Helena (No. 18, Figure 1). Limestone quarried from the Madison Group a few miles west is used at their plant. This plant was initially constructed by Kaiser Cement in 1962 and was acquired in 1987 by Hanson Ltd. when Hanson acquired Kaiser Cement. A few months later Hanson Ltd. sold the plant to Ash Grove Cement West.

Holnam owns and operates a cement plant at Trident, where the Gallatin, Madison, and Jefferson Rivers join to form the Missouri River, 55 miles (88 km) east of Butte (No. 19, Figure 1). This plant was constructed in 1910 by Ideal Cement and acquired by Holnam in 1990. This facility probably has the longest record of production using a local mineral resource in Montana. Some cement from this plant is shipped to Spokane, Washington, where, because of its high uniform quality, it is used in the manufacture of concrete railroad ties. Gypsum, used by both cement producers, is shipped from a source in northern Wyoming, whereas iron ore, also used in small quantities in the manufacture of cement, is mined near White Sulphur Springs, in central Montana.

Talc

In recent years, Montana has been the leading state in the United States in talc production, as measured in volume or in value of talc produced, with annual production around 400,000 tons. Production in 1992 was 390,765 metric tons (U.S. Bureau of Mines, 1993). Montana talc producers have been able to compete effectively because of the high purity of talc in

these deposits and also because most deposits are of sufficient size to be mined efficiently in open pit mines. The lack of tremolite or other amphiboles in Montana talc has also been an important market consideration. Dolomitic marble of Archean age has been locally replaced by talc as a result of hydrothermal activity (Berg, 1991). Markets for talc mined in Montana include cosmetics, paint, plastics, paper, rubber, and ceramics. The paper industry, where talc is used for pitch control, continues to be an important market for Montana talc. Another important market is the ceramic substrate used in catalytic converters, which is made from a mixture of talc and clay. Essentially, all of substrates used in Japan, North America, and Western Europe incorporate talc mined from Montana deposits.

The largest talc mine in Montana is the Yellowstone mine, situated 20 miles (32 km) south of Ennis (No. 20, Figure 1). Sierra Talc began mining talc from what is now known as the Yellowstone mine (Figures 2 and 3) in the 1940s with some early production of steatite talc used in the manufacture of insulators. Steatite talc occurs in the upper part of the deposit and could be machined into shapes, which were then fired to make ceramic insulators. Talc from this mine (Figure 4) is processed at two mills: the larger at Three Forks built in 1960 (No. 21, Figure 1) and a smaller mill at Sappington built in 1985 about 13 miles (21 km) southwest of Three Forks (No. 22, Figure 1). In 1964, Sierra Talc was acquired by Cyprus Industrial Minerals, which in turn was acquired by Luzenac America, Inc. in 1992. Cyprus Industrial Minerals installed a mechanical sorting device for the separation of talc from waste dolomite at their Yellowstone mine in 1987. Until the development of this mechanical sorter, essentially all talc produced in Montana was sorted by hand on sorting belts. The mechanical sorter makes use of the difference in coefficient of friction between talc and dolomite. Crushed and sized ore that consists of talc and dolomite is fed onto a revolving disc where talc slides to the outer edge more rapidly than the less slippery dolomite. In December 1991, Cyprus Industrial Minerals obtained a U.S. patent on this mechanical sorter.

Another company, Montana Talc, began construction of a mill at Sappington in 1985 and in 1986 began stripping at their Johnny Gulch mine (No. 23, Figure 1) adjacent to the Yellowstone mine. Montana Talc was a joint venture between Nicor Mineral Ventures and Meridian Land and Minerals Company. In 1986, Nicor Mineral Ventures sold their share of ownership to Costain Holdings, Inc. owned by the Costain Group PLC of the United Kingdom. Westmont Mining Inc., a wholly owned subsidiary of Costain, became the sole owner of Montana Talc in 1989. Luzenac America,

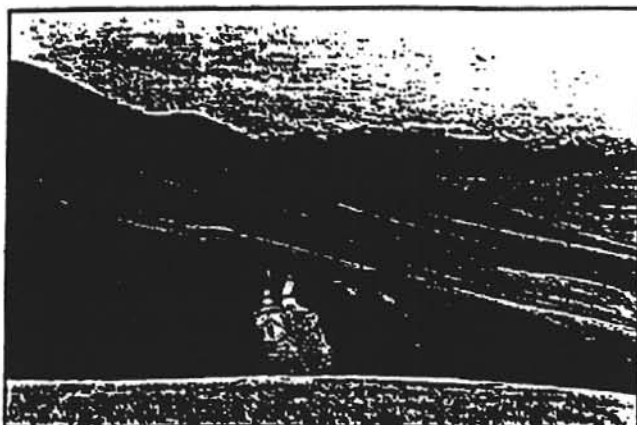


Figure 2. A distant view of the earliest mining of talc in the fall of 1941 at what is now the Yellowstone mine (Anderson, 1942). The mine dump is the light-colored area in the lower center of the photograph.

Inc. purchased Montana Talc in May, 1994 and immediately closed Montana Talc's Johnny Gulch open pit mine, citing safety considerations. Montana Talc's Sappington mill, now owned by Luzenac, continues in production. During the last two years Luzenac America, Inc., has spent \$7 million on expansion and modernization of the Three Forks mill which now has a capacity of 125,000 tons/year. The Sappington mill has a capacity of 110,000 tons/year.

Luzenac America, Inc. also mines very high-quality talc at the Beaverhead mine in the Ruby Range 16 miles (26 km) east of Dillon (No. 24, Figure 1). The Beaverhead mine was operated as an open pit until 1986, when, because of the need for excessive stripping, the decision was made to mine this ore body underground.

Talc mining in the Dillon area began about the same time as that south of Ennis, with Tri State Minerals Company (a division of Southern California Minerals Company) beginning to mine talc in 1943. They constructed a crushing plant at Barretts, 7 miles (11 km) southwest of Dillon, in the same year (No. 25, Figure 1). This plant was expanded in 1954 with the addition of equipment for pulverizing talc. In the 1960s, Southern California Minerals Company was sold to Pfizer, Inc., whose Pigments and Metals Division operated the talc mine and mill. Talc is mined from two adjacent ore bodies: the Treasure Chest and the Treasure State, at the Treasure mine on Stone Creek, 16 miles (26 km) east of Dillon in the Ruby Range. In 1990, Pfizer constructed a fully automated beneficiation plant that utilizes wet grinding and flotation at their Barretts mill to allow processing some of their less pure talc ore. This is the first flotation mill for talc to be constructed in Montana. In October 1992, a new company, Minerals Technologies, Inc., was formed



Figure 3. A close up view of the Yellowstone talc mine as it appeared in the fall of 1941 (from Anderson, 1942).

to operate what had been Pfizer's minerals business. In April 1993, Pfizer's remaining partial ownership of Minerals Technologies, Inc. was completely acquired by Minerals Technologies. The Treasure mine and Barretts mill are now owned and operated by Barretts Minerals, a subsidiary of Specialty Minerals, Inc., which is owned by Minerals Technologies, Inc. In 1995, Barretts Minerals expanded their mill with the construction of a warehouse and new laboratory facilities. Barretts Minerals plans to mine talc in the near future from the Regal mine, also an open pit mine in the Ruby Range.

als; the property was subsequently acquired by Luzenac America, Inc., when they acquired Cyprus' talc operations in 1992. Annual chlorite production from this mine is about 15,000 short tons.

Barite

Because the major market for barite mined in Montana is as a weighting agent in drilling fluids, barite production from Montana deposits has been largely controlled by oil and gas drilling activity in the United

The open pit Willow Creek mine was operated by Resource Processors from 1970 until 1979 when it was closed. Talc mined from this deposit, situated in the Greenhorn Range approximately 20 miles (32 km) southwest of Ennis (No. 27, Figure 1), was hand sorted at the mine and then shipped directly to processors. Cyprus Industrial Minerals bought the lease on this property from Resource Processors and subsequently lost this lease in a court decision. The property was later leased to Conagra, and after that, to Southern Talc. In 1986 and 1987 some development work was completed on this property, and a small amount of talc was mined.

Chlorite

The Antler mine, probably the only chlorite mine in the United States, is situated near Silver Star, about 30 miles (48 km) southeast of Butte (No. 28, Figure 1). Magnesian chlorite, formed by the replacement of Precambrian quartzofeldspathic gneiss, is used in some of the same applications as talc (Berg, 1983). Mining of this deposit was begun in 1977 by Cyprus Industrial Minerals.



Figure 4. 1995 Oblique aerial view of the Yellowstone mine in 1995. Photograph provided by Luzenac America, Inc.

States and Canada. All barite deposits that have been mined in the state occur in slightly metamorphosed rocks of the Proterozoic Belt Supergroup exposed in the western part of the state (Berg, 1988). The Finlen and Sheridan Company began mining barite from the Greenough mine on Elk Creek, 30 miles (48 km) east of Missoula (No. 29, Figure 1) in 1951, and in 1952 they completed a mill for processing this barite. Both the mine and mill were sold to the Baroid Sales Division of the National Lead Company in 1956, who closed the mill in 1966 because of a declining market. The mill was subsequently dismantled. With an increase in domestic drilling activity in 1976, the Montana Barite Company constructed a mill in Missoula,

where they ground barite mined from the Greenough deposit (also known as the Elk Creek mine), and from two other barite deposits near this mine. They also shipped in some barite from a deposit near Northport, Washington. In 1983, the mill and leases were sold to Nicor Mineral Venture, who sold it to Mountain Minerals several years later. Shortly after this sale the Missoula mill was dismantled. Mountain Minerals continued to mine a small amount of barite for specialty markets from the underground Elk Creek mine for several years, but is now processing only a small amount of barite from the Coloma mine situated 3.5 miles (5.6 km) southwest of the Elk Creek mine for the drilling fluid market.

Mineral commodities with no current production

Fluorspar

Fluorspar was mined from the Crystal Mountain deposit 22 miles (35 km) southeast of Hamilton (No. 30, Figure 1) from 1952 until 1973, when mining was discontinued, but processing of previously mined ore at the heavy media mill at Darby continued into the 1980s. Mining of this deposit was begun by the Cummings-Roberts Company and later continued by Darby Spar, Inc. The principal market for fluorspar from this mine was the steel industry. F and S Mining Co. also mined fluorspar from the Snowbird deposit, situated along the Idaho-Montana border 36 miles (58 km) southwest of Missoula (No. 31, Figure 1). In 1958, after two years of mining, the deposit was considered mined out (Sahinen, 1962). In 1980, a small amount of acid-grade fluorspar was mined from this deposit in an underground mine.

Gypsum

Underground mining of gypsum at the Shoemaker mine, 9 miles (14 km) southeast of Lewistown (No. 32, Figure 1) was begun in 1916, with the construction of a mill in 1920 (Perry, 1949). In 1928, U.S. Gypsum bought the operation and in 1936 constructed a wallboard plant next to the mine. Gypsum mining for the wallboard plant continued until 1987, when the mine and plant were closed primarily because of the high cost of underground mining and prohibitive transportation costs for shipment of wallboard to markets outside Montana.

Phosphate

The Warm Springs mine, located in the Garrison Phosphate district 56 miles (90 km) southeast of Missoula (No. 33, Figure 1), was one of the longest operating mines in Montana and was reported to be the only underground phosphate mine in the Western Hemisphere at the time of its closure in 1993. Cominco American, Inc. began mining phosphate from the Phosphoria Formation of Permian age in 1929 and shipped the phosphate rock to their lead-zinc smelters at Trail and Kimberly, British Columbia, where sulfuric acid, recovered in the smelting process, was used in the manufacture of fertilizer from the phosphate rock. This mine was closed because of the higher cost of mining phosphate underground, as compared to surface phosphate mines. Also, transportation costs made it uneconomical to mine and ship

this phosphate rock to Trail and Kimberly, British Columbia. In Garrison, Rocky Mountain Phosphate operated a facility for roasting phosphate rock for use as a feed supplement for cattle, initially using phosphate rock mined in the Garrison Phosphate district. For a short period of time, however, this roasting facility used phosphate feed mined in Florida. This unusual example of almost unbelievable transport of phosphate rock was made possible by low freight rates resulting from back hauls. This plant was closed in 1976 and has since been dismantled.

Phosphate was mined underground in the Melrose Phosphate district for production of elemental phosphorus at Stauffer Chemical Company's plant at Silver Bow 23 miles (37 km) southwest of Butte (No. 34, Figure 1). In 1968, these underground mines were closed in favor of shipping phosphate rock by unit train from the Wooley Valley mine, near Soda Springs, Idaho, to the Silver Bow plant. In 1987, Rhone Poulenc purchased the phosphate plant at Silver Bow and in 1995, the plant was put on standby because the decision was made to provide customers with elemental phosphorus made on contract at FMC's Pocatello, Idaho plant. FMC's larger plant can produce phosphorus more economically than the Silver Bow plant.

Phosphate was mined at the Douglas Creek mine, 22 miles (35 km) northwest of Deer Lodge (No. 35, Figure 1) from 1963 until 1968, when the mine was closed. Montana Phosphate Products Company constructed a flotation plant near the mine for beneficiation of the ore prior to shipment to Kimberly and Trail, British Columbia for fertilizer manufacture.

Vermiculite

A major source of vermiculite in the United States for many years was the Zonolite mine, 8 miles (13 km) northeast of Libby (No. 36, Figure 1). Mining of this large vermiculite deposit began in 1925 (Perry, 1948) and continued until 1990. Some stockpiled ore was processed after closure of the mine, but the mine has since been reclaimed and the mill dismantled. Declining demand by the insulation markets was cited as the major reason for closing this mine, which had not been producing at capacity for several years. A contributing factor cited by some in the decision to close the mine is the occurrence of small concentrations of tremolite in the ore. Although removed from the vermiculite in processing, the presence of tremolite presented a constant concern.

A small amount of vermiculite was mined from the Elk Creek deposit 13 miles (21 km) southeast of Dillon (No. 37, Figure 1). In 1990 a mill was constructed at this deposit, and vermiculite was mined and processed during 1990 and 1991. This deposit has been extensively drilled and is being further evaluated. The Hamilton deposit, 13 miles (21 km) east of Hamilton (No. 38, Figure 1) has been permitted after much discussion and controversy. Another vermiculite deposit situated on the northeastern flank of the Tobacco Root Mountains, 35 miles (56 km) southeast of Butte (No. 39, Figure 1) near the small town of Pony and usually referred to as the Pony deposit, has not been thoroughly evaluated.

Zeolite

A deposit of clinoptilolite is situated along Grasshopper Creek 12 miles (20 km) southwest of Dillon (No. 40, Figure 1). The Montana Bureau of Mines and Geology has been conducting research on the effectiveness of clinoptilolite from this deposit and from other deposits in removing metals from water. In 1994 Montana Clino-Z mined a 100-ton sample from the Grasshopper Creek deposit for evaluation.

Conclusions

As is generally well recognized, transportation costs to large market areas, notably the West Coast and Midwest markets will continue to be a deterrent to the development of many deposits of industrial minerals. It appears that those minerals with relatively high val-

ues, such as some of the specialty minerals, will have the most success in competing in distant markets. The minerals with low market values can generally only compete effectively for local markets, where freight cost is not a serious hindrance.

Acknowledgments

Many individuals have provided information about dates, ownership, and general information that has been incorporated in this paper. Their willingness to

share information, not just for this paper, but over many years is sincerely appreciated.

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VERMICULITE, HYDROBIOTITE, AND BIOTITE IN THE RAINY CREEK IGNEOUS COMPLEX NEAR LIBBY, MONTANA

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ABSTRACT: Vermiculite and hydrobiotite both occur as alteration products of biotite pyroxenite near Libby, Montana. Hydrothermal and weathering studies and new chemical analyses by C. O. Ingamells suggest that the vermiculite is a product of leaching of biotite by ground waters; the hydrobiotite may be a higher temperature alteration product.

Vermiculite and hydrobiotite* are both widely distributed throughout a pluton of altered biotite clinopyroxenite that is part of the alkaline-ultramafic igneous complex near Libby, Montana. Both of these minerals constitute the material of commercial value ('vermiculite') that is mined at this locality.

The genesis of vermiculite and hydrobiotite in the Rainy Creek pluton and elsewhere has received considerable attention. Most investigators of 'vermiculite' deposits have concluded that these minerals are products of reaction of biotite or ferruginous phlogopite with dilute aqueous solutions, but little agreement has been reached whether these solutions are of magmatic or meteoric origin. For example, 'vermiculite' at the Day Brook dunite deposits in North Carolina (Kulp & Brobst, 1954) and the 'vermiculite' at Tigerville, South Carolina (Buie & Stewart, 1954) were believed by the investigators to be weathering products of biotite and phlogopite. 'Vermiculite' near Gold Butte, Nevada was believed by Leighton (1954) to be a product of the hydrothermal alteration of biotite which may have been continued by weathering. Deer, Howie & Zussman (1962, vol. 3) conclude that vermiculite ordinarily is a weathering product whereas hydrobiotite is the result of hydrothermal activity. At Rainy Creek, the origin is no less enigmatic. Larsen & Pardee (1929) ascribe the 'vermiculite' deposits to hydrothermal alteration. Bassett (1959) believed that both the vermiculite and hydrobiotite are supergene

* Hydrobiotite herein refers to a regular 1:1 heteropolytypic (mixed-layer) biotite:vermiculite.

minerals. In part, this dilemma may result from poorly defined terminology. In particular, the name hydrobiotite has been used in a variety of ways and should be defined wherever used. Deer *et al.* (1962, vol. 3) may have complicated this issue by incorrectly stating that hydrobiotite as originally defined by Gruner (1934) is a random mixture. Gruner used this term to define regularly interstratified biotite and vermiculite—no name was proposed by him for a heterogeneous arrangement of layers. It is suggested that the mineralogy of other 'vermiculite' deposits be re-checked before generalizations are made.

In consequence of these contradictory tenets regarding the origin of 'vermiculite', new mineralogical data were collected and experimental hydrothermal and weathering investigations were undertaken as a possible means of gaining insight into the nature of these paragenetic sequences.

GENERAL MINERALOGY

Biotite, vermiculite, and hydrobiotite in the Rainy Creek pluton can be distinguished from one another with the petrographic microscope if reasonable care is exercised, as indicated in Table 1. Vermiculite, hydrobiotite, and biotite show

TABLE 1. Optical properties of biotite, hydrobiotite, and vermiculite

Sample	n_x ± 0.003	$n_y = n_z$ ± 0.001	$n_y - n_x$	$2V_x$ \geq	Pleochroism
Biotite RCB-12	1.569	1.609	0.040	11°	$X < Y = Z$, X = light brown, $Y = Z$ = greenish brown
Biotite RCSp-55	1.568	1.609	0.041	12°	Same as above
Hydrobiotite RCSp-49	—	1.575	—	13°	$X < Y = Z$, X = light brown, $Y = Z$ = moderate brown
Hydrobiotite RCSa-36	—	1.573	—	12°	Same as above
Vermiculite RCSa-59	1.519	1.545	0.026	9°	$X < Y = Z$, Y = light brown, $Y = Z$ = moderate brown to red brown
Vermiculite RC-level 12	1.517	1.544	0.027	7°	Same as above

successively higher refractive indices and birefringence. To obtain sufficient illumination for the measurement of n_x , white light was necessary, and the values are thus accurate to only 0.003 compared to 0.001 for n_y and n_z , which were measured in sodium light. The range of values of n_z obtained for hydrobiotite exceeded 0.003.

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as above

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Same as above

$X < Y = Z$, Y = light
brown, $Y = Z$ = moder-
ate brown to red brown

Same as above

tain sufficient illumina-
y, and the values are
, which were measured
biotite exceeded 0.003,

and, therefore, they are disregarded in Table 1. Optic angles were measured accord-
ing to the procedure described by Bloss (1965), and, as suggested by him, all angles
are recorded as minimum values. Optic angles in the vermiculite are consistently
lower than in the biotite or hydrobiotite, but the difference is small and requires
careful observation.

These layer silicates can be distinguished readily by X-ray diffraction. Values

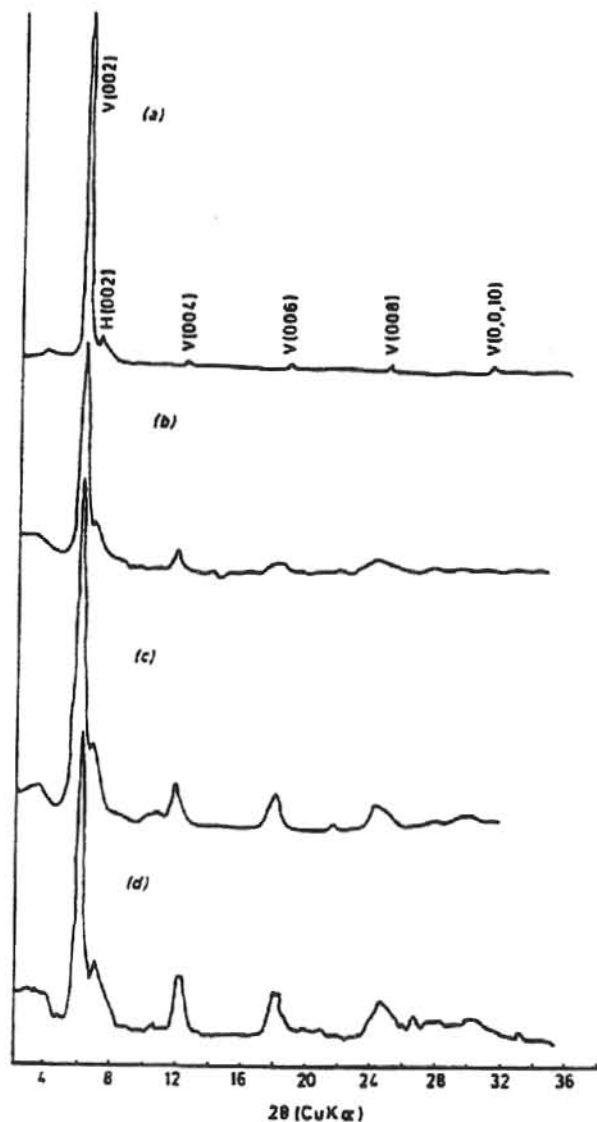


FIG. 1. X-ray diffraction patterns of oriented vermiculite. (a) is untreated vermiculite; (b), (c), and (d) are vermiculite treated hydrothermally at 400, 505, and 550° C, respectively.

for $d(001)$ of 10.1, 25.5, and 28.8 Å were measured for biotite, hydrobiotite, and vermiculite respectively—the latter two values varying slightly with changes in relative humidity. X-ray and differential thermal analysis (d.t.a.) patterns for the vermiculite and hydrobiotite are shown in Figs. 1–3. The sharp peak at 25.5 Å and the high order of rational basal peaks obtainable in the X-ray diffraction patterns of the

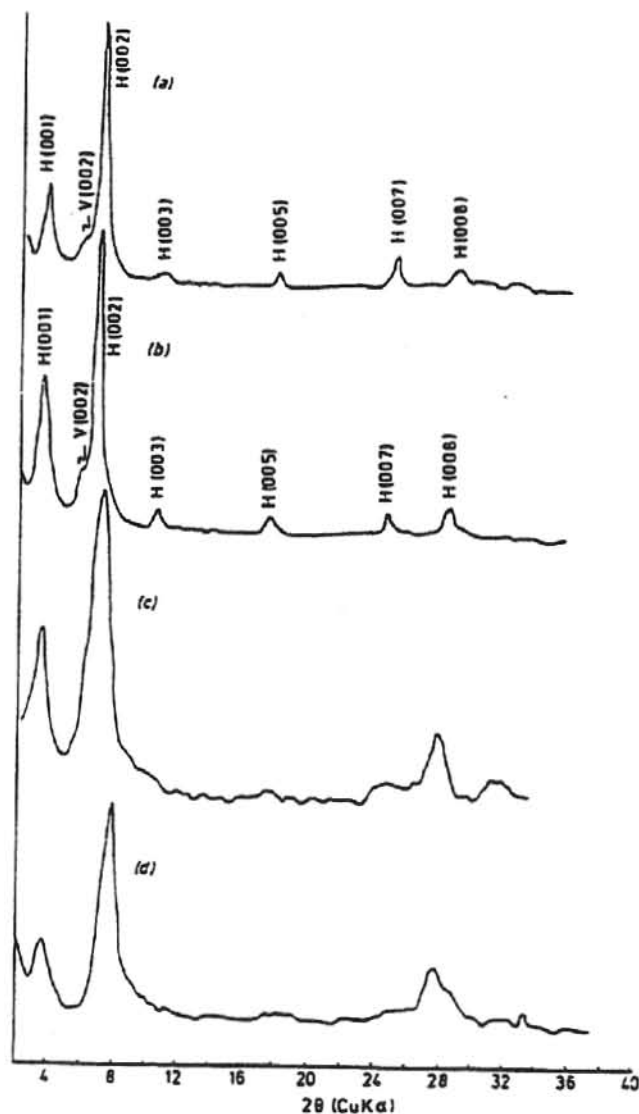


FIG. 2. X-ray diffraction patterns of oriented hydrobiotite. (a) is untreated hydrobiotite; (b), (c), and (d) are hydrobiotite treated hydrothermally at 480, 510, and 550° C, respectively.

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hydrobiotite attest to the regularity of stacking. Two chemical analyses for each of the three minerals are presented in Table 2. Structural formulae appear in Table 3.

HYDROTHERMAL STUDIES

Previous work

The only previous investigation of the behaviour of vermiculite during hydrothermal treatment is that of Roy & Romo (1957), who used samples from Chester

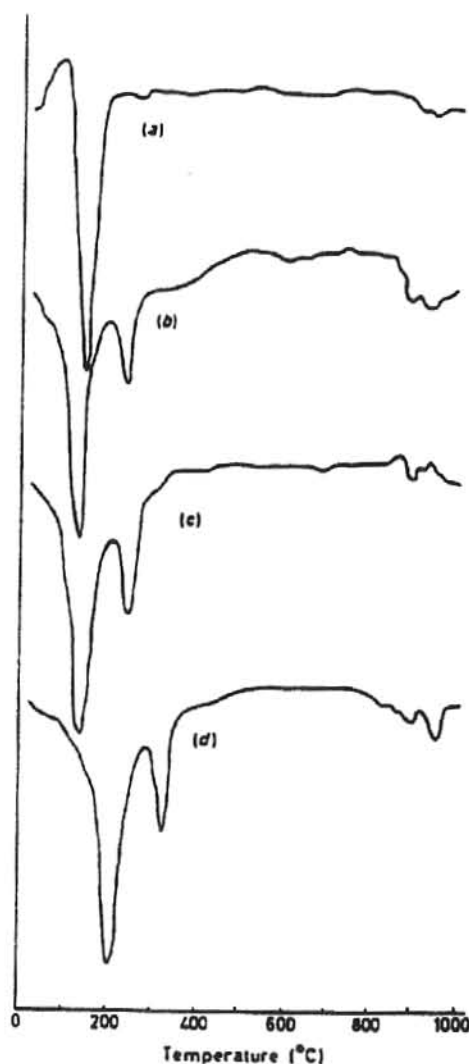


FIG. 3. Differential thermal analysis patterns of hydrobiotite and vermiculite. (a) and (b) are hydrobiotite treated hydrothermally at 560 and 480° C, respectively; (c) is untreated hydrobiotite; (d) is untreated vermiculite.

untreated hydro-
480, 510, and

County, Pennsylvania, and concluded that vermiculite is unstable under hydrothermal conditions. To compare Rainy Creek vermiculite with the sample Roy & Romo and to compare the behaviour of vermiculite and hydrobiotite, present writer examined these materials using a modification of Roy & Romo's procedure.

TABLE 2. Chemical analyses of biotite, hydrobiotite, and vermiculite

	RCSa-59 vermiculite	RC-Level 12 vermiculite	RCSa-36 hydrobiotite	RCSp-49 hydrobiotite	RCB-12 biotite	RCSp-55 biotite
SiO ₂	35.57	35.43	35.60	36.77	38.63	39.10
Al ₂ O ₃	11.47	11.30	11.85	11.60	13.08	13.30
TiO ₂	1.06	0.91	1.13	1.02	1.55	1.21
Cr ₂ O ₃ *	0.18	0.26	0.03	0.27	0.23	0.25
Fe ₂ O ₃	7.49	6.65	10.28	8.19	2.50	2.56
FeO	0.34	0.27	0.81	0.98	8.75	7.23
NiO	0.02	0.01	0.00	0.01	0.02	0.02
MnO	0.06	0.05	0.08	0.08	0.14	0.10
MgO	22.57	23.56	20.17	20.04	19.94	21.55
CaO	0.73	0.39	1.44	1.94	0.18	0.12
SrO*	0.01	0.01	0.005	0.01	0.005	0.005
BaO*	0.10	0.03	0.17	0.19	0.45	0.35
Na ₂ O	0.00	0.00	0.16	0.12	0.26	0.23
K ₂ O	0.96	0.14	3.17	3.84	10.00	10.05
Rb ₂ O	0.00	0.00	0.0129	0.0158	0.04	0.03
Cs ₂ O	—	—	0.00041	0.00050	—	—
H ₂ O+†	9.01	9.47	7.56	6.69	3.52	3.74
H ₂ O—	10.11	11.26	7.20	7.80	0.30	0.06
P ₂ O ₅	0.06	0.05	0.07	0.06	0.06	0.00
F	—	—	0.21	0.30	0.30	0.35
			99.95	99.93	99.95	100.26
O F			— 0.09	— 0.12	— 0.12	— 0.18
Total	99.74	99.79	99.86	99.81	99.83	100.08

Analyst: C. O. Ingamells.

* Spectrometric analyses by N. H. Suhr.

† The water reported as H₂O+ is the total hydrogen as H₂O less loss in weight at 105° C (which is reported as H₂O—). Total hydrogen was determined by a modified Penfield method (Cruft, Ingamells & Muysen, 1965). Ignition-loss determinations yielded the following values: 19.06 (RCSa-59), 20.72 (RC-Level 12), 15.00 (RCSa-36), and 14.72 (RCSp-49).

Sample preparation

Samples of vermiculite and hydrobiotite were obtained from clean, single cleavage flakes wet ground in a Waring blender. After grinding, the fines (<2 μ) were separated using normal sedimentation techniques. To promote equilibration, only these fines were used in subsequent experiments. Chemical analyses, d.t.a.

is unstable under hydro-
lytic with the samples of
biotite hydrobiotite, the
composition of Roy & Romo's

patterns, and X-ray diffraction patterns for the starting materials (sample RCSa-59 for the vermiculite and sample RCSp-49 for the hydrobiotite) appear in Table 2 and Figs. 1-3. The X-ray patterns show that the vermiculite contains small percentages of hydrobiotite and vice versa. Such contamination is, unfortunately, unavoidable in the Rainy Creek samples which must be large enough for both chemical analysis and experimentation, but the contamination is probably too small to affect the results of these studies.

and vermiculite

te	RCB-12 biotite	RCSp-55 biotite
	38.63	39.10
	13.08	13.30
	1.55	1.21
	0.23	0.25
	2.50	2.56
	8.75	7.23
	0.02	0.02
	0.14	0.10
	19.94	21.55
	0.18	0.12
	0.005	0.005
	0.45	0.35
	0.26	0.23
	10.00	10.05
	0.04	0.03
	—	—
	3.52	3.74
	0.30	0.06
	0.06	0.00
	30	0.35
	99.95	100.26
	-0.12	-0.18
	99.83	100.08

in weight at 105° C (which
used Penfield method (Cruft,
the following values: 19.06
p-49).

ed from clean, single
iding, the fines (<2 μ)
promote equilibration,
chemical analyses, d.t.a.

TABLE 3. Half-cell structural formulae for biotite, vermiculite, and hydrobiotite

(a)	$(\text{Mg}_{2.30}\text{Fe}^{++}_{0.14}\text{Mn}_{0.01}\text{Fe}^{+++}_{0.14}\text{Ti}_{0.00}\text{Cr}_{0.01}) (\text{Si}_{2.00}\text{Al}_{1.14}) \text{O}_{10.18} (\text{OH}_{1.74}\text{F}_{0.07}) (\text{K}_{0.04}\text{Na}_{0.04}\text{Ca}_{0.01}\text{Ba}_{0.01})$
(b)	$(\text{Mg}_{2.25}\text{Fe}^{++}_{0.44}\text{Mn}_{0.01}\text{Fe}^{+++}_{0.14}\text{Ti}_{0.07}\text{Cr}_{0.01}) (\text{Si}_{2.00}\text{Al}_{1.12}) \text{O}_{10.00} (\text{OH}_{1.07}\text{F}_{0.04}) (\text{K}_{0.02}\text{Na}_{0.02}\text{Ca}_{0.01}\text{Ba}_{0.01})$
(c)	$(\text{Mg}_{0.71}\text{Fe}^{++}_{0.03}\text{Fe}^{+++}_{0.03}\text{Ti}_{0.00}\text{Cr}_{0.01}\text{Ca}_{0.02}\text{K}_{0.10}) (\text{Si}_{2.00}\text{Al}_{1.14}) \text{O}_{10.00} (\text{OH})_{2.00} \text{X}3.83 \text{H}_2\text{O}$
(d)	$(\text{Mg}_{2.07}\text{Fe}^{++}_{0.03}\text{Fe}^{+++}_{0.01}\text{Ti}_{0.00}\text{Cr}_{0.01}\text{Ca}_{0.02}\text{K}_{0.01}) (\text{Si}_{2.00}\text{Al}_{1.14}) \text{O}_{10.00} (\text{OH})_{2.00} \text{X}4.11 \text{H}_2\text{O}$
(e)	$(\text{Mg}_{2.30}\text{Fe}^{++}_{0.04}\text{Fe}^{+++}_{0.01}\text{Ti}_{0.07}\text{Ca}_{0.12}\text{Ba}_{0.01}\text{K}_{0.02}\text{Na}_{0.02}) (\text{Si}_{2.00}\text{Al}_{1.18}) \text{O}_{10.00} (\text{OH}_{1.04}\text{F}_{0.04}) \text{X}3.01 \text{H}_2\text{O}$
(f)	$(\text{Mg}_{2.24}\text{Fe}^{++}_{0.07}\text{Fe}^{+++}_{0.00}\text{Ti}_{0.00}\text{Cr}_{0.01}\text{Ca}_{0.17}\text{Ba}_{0.01}\text{K}_{0.02}\text{Na}_{0.02}) (\text{Si}_{2.00}\text{Al}_{1.09}) \text{O}_{10.00} (\text{OH}_{1.02}\text{F}_{0.02}) \text{X}2.58 \text{H}_2\text{O}$

(a) Biotite RCB-12 and (b) biotite RCSp-55 calculated by method of Foster, Wones & Eugster (1963) based on $\text{H}_2\text{O} +$ assuming (tetrahedral) = 4.00. (c) Vermiculite RCSa-59, (d) vermiculite RC-Level 12, (e) hydrobiotite RCSa-36, and (f) hydrobiotite RCSp-49 calculated from modifications of methods of Ross & Hendricks (1945) and Mackenzie (1957) based on $\text{H}_2\text{O} +$ assuming (tetrahedral) = 4.00, O = 10.00 and (OH, F) = 2.00.

Procedure

Small samples (about 30 mg) of the minerals, together with 20 weight per cent H_2O , were placed in welded gold capsules and run for 3 days to 2 weeks at $P_{\text{H}_2\text{O}} = 18,000 \text{ lb/in}^2$ (1.2 kb) in Stellite steel, cold-seal, test-tube apparatus (Tuttle, 1949) at temperature intervals of no greater than 25° C. Several runs were made using 0.18 g samples in larger bombs so that d.t.a. curves of the materials could be obtained. Additional runs at $P_{\text{H}_2\text{O}} = 5 \text{ kb}$ were kindly performed by John Carman at the Pennsylvania State University. To determine the effects of f_{O_2} on the results, the oxygen-buffer method described by Eugster & Wones (1962) was employed. In all of the runs, water pressure was maintained with an external pump before heating and during the air quench.

After runs were completed, the products were placed in the X-ray diffraction units immediately after removal from the capsules. The most significant parts of the X-ray patterns were obtained in less than 10 mins after the capsules were removed from the bombs.

Results

Vermiculite. In the vermiculite runs at $P_{\text{H}_2\text{O}} = 1.2 \text{ kb}$, no change in the X-ray patterns or the d.t.a. pattern could be observed up to about 350° C. Above this

temperature, a decrease was noted in the ratio of the intensities of the 144 Å (002) peak relative to that of the 004, 006, and higher order basal peaks, although the basal spacings remained constant. This change is very gradual with increasing temperature, and may have occurred undetected below 350° C. The progressive change is illustrated in Fig. 1, where (a) is the pattern for the starting material and (b), (c), and (d) are the patterns for the vermiculite treated at 400, 505, 550° C, respectively. Above 600° C, dehydration occurs, and only a 10 Å phase remains at 650° C. Therefore, the results of these runs are similar to those obtained by Roy & Romo and differ from them in only two minor points. First, in their experiments a change in the relative intensities of the basal peaks was 'appreciable' at 300° C and 'detectable' as low as 200° C. Secondly, they reported that the intensity of the 004 peak increased to become nearly equal with that of 002. As shown in the diffraction patterns for the present runs, the intensities of the high order peaks remain considerably less than that of 002 at 550° C.

Roy & Romo attributed the observed changes to a migration of Mg ions, during hydrothermal treatment, from octahedral sites to interlayer positions. This migration would tend to produce an interlayer 'brucite' structure that is characteristic of chlorites, as compared to the 10–15% occupancy of the 'brucite' Mg positions in vermiculites reported by Bradley & Serratos (1960). Roy & Romo (1957) proposed the same 'pseudo-chlorite' for the hydrothermally treated vermiculites.

Bassett (1959) suggested that, in Roy & Romo's experiments, hydrolysis in the bomb substituted (OH) ions for H₂O molecules in the interlayer positions. Although unmentioned by Bassett, oxidation of a variable-valence element to maintain electrical neutrality would be required by such an exchange. Therefore, to test the two hypothesis, runs were made at different P_{H_2O} , different f_{O_2} , and different pH. If the hypothesis of Roy & Romo is correct, none of these variables should greatly effect the results and perhaps would have no effect at all. Alternatively, different f_{O_2} and pH should produce changes if oxidation and hydrolysis are involved.

The runs made at 550° C at $P_{H_2O} P$ 5 kb produced the same results as the runs at 1.2 kb at the same temperature. Furthermore, no changes were detected when weak HCl solutions were used as a substitute for H₂O or when f_{O_2} was controlled with the Fe₃O₄–Fe₂O₃ buffer (the highest f_{O_2} at which magnetite is stable) or the Fe₃O₄–Fe buffer (the lowest f_{O_2} at which magnetite is stable). In the runs without oxygen buffers, the resulting f_{O_2} was close to that of the Ni–NiO buffer (Eugster & Wones, 1962) or about midway between the f_{O_2} values of the above-mentioned buffers in the temperature range under consideration. However, as stated by Eugster & Wones (1962), equilibrium at low f_{H_2} and low temperature probably was not attained, so that the runs with the Fe₃O₄–Fe₂O₃ buffer below 500° C are of questionable value. In addition, runs employing the Fe₃O₄–Fe₂O₃ buffer were limited to about 25 hr, after which time the Fe₂O₃ was completely reduced to Fe₃O₄. It is uncertain whether equilibrium was established within the charge during this duration, regardless of the degree of approach toward equilibrium of the buffer or between buffer and charge.

es of the 14.4 Å (002) peaks. Although the basal spacing changes with increasing temperature, the progressive change is not significant for the material and (b), (c), and (d) are at 550°C, respectively. The material remains at 650°C. The results obtained by Roy & Romo in their experiments show a change in the basal spacing at 300°C and the intensity of the 004 peak in the diffraction pattern. The peaks remain con-

cent of Mg ions, during the experiments. This migration of Mg ions is characteristic of the 'brucite' Mg positions in the vermiculite. Roy & Romo (1957) produced vermiculites.

In the experiments, hydrolysis in the interlayer positions. The presence of an element to maintain the basal spacing. Therefore, to test the effect of f_{O_2} and different experimental variables should be considered. Alternatively, the results of hydrolysis are

the same results as the changes were detected in the basal spacing of H_2O or when f_{O_2} was changed. At which magnetic field, which magnetite is present, was close to that of the untreated material. The difference between the f_{O_2} under consideration. At low f_{H_2} and low f_{O_2} , the $Fe_3O_4-Fe_2O_3$ transition was established. The results employing the same time the Fe_2O_3 was established. The approach toward

Despite these limitations, it may be qualitatively stated that the changes observed during the hydrothermal treatment of vermiculite were not noticeably effected by changes in f_{O_2} and therefore, did not involve an oxidation-reduction reaction. The writer therefore accepts the general conclusions of Roy & Romo. The apparent higher temperature stability of the Rainy Creek vermiculite relative to that from Chester County, Pennsylvania, may result from differences in the occupancy of the interlayer sites. On the other hand, the greater ratio of the intensities of 002:004 in the diffraction patterns of the Rainy Creek material may result from compositional differences, particularly in the ratio of Fe:Mg.

As a final check, the treated vermiculites ('pseudo-chlorites') and untreated vermiculite were exposed to ethylene glycol vapour. In all trials, the vermiculites which had been treated hydrothermally above 350°C expanded up to as much as $d(001) = 16.7$ Å whereas untreated vermiculite and vermiculite treated below this temperature showed little or no change in $d(001)$. It is of interest that Stephen & MacEwan (1951) report 'swelling chlorites' which expand up to 17.8 Å with glycerol treatment, and which may be, according to Vivaldi & MacEwan (1960), members of a complete series extending from chlorite to vermiculite, that is from complete interlayer 'brucite' sheets to layers with only small amounts of interlamellar hydroxide impurity.

Hydrobiotite. No change in the X-ray diffraction pattern or the d.t.a. pattern of the treated hydrobiotite was observed until 480°C at $P_{H_2O} = 1.2$ kb. Above this temperature the 002 peak on the diffraction pattern broadened and shifted from about 12.4 to 11.5 Å at 550°C, and a broad peak developed at about $2\theta = 3.2^\circ$. These changes are illustrated in Fig. 2 in which (a) is the untreated hydrobiotite and (b), (c), and (d) are the hydrobiotites treated at 485, 510, and 550°C, respectively. In Fig. 3, d.t.a. curves of hydrobiotite treated at $P_{H_2O} = 1.2$ kb at 480°C (a) and 480°C (b) are compared with the curves for untreated hydrobiotite (c) and vermiculite (d). The curve for hydrobiotite resembles that for vermiculite, which is to be expected as biotite shows no pronounced deflections at this scale up to 1000°C. The exact positions of the peaks for any of these materials is significantly affected by grain size and the degree of compaction of the sample in the holders, but, in general, the endothermic peaks for vermiculite occur at higher temperatures than the corresponding peaks for hydrobiotite. The d.t.a. pattern of hydrobiotite treated at 480°C resembles that of the untreated hydrobiotite within the reproducibility of different trials, but higher temperatures produce a significant difference, which agrees with the X-ray studies. That this change is not a simple dehydration is shown by the inability of the altered hydrobiotite to rehydrate after prolonged treatment with H_2O . Also, the converted hydrobiotite when treated with ethylene glycol vapour expands from a $d(001)$ of about 23.2 Å to about 26.6 Å, but little or no expansion was noted in similarly treated hydrobiotite.

As was found in the experiments on vermiculite, the temperature at which this change occurs in hydrobiotite remained unaffected by an increase in P_{H_2O} to 5 kb, a change in f_{O_2} with the oxygen buffers described earlier, or the addition of HCl.

but the same limitations on the use of the buffers applies equally as well here as with the vermiculites.

The nature of the change that occurs in hydrobiotite when heated hydrothermally above 480° C remains unknown, but the formation of interlayer biotite-'pseudo-chlorite' is one possibility. If this has occurred, the single low-temperature endothermic peak in the d.t.a. pattern remains unexplained. Perhaps it is attributable to the expulsion of 'unbound' H₂O.

When considering the present work on vermiculite and hydrobiotite, the possibility must be entertained that neither of these minerals has a P-T stability field, but may only represent highly metastable phases. However, the work of Iiyama & Roy (1963) suggests that at least some heteropolytypic layer silicates may be stable at high P_{H₂O}.

WEATHERING STUDIES

Previous work

Previous experimental studies (Barshad, 1948; Bassett, 1959; Weaver, 1958) have attempted to simulate the weathering of biotite. In these experiments, biotite was treated with dilute Mg or Ca solutions at low temperatures (25–100° C) in an attempt to provide evidence that vermiculite and/or hydrobiotite are products of weathering processes acting on biotite or ferruginous phlogopite. All of these attempts were reported to be successful in producing vermiculite, apparently by simply replacing the interlayer K ions of biotite with hydrated Mg ions. On the other hand, hydrobiotite, as defined in this paper, was not produced in any of these trials. Because the exact nature of the starting materials used in the previous studies remains uncertain, the writer conducted similar experiments, starting with biotite (RCSp-55 and RCB-12) and hydrobiotites (RCSa-36 and RCSp-49) for which chemical analyses are listed in Table 2.

Procedure and results

All of the samples were treated with 1 N MgCl₂ solutions at room temperature for periods up to 30 days. For all samples, a 14.4 Å phase was obtained, although frequent changes of the solutions were required to prevent the concentration of K ions in solution from exceeding a critical value as described by Bassett (1959). In agreement with Barshad (1948), the hydrobiotite, in all trials, inverted to the 14.4 Å phase more rapidly than biotite of the same grain size.

Despite the results of these and the previous weathering experiments, it is suggested that these processes are dissimilar to those that have formed natural vermiculite, because a comparison of the compositions of natural vermiculites with those of biotites indicates differences other than the substitution of Mg for K. Roy & Romo (1957) have proposed that the weathering of natural biotites proceeds with the expulsion of the interlayer K ions and the migration of Mg from the octahedral to the interlayer positions concomitantly with the oxidation of octahedral ferrous ions to maintain charge balance. In support of this idea, they note that no true

(iron-free) phlogopite has been known to alter to vermiculite, and later, Roy & Mumpton (1958) illustrated that an iron-poor (0.5% Fe) phlogopite weathered to septeclorite, not vermiculite. An inspection of the analyses of vermiculites and igneous biotites, as compiled by Deer *et al.* (1962, vol. 3) reveals that all of the vermiculites have $\text{Fe}_2\text{O}_3 > \text{FeO}$, the reverse being true for the biotites. The analyses reported in the present paper illustrate the same relationship. Therefore, if any of the analysed vermiculites is a weathering product, the oxidation of iron was a necessary part of the process. If then, in the earlier experiments, hydrated Mg ions were simply substituted for K ions, the product may have been a K-poor, Mg and H_2O -rich 'biotite', not vermiculite, and the results would hardly prove that this process operates in nature.

To test the hypothesis of Roy & Romo that Mg migrates to the interlayer positions with the concomitant oxidation of ferrous ions during the weathering of biotite and ferruginous phlogopite, and to evaluate the applicability of previous studies, the writer exposed biotites RSp-55 and RCB-12 to an oxidizing environment without the use of foreign-ion solutions. Thirty milligrams of biotite (-100 mesh) were placed in a 500 ml beaker filled with specially distilled H_2O through which O_2 gas was bubbled continuously, and the mixture was continuously agitated with a magnetic stirrer. In hope of increasing the reduction rate by reducing the concentration of K ions in solution, the H_2O was replaced every 5 days. After 35 days, the X-ray pattern showed that the biotite was converted entirely to a 14.4 Å phase. This experiment and the high $\text{Fe}_2\text{O}_3 : \text{FeO}$ ratio of natural vermiculites suggest that leaching of K and oxidation of ferrous ions, not merely the replacement of K with hydrated Mg, is more nearly analogous to natural processes where a weathering origin of vermiculite is suggested. Such a mechanism also eliminates the necessity of large amounts of Mg, the source of which has posed serious difficulty in some other localities where a weathering origin has been proposed.

Attempts to experimentally produce hydrobiotite from biotite by ion-exchange or other methods have thus far proved unsuccessful. Bassett (1959) has produced a 'copper hydrobiotite' by immersing biotite in CuCl_2 solutions, but this product reportedly contains OH ions rather than H_2O in the interlayer positions and, in this respect, would resemble chlorite more than vermiculite. Bassett also has produced 'hydrobiotite' by treating vermiculite with K-rich solutions, but he states that this material does not form a stable ratio as does natural hydrobiotite. Therefore, as hydrobiotite has not been produced in the laboratory at low temperatures, no experimental evidence can be cited in support of a weathering origin.

ORIGIN OF VERMICULITE AND HYDROBIOTITE

Because vermiculite and hydrobiotite are unstable at magmatic temperatures, this writer contends that pervasive dilute fluids have altered the biotite pyroxenite, possibly in two separate events, to form the vermiculite and hydrobiotite at Rainy Creek.

Evidence for the leaching of biotite to vermiculite can be seen in the chemical

analyses in Table 2, being particularly revealing when comparing the structural formulae in Table 3. Na_2O is absent in both vermiculites. McLaughlin (1955) reports that Na is readily removed during natural leaching. Fe in the vermiculites is near all in the ferric state, although total Fe is approximately the same as in the biotites. SiO_2 and Al_2O_3 are not significantly different in biotite and vermiculite. The differences in the MgO contents of vermiculite and biotite is small when both are calculated H_2O - and K_2O -free. Thus, the major dissimilarity between these two minerals is a lower content of alkali metals and a higher oxidation state in the vermiculite, which is in accord with the results of the leaching experiments described earlier.

The relationship between biotite and hydrobiotite is less apparent. Na_2O in the hydrobiotites is higher, relative to K_2O , than in the biotites, and CaO is high relative to both vermiculite and biotite. The oxidation state of Fe in hydrobiotite is greater than that of biotite, but Fe, SiO_2 , Al_2O_3 , and MgO are not greatly different. In short, hydrobiotite does not appear to be an intermediate stage in the leaching of biotite.

Bassett (1959) has suggested that, given long periods of time, H_2O and Mg (or Ca) from dilute solutions would replace K ions in a single-layer biotite, resulting in a weaker bond in that layer and a stronger bond in the adjacent layers. Therefore, because of the increased bond strengths, replacement of K in the adjacent layers would not occur, producing a 1:1 regularly layered polytype. Such an explanation is unsatisfying to this writer, because, although the substitution of hydrated Mg for K would reduce the bond strengths between adjacent tetrahedral layers, the effects would not be transmitted through the 'talc' unit to the next interlayer. Equally implausible is the possibility that the 1:1 regular stacking results from the migration of Mg and K to alternate interlayers in a parent of the same bulk composition. Therefore, this writer favours one of the following two possibilities for the origin of the 1:1 stacking sequence in hydrobiotite: (1) the sequence represents the attainment of homogeneous equilibrium at the time of the alteration of the parent biotite, and (2) the sequence reflects the nature of stacking in the parent biotite, being controlled by kinetic factors rather than by internal equilibrium.

Regarding the first alternative, experimental data on this problem are scarce, but the work of Iiyama & Roy (1963) suggests that regularity of stacking in heteropolytypes is the result of high pressure and that these regularly stacked polytypes generally are 'primary' not weathering, phases.

Considering the second alternative, the writer was first attracted by the possibility that the observed stacking in hydrobiotite results from the alteration of a two-layer biotite arranged such that the crystal-chemical environment of the interlayer K ions differs slightly in alternate layers. However, Dr E-an Zen (personal communication) kindly pointed out that because of the three-fold symmetry of the basal oxygen ions in the tetrahedral layers, the K ions in two-layer polytypes have the same environment from layer to layer. He further indicated that a four-layer biotite, for example, with a stacking sequence of 3030 (see Ross, Takeda & Wones, 1966), could have the K ions in the same environment only in alternate layers.

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Consequently, the writer determined the polytypism of three samples of the un-
altered biotite from Rainy Creek using the precession method of Ross *et al.* (1966).
All samples were determined to be the one-layer (1M[0]) polytype, and it is con-
cluded that the stacking sequence in the hydrobiotite at Rainy Creek is not
controlled by that of the parent biotite.

CONCLUSIONS

Vermiculite and hydrobiotite both occur as widely distributed alteration products
of biotite in a biotite pyroxenite near Libby, Montana. Hydrothermal studies
suggest that the maximum upper limit of stability of the vermiculite is about 350°C
from 1 to 5 kb $P_{\text{H}_2\text{O}}$. Leaching and ion-exchange experiments suggest that vermi-
culite-like phases can be produced from biotite by the removal of alkali metals and
the concomitant oxidation of ferrous ions or by the substitution of hydrated Mg
ions for K ions. Inasmuch as chemical analyses show that the vermiculite differs
principally from the biotite by having a lower content of alkali metals and a higher
ratio of $\text{Fe}_2\text{O}_3 : \text{FeO}$, it is concluded that vermiculite originated by leaching of
biotite by ground waters.

On the other hand, the hydrothermal studies suggest that the upper stability
limit of hydrobiotite may be as high as 480°C from 1 to 5 kb $P_{\text{H}_2\text{O}}$. A comparison
of chemical analyses of the hydrobiotite and biotite suggest no simple compositional
relationship as might be expected if the hydrobiotite is a simple weathering product.
Single-crystal studies indicate that the regular stacking sequence exhibited by the
hydrobiotite is not inherited from the parent biotite. Consequently, the hydrobiotite
is considered to be a high-temperature alteration product in which the 1:1 stacking
sequence represents the attainment of homogeneous equilibrium at the time of
alteration.

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STATE OF MONTANA
BUREAU OF MINES AND GEOLOGY
Francis A. Thomson, Director

Memoir No. 27

TALC, GRAPHITE
VERMICULITE AND ASBESTOS
DEPOSITS IN MONTANA

By
Eugene S. Perry

MONTANA SCHOOL OF MINES
BUTTE, MONTANA
1948

PART III. VERMICULITE

General Considerations.

The vermiculite deposit near Libby, Montana, recognized as such in 1916, is the first to be worked in the United States successfully on a large commercial scale; and development of this deposit, beginning in 1923, marked the initiation of a new industry not only in this state but in the nation. In 1947 this industry yielded over a million dollars from material mined. Although the Libby deposit is the only one being operated in Montana at present, other deposits of this unusual mineral are known in the state, and their future awaits systematic exploration and development.

Vermiculite is an unusual mica-like material which receives its name from its peculiar property of expanding and opening out into worm-like forms when heated to red heat. (Latin—vermiculari, to breed worms). Good vermiculite should expand 12 to 15 times its original volume. The mineral occurs as flat tabular greenish to brownish crystals which can be separated into thin sheets, and it differs from true mica in that the sheets when bent will not spring back to their original shape. Its hardness is about 1.5 and its specific gravity 2.3 to 2.4. The simplest test for vermiculite is to heat it and observe its expansion—other types of micaceous minerals will not expand. In composition vermiculite is a hydrated silicate of magnesium, aluminum, and iron in which the chemically combined water amounts to about 20 per cent. Percentage of constituents may vary considerably.

The principal use of vermiculite is in heat, cold, and sound insulation. It may be fabricated into blocks, bricks, or wall board with the aid of a binder; it may be used in plaster; and it is used for many other purposes such as for packing, lubricants, rubber goods, and in paper, inks; and paints. Its acoustic properties are notable. A very large quantity is used in loose form for heat and fire insulation in walls and ceilings.. It also is used as a light-weight aggregate in concrete, and plaster, and this is now the largest use of this material. It has some practical value in its natural state, but most of the vermiculite is expanded prior to use. The expanded material will float on water. Tyler* in 1938 stated that "For expanded vermiculite the standard volume ratio is 6 pounds per cubic foot, but varieties that cannot meet this standard are likely to be used increasingly, although perhaps not at the same price per ton or even per bag."

As an insulator vermiculite competes with mineral or rock wool, a manufactured product made by forming fine fibers from molten rock blown into a stream of air or steam, and there are other competing materials.

Vermiculite has been found and worked in several other states and in foreign countries. Deposits were discovered in North Carolina as early as 1873 and in Pennsylvania about the same time. Several deposits were discovered in Colorado about 1913, and in Wyoming in about 1938, and this natural resource occurs in other states. Considerable vermiculite has been mined and shipped from Colorado and Wyoming. Vermiculite is being mined and expanded in South Carolina on a large scale, and these deposits are the source of supply for southeastern United States. Large deposits of vermiculite occur in Africa; some has been shipped to the United States, and foreign producers are encroaching on the American market. As this inconspicuous and seldom recognized mineral becomes better known, it is probable that additional deposits will be discovered.

Actually the term vermiculite includes a group of similar minerals which are essentially alteration products of biotite or phlogopite (black and brown

*Tyler, P. M., Minor nonmetals: U. S. Bur. Mines, Minerals Yearbook, 1936, p. 1314.

micaceous) or possibly hornblende, which are present as the ordinary constituents of dark-colored intrusive igneous rocks such as peridotite. However, vermiculite is also observed in layered or metamorphic rocks such as mica schists or gneisses. The cause of the alteration is uncertain; it is generally assigned to hydrothermal (hot water) action, and bearing on this mode of origin is the regular association of pegmatite dikes with vermiculite deposits. An alternative theory for its origin is by action of weathering and surface waters; but it seems probable to the writer that, even if weathering has had a part in the alteration, it is subsequent to an earlier deep-seated change in the original minerals. These considerations have a bearing on continuation of deposits with depth, in that if the material has been developed by weathering, deposits would be expected to be relatively shallow, but if developed by hydrothermal solutions, deposits would be expected to continue to considerable depth.

In Montana this mineral is known to occur in several localities, chief of which are near Libby, Lincoln County; Hamilton, Ravalli County; Pony, Madison County; and in the Bearpaw Mountains near Box Elder in Hill County. Other deposits of micaceous minerals similar to vermiculite also are known, for example on Squaw Creek south of Bezean. All of these occurrences, except near Pony and vicinity, are of direct igneous origin, the mineral being found in large intrusive masses or dikes. The deposits near Pony and in the region southward occur in pre-Cambrian biotite or hornblende schists. Pegmatite dikes cut the vermiculite deposits in most cases, and they are always in the immediate vicinity of the vermiculite. The vermiculite in the large intrusive masses appears to occur as local concentrations where dark (ferro-magnesian) minerals were originally more plentiful, or else where zones of alteration were more intense; however, certain dike-like bodies are almost all vermiculite. High grade vermiculite bodies are generally very irregular and more lens-like in character at Libby, and dike-like bodies are rarely seen. Because of its mode of origin, vermiculite is to be expected only in the mountainous areas in Montana, as it is only in these areas that conditions suitable for its formation existed.

Vermiculite deposits near Libby

The deposits of vermiculite near Libby are the largest yet worked, and a reserve for many years has been proved. They lie seven miles northeast of Libby, and are readily accessible by automobile by traveling first for four miles east along State Highway No. 37 which follows the north side of Kootenai River, and thence three miles northeast up Rainy Creek. The elevation of Libby is 2050, and of the vermiculite mines between 2,800 and 4,200 feet. Topography may be considered mountainous, and slopes which rise abruptly 1,000 to 2,000 feet above the major drainage are for the most part heavily timbered.

Libby, whose population is about 3000 is on the main line of the Great Northern Railway, and also on U. S. Highway No. 2. Large lumber mills are at Libby, but grazing and some agriculture and metal mining are carried on in the surrounding region. Annual precipitation may reach 50 inches, and snow is deep in winter.

The deposits, discovered about 1915, were soon investigated by Mr. E. N. Alley who, seeing the commercial possibilities of the expanded material, experimented with the processing and utilization of the vermiculite, and he devoted time to promoting its development, a difficult task because the material was so little known. However, the Conolite Company was eventually formed, and commercial production on a small scale began in 1925 from material taken from shallow open-cut workings. The vermiculite was expanded in a small expansion plant which had been erected at Libby in about 1922.

Two other companies, the Micalite Company and the Vermiculite and Asbestos Company, were subsequently formed in 1926. The former did not function long, but the latter sunk pits and drove adits on exposures of vermiculite lying northwest of the original discovery. In 1931 the Dominion Stucco Company of Manitoba acquired an interest in the Zonolite Company. In 1934 the first concentrating plant was erected near the mines. In 1939 the Zonolite Company and the Vermiculite and Asbestos Company merged to form the Universal Zonolite Insulation Company, leaving but one company operating in the district. In 1948 this company changed its name to Zonolite Company, head office of which is in Chicago, and the Zonolite Company now operates the mine, the mill, and the marketing of the product. The original concentrating plant has been remodeled and enlarged from time to time between 1936 and 1947, and the process of concentration changed as more improved methods were developed. The present mill (1948) uses approximately 1,000 tons of feed per day which yields between 350 and 400 tons of concentrate. The original expansion plant at Libby has been reconstructed.

Production of crude and expanded vermiculite gradually increased as the product became better known from meager shipments in 1925 to about 20,000 tons in 1940, and 75,000 tons in 1946. The value at the beginning of operations of the unexpanded vermiculite at the mines was approximately \$12 per ton, but with increasing volume of production, varying market conditions, and demand for various grades, prices have ranged from \$8 to \$13.50 per ton at the mines. The value of expanded vermiculite (f.o.b. processing point) ranges from \$.70 to \$1.25 per bag of four cubic feet weighing about 25 pounds, which is a rate of from \$56 to \$100 per short ton.

Mining at Libby has been carried on mainly by means of open cut methods, the rock being dug with power shovels and hauled by half-track truck and conveyor belt to the concentrating plant which is near the mines. Selective mining is practiced. Dimensions of the pit are: length 1200 feet, width 700 feet, maximum depth 100 feet. The concentrate is hauled by truck to Libby where it may be expanded, or as is the case with most of the material, shipped unexpanded to a plant at Great Falls and to cities in other states, Canada, and foreign countries. Several adits have been driven, and one adit 750 feet long has been driven beneath the open cut so that it crosses the deposit at a depth of 265 feet beneath the surface. The general character of the vermiculite in this adit is not particularly different from that near the surface.

The separation of mixed rock minerals and vermiculite has proved difficult, and several methods have been tried. Wet processes yielded satisfactory separation, but was considered less economical than other methods. Flotation is not suitable for concentrating coarse material. Various applications of air suction, of air lift, and of electrostatic separation were tried. At present concentration is accomplished essentially by sizing and screening in conjunction with differential crushing, and a recovery of between 75 and 80 per cent is achieved on run-of-mine material averaging from 40 to 50 per cent vermiculite. A concentrate containing 90 per cent vermiculite is obtained. Extensive studies on concentration, processing, and utilization are being continued.

Weight of the unexpanded Libby vermiculite concentrate is about 55 pounds per cubic foot, and the weight of the expanded material is about 6 pounds per cubic foot. During the process of expansion a loss in weight of about 10 per cent occurs, due mainly to escape of chemically combined water, although not all of the combined water is driven off. The expansion of the crude mineral is achieved by heating quickly to a red heat (1600° to 2000° F in 5 to 10 seconds). The material is then cooled rapidly, the rapid cooling resulting in better pliability and toughness to the rather brittle particles. Several types of exfoli-

ators are in use. One difficulty encountered in exfoliation is that the partly expanded particles tend to insulate themselves and thus prevent complete exfoliation. When vermiculite is expanded in an oxidizing atmosphere, it yields a golden-colored product. In a reducing atmosphere, the end product is silver-colored. This characteristic is important when expanded vermiculite is used in paints, pigments, and inks.

Geology

The general geology of the area was first studied in detail by Pardee and Larsen*, although other investigators and the writer also have studied the area. This part of Montana is underlain by quartzite and argillite (hardened sandstone and shale) and impure limestone of the Belt series of uppermost pre-Cambrian age,

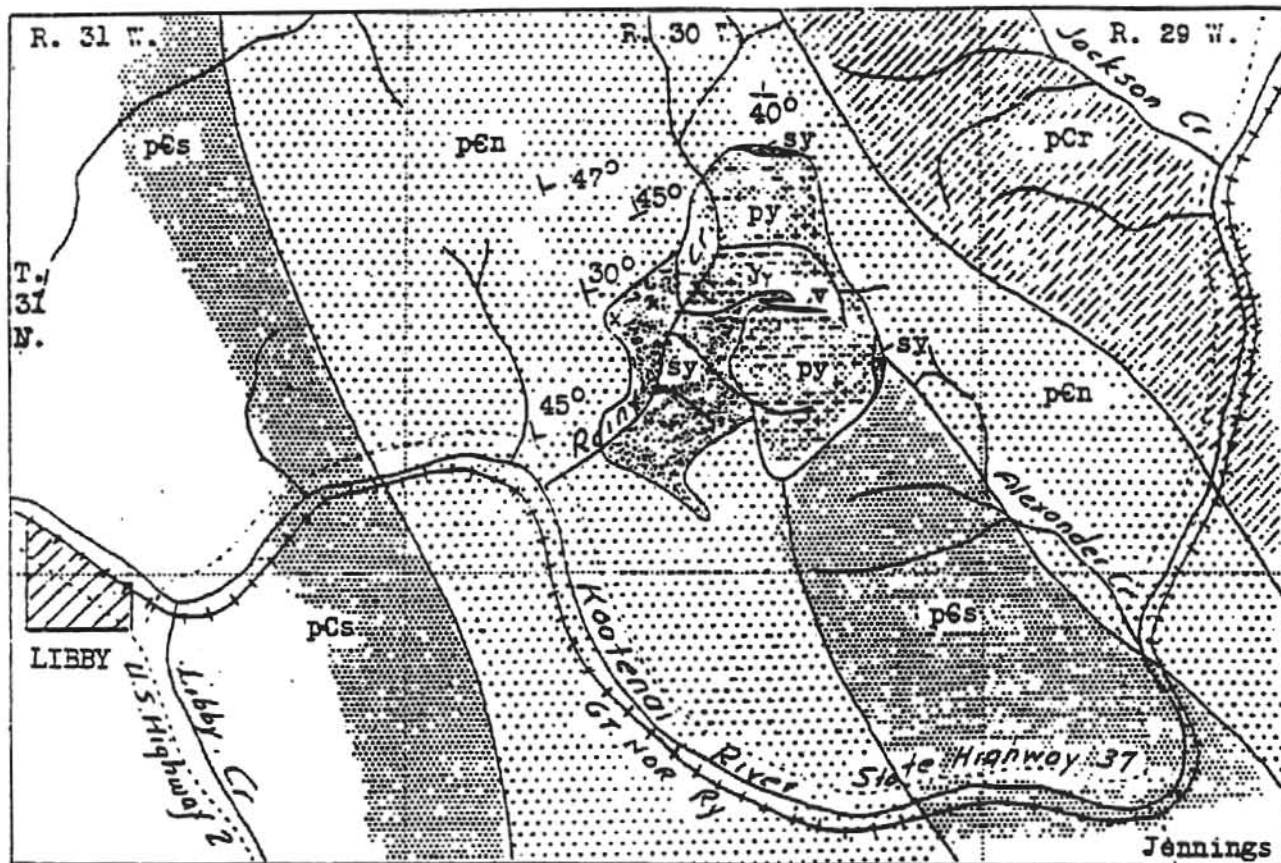


Figure 4.--Geologic map of Libby vermiculite deposit, Lincoln County. pCs, Spokane formation; pEn, Newland formation; pCr, Ravalli formation, sy, syenite; py, pyroxenite; v, biotite rock altered to vermiculite.

totaling more than two miles in thickness. The general regional structure at Rainy Creek is a large open syncline in which the Spokane and Newland formations (subdivisions of the Belt) lie in the center. Minor folding and faulting are present, and dip of strata is commonly 30 to 50 degrees. At Rainy Creek intrusions of pyroxenite and syenite, together with some pegmatite, intruded the Belt strata in late Cretaceous or possibly early Tertiary time, and these rocks

*Pardee, J. T., and Larsen, E. S., Deposits of vermiculite and other minerals in the Rainy Creek district near Libby, Montana: U. S. Geol. Survey, Bull. 805-B, pp. 17-29, 1929.

now form a stock about four miles long and two miles wide. Proportions of the pyroxenite and syenite are about two-thirds and one-third respectively. (See map, figure 4). The vermiculite is a constituent of the pyroxenite.

The pyroxenite, first intrusive of this group, is a coarse-grained dark-colored rock with a greenish tinge, so altered that it can be crushed by squeezing in the hands. In the shallow workings holes for blasting could be drilled with an auger if so desired, however excavation is essentially by power shovels without blasting. Mineral composition of this intrusive differs from place to place from nearly pure pyroxene (diopside) to nearly pure biotite. Alteration has produced vermiculite and in some places amphibole asbestos. Apatite (calcium phosphate) containing much fluorine may constitute 5 to 10 per cent of the rock, an amount unusually high, and titanite and magnetite with ilmenite are locally present up to 10 per cent. Feldspar is present in varying amounts, generally less than 15 per cent. Vanadium is a minor constituent of some of the pyroxenite, although it is reported to be present up to four per cent in small concentrations.** The vermiculite-bearing area has been described as lying in a zone about 2000 feet wide and two miles long striking northerly. Hard, resistant vertical syenite dikes 5 to 10 feet wide lie parallel and form "ribs" in the vermiculite zone.

Specific gravity of the pyroxenite is about 3.4. An analysis of a sample of the pyroxenite shows the following constituents calculated in terms of oxides of metals, although of course practically all constituents are in the form of silicate minerals.

Analysis of pyroxenite from Rainy Creek, Montana*

	per cent		per cent
Silica	37.47	Sodium and potassium oxides. .	1.30
Alumina.	2.86	Water.	1.00
Ferric oxide . . .	11.77	Titanium oxide	1.07
Ferrous oxide. . .	7.83	Phosphorus pentoxide	4.33
Magnesium oxide. .	10.12	Vanadium oxide	0.12
Calcium oxide. . .	21.68	Fluorine	0.36

The syenite is medium to coarse grained, nearly white when fresh, but iron-stained on weathered surfaces. In addition to the main mass are the many dikes which cut the pyroxenite, and it is suggested that the large body of syenite may actually be made up of several smaller separate intrusions massed together. Mineral composition is chiefly potash and soda feldspars with about 15 per cent muscovite locally, and accessory minerals are dark diopside and hornblende, fluorite, apatite, titanite, biotite, and garnet. The syenite differs both in texture and composition with locality, and at the south end of the stock a syenite dike containing nepheline and albite is reported.

Pegmatite dikes are rather common. Three different types have been noted: (1) mafic, that is, dark colored and composed largely of pyroxene; (2) syenitic, that is, light colored and composed mainly of feldspar without quartz; and (3) granitic, that is, composed mainly of feldspar with quartz. This order is also probably the age sequence. The granitic types are small and most common, they cut all rocks of the district, and they grade into glassy quartz veins which locally contain small amounts of copper, lead, and manganese minerals. The syenitic pegmatites grade along their strike into ordinary syenite, and they

**Larsen, E. S. and Hunt, L. F., Two vanadiferous aegirites from Libby, Montana: Am. Jour. Sci., 4th ser., vol. 36, no. 213, pp. 289-295, 1913.

*Pardee, J. T. and Larson, op. cit., p. 21.

appear to be associated with a wide-spread wave of hydrothermal alteration which affected the pyroxenite, altering pre-existing minerals to vermiculite, asbestos, and sericite mica.

The vermiculite has no natural exposures, but soils in the outcrop areas show mica-like flakes, and have a yielding, slippery feel under foot. Vermiculite occurs disseminated in the pyroxenite throughout its area of exposure, and in several dike-like or irregular lens-shaped concentrations the rock may be nearly pure vermiculite. Locally, crystals (books) up to ten inches across may be irregularly massed together, but in the pyroxenite, crystals are commonly less than one or two inches across. The margins of concentrations generally grade into the pyroxenite, the amount of pyroxene increasing until the amount of vermiculite may be less than 10 or even 5 per cent. The concentrations have a nearly vertical trend, and may be as much as 100 feet wide and 1000 feet long, although their width is more commonly 20 to 40 feet. Slip planes cutting the concentrations of vermiculite are common, but are apparently much later and had quality of the vermiculite.

The chemical composition of the vermiculite, as analyzed by the National Bureau of Standards, is as follows:

Analysis of vermiculite from Rainy Creek, Montana

	Per cent		Per cent
Silica	41.0	Magnesium oxide	21.0
Alumina	18.0	Sodium and potassium oxides	1.0
Iron oxide	7.0	Moisture	11.0
Calcium oxide.	1.0		

Information on reserves of vermiculite is not available, but it is reported to be adequate for many years to come. The grade over a period of years has met all market requirements, and there is no indication that grade will change within the known bodies of reserve material.

Vermiculite deposits near Hamilton.

The vermiculite deposits on Gird Creek about 11 air-line miles east of Hamilton (see figure 5) have been opened only by shallow pits and short adits. Extensive tests on the grade of material (amount of expansion, etc.) have not been made throughout all parts of the area. The deposit of vermiculite-bearing rock, about three miles long and one mile wide, shows promise of being commercial, and would seem to warrant additional development work.

The deposit may be reached from Hamilton by automobile over about 6 miles of graded road and 12 miles of mountain road the last half of which has been cut by bull-dozer along a steep mountain slope on the north side of Gird Creek drainage. The area is near the crest of the south end of the Sapphire Mountains, a rugged range thickly covered with timber and reaching altitudes of over 8000 feet or about 5000 feet above Bitter Root River valley at Hamilton. State Highway 57, locally known as the Skalkaho road, crosses the range about $2\frac{1}{2}$ miles southeast of the deposit; but only trails extend from the deposit to this highway. Creeks flowing east and west from the Sapphire Range pass through deep narrow canyon-like valleys mostly inaccessible by automobile. Much of the immediate area of vermiculite-bearing rock has been the site of a forest fire, and fallen timber causes difficulty in traveling.

Hamilton, population about 2000, is the county seat of Ravalli County. It is on a branch line of the Northern Pacific Railway 48 miles south of

ATTACHMENT 3

**TELEPHONE RECORDS WITH
VERMICULITE CONSULTANTS**



RECORD OF TELECON

Project Name: OU1333, ER Site 10 NFA

Project Number: 301462.18303000

Date and Time: December 7, 1997

Call From: Devon Jercinovic

Call To: Dick Berg
Montana Bureau of Mines
(406) 496-4172

Subject: Vermiculite from Libby, Montana

Summary of Discussion:

(1) I asked Dr. Berg what information was available regarding the Libby vermiculite mine (now closed) and if he knew who I could contact for possible samples. Dr. Berg indicated that he himself had very small amounts that he used for classroom demonstrations (exfoliation), but he could not part with any of it. He thought that published information on the chemistry of Libby vermiculite was available and recommended I obtain an article in Clay Minerals by Art L.

Boettcher. Boettcher had performed a Masters thesis on the Libby deposits and looked at all the chemical compositions.

(2) I asked Dr. Berg about the possible origins of vermiculite products in New Mexico in the late 1970s. He felt that given the western location and the market production of the Libby Mine, it was very likely that the vermiculite ore came from Libby. I confirmed that the vermiculite at the site was relatively small-grained and dark (as opposed to current "Strong-Lite" vermiculite now stored in most Sandia facilities). He indicated that in the 1970s, South Carolina was the only other significant producer of vermiculite.

(3) Dr. Berg recommended that I contact James Hindman, an independent consultant in Montana, previously employed by W.R. Grace at the Libby mine. Dr. Berg felt like Hindman was the vermiculite expert in the area.

Required Action: Contact James Hindman, Dillon, Montana (406) 683-4365

Devon Jercinovic

Prepared by (Signature)



**INTERNATIONAL
TECHNOLOGY
CORPORATION**

RECORD OF TELECON

Project Name: OU1333, Site 10 NFA

Project Number: 301462.18303000

Date and Time: December 16, 1997

Call From: Devon Jercinovic

**Call To: James Hindman
(406) 683-4365**

Subject: Vermiculite from Libby, Montana

Summary of Discussion:

Hindman stated that he is currently a private consultant to industry on vermiculite and associated minerals. However, he was employed by W.R. Grace at the Libby Mine until it closed.

(1) I asked about domestic vermiculite production in the late 1970s as related to ore sources. He said that approximately 2/3 of all domestic production came from Libby at that time (approximately 1/4 million tons/year). The only other significant producer was Enore, South Carolina at that time was accounted for the other 1/3 domestic production. Hindman felt that it was likely that vermiculite shipped to New Mexico probably came from Libby.

(2) I asked about the availability of vermiculite samples from Libby that might be archived or sitting in warehouses. Hindman indicated that while W.R. Grace may have some stockpiles, he doubted any would be released for "environmental analyses." He felt that the best source might be the local exfoliators. He recommended I call Southwest Exfoliators in Albuquerque.

(3) Hindman recommended that I consult his "vermiculite" website at www.mcn.net/vermiculite. He is also the publisher of the Vermiculite Technology Newsletter.

Required Action: Contact Southwest Vermiculite (505) 345-1633 in Albuquerque, New Mexico regarding exfoliation of Libby, Montana vermiculite.

Devon E. Jercinovic
Prepared by (Signature)

cc: file



RECORD OF TELECON

Project Name: OU1333, ER Site 10 NFA

Project Number: 301462.18303000

Date and Time: December 16, 1997

Call From: Devon Jercinovic

Call To: Steve Raines
Thermic Refractories
(217) 61702101

Subject: Vermiculite from Libby, Montana

Summary of Discussion:

I asked Mr. Raines if Thermic Refractories still had any Libby vermiculite ore in its possession and if so, could I obtain a sample for testing. Mr. Raines indicated that the firm no longer possessed a stockpile of Libby vermiculite. He concluded by saying that even if he had any left, he would not have provided a sample for analytical testing due to legal implications.

Required Action: None

Devon Jercinovic

Prepared by (Signature)

cc: file



RECORD OF TELECON

Project Name: OU1333, ER Site 10 NFA

Project Number: 301462.18303000

Date and Time: December 16, 1997

Call From: Devon Jercinovic

Call To: John Wright
Southwest Vermiculite
(505) 345-1633

Subject: Vermiculite from Libby, Montana

Summary of Discussion:

Mr. Wright has been the owner of Southwest Vermiculite since they opened in 1976. Southwest Vermiculite purchased large quantities of Libby, Montana vermiculite and Sandia was a customer in the 1970's. The firm had some Libby vermiculite ore warehoused until last year. Mr. Wright thought that they only two remaining sources of Libby vermiculite would be W.R. Grace themselves or Thermic Refractories, a firm in Girard, Illinois who bought up large quantities of the Libby vermiculite when the mine closed.

Required Action: Contact Thermic Refractories

Devon Jercinovic

Prepared by (Signature)

cc: file

RECORD OF TELECON

Project Name: OU1333, ER Site 10 NFA

Project Number: 301462.18303000

Date and Time: November 26, 1997

Call From: Devon Jercinovic

Call To: Tim DeJarnette
Strong-Lite Products Corporation
1-800-255-9057

Subject: Vermiculite Products

Summary of Discussion:

I told Mr. DeJarnette that Sandia currently stocked their Strong-Lite product and I was trying to get information to determine the source of the vermiculite since it looks much different than the vermiculite seen at ER Site 10. DeJarnette indicated that all their product comes almost exclusively from the Phalabowra Mine in South Africa now. It is light colored and very coarse-grained, ideal for adsorption. He said the small-grained, dark color product I was describing was likely a domestic vermiculite. I indicated that the vermiculite was probably purchased in the 1970s. DeJarnette said there were only two main sources of domestic vermiculite in the 1970s, Libby, Montana and South Carolina. He agreed to send me a sample of South Carolina domestic vermiculite for analyses.

Required Action: Send in sample for analyses pending receipt of material.

Devon Jercinovic 

Prepared by (Signature)

cc: file

ATTACHMENT 4

**VERMICULITE INFORMATION
COLLECTED FROM THE INTERNET**

Welcome

This should be the first stop for anyone searching for information about vermiculite. This website is intended to be not only a contact point for subscribers to the Vermiculite Technology Newsletter, but as a source of basic information on commercial vermiculite. It has been my experience that people new to the field of commercial vermiculite do not have access to the basic technical data which is taken for granted by industry professionals.

Although much of the information contained in these pages can be found elsewhere, a visit to these pages may save you a trip to the library. Information will be updated or added to this site, so please stop by again!

What is vermiculite?

The term vermiculite is used interchangeably for both the naturally occurring mineral and the thermally exfoliated product. In either form, vermiculite has a wide range of uses based on its crystal structure, ion exchange capacity, particle size, and thermal behavior. I've attached a short [overview of commercial vermiculite](#).

What is vermiculite used for?

It's hard to imagine any other industrial mineral that can be used in such a wide variety of applications. Vermiculite is used in both beneficiated concentrate and thermally exfoliated forms. [Click here for a short list of uses for vermiculite](#) and [here for links to related web pages](#).

Looking for more information?

Information on commercial vermiculite is not always easy to find. Sometimes the simplest question is the hardest to find an answer for. data is incomplete. Keeping in mind the usual cautions concerning accuracy and responsibility I've included a page for [frequently asked questions](#).

Specific data concerning prices and availability of any vermiculite product is best obtained from the companies actively engaged in the mining, production, and manufacturing of vermiculite and vermiculite based products. [Click here for an abbreviated listing of vermiculite mining companies and exfoliation plants](#).

For those needing specialized assistance and technical information in the areas of vermiculite mining, beneficiation, sales, and product development: [click here for consulting services and the Vermiculite Technology Newsletter.](#)

Comments and suggestions are always welcome. You can reach me by e-mail at: drhindman@aol.com





Vermiculite as an Industrial Mineral

by James R. Hindman

Introduction

Vermiculite is the mineralogical name generally applied to a group of hydrated, trioctahedral ferromagnesian aluminum platy or micaceous silicate minerals. In microscopic particles the mineral is differentiated from montmorillonite by a higher Si:Al ratio of approximately 3:1 and a higher layer charges and higher cation exchange capacities. Commercial vermiculite, the vermiculite which is mined, beneficiated and discussed here, is an important industrial mineral which is formed by the alteration of macroscopic particles of biotite and iron-bearing phlogopite. In natural form it has the size and shape of mica, while possessing the ion exchangeable properties of zeolites and some clays.

Within the internal structure of vermiculite lie water molecules, which when rapidly heated to high temperature, transform into steam causing the vermiculite particles to increase in volume. This process of thermal exfoliation produces a lightweight product which finds use in various construction products, agriculture, horticulture, and other industrial applications. In exfoliated form it has the low density and biological inertness of expanded perlite, while maintaining a chemically active surface. Most of the uses of vermiculite are for the thermally exfoliated material. Trade names such as *Strong-Lite* and *Zonolite* are sometimes used to denote thermally exfoliated vermiculite and their related products.

In addition, the cation exchange potential of vermiculite and its layer-silicate structure are properties which can be used as the basis for numerous products including intumescent coatings and gaskets, inorganic films, and the treatment of nuclear and other toxic waste. When chemically and physically modified, it possesses some properties common to organoclays and synthetic compounds. In high purity concentrates and manufactured products, these properties can be altered and optimized in applications to produce superior performance.

Basic Definitions

A common shortcoming in a surprisingly large number of technical papers is the lack of definition for the *vermiculite* being discussed. I sometimes find that even after reading the entire paper, I cannot determine if the work involves thermally exfoliated vermiculite or the raw concentrate produced at the minesite. Clearly, a simple and concise definition of vermiculite is needed. The original description given by Webb in 1824 gives the essential aspect of commercial vermiculite: "If subjected to the flame of a blowpipe, or that of a common lamp, it expands and shoots out into a variety of fanciful forms, resembling most generally small *worms* having the *vermicular motion exact*". This definition is elegant in its simplicity and lack of technobabble. However, it is not adequate for studies dealing with clays, soils and chemically modified materials. The identification and interpretation of vermiculite in these instances requires x-ray diffraction analysis. In order to further contrast the interests of soil scientists and clay

requires x-ray diffraction analysis. In order to further contrast the interests of soil scientists and clay mineralogists with industrial applications of the mineral, the term *commercial vermiculite* is used to indicate the vermiculite of commerce. Commercial vermiculite is normally a beneficiated product composed of particles generally larger than one millimeter in size.

The term *exfoliation* is used when the layers within the vermiculite structure are separated from each other in a direction roughly perpendicular to the silicate sheets. This term is used in preference to the nondirectional behavior described by expansion (such as with perlite). The physical thickness of the vermiculite particles can be altered by both thermal exfoliation and chemical exfoliation.

A term which should be avoided is hydrobiotite. This term, although widely used, is not applicable to commercial vermiculite. Hydrobiotite suggests that water molecules are incorporated into the biotite structure during the initial growth of the crystal. Although this might be possible, the water molecules in vermiculite have been introduced as a result of the weathering and alteration of biotite. It is very likely that the original papers dealing with hydrobiotite were actually dealing with mixtures of potassium, calcium, and magnesium vermiculites and not interstratified biotite and vermiculite.

Although the confusion caused by these early studies has been resolved, the abuses resulting from the mining and marketing of vermiculite still exist. The common usage of the term vermiculite for the thermally exfoliated product is so entrenched with contractors and the general public that it would be easier to redefine the naturally occurring material. I restrict the term *vermiculite* to refer to the untreated mineral and modify the term to indicate any modification of the original material. Terms commonly used include *thermally exfoliated vermiculite* (TEV), *chemically exfoliated vermiculite* (CEV), and *ground vermiculite* (CEV).

Mining and Beneficiation

The production of commercial vermiculite began in 1915 with the unsuccessful marketing of "Tung Ash", the name given to vermiculite mined near Hecla, Colorado. In fact, vermiculite was inadvertently mined in the 1800's as a major accessory mineral in the Jenks Mine, NC, corundum deposit. The vermiculite mine started by the Zonolite Company at Libby, Montana in 1921 was the first successful venture in the vermiculite industry.

The Libby deposit was the oldest and largest producing vermiculite mine. It had been developed and enlarged for almost 70 years until it was closed in 1990. Vermiculite had also been mined for short periods of time in other states including Colorado, Nevada, North Carolina, Wyoming and Texas. Current production in the United States is restricted to mines in South Carolina, Virginia and Montana. Production of vermiculite outside the United States is predominantly from Phalabowra, Republic of South Africa. Other countries currently producing vermiculite include Brazil, China, Egypt, India, Japan, and Russia.

Commercial vermiculite is generally marketed as concentrates of sized particles, with an average grade (i.e. purity) of 90% by weight. Deposits of vermiculite ore may sometimes contain zones of almost pure vermiculite, but vermiculite ore is normally a mixture of vermiculite and gangue minerals. Common gangue minerals include pyroxenes, magnetite, feldspar, and apatite.

There are various techniques which can be employed to recover vermiculite concentrates from ore. These techniques include both dry and wet techniques such as froth flotation, gravity separations, winnowing, and electrostatic separation. No matter what techniques are used, the resulting concentrates are screened to sized particles to become the vermiculite of commerce. There are two widely used product classifications. The American system is the oldest and is based on the Tyler series of sieves (e.g.

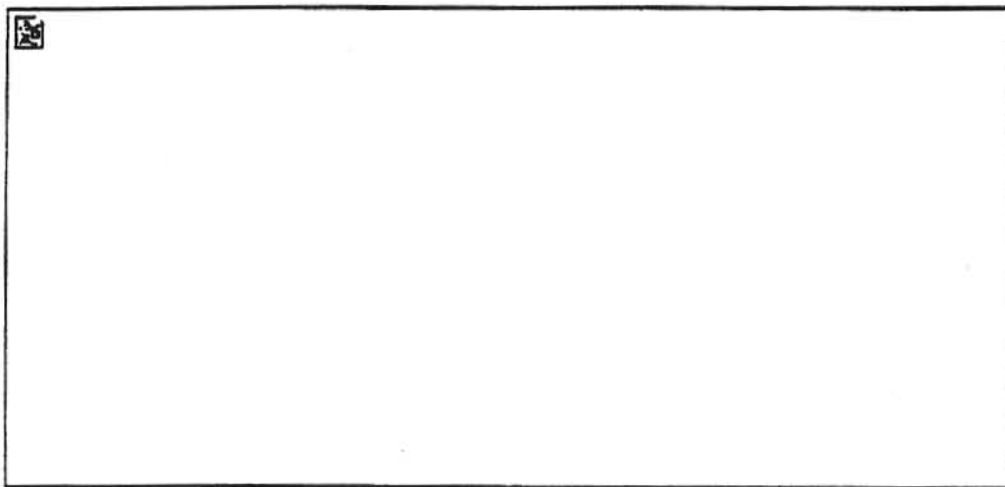
product classifications. The American system is the oldest and is based on the Tyler series of sieves (e.g. 3 mesh, 6 mesh, 10 mesh, etc), while most foreign producers screen their concentrates to Metric specifications (8mm, 4mm, 2mm, etc).

The Structure of Vermiculite

The crystal structure and chemistry of vermiculite is well known, especially to those working with commercial vermiculite. A brief review of the structure and crystal chemistry of vermiculite seems appropriate to clarify the nomenclature used in this area.

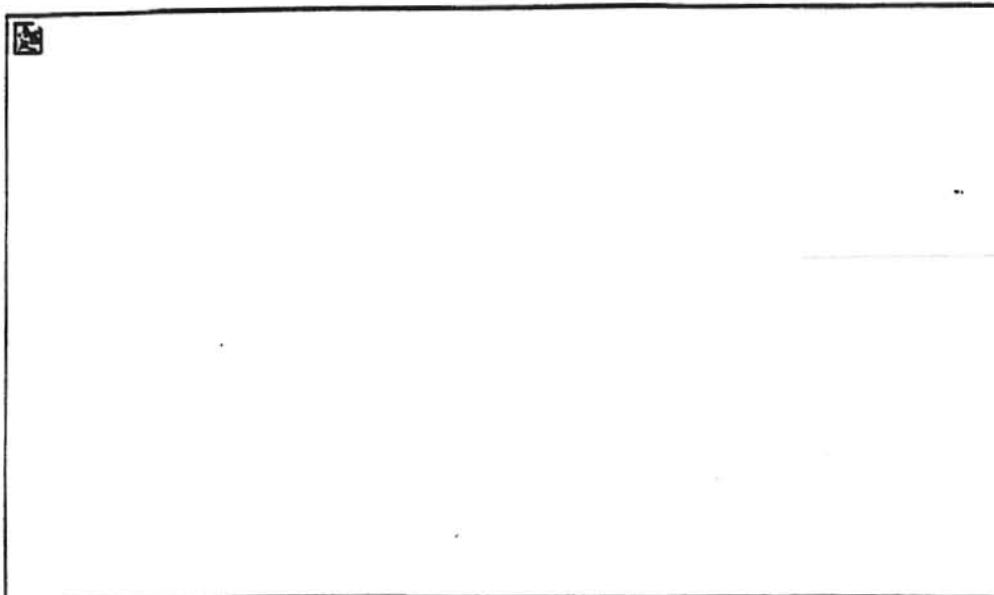
Commercial vermiculite (i.e. the material which is mined and beneficiated) is formed by the near surface weathering of rocks containing large crystals of micas known as iron-bearing phlogopite and biotite. The difference between iron-bearing phlogopite and biotite is simply the amount of iron substituting for magnesium in the phlogopite structure.

The basic structure of mica is shown below. The prominent feature of the structure are sheets of silica and alumina tetrahedra (i.e. a pyramid of with three oxygen atoms forming the base, one oxygen atom forming the apex, and a silicon or aluminum atom hidden in the center of the group) linked together in an hexagonal array, much like honeycomb. These sheets, called tetrahedral layers my mineralogists, are shown in edge-on views in the drawing. If one were to view them towards their flat base, one would see only oxygen atoms linked in a thick-walled honeycomb outline with six sided holes that are not quite large enough to contain a sodium ion. The other side of these sheets are made up of the fourth, or apical, oxygen of the tetrahedra. The silicon and aluminum atoms are tightly held in the center of these oxygen groupings and are not generally shown in structure drawings because of their small size.



The resulting sandwich of tetrahedral and octahedral layers is the basic building block of the micas, chlorites, and vermiculites. This sandwich is composed of two tetrahedral layers bound together by one octahedral layer and is often referenced in the literature by a term such as a 2:1 phyllosilicate. (The term phyllosilicate means sheet or layer silicate, and is used to describe minerals such as mica, vermiculite, talc, kaolinite, bentonite, etc.).

What is important to remember in both the genesis and product development of vermiculite is that the tetrahedral layer is the basic building block of the structure, the octahedral layer the connecting unit of the structure, and the interlayer is the the filler unit of the structure. When biotite is altered to vermiculite the interlayer changes from potassium ions sitting on the surface of the silicate sheets, to hydrated units of calcium or magnesium ions surrounded by closely held water molecules. This structure is shown below:



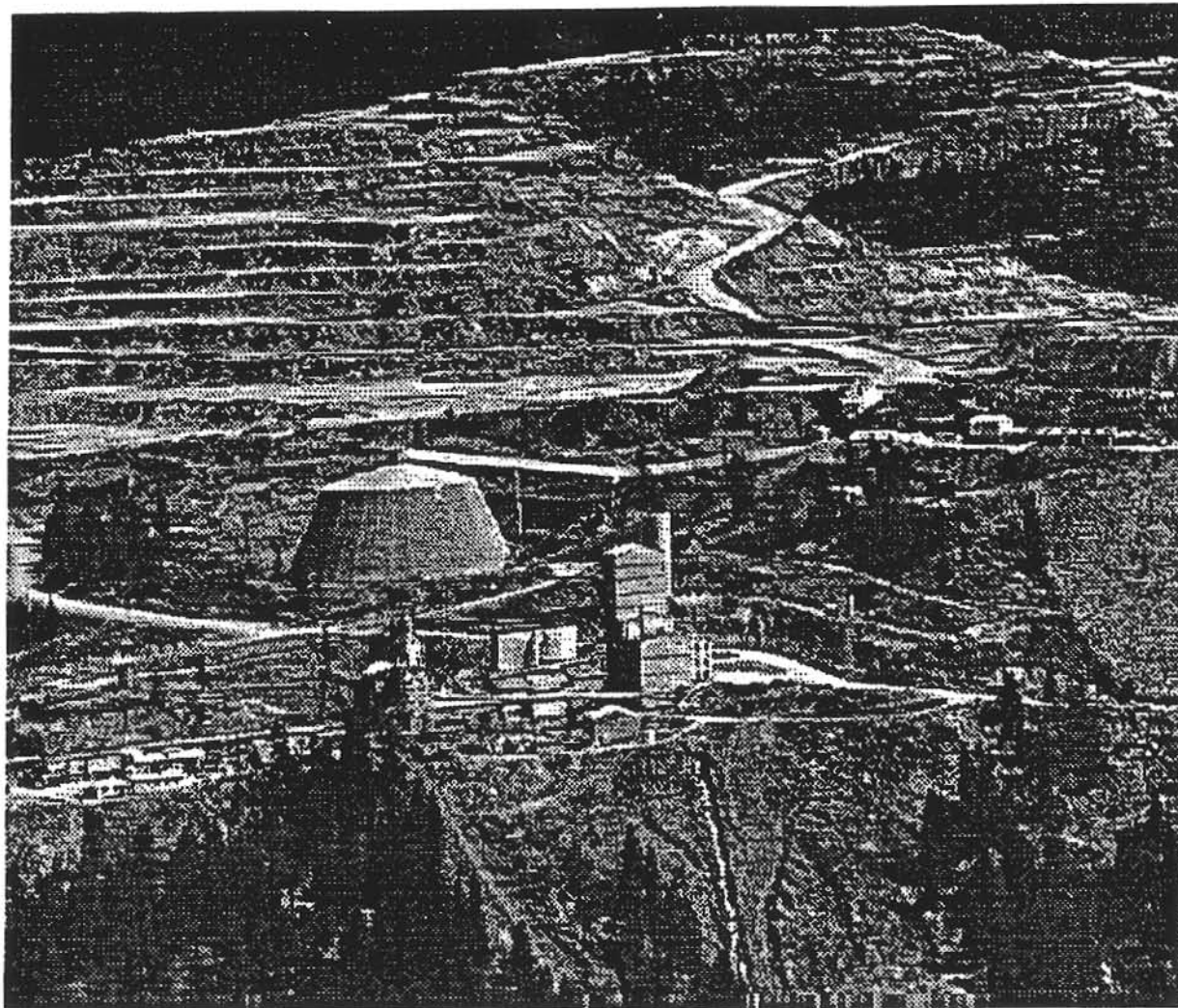
Summary

Vermiculite as an industrial mineral shares a number of useful properties with other commodities. In natural form it has the size and shape of mica, while possessing the ion exchangeable properties of zeolites and some clays. In exfoliated form it has the low density and biological inertness of expanded perlite, while maintaining a chemically active surface. When chemically and physically modified, it possesses some properties common to organoclays and synthetic compounds. In high purity concentrates and manufactured products, these properties can be altered and optimized in applications to produce superior performance.

A number of useful products have been developed to take advantage of these properties, and the commercial vermiculite industry has grown because of this. Still, many interesting properties of vermiculite have yet to be fully explored. The area of developing technologies offers the new area of growth in the vermiculite industry, and the promise of profitable new markets for vermiculite.

[Vermiculite Technologies](#) · [FAQ's](#) · [Uses](#) · [Suppliers](#) · [Links to Related Sites](#) · [Vermiculite Technology Newsletter](#)

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James R. Hindman, Ph.D.

For some years now I have been an acknowledged expert (*blush*) in the field of vermiculite technologies. I started my career in the vermiculite industry at Libby, Montana (shown above). Although my activities will sometimes branch off into clays, diatomaceous earth, micas, perlite, and natural zeolites; my primary interests lie in vermiculite exploration, mining, beneficiation, marketing and product development.

My personal areas of research are directed towards using modified commercial vermiculite in product applications. Particular areas include (1) vermiculite synthesis, (2) extending the thermal range of vermiculite stability, (3) osmotic swelling of vermiculite for product beneficiation and particle delamination, (4) vermiculite dispersion, gel, and film technology, and (5) the preparation of organovermiculite compounds for use in toxin removal, plastic fillers, drilling mud and lost circulation materials. Current research also includes the preparation of a text on the beneficiation, modification, and applications of commercial vermiculite.

I have been fortunate to have been able to provide consulting services to the following companies in the area of **Mining and Beneficiation**: Australian Vermiculite Ltd., Helix Resources N.L. (an Australian mining company), Ikerd-Bandy, Inc., Stansbury Holdings, UBM - União Brasileira de Mineração S.A. (a major Brazilian vermiculite company), US Borax, and USMX, Inc.

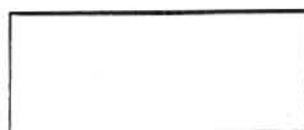
In the area of **Product Development and Process Applications**: BNZ Materials, W.R. Grace and Company, Hercules Incorporated ICI Americas Inc., Metex Corporation, Minnesota Mining and Manufacturing Company, and Unifrax Corporation (formerly Carborundum).

Finally, in the area of **Vermiculite Trade**: F&S Alloys and Minerals Corporation, Nam Fong Trading Company and Southern Importers.

In addition to the Vermiculite Technology Newsletter, I prepared the section on vermiculite for the Metals & Minerals Annual Review of the Mining Journal, London. I also authored the chapter on vermiculite for Industrial Minerals and Rocks, 6th Edition. (Society for Mining, Metallurgy, and Exploration, Inc., 1994, pages 1103-11).

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Prelude #3 - Bach

VERMICULITE

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: One company, with mining and processing facilities in South Carolina, remained the largest producer of vermiculite concentrate. Three other companies each had an active operation for producing concentrate, two in South Carolina and one in Virginia. Most of the vermiculite concentrate was shipped to 22 exfoliating plants in 15 States. The end uses for exfoliated vermiculite were estimated to be agriculture, 55%; insulation, 26%; and lightweight concrete aggregates (including concrete, plaster, and cement premixes) and other, 19%.

Salient Statistics—United States:	1992	1993	1994	1995	1996*
Production ¹	190	190	180	170	W
Imports for consumption*	40	30	30	30	30
Exports*	8	7	7	6	5
Consumption, apparent, concentrate	222	213	203	194	W
Consumption, exfoliated	140	140	130	130	130
Price, average value, concentrate, dollars per ton, f.o.b. mine	W	W	W	W	W
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, mine and mill*, number	230	230	230	230	230
Net import reliance ² as a percent of apparent consumption	14	11	11	12	W

Recycling: Insignificant.

Import Sources (1992-95):* South Africa, 99%; and other, 1%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/96	Non-MFN² 12/31/96
Mineral substances not specifically provided for	2530.10.0000	Free	Free.
Exfoliated vermiculite as mixtures and articles of heat-insulating, sound- insulating, or sound-absorbing materials	6806.20.0000	2.9% ad val.	30% ad val.

Depletion Allowance: 14% (Domestic), 14% (Foreign).

Government Stockpile: None.

VERMICULITE

Events, Trends, and Issues: Besides the traditional end uses for vermiculite, possible new applications include detoxification of water and soil, nuclear waste containment and removal, and industrial spill containment and clean-up.

Prices for South African vermiculite exported to Europe were reported to have increased in the first half of 1996 by 9% to 13%. The lowest grade material, fine, bulk, f.o.b. Rotterdam, increased to \$180 per ton. High grade, large flake material, f.o.b. Rotterdam, reached \$260 per ton. South African vermiculite imported into the United States was listed in late 1996, bulk, f.o.b. barge, Gulf Coast, at \$127 per ton for fine material and \$209 per ton for high-grade material.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves ⁴	Reserve base ⁴
	1995	1996 ⁵		
United States ¹	170	W	25,000	100,000
Russia	40	40	NA	NA
South Africa	222	220	20,000	80,000
Other countries ⁵	46	60	5,000	20,000
World total	478	320	50,000	200,000

World Resources: Marginal reserves of vermiculite, occurring in Colorado, Nevada, North Carolina, Texas, and Wyoming, are estimated to be 2 to 3 million tons. Resources in other countries may include material that does not exfoliate as well as U.S. and South African vermiculite. Total world resources are estimated to be up to three times the reserve amount.

Substitutes: Expanded perlite is a substitute for vermiculite in lightweight concrete and plaster. Other more dense but less costly material substitutes in these applications are expanded clay, shale, slate, and slag. Alternate materials for loosefill fireproofing insulation include fiberglass, perlite, and slag wool. In agriculture, substitutes include peat, perlite, sawdust, bark and other plant materials, and synthetic soil conditioners.

⁴Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data.

¹Concentrate sold and used by producers.

²Defined as imports - exports + adjustments for Government and industry stock changes.

³See Appendix B.

⁴See Appendix C for definitions.

⁵Excludes the United States (1996) and countries for which information is not available.

⁶Excludes the United States.

Properties of Vermiculite

Exfoliation or Expansion

When heated quickly to an elevated temperature, particles of vermiculite exfoliate by expanding at right angles to the cleavage, into worm-like pieces (the name vermiculite is derived from the Latin 'vermiculare', to breed worms). This characteristic of exfoliation, the basis for commercial use of the mineral, is the result of the mechanical separation of the layers by the rapid conversion of contained water to steam. The increase in bulk volume of commercial grades is 8 to 12 times, but individual flakes may exfoliate as many as 30 times. There is a color change during expansion that is dependent upon the composition of the vermiculite and furnace temperature.

Typical Physical Properties Of Exfoliated Vermiculite

Color:	Light to dark brown
Shape:	Accordion-shaped granule
Bulk density(a):	64-160 kg/cu m 4-10 lb/cu ft
Moisture loss @ 110°C (230°F):	4-10%
pH (in water):	6-9
Combustibility:	Non-combustible
Sintering temperature:	1150-1250°C 2100-2280°F
Fusion point:	1200-1320°C 2200-2400°F
Cation exchange capacity (b):	50-150 me/100g
Specific heat:	0.84-1.08 kJ/kgK 0.20-0.26 kcal/kgK 0.20-0.26 Btu/lb°F
Waterholding capacity (a):	200-325% by wt 20-50% by vol

Thermal conductivity at different bulk densities

Bulk densities		Thermal conductivity values	
Kg/cu m	lb/cu ft	Lambda W/mK	Btu in/sq ft h°F
56-64	3.5-4.0	0.058	0.40
80-96	5.0-6.0	0.064	0.44

Notes:

(a) Bulk density and water holding capacity vary with particle size.

(b) Exchangeable ions are Mg^{+2} and Ca^{+2} sodium acetate saturation/ammonium acetate substitution method.

Typical Sieve Analysis

	Grading Cumulative Percent Retained						
	U.S. Sieve No.						
	3 1/2	5	7	14	25	30	50
Extra Coarse (1)	35-55	60-85		90-100			
Coarse (2)		5-20	30-65	75-95	90-100		
Medium (3)			0-10	60-85		90-100	
Fine (4)				10-35	60-85		90-100

Sizes and densities of the standard grades are as follows:

Grade	Size	Density (lb/ft ³)
Extra Coarse (1)	8mm	4.7 - 6.0
Coarse (2)	4mm	5.0 - 6.5
Medium (3)	2mm	5.3 - 7.0
Fine (4)	1mm	5.6 - 8.0

Packaging: Exfoliated

Approximately 4 cu. ft. two ply paper bags. Weight range of 15 to 30 lbs./bag.

Asbestos Content

A microscopical examination of vermiculite from the Palabora Mining Company Limited deposit has shown that no asbestos is present in it.

Free Silica Content

A laboratory examination of Palabora vermiculite gave a free silica content by chemical analysis of less than 1%.

Typical Range of Chemical Analysis

SiO₂ 38.0 to 49.0 %

MgO	20.0 to 23.5%
Al ₂ O ₃	12.0 to 17.5%
Fe ₂ O ₃	5.4 to 9.3%
FeO	0 to 1.2%
K ₂ O	5.2 to 7.9%
Na ₂ O	0 to 0.8%
CaO	0.7 to 1.5%
TiO ₂	0 to 1.5%
Cr ₂ O ₃	0 to 0.5%
MnO	0.1 to 0.3%
Cl	0 to 0.5%
CO ₂	0 to 0.6%
S	0 to 0.2%
H ₂ O	5.2 to 11.5%

-
- **Specific Heat 0.2**
 - **Specific Gravity 2.6**
 - **pH value 8.0 but due to the presence of associated alkaline impurities the reaction is normally alkaline**
 - **Thermal conductivity $k = 0.43 - 0.45 \text{ Btu in/ft}^2 \text{ h } ^\circ\text{F}$**
 - **Vermiculite is incombustible**
 - **Vermiculite is inert to organic solvents, and is insoluble in water**
 - **Vermiculite is clean to handle, non-abrasive, reflective, rot proof, odorless, moldable and non-irritant**

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Welcome to the Homepage of

The Vermiculite Association (TVA) is the international organization representing mining companies, manufacturers, suppliers of equipment or materials, and consultants to the vermiculite industry.

It was founded in 1948, with a mission to promote the knowledge and use of vermiculite around the world.



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Vermiculite - Its Properties and Uses

Upcoming Meetings



E-mail : tva@vermiculite.org

Thank you for calling.
New pages and links will be added in due course so please check again soon.



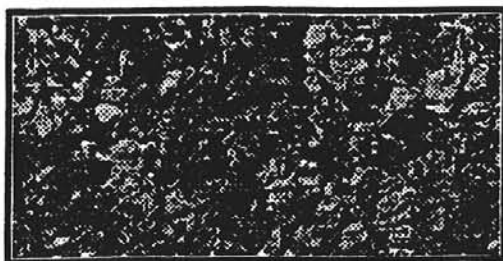
Visitors since 25 June 1997

Page last updated: 22 January 1998

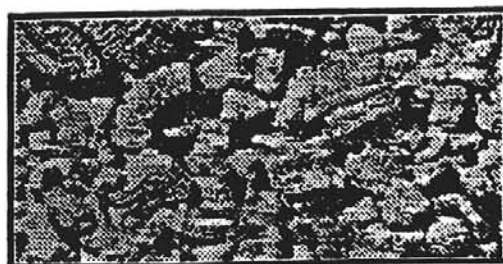
Designed and maintained by Michael Carr
Star-Lite Computing Services



Vermiculite - Its Properties and Uses



Raw Vermiculite



Exfoliated Vermiculite

Vermiculite is the mineralogical name given to hydrated laminar magnesium-aluminum-iron silicate which resembles mica in appearance.

When subjected to heat, it has the unusual property of exfoliating or expanding, due to the generation of interlaminar steam.

Vermiculite is found in various parts of the world.

Locations of the predominant commercial mines are in North America, South America, and Africa.

Other deposits in countries such as India, Japan, Kenya, Zimbabwe, China, the former Soviet Union and Australia are being developed.

Vermiculite mines are surface operations where ore is separated from other minerals, and then screened or classified into several basic particle sizes.

The bulk density of crude vermiculite or vermiculite concentrate is in the range of 640-1120 kg/cu m or 40-70 lb/cu ft.

EXFOLIATION OR EXPANSION

When heated quickly to an elevated temperature, particles of vermiculite exfoliate by expanding at right angles to the cleavage, into worm-like pieces (the name vermiculite is derived from the Latin *vermiculare*, to breed worms).

This characteristic of exfoliation, the basis for commercial use of the mineral, is the result of the mechanical separation of the layers by the rapid conversion of contained water to steam.

The increase in bulk volume of commercial grades is 8 to 12 times,
but individual flakes may exfoliate as many as 30 times.

There is a color change during expansion that is dependent upon the
composition of the vermiculite and furnace temperature.

TYPICAL CHEMICAL ANALYSIS

Element	Percent by Weight
SiO ₂	38-46
Al ₂ O ₃	10-16
MgO	16-35
CaO	1-5
K ₂ O	1-6
Fe ₂ O ₃	6-13
TiO ₂	1-3
H ₂ O	8-16
Other	0.2-1.2

Chemical Formula: (Mg,Ca,K,Fe^{II})₃(Si,Al,Fe^{III})₄O₁₀(OH)₂·4H₂O

TYPICAL PHYSICAL PROPERTIES OF EXFOLIATED VERMICULITE

Colour: Light to dark brown

Shape: Accordion-shaped granule

Bulk density (a): 64-160 kg/cu m
4-10 lb/cu ft

Moisture loss
@110°C (230°F): 4-10%

pH (in water): 6-9

Combustibility: Non-combustible

Sintering
temperature: 1150-1250°C
2100-2280°F

Fusion point: 1200-1320°C
2200-2400°F

Specific heat: 0.84-1.08 kJ/kgK

kcal/kgK

Cation exchange

0.20-0.26

capacity (b): 50-150 me/100g

0.20-0.26 Btu/lb

F

Waterholding capacity (a): 220-325% by wt

20-50% by vol

Thermal conductivity at different bulk densities

Bulk densities

Thermal conductivity values

kg/cu m	lb/cu ft	Lambda W/mK	Btu in/sq ft h °F
56-64	3.5-4.0	0.058	0.40
80-96	5.0-6.0	0.064	0.44
160-192	10-12	0.071	0.49

Notes: (a) Bulk density and water holding capacity vary with particle size.

(b) Exchangeable ions are Mg^{+2} and Ca^{+2} , sodium acetate

saturation/ammonium

acetate substitution method.

EXFOLIATED VERMICULITE PARTICLE SIZES

Size			Densities		Equivalent	
names/designations						
mm	in		kg/cu m	lb/cu ft	System A	System B
16	5/8	down	56-72	3.5-4.5	NA	Premium (6)
8	5/16	down	64-85	4.0-5.0	1	Large (4)
4	5/32	down	72-90	4.5-5.5	2	Medium (3)
2	0.08	down	75-112	4.7-7.0	3	Fine (2)
1	0.04	down	80-144	5.0-9.0	4	Superfine (1)
0.8	0.02	down	90-160	5.6-10.0	5	Micron (0)

HOW VERMICULITE CAN BE USED

Vermiculite has been used in various industries for over 70 years.

It is used in the construction, horticultural, agricultural, and industrial markets.

Some examples of vermiculite uses include:

CONSTRUCTION	HORTICULTURAL	AGRICULTURAL	INDUSTRIAL
Gypsum plaster Air setting binder Board Loft insulation Fire protection (internal/external) Acoustic finishes Floor & roof screeds (lightweight insulating concrete) Sound deadening compounds	Seed germination Sowing composts Seedling wedgemix Blocking mixes Rooting cuttings Micro-propagation Twin scaling bulbs Potting mixes Hydroponics	Animal feed Pesticide Fertilizer Bulking agent Seed encapsulant Anti-caking material Soil conditioner	Paints Moulded products Brake pads & brake shoes Fireproof safes Filtration Insulation - high & low temperature Insulation blocks & shapes Furnaces Sealants Fixation of hazardous material Castables Drilling muds Nuclear waste disposal Absorbent packing Perfume absorbent Molten metal insulation Dispersions

Below are some examples of typical binders and other materials which are often used in combination with vermiculite:

Portland cement

Resins

High alumina cement

Sodium

silicate

Plaster (gypsum)

Clay
PeatPotassium silicate
Bark

Fertilizers

Consider vermiculite if you are looking for:

Loosefill
aggregates

Carriers

Lightweight

Soil conditioners
modifiers

Asbestos substitutes

Density

Absorbents
insulation

Fire protection

Industrial heat

SAFETY, STORAGE AND HANDLING

Information on safe handling, storage, personal protection, health, and environmental considerations has been gathered on this product and is available from the material suppliers upon request.

It is recommended that all users and specifiers acquaint themselves with this information.

We hope the information given here will be helpful.

It is based on data and knowledge considered to be true and accurate and is offered for the user's consideration, investigation and verification but we do not warrant the results to be obtained.

No statement, recommendation or suggestion is intended for any use which would infringe any patent or copyright.

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Page last updated: 22 October 1997

ANNEX 3-B
Gamma Spectroscopy Results

ANALYSIS REQUEST AND CHAIN OF CUSTODY

PAGE 1 OF 2

Internal Lab

Batch No. 700527

AR/COC- 06546

SF 2001 CUC 16-050

Dept. No./Mail Stop: 6682/B5/MS-1147	Date Samples Shipped: 4/9/97	Contract No.: NA
Project/Task Manager: PAULA SLAVIN	Carrier/Waybill No.: HC	Case No.: 0521-201200
Project Name: STEADY STATE SUPPLC	Lab Contact: FERNANDO DOMINGUEZ	SMO Authorization: [Signature]
Record Center Code: 206 ER/1333/019/DAT	Lab Destination: SNL RP LAB	Bill to: Sandia National Laboratories
Logbook Ref No: 206	SMO Contact/Phone: PAUL PUSAN/844-3185	Supplier Services Department
Service Order No.: CF0394	Send Report to SMO: PAULA SLAVIN	P.O. Box 5800 MS 0154
		Albuquerque, NM 87185-0154

Location		Tech Area		Beginning Depth in Ft.	ER Site No.	Date/Time Collected	Reference LOV (available at SMO)				Sample Matrix	Type	Volume	Preservative	Sample Collection Method	Sample Type	Lab Sample ID
Building	Room	Sample No. - Fraction	ER Sample ID or Sample Location Detail				Container	Type	Volume	Preservative							
		032958-002	CY10-M1-T1-M	0.5	10	4-8-97 1400	Soil	Poly	1X500M	None							
		032959-002	CY10-M1-T1-B			1405											
		032960-002	CY10-M1-T2-M			1410											
		032961-002	CY10-M1-T2-B			1411											
		032962-002	CY10-M2-T1-M			1415											
		032963-002	CY10-M2-T1-B			1417											
		032964-002	CY10-M2-T2-M			1435											
		032965-002	CY10-M2-T2-B			1439											
		032966-002	CY10-M2-T3-M			1450											
		032967-002	CY10-M2-T3-B			1458											

RMMA <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Ref. No. _____	Sample Tracking <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	Special Instructions/QC Requirements	Abnormal Conditions on Receipt	
Sample Disposal <input checked="" type="checkbox"/> Return to Client <input type="checkbox"/> Disposal by lab	Date Entered (mm/dd/yy) _____	PLEASE NOTE: RESULTS ANALYSIS ON: 032962, 032968, 032969, 032976, 032977	NORMAL TAT ON REMAINING	
Turnaround Time <input checked="" type="checkbox"/> Normal <input type="checkbox"/> Rush Required Report Date 04/19/97	QC Initials _____			
Sample Team Members	Name	Signature	Init	Company/Organization/Phone
	CONCETTA CACCIATO	[Signature]	CC	MDM/6684/259-5778
	ERNIE ROSS	[Signature]	ER	IT/6684/263-2257

1. Relinquished by: Concetta Caciato	Org: 6684	Date: 4/9/97	Time: 10:15	4. Relinquished by:	Org.	Date	Time
1. Received by: Rod Haged	Org: IT/6684	Date: 4-9-97	Time: 10:15	4. Received by:	Org.	Date	Time
2. Relinquished by: Rod Haged	Org: IT/6684	Date: 4-9-97	Time: 1303	5. Relinquished by:	Org.	Date	Time
2. Received by: [Signature]	Org: SNL 7578	Date: 4/5/97	Time: 1303	5. Received by:	Org.	Date	Time
3. Relinquished by: [Signature]	Org: 7578	Date: 4/16/97	Time: 1515	6. Relinquished by:	Org.	Date	Time
3. Received by: Rod Haged	Org: 6684	Date: 4-16-97	Time: 1515	6. Received by:	Org.	Date	Time

WHITE - To Accompany Samples, Laboratory Copy

BLUE - To Accompany Samples, Return to SMO

YELLOW - SMO Suspense Copy

PINK - Field Copy

ANALYSIS REQUEST AND CHAIN OF CUSTODY

PAGE 2 OF 2

SF 2001-COD (9-94)

AR/COC- 06546

BATCH# 700527

Project Name: STE/OCANF SMLG Project/Task Manager: PAULA SLAVIN Case No.: 8821.201200

Location		Tech Area	Beginning Depth in Ft.	ER Site No.	Date/Time Collected	Reference LOV (available at SMO)					Sample Type	Lab Sample ID
Building	Room					Sample Matrix	Container Type	Volume	Preservative	Sample Collection Method		
032968-002	CY10-M3-S1		0.5	10	4.8.97 1430							
032969-002	CY10-M3-S1-D				1431							
032970-002	CY10-M3-S2				1453	S	P	500ml	None	GAS	SA	X
032971-002	CY10-M3-S3		↓		1500						↓	X
032957-002	CY10-RBA		NA		1510						EB	X
032975-002	CY10-M4-S1		0.5		1530						SA	X
	76-002				1540							
	77-002				1542							
032979-002	CY10-M5-S1		↓		1535						SA	X
032980-002	CY10-M5-S2		↓		1555						SA	X
034327-002	CY10-SB9-1		0.5	10	4.7.97 1620	S	P	500ml	None	GAS	SA	X
034328-002	CY10-SB9-2		↓	↓	↓ 1622	↓	↓	↓	↓	↓	↓	↓

Abnormal Conditions on Receipt

LAB USE

WHITE - To Acc Labor

ny Samples, copy

BLUE-

To Accompany Samples, Return to SMO

YELLOW- SMO

nse Copy

PINK- Field Copy

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-09-97 3:23:35 PM *

* Analyzed by: *[Signature]* 4/10/97 Reviewed by: *[Signature]* 4/11/97 *

Customer : P.SLAVIN/R.NAGEL (6682/IT)
 Customer Sample ID : 032958-002
 Lab Sample ID : 70052701

CY10-M1-71-M

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 825.000 gram
 Sample Date/Time : 4-08-97 2:00:00 PM
 Acquire Start Date/Time : 4-09-97 1:40:53 PM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6003 seconds

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	4.59E+00	3.91E+00	1.74E+00
TH-234	4.78E+00	1.07E+00	5.46E-01
RA-226	2.83E+00	1.03E+00	6.08E-01
PB-214	9.89E-01	1.74E-01	5.61E-02
BI-214	8.58E-01	1.57E-01	5.84E-02
TH-232	1.10E+00	5.43E-01	1.84E-01
RA-228	1.16E+00	2.83E-01	1.83E-01
AC-228	1.15E+00	2.66E-01	1.15E-01
TH-228	1.22E+00	5.18E-01	5.12E-01
RA-224	4.59E-01	1.33E-01	2.87E-02
PB-212	1.12E+00	1.90E-01	4.43E-02
BI-212	6.91E-01	2.41E-01	2.14E-01
TL-208	3.81E-01	7.09E-02	2.74E-02
U-235	1.19E-01	1.79E-01	2.48E-01
TH-231	Not Detected	-----	1.04E+01
PA-231	Not Detected	-----	1.61E+00
TH-227	Not Detected	-----	4.20E-01
RA-223	Not Detected	-----	1.73E-01
RN-219	Not Detected	-----	4.50E-01
PB-211	Not Detected	-----	1.03E+00
TL-207	Not Detected	-----	1.73E+01
AM-241	Not Detected	-----	2.22E-01
PU-239	Not Detected	-----	4.09E+02
NP-237	7.01E-01	1.69E-01	2.54E-01
PA-233	Not Detected	-----	6.33E-02
TH-229	Not Detected	-----	2.35E-01

not detected 4/10/97

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-09-97 5:12:04 PM *

 * Analyzed by: *J* 4/10/97 Reviewed by: *SA* 4/11/97 *

Customer : P.SLAVIN/R.NAGEL (6682/IT)
 Customer Sample ID : 032959-002
 Lab Sample ID : 70052702

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 769.000 gram
 Sample Date/Time : 4-08-97 2:05:00 PM
 Acquire Start Date/Time : 4-09-97 3:27:01 PM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6003 seconds

CY10-M1-T1-B

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	1.36E+00	1.22E+00	1.55E+00
TH-234	1.63E+00	4.57E-01	5.45E-01
RA-226	2.18E+00	6.05E-01	6.32E-01
PB-214	8.89E-01	1.69E-01	5.44E-02
BI-214	8.15E-01	1.62E-01	5.56E-02
TH-232	1.05E+00	5.02E-01	1.61E-01
RA-228	1.05E+00	3.62E-01	2.00E-01
AC-228	9.67E-01	2.33E-01	1.08E-01
TH-228	9.03E-01	6.78E-01	4.81E-01
RA-224	3.29E-01	2.78E-01	4.33E-02
PB-212	1.07E+00	3.98E-01	4.22E-02
BI-212	Not Detected	-----	2.26E-01
TL-208	3.68E-01	7.08E-02	2.99E-02
U-235	2.38E-01	1.73E-01	2.40E-01
TH-231	Not Detected	-----	9.91E+00
PA-231	Not Detected	-----	1.59E+00
TH-227	Not Detected	-----	4.28E-01
RA-223	Not Detected	-----	1.67E-01
RN-219	2.53E-01	3.90E-01	4.81E-01
PB-211	Not Detected	-----	1.08E+00
TL-207	Not Detected	-----	1.75E+01
AM-241	Not Detected	-----	2.15E-01
PU-239	Not Detected	-----	4.07E+02
NP-237	6.26E-01	1.76E-01	2.25E-01
PA-233	Not Detected	-----	6.41E-02
TH-229	Not Detected	-----	2.27E-01

not detected J 4/10/97

not detected J 4/10/97

[Summary Report] - Sample ID: : 70052702

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	5.14E-02
AG-110m	Not Detected	-----	4.25E-02
BA-133	Not Detected	-----	6.30E-02
BE-7	Not Detected	-----	2.97E-01
CD-109	Not Detected	-----	1.09E+00
CD-115	Not Detected	-----	1.06E-01
CE-139	Not Detected	-----	2.94E-02
CE-141	Not Detected	-----	5.17E-02
CE-144	Not Detected	-----	2.25E-01
CO-56	Not Detected	-----	3.02E-02
CO-57	Not Detected	-----	2.69E-02
CO-58	Not Detected	-----	4.07E-02
CO-60	Not Detected	-----	4.82E-02
CR-51	Not Detected	-----	2.76E-01
CS-134	Not Detected	-----	5.04E-02
CS-137	4.43E-02	2.18E-02	2.48E-02
EU-152	Not Detected	-----	8.16E-02
EU-154	Not Detected	-----	2.38E-01
EU-155	Not Detected	-----	9.49E-02
FE-59	Not Detected	-----	9.62E-02
GD-153	Not Detected	-----	9.42E-02
HG-203	Not Detected	-----	3.63E-02
I-131	Not Detected	-----	3.65E-02
IR-192	Not Detected	-----	3.15E-02
K-40	2.31E+01	3.42E+00	3.02E-01
MN-52	Not Detected	-----	4.47E-02
MN-54	Not Detected	-----	2.49E-02
MO-99	Not Detected	-----	3.83E-01
NA-22	Not Detected	-----	5.61E-02
NA-24	Not Detected	-----	1.33E-01
NB-95	Not Detected	-----	2.20E-01
ND-147	Not Detected	-----	2.58E-01
NI-57	Not Detected	-----	1.04E-01
PB-210	Not Detected	-----	8.79E+00
RU-103	Not Detected	-----	3.65E-02
RU-106	Not Detected	-----	3.47E-01
SB-122	Not Detected	-----	6.31E-02
SB-124	Not Detected	-----	3.60E-02
SB-125	Not Detected	-----	9.73E-02
SN-113	Not Detected	-----	4.22E-02
SR-85	Not Detected	-----	4.36E-02
TA-182	Not Detected	-----	2.07E-01
TA-183	Not Detected	-----	2.11E-01
TC-99m	Not Detected	-----	5.23E-01
TL-201	Not Detected	-----	1.56E-01
XE-133	Not Detected	-----	1.52E-01
Y-88	Not Detected	-----	3.65E-02
ZN-65	Not Detected	-----	1.39E-01
ZR-95	Not Detected	-----	7.30E-02

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-09-97 7:00:44 PM *

* Analyzed by: *[Signature]* 4/10/97 Reviewed by: *[Signature]* 4/11/97 *

Customer : P.SLAVIN/R.NAGEL (6682/IT)
 Customer Sample ID : 032960-002
 Lab Sample ID : 70052703

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 772.000 gram
 Sample Date/Time : 4-08-97 2:10:00 PM
 Acquire Start Date/Time : 4-09-97 5:15:06 PM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6003 seconds

CY10-M1-T2-M

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	1.11E+00
TH-234	1.91E+00	4.94E-01	5.49E-01
RA-226	2.27E+00	6.25E-01	6.08E-01
PB-214	1.04E+00	2.71E-01	5.37E-02
BI-214	9.35E-01	1.82E-01	5.76E-02
TH-232	1.25E+00	5.90E-01	1.82E-01
RA-228	1.07E+00	3.53E-01	1.99E-01
AC-228	1.21E+00	2.11E-01	1.10E-01
TH-228	5.82E-01	4.08E-01	5.44E-01
RA-224	4.26E-01	1.23E-01	4.10E-02
PB-212	1.15E+00	3.75E-01	4.59E-02
BI-212	6.92E-01	4.12E-01	1.97E-01
TL-208	3.97E-01	3.83E-01	2.77E-02
U-235	1.31E-01	1.79E-01	2.49E-01
TH-231	Not Detected	-----	1.04E+01
PA-231	Not Detected	-----	1.61E+00
TH-227	Not Detected	-----	4.43E-01
RA-223	Not Detected	-----	1.74E-01
RN-219	Not Detected	-----	2.42E-01
PB-211	Not Detected	-----	1.09E+00
TL-207	Not Detected	-----	1.75E+01
AM-241	Not Detected	-----	2.17E-01
PU-239	Not Detected	-----	4.18E+02
NP-237	7.84E-01	1.98E-01	2.30E-01
PA-233	Not Detected	-----	6.56E-02
TH-229	Not Detected	-----	2.34E-01

Not detected 4/10/97

[Summary Report] - Sample ID: : 70052703

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	5.38E-02
AG-110m	Not Detected	-----	3.92E-02
BA-133	Not Detected	-----	6.71E-02
BE-7	Not Detected	-----	3.08E-01
CD-109	Not Detected	-----	7.80E-01
CD-115	Not Detected	-----	1.16E-01
CE-139	Not Detected	-----	3.11E-02
CE-141	Not Detected	-----	5.48E-02
CE-144	Not Detected	-----	2.25E-01
CO-56	Not Detected	-----	4.35E-02
CO-57	Not Detected	-----	2.89E-02
CO-58	Not Detected	-----	3.96E-02
CO-60	Not Detected	-----	4.93E-02
CR-51	Not Detected	-----	2.75E-01
CS-134	Not Detected	-----	5.35E-02
CS-137	Not Detected	-----	4.70E-02
EU-152	Not Detected	-----	8.63E-02
EU-154	Not Detected	-----	2.47E-01
EU-155	Not Detected	-----	1.33E-01
FE-59	Not Detected	-----	9.90E-02
GD-153	Not Detected	-----	9.65E-02
HG-203	Not Detected	-----	3.75E-02
I-131	Not Detected	-----	3.91E-02
IR-192	Not Detected	-----	3.23E-02
K-40	2.48E+01	3.77E+00	3.20E-01
MN-52	Not Detected	-----	4.60E-02
MN-54	Not Detected	-----	4.65E-02
MO-99	Not Detected	-----	3.98E-01
NA-22	Not Detected	-----	5.88E-02
NA-24	Not Detected	-----	1.43E-01
NB-95	Not Detected	-----	2.31E-01
ND-147	Not Detected	-----	2.68E-01
NI-57	Not Detected	-----	1.03E-01
PB-210	Not Detected	-----	9.29E+00
RU-103	Not Detected	-----	3.46E-02
RU-106	Not Detected	-----	3.58E-01
SB-122	Not Detected	-----	6.64E-02
SB-124	Not Detected	-----	3.75E-02
SB-125	Not Detected	-----	1.03E-01
SN-113	Not Detected	-----	4.57E-02
SR-85	Not Detected	-----	4.52E-02
TA-182	Not Detected	-----	2.12E-01
TA-183	Not Detected	-----	2.15E-01
TC-99m	Not Detected	-----	6.49E-01
TL-201	Not Detected	-----	1.67E-01
XE-133	Not Detected	-----	8.18E-02
Y-88	Not Detected	-----	3.85E-02
ZN-65	Not Detected	-----	1.46E-01
ZR-95	Not Detected	-----	7.82E-02

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-09-97 8:46:00 PM *

* Analyzed by: *[Signature]* 4/10/97 Reviewed by: *[Signature]* 4/11/97 *

 Customer : P.SLAVIN/R.NAGEL (6682/IT)
 Customer Sample ID : 032961-002
 Lab Sample ID : 70052704

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 825.000 gram
 Sample Date/Time : 4-08-97 2:11:00 PM
 Acquire Start Date/Time : 4-09-97 7:03:21 PM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6003 seconds

CY10-M1-T2-B

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	1.68E+00
TH-234	1.67E+00	4.57E-01	5.20E-01
RA-226	2.06E+00	7.67E-01	6.70E-01
PB-214	1.04E+00	1.87E-01	5.44E-02
BI-214	9.21E-01	1.76E-01	5.94E-02
TH-232	1.10E+00	5.23E-01	1.63E-01
RA-228	1.09E+00	3.58E-01	1.97E-01
AC-228	1.08E+00	2.38E-01	1.13E-01
TH-228	1.13E+00	7.65E-01	5.87E-01
RA-224	4.14E-01	1.45E-01	2.53E-02
PB-212	1.09E+00	1.76E-01	4.44E-02
BI-212	5.98E-01	2.35E-01	2.17E-01
TL-208	3.33E-01	6.74E-02	3.07E-02
U-235	Not Detected	-----	2.35E-01
TH-231	Not Detected	-----	9.82E+00
PA-231	Not Detected	-----	1.58E+00
TH-227	Not Detected	-----	4.18E-01
RA-223	Not Detected	-----	1.68E-01
RN-219	Not Detected	-----	4.65E-01
PB-211	Not Detected	-----	1.07E+00
TL-207	2.48E+00	2.12E+00	7.88E+00
AM-241	Not Detected	-----	2.12E-01
PU-239	Not Detected	-----	3.98E+02
NP-237	Not Detected	-----	2.38E-01
PA-233	Not Detected	-----	6.40E-02
TH-229	Not Detected	-----	2.25E-01

not detected *[Signature]* 4/10/97

[Summary Report] - Sample ID: : 70052704

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	5.07E-02
AG-110m	Not Detected	-----	3.67E-02
BA-133	Not Detected	-----	6.42E-02
BE-7	Not Detected	-----	2.90E-01
CD-109	2.41E+00	6.35E-01	8.07E-01
CD-115	Not Detected	-----	1.10E-01
CE-139	Not Detected	-----	2.97E-02
CE-141	Not Detected	-----	5.27E-02
CE-144	Not Detected	-----	2.17E-01
CO-56	Not Detected	-----	4.34E-02
CO-57	Not Detected	-----	2.78E-02
CO-58	Not Detected	-----	4.13E-02
CO-60	Not Detected	-----	4.81E-02
CR-51	Not Detected	-----	2.60E-01
CS-134	Not Detected	-----	5.17E-02
CS-137	Not Detected	-----	4.41E-02
EU-152	Not Detected	-----	8.31E-02
EU-154	Not Detected	-----	2.36E-01
EU-155	Not Detected	-----	1.30E-01
FE-59	Not Detected	-----	9.43E-02
GD-153	Not Detected	-----	9.15E-02
HG-203	Not Detected	-----	3.55E-02
I-131	Not Detected	-----	3.78E-02
IR-192	Not Detected	-----	3.07E-02
K-40	2.70E+01	3.97E+00	2.82E-01
MN-52	Not Detected	-----	4.91E-02
MN-54	Not Detected	-----	4.18E-02
MO-99	Not Detected	-----	4.22E-01
NA-22	Not Detected	-----	5.57E-02
NA-24	Not Detected	-----	1.62E-01
NB-95	Not Detected	-----	2.21E-01
ND-147	Not Detected	-----	2.59E-01
NI-57	Not Detected	-----	1.12E-01
PB-210	Not Detected	-----	8.91E+00
RU-103	Not Detected	-----	3.38E-02
RU-106	Not Detected	-----	3.41E-01
SB-122	Not Detected	-----	6.52E-02
SB-124	Not Detected	-----	3.43E-02
SB-125	Not Detected	-----	9.91E-02
SN-113	Not Detected	-----	4.48E-02
SR-85	Not Detected	-----	4.31E-02
TA-182	Not Detected	-----	2.09E-01
TA-183	Not Detected	-----	2.12E-01
TC-99m	Not Detected	-----	7.72E-01
TL-201	Not Detected	-----	1.58E-01
XE-133	Not Detected	-----	1.56E-01
Y-88	Not Detected	-----	3.08E-02
ZN-65	Not Detected	-----	1.41E-01
ZR-95	Not Detected	-----	7.59E-02

not detected 7/10/9

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-09-97 10:31:12 PM *

* Analyzed by: *[Signature]* 4/10/97 Reviewed by: *[Signature]* 4/11/97 *

Customer : P.SLAVIN/R.NAGEL (6682/IT)
 Customer Sample ID : 032963-002
 Lab Sample ID : 70052705

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 850.000 gram
 Sample Date/Time : 4-08-97 2:17:00 PM
 Acquire Start Date/Time : 4-09-97 8:48:27 PM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6003 seconds

CY10-M2-T1-B

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	1.69E+00
TH-234	1.62E+00	4.37E-01	5.17E-01
RA-226	2.15E+00	8.66E-01	7.07E-01
PB-214	9.57E-01	1.55E-01	5.29E-02
BI-214	8.85E-01	1.76E-01	5.63E-02
TH-232	1.16E+00	1.03E+00	1.63E-01
RA-228	1.22E+00	1.93E+00	1.87E-01
AC-228	1.22E+00	3.17E-01	1.06E-01
TH-228	1.20E+00	7.87E-01	5.38E-01
RA-224	4.20E-01	1.27E-01	3.05E-02
PB-212	1.17E+00	1.79E-01	4.58E-02
BI-212	7.40E-01	3.45E-01	2.31E-01
TL-208	3.95E-01	7.06E-02	2.68E-02
U-235	Not Detected	-----	2.39E-01
TH-231	Not Detected	-----	9.72E+00
PA-231	Not Detected	-----	1.54E+00
TH-227	Not Detected	-----	4.18E-01
RA-223	Not Detected	-----	1.66E-01
RN-219	3.87E-01	3.75E-01	4.64E-01
PB-211	Not Detected	-----	1.05E+00
TL-207	Not Detected	-----	1.65E+01
AM-241	Not Detected	-----	2.05E-01
PU-239	Not Detected	-----	4.00E+02
NP-237	8.45E-01	2.62E-01	2.58E-01
PA-233	Not Detected	-----	6.25E-02
TH-229	Not Detected	-----	2.31E-01

not detected 4/10/97

not detected 4/10/97

[Summary Report] - Sample ID: : 70052705

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	5.13E-02
AG-110m	Not Detected	-----	4.21E-02
BA-133	Not Detected	-----	6.31E-02
BE-7	Not Detected	-----	2.93E-01
CD-109	Not Detected	-----	1.11E+00
CD-115	Not Detected	-----	1.14E-01
CE-139	Not Detected	-----	2.98E-02
CE-141	Not Detected	-----	5.34E-02
CE-144	Not Detected	-----	2.18E-01
CO-56	Not Detected	-----	4.32E-02
CO-57	Not Detected	-----	2.70E-02
CO-58	Not Detected	-----	4.24E-02
CO-60	Not Detected	-----	4.82E-02
CR-51	Not Detected	-----	2.63E-01
CS-134	Not Detected	-----	4.99E-02
CS-137	Not Detected	-----	2.60E-02
EU-152	Not Detected	-----	8.08E-02
EU-154	Not Detected	-----	2.37E-01
EU-155	Not Detected	-----	1.29E-01
FE-59	Not Detected	-----	9.10E-02
GD-153	Not Detected	-----	9.32E-02
HG-203	Not Detected	-----	3.54E-02
I-131	Not Detected	-----	3.65E-02
IR-192	Not Detected	-----	3.08E-02
K-40	2.45E+01	3.57E+00	3.00E-01
MN-52	Not Detected	-----	4.45E-02
MN-54	Not Detected	-----	2.58E-02
MO-99	Not Detected	-----	4.08E-01
NA-22	Not Detected	-----	5.26E-02
NA-24	Not Detected	-----	1.82E-01
NB-95	Not Detected	-----	2.24E-01
ND-147	Not Detected	-----	2.62E-01
NI-57	Not Detected	-----	1.08E-01
PB-210	Not Detected	-----	8.55E+00
RU-103	Not Detected	-----	3.29E-02
RU-106	Not Detected	-----	3.35E-01
SB-122	Not Detected	-----	6.65E-02
SB-124	Not Detected	-----	3.48E-02
SB-125	Not Detected	-----	9.94E-02
SN-113	Not Detected	-----	4.28E-02
SR-85	Not Detected	-----	4.43E-02
TA-182	Not Detected	-----	1.97E-01
TA-183	Not Detected	-----	2.07E-01
TC-99m	Not Detected	-----	9.36E-01
TL-201	Not Detected	-----	1.60E-01
XE-133	Not Detected	-----	1.60E-01
Y-88	Not Detected	-----	3.36E-02
ZN-65	Not Detected	-----	1.35E-01
ZR-95	Not Detected	-----	7.26E-02

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-10-97 12:16:35 AM *

* Analyzed by: *[Signature]* 4/10/97 Reviewed by: *[Signature]* 4/11/97 *

 Customer : P.SLAVIN/R.NAGEL (6682/IT)
 Customer Sample ID : 032964-002
 Lab Sample ID : 70052706

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 826.000 gram
 Sample Date/Time : 4-08-97 2:35:00 PM
 Acquire Start Date/Time : 4-09-97 10:33:46 PM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6003 seconds

CY10-M2-T2-M

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	1.68E+00
TH-234	1.41E+00	4.07E-01	4.86E-01
RA-226	1.85E+00	5.58E-01	6.10E-01
PB-214	9.66E-01	1.77E-01	5.08E-02
BI-214	8.63E-01	1.68E-01	5.54E-02
TH-232	1.10E+00	5.24E-01	1.71E-01
RA-228	1.01E+00	4.69E-01	1.84E-01
AC-228	1.10E+00	2.48E-01	1.04E-01
TH-228	Not Detected	-----	4.87E-01
RA-224	4.19E-01	1.45E-01	3.03E-02
PB-212	1.13E+00	1.90E-01	4.44E-02
BI-212	7.14E-01	3.18E-01	2.23E-01
TL-208	3.73E-01	1.15E-01	2.80E-02
U-235	Not Detected	-----	2.30E-01
TH-231	Not Detected	-----	8.14E+00
PA-231	Not Detected	-----	1.56E+00
TH-227	Not Detected	-----	4.15E-01
RA-223	Not Detected	-----	1.33E-01
RN-219	2.36E-01	3.70E-01	4.57E-01
PB-211	Not Detected	-----	1.02E+00
TL-207	Not Detected	-----	1.69E+01
AM-241	Not Detected	-----	2.14E-01
PU-239	Not Detected	-----	3.99E+02
NP-237	Not Detected	-----	3.23E-01
PA-233	Not Detected	-----	6.30E-02
TH-229	Not Detected	-----	2.23E-01

not detected *[Signature]* 4/10/97

[Summary Report] - Sample ID: : 70052706

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	5.11E-02
AG-110m	Not Detected	-----	5.63E-02
BA-133	Not Detected	-----	6.21E-02
BE-7	Not Detected	-----	3.01E-01
CD-109	1.96E-00	5.68E-01	8.36E-01
CD-115	Not Detected	-----	1.14E-01
CE-139	Not Detected	-----	2.90E-02
CE-141	Not Detected	-----	5.19E-02
CE-144	Not Detected	-----	2.11E-01
CO-56	Not Detected	-----	4.38E-02
CO-57	Not Detected	-----	2.69E-02
CO-58	Not Detected	-----	3.84E-02
CO-60	Not Detected	-----	4.50E-02
CR-51	Not Detected	-----	2.62E-01
CS-134	Not Detected	-----	4.93E-02
CS-137	2.60E-01	1.06E-01	3.03E-02
EU-152	Not Detected	-----	8.05E-02
EU-154	Not Detected	-----	2.38E-01
EU-155	Not Detected	-----	1.24E-01
FE-59	Not Detected	-----	9.00E-02
GD-153	Not Detected	-----	9.18E-02
HG-203	Not Detected	-----	3.58E-02
I-131	Not Detected	-----	3.58E-02
IR-192	Not Detected	-----	3.00E-02
K-40	2.15E+01	3.23E+00	2.87E-01
MN-52	Not Detected	-----	4.19E-02
MN-54	Not Detected	-----	2.22E-02
MO-99	Not Detected	-----	3.95E-01
NA-22	Not Detected	-----	5.04E-02
NA-24	Not Detected	-----	1.69E-01
NB-95	Not Detected	-----	2.24E-01
ND-147	Not Detected	-----	2.59E-01
NI-57	Not Detected	-----	1.07E-01
PB-210	Not Detected	-----	8.56E+00
RU-103	Not Detected	-----	3.48E-02
RU-106	Not Detected	-----	3.28E-01
SB-122	Not Detected	-----	6.52E-02
SB-124	Not Detected	-----	3.32E-02
SB-125	Not Detected	-----	1.04E-01
SN-113	Not Detected	-----	4.25E-02
SR-85	Not Detected	-----	4.44E-02
TA-182	Not Detected	-----	1.95E-01
TA-183	Not Detected	-----	2.18E-01
TC-99m	Not Detected	-----	1.07E+00
TL-201	Not Detected	-----	1.61E-01
XE-133	Not Detected	-----	1.36E-01
Y-88	Not Detected	-----	3.46E-02
ZN-65	Not Detected	-----	1.30E-01
ZR-95	Not Detected	-----	6.94E-02

not detected

4/10/15

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-10-97 2:01:49 AM *

* Analyzed by: *[Signature]* 4/10/97 Reviewed by: *[Signature]* 4/11/97 *

Customer : P.SLAVIN/R.NAGEL (6682/IT)
 Customer Sample ID : 032965-002
 Lab Sample ID : 70052707

CY10-M2-T2-6

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 849.000 gram
 Sample Date/Time : 4-08-97 2:39:00 PM
 Acquire Start Date/Time : 4-10-97 12:19:08 AM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6003 seconds

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	*MDA (pCi/gram)
U-238	Not Detected	-----	1.68E+00
TH-234	1.59E+00	4.33E-01	5.11E-01
RA-226	1.78E+00	5.88E-01	6.07E-01
PB-214	9.02E-01	1.48E-01	5.01E-02
BI-214	8.70E-01	2.03E-01	5.14E-02
TH-232	1.11E+00	5.28E-01	1.65E-01
RA-228	1.12E+00	1.06E+00	1.91E-01
AC-228	1.06E+00	2.59E-01	1.03E-01
TH-228	1.15E+00	1.46E+00	4.47E-01
RA-224	4.07E-01	1.29E-01	3.22E-02
PB-212	1.10E+00	1.75E-01	4.44E-02
BI-212	6.92E-01	2.46E-01	2.21E-01
TL-208	3.84E-01	7.06E-02	2.75E-02
U-235	Not Detected	-----	2.24E-01
TH-231	Not Detected	-----	9.47E+00
PA-231	Not Detected	-----	1.51E+00
TH-227	Not Detected	-----	4.07E-01
RA-223	Not Detected	-----	1.63E-01
RN-219	Not Detected	-----	4.38E-01
PB-211	Not Detected	-----	1.01E+00
TL-207	Not Detected	-----	1.67E+01
AM-241	Not Detected	-----	2.04E-01
PU-239	Not Detected	-----	3.92E+02
NP-237	Not Detected	-----	3.18E-01
PA-233	Not Detected	-----	6.29E-02
TH-229	Not Detected	-----	2.15E-01

[Summary Report] - Sample ID: : 70052707

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.88E-02
AG-110m	Not Detected	-----	4.18E-02
BA-133	Not Detected	-----	6.19E-02
BE-7	Not Detected	-----	2.69E-01
CD-109	2.09E+00	5.76E-01	8.21E-01
CD-115	Not Detected	-----	1.16E-01
CE-139	Not Detected	-----	2.84E-02
CE-141	Not Detected	-----	5.05E-02
CE-144	Not Detected	-----	2.07E-01
CO-56	Not Detected	-----	2.54E-02
CO-57	Not Detected	-----	2.65E-02
CO-58	Not Detected	-----	3.95E-02
CO-60	Not Detected	-----	4.54E-02
CR-51	Not Detected	-----	2.59E-01
CS-134	Not Detected	-----	4.93E-02
CS-137	5.82E-02	2.49E-02	2.65E-02
EU-152	Not Detected	-----	7.95E-02
EU-154	Not Detected	-----	2.27E-01
EU-155	Not Detected	-----	1.25E-01
FE-59	Not Detected	-----	9.12E-02
GD-153	Not Detected	-----	8.96E-02
HG-203	Not Detected	-----	3.50E-02
I-131	Not Detected	-----	3.49E-02
IR-192	Not Detected	-----	3.02E-02
K-40	2.35E+01	3.51E+00	3.07E-01
MN-52	Not Detected	-----	4.19E-02
MN-54	Not Detected	-----	4.04E-02
MO-99	Not Detected	-----	4.02E-01
NA-22	Not Detected	-----	5.06E-02
NA-24	Not Detected	-----	2.00E-01
NB-95	Not Detected	-----	2.22E-01
ND-147	Not Detected	-----	2.52E-01
NI-57	Not Detected	-----	1.20E-01
PB-210	Not Detected	-----	8.31E+00
RU-103	Not Detected	-----	3.43E-02
RU-106	Not Detected	-----	3.42E-01
SB-122	2.55E-02	3.55E-02	3.95E-02
SB-124	Not Detected	-----	3.49E-02
SB-125	Not Detected	-----	9.60E-02
SN-113	Not Detected	-----	4.18E-02
SR-85	Not Detected	-----	4.32E-02
TA-182	Not Detected	-----	1.98E-01
TA-183	Not Detected	-----	2.10E-01
TC-99m	Not Detected	-----	1.29E+00
TL-201	Not Detected	-----	1.63E-01
XE-133	Not Detected	-----	1.61E-01
Y-88	Not Detected	-----	3.31E-02
ZN-65	Not Detected	-----	1.32E-01
ZR-95	Not Detected	-----	7.22E-02

not detected 7/4/10

not detected 7/4/10

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-10-97 3:47:00 AM *

* Analyzed by: *[Signature]* 4/10/97 Reviewed by: *[Signature]* 4/11/97 *

Customer : P.SLAVIN/R.NAGEL (6682/IT)
 Customer Sample ID : 032966-002
 Lab Sample ID : 70052708

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 969.000 gram
 Sample Date/Time : 4-08-97 2:50:00 PM
 Acquire Start Date/Time : 4-10-97 2:04:16 AM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6004 seconds

CY10-M2-T3-M

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	2.06E+00	1.31E+00	1.62E+00
TH-234	2.51E+00	6.19E-01	5.09E-01
RA-226	2.39E+00	9.87E-01	6.69E-01
PB-214	9.88E-01	1.67E-01	5.04E-02
BI-214	9.11E-01	1.75E-01	4.85E-02
TH-232	1.22E+00	5.67E-01	1.54E-01
RA-228	1.24E+00	3.54E-01	1.94E-01
AC-228	1.18E+00	2.67E-01	1.04E-01
TH-228	1.32E+00	4.44E-01	4.20E-01
RA-224	4.57E-01	1.30E-01	2.83E-02
PB-212	1.21E+00	1.91E-01	4.04E-02
BI-212	7.03E-01	2.23E-01	1.98E-01
TL-208	3.75E-01	5.78E-02	2.65E-02
U-235	Not Detected	-----	2.21E-01
TH-231	Not Detected	-----	9.49E+00
PA-231	Not Detected	-----	1.47E+00
TH-227	Not Detected	-----	3.99E-01
RA-223	Not Detected	-----	1.62E-01
RN-219	Not Detected	-----	4.22E-01
PB-211	Not Detected	-----	9.43E-01
TL-207	Not Detected	-----	1.60E+01
AM-241	Not Detected	-----	2.05E-01
PU-239	Not Detected	-----	3.81E+02
NP-237	Not Detected	-----	3.10E-01
PA-233	Not Detected	-----	6.14E-02
TH-229	Not Detected	-----	2.13E-01

[Summary Report] - Sample ID: : 70052708

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.80E-02
AG-110m	Not Detected	-----	3.54E-02
BA-133	Not Detected	-----	6.01E-02
BE-7	Not Detected	-----	2.67E-01
CD-109	2.31E+00	5.84E-01	7.88E-01
CD-115	Not Detected	-----	1.14E-01
CE-139	Not Detected	-----	2.79E-02
CE-141	Not Detected	-----	4.94E-02
CE-144	Not Detected	-----	2.06E-01
CO-56	Not Detected	-----	3.91E-02
CO-57	Not Detected	-----	2.57E-02
CO-58	Not Detected	-----	3.77E-02
CO-60	Not Detected	-----	4.43E-02
CR-51	Not Detected	-----	2.50E-01
CS-134	Not Detected	-----	4.54E-02
CS-137	Not Detected	-----	4.07E-02
EU-152	Not Detected	-----	7.75E-02
EU-154	Not Detected	-----	2.23E-01
EU-155	Not Detected	-----	1.22E-01
FE-59	Not Detected	-----	8.83E-02
GD-153	Not Detected	-----	8.90E-02
HG-203	Not Detected	-----	3.36E-02
I-131	Not Detected	-----	3.44E-02
IR-192	Not Detected	-----	2.85E-02
K-40	2.35E+01	3.43E+00	2.95E-01
MN-52	Not Detected	-----	4.29E-02
MN-54	Not Detected	-----	4.16E-02
MO-99	Not Detected	-----	4.01E-01
NA-22	Not Detected	-----	4.92E-02
NA-24	Not Detected	-----	1.98E-01
NB-95	Not Detected	-----	2.20E-01
ND-147	Not Detected	-----	2.52E-01
NI-57	Not Detected	-----	1.13E-01
PB-210	Not Detected	-----	8.24E+00
RU-103	Not Detected	-----	3.28E-02
RU-106	Not Detected	-----	3.11E-01
SB-122	Not Detected	-----	6.26E-02
SB-124	Not Detected	-----	3.03E-02
SB-125	Not Detected	-----	9.42E-02
SN-113	Not Detected	-----	4.02E-02
SR-85	Not Detected	-----	4.05E-02
TA-182	Not Detected	-----	1.85E-01
TA-183	Not Detected	-----	2.13E-01
TC-99m	Not Detected	-----	1.53E+00
TL-201	Not Detected	-----	1.60E-01
XE-133	Not Detected	-----	1.66E-01
Y-88	Not Detected	-----	3.29E-02
ZN-65	Not Detected	-----	1.26E-01
ZR-95	Not Detected	-----	6.78E-02

not detected 7/4/01

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-10-97 5:32:17 AM *

* Analyzed by: *J* 4/10/97 Reviewed by: *W* 4/10/97 *

Customer : P.SLAVIN/R.NAGEL (6682/IT)
 Customer Sample ID : 032967-002
 Lab Sample ID : 70052709

CY10-M2-T3-B

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 832.000 gram
 Sample Date/Time : 4-08-97 2:58:00 PM
 Acquire Start Date/Time : 4-10-97 3:49:30 AM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6003 seconds

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	1.74E+00
TH-234	2.31E+00	5.63E-01	5.23E-01
RA-226	3.91E-01	7.14E-01	6.26E-01
PB-214	7.89E-01	1.32E-01	4.91E-02
BI-214	8.65E-01	1.68E-01	5.37E-02
TH-232	9.41E-01	1.49E+00	1.69E-01
RA-228	1.02E+00	2.09E-01	1.79E-01
AC-228	1.01E+00	2.33E-01	1.05E-01
TH-228	8.07E-01	4.13E-01	4.98E-01
RA-224	4.13E-01	1.69E-01	2.52E-02
PB-212	1.06E+00	1.61E-01	4.32E-02
BI-212	6.91E-01	2.50E-01	2.09E-01
TL-208	3.61E-01	6.89E-02	3.06E-02
U-235	1.05E-01	1.75E-01	1.52E-01
TH-231	Not Detected	-----	9.49E+00
PA-231	Not Detected	-----	1.52E+00
TH-227	Not Detected	-----	4.05E-01
RA-223	2.02E-01	6.55E-02	1.27E-01
RN-219	Not Detected	-----	4.38E-01
PB-211	Not Detected	-----	9.88E-01
TL-207	Not Detected	-----	1.71E+01
AM-241	Not Detected	-----	2.08E-01
PU-239	Not Detected	-----	3.86E+02
NP-237	0.45E-01	2.07E-01	2.55E-01
PA-233	Not Detected	-----	6.42E-02
TH-229	Not Detected	-----	2.18E-01

not detected *J* 4/10

not detected *J* 4/10/97

not detected *J* 4/10/97

[Summary Report] - Sample ID: : 70052709

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	5.02E-02
AG-110m	Not Detected	-----	3.69E-02
BA-133	Not Detected	-----	6.31E-02
BE-7	Not Detected	-----	2.61E-01
CD-109	Not Detected	-----	1.09E+00
CD-115	Not Detected	-----	1.16E-01
CE-139	Not Detected	-----	2.84E-02
CE-141	Not Detected	-----	5.12E-02
CE-144	Not Detected	-----	2.11E-01
CO-56	Not Detected	-----	4.21E-02
CO-57	Not Detected	-----	2.70E-02
CO-58	Not Detected	-----	3.72E-02
CO-60	Not Detected	-----	4.18E-02
CR-51	Not Detected	-----	2.60E-01
CS-134	Not Detected	-----	4.85E-02
CS-137	1.58E-02	1.35E-02	2.53E-02
EU-152	Not Detected	-----	8.11E-02
EU-154	Not Detected	-----	2.34E-01
EU-155	Not Detected	-----	1.27E-01
FE-59	Not Detected	-----	9.22E-02
GD-153	Not Detected	-----	8.95E-02
HG-203	Not Detected	-----	3.48E-02
I-131	Not Detected	-----	3.46E-02
IR-192	Not Detected	-----	2.95E-02
K-40	2.17E+01	3.26E+00	2.76E-01
MN-52	Not Detected	-----	4.60E-02
MN-54	Not Detected	-----	3.94E-02
MO-99	Not Detected	-----	4.27E-01
NA-22	Not Detected	-----	5.27E-02
NA-24	Not Detected	-----	2.25E-01
NB-95	3.93E-02	1.63E-02	1.03E-01
ND-147	Not Detected	-----	2.57E-01
NI-57	Not Detected	-----	1.20E-01
PB-210	Not Detected	-----	8.13E+00
RU-103	Not Detected	-----	3.44E-02
RU-106	Not Detected	-----	3.39E-01
SB-122	Not Detected	-----	6.73E-02
SB-124	Not Detected	-----	3.41E-02
SB-125	Not Detected	-----	9.86E-02
SN-113	Not Detected	-----	4.14E-02
SR-85	Not Detected	-----	4.28E-02
TA-182	Not Detected	-----	1.89E-01
TA-183	Not Detected	-----	2.18E-01
TC-99m	Not Detected	-----	1.86E+00
TL-201	Not Detected	-----	1.67E-01
XE-133	Not Detected	-----	1.67E-01
Y-88	Not Detected	-----	3.03E-02
ZN-65	Not Detected	-----	1.29E-01
ZR-95	Not Detected	-----	6.92E-02

not detected 4/10/5

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-09-97 3:44:29 PM *

 * Analyzed by: *[Signature]* 4/10/97 Reviewed by: *[Signature]* 4/11/97 *

Customer : P.SLAVIN/R.NAGEL (6682/IT)
 Customer Sample ID : 032970-002
 Lab Sample ID : 70052710

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 944.000 gram
 Sample Date/Time : 4-08-97 2:53:00 PM
 Acquire Start Date/Time : 4-09-97 1:58:17 PM
 Detector Name : LAB02
 Elapsed Live/Real Time : 6000 / 6004 seconds

CY10-M3-SZ

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	7.43E+00	5.44E+00	3.45E+00
TH-234	8.11E+00	2.27E+00	6.92E-01
RA-226	Not Detected	-----	5.88E-01
PB-214	8.83E-01	1.52E-01	4.54E-02
BI-214	8.06E-01	2.54E-01	1.91E-01
TH-232	1.02E+00	4.78E-01	1.47E-01
RA-228	1.14E+00	2.46E-01	1.44E-01
AC-228	1.12E+00	2.18E-01	7.60E-02
TH-228	1.02E+00	2.80E-01	4.36E-01
RA-224	3.89E-01	1.07E-01	1.96E-02
PB-212	1.05E+00	1.82E-01	4.24E-02
BI-212	5.42E-01	1.86E-01	1.72E-01
TL-208	3.30E-01	2.17E-01	2.32E-02
U-235	2.25E-01	1.15E-01	1.59E-01
TH-231	Not Detected	-----	1.44E+01
PA-231	Not Detected	-----	1.41E+00
TH-227	Not Detected	-----	3.59E-01
RA-223	Not Detected	-----	2.38E-01
RN-219	Not Detected	-----	3.77E-01
PB-211	Not Detected	-----	8.46E-01
TL-207	Not Detected	-----	1.30E+01
AM-241	Not Detected	-----	5.16E-01
PU-239	Not Detected	-----	4.64E+02
NP-237	5.73E-01	1.70E-01	3.36E-01
PA-233	Not Detected	-----	5.77E-02
TH-229	Not Detected	-----	2.78E-01

not detected 7/10/97

[Summary Report] - Sample ID: : 70052710

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	3.96E-02
AG-110m	Not Detected	-----	3.18E-02
BA-133	Not Detected	-----	6.46E-02
BE-7	Not Detected	-----	2.49E-01
CD-109	Not Detected	-----	1.14E+00
CD-115	Not Detected	-----	8.91E-02
CE-139	Not Detected	-----	3.06E-02
CE-141	Not Detected	-----	5.58E-02
CE-144	Not Detected	-----	2.53E-01
CO-56	Not Detected	-----	1.94E-02
CO-57	Not Detected	-----	3.20E-02
CO-58	Not Detected	-----	3.11E-02
CO-60	Not Detected	-----	3.45E-02
CR-51	Not Detected	-----	2.30E-01
CS-134	Not Detected	-----	4.76E-02
CS-137	2.44E-02	1.93E-02	1.99E-02
EU-152	Not Detected	-----	9.64E-02
EU-154	Not Detected	-----	1.82E-01
EU-155	Not Detected	-----	1.58E-01
FE-59	Not Detected	-----	6.99E-02
GD-153	Not Detected	-----	1.18E-01
HG-203	Not Detected	-----	3.17E-02
I-131	Not Detected	-----	3.03E-02
IR-192	Not Detected	-----	2.69E-02
K-40	2.27E+01	3.24E+00	2.39E-01
MN-52	Not Detected	-----	3.30E-02
MN-54	Not Detected	-----	1.85E-02
MO-99	Not Detected	-----	2.98E-01
NA-22	Not Detected	-----	4.04E-02
NA-24	Not Detected	-----	9.27E-02
NB-95	Not Detected	-----	1.99E-01
ND-147	Not Detected	-----	2.09E-01
NI-57	7.24E-02	4.19E-02	3.96E-02
PB-210	Not Detected	-----	3.68E+01
RU-103	Not Detected	-----	2.80E-02
RU-106	Not Detected	-----	2.75E-01
SB-122	Not Detected	-----	4.85E-02
SB-124	Not Detected	-----	2.95E-02
SB-125	Not Detected	-----	7.97E-02
SN-113	Not Detected	-----	3.72E-02
SR-85	Not Detected	-----	3.59E-02
TA-182	Not Detected	-----	1.44E-01
TA-183	Not Detected	-----	5.02E-01
TC-99m	Not Detected	-----	4.34E-01
TL-201	Not Detected	-----	2.53E-01
XE-133	Not Detected	-----	2.18E-01
Y-88	Not Detected	-----	2.50E-02
ZN-65	Not Detected	-----	9.93E-02
ZR-95	Not Detected	-----	5.72E-02

not detected 7/10/57

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-09-97 5:31:43 PM *

 * Analyzed by: *J 4/10/97* Reviewed by: *W 4/11/97* *

 Customer : P.SLAVIN/R.NAGEL (6682/IT)
 Customer Sample ID : 032971-002
 Lab Sample ID : 70052711

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 932.000 gram
 Sample Date/Time : 4-08-97 3:00:00 PM
 Acquire Start Date/Time : 4-09-97 3:47:35 PM
 Detector Name : LAB02
 Elapsed Live/Real Time : 6000 / 6004 seconds

CY10-M3-S3

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	2.63E+00	3.18E+00	3.18E+00
TH-234	4.07E+00	2.11E+00	6.29E-01
RA-226	6.37E-01	6.62E-01	5.89E-01
PB-214	7.70E-01	1.25E-01	4.46E-02
BI-214	7.87E-01	1.83E-01	1.93E-01
TH-232	9.66E-01	4.51E-01	1.40E-01
RA-228	1.06E+00	2.84E-01	1.40E-01
AC-228	9.75E-01	2.46E-01	8.06E-02
TH-228	9.27E-01	2.61E-01	4.39E-01
RA-224	3.81E-01	1.10E-01	1.79E-02
PB-212	9.46E-01	1.51E-01	3.86E-02
BI-212	Not Detected	-----	1.70E-01
TL-208	3.22E-01	5.64E-02	2.20E-02
U-235	1.24E-01	1.23E-01	1.56E-01
TH-231	Not Detected	-----	1.30E+01
PA-231	Not Detected	-----	1.37E+00
TH-227	Not Detected	-----	3.43E-01
RA-223	Not Detected	-----	2.16E-01
RN-219	Not Detected	-----	3.54E-01
PB-211	Not Detected	-----	8.22E-01
TL-207	Not Detected	-----	1.30E+01
AM-241	Not Detected	-----	4.87E-01
PU-239	Not Detected	-----	4.49E+02
NP-237	Not Detected	-----	3.26E-01
PA-233	Not Detected	-----	5.52E-02
TH-229	Not Detected	-----	2.58E-01

[Summary Report] - Sample ID: : 70052711

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	3.91E-02
AG-110m	Not Detected	-----	3.46E-02
BA-133	Not Detected	-----	6.18E-02
BE-7	Not Detected	-----	2.42E-01
CD-109	2.37E+00	1.03E+00	1.10E+00
CD-115	Not Detected	-----	8.94E-02
CE-139	Not Detected	-----	2.99E-02
CE-141	Not Detected	-----	5.41E-02
CE-144	Not Detected	-----	2.44E-01
CO-56	Not Detected	-----	3.29E-02
CO-57	Not Detected	-----	3.04E-02
CO-58	Not Detected	-----	3.20E-02
CO-60	Not Detected	-----	3.26E-02
CR-51	Not Detected	-----	2.32E-01
CS-134	Not Detected	-----	4.73E-02
CS-137	6.04E-02	2.30E-02	2.09E-02
EU-152	Not Detected	-----	9.15E-02
EU-154	Not Detected	-----	1.81E-01
EU-155	Not Detected	-----	1.51E-01
FE-59	Not Detected	-----	6.70E-02
GD-153	Not Detected	-----	1.09E-01
HG-203	Not Detected	-----	3.10E-02
I-131	Not Detected	-----	2.93E-02
IR-192	Not Detected	-----	2.66E-02
K-40	2.33E+01	3.30E+00	2.49E-01
MN-52	Not Detected	-----	3.31E-02
MN-54	Not Detected	-----	3.28E-02
MO-99	Not Detected	-----	2.95E-01
NA-22	Not Detected	-----	3.98E-02
NA-24	Not Detected	-----	9.53E-02
NB-95	Not Detected	-----	1.92E-01
ND-147	Not Detected	-----	1.97E-01
NI-57	Not Detected	-----	3.82E-02
PB-210	Not Detected	-----	3.48E+01
RU-103	Not Detected	-----	2.83E-02
RU-106	Not Detected	-----	2.88E-01
SB-122	Not Detected	-----	4.93E-02
SB-124	Not Detected	-----	2.96E-02
SB-125	Not Detected	-----	7.81E-02
SN-113	Not Detected	-----	3.59E-02
SR-85	Not Detected	-----	3.50E-02
TA-182	Not Detected	-----	1.45E-01
TA-183	Not Detected	-----	4.77E-01
TC-99m	Not Detected	-----	5.06E-01
TL-201	Not Detected	-----	2.40E-01
XE-133	Not Detected	-----	2.03E-01
Y-88	Not Detected	-----	2.36E-02
ZN-65	Not Detected	-----	1.00E-01
ZR-95	Not Detected	-----	5.60E-02

not detected *4/10/15*

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-10-97 5:17:14 PM *

 * Analyzed by: *[Signature]* 4/11/97 Reviewed by: *[Signature]* 4/11/97 *

 Customer : P.SLAVIN/R.NAGEL (6682/IT)
 Customer Sample ID : 032957-002
 Lab Sample ID : 70052712

Sample Description : MARINELLI LIQUID SAMPLE
 Sample Quantity : 500.000 mL
 Sample Date/Time : 4-08-97 3:10:00 PM
 Acquire Start Date/Time : 4-09-97 5:43:08 PM
 Detector Name : LAB02
 Elapsed Live/Real Time : 6000 / 6001 seconds

CY10-RBA
 (Equip. Blank)

Comments:

Nuclide Name	Activity (pCi/mL)	2-sigma Error	MDA (pCi/mL)
U-238	Not Detected	-----	1.73E+00
TH-234	Not Detected	-----	3.97E-01
RA-226	Not Detected	-----	5.25E-01
PB-214	Not Detected	-----	5.62E-02
BI-214	Not Detected	-----	6.30E-02
TH-232	Not Detected	-----	1.56E-01
RA-228	Not Detected	-----	1.45E-01
AC-228	Not Detected	-----	8.50E-02
TH-228	Not Detected	-----	5.11E-01
RA-224	Not Detected	-----	4.54E-02
PB-212	Not Detected	-----	3.76E-02
BI-212	Not Detected	-----	1.92E-01
TL-208	Not Detected	-----	2.35E-02
U-235	Not Detected	-----	1.60E-01
TH-231	Not Detected	-----	6.67E+00
PA-231	Not Detected	-----	1.06E+00
TH-227	Not Detected	-----	1.45E-01
RA-223	Not Detected	-----	1.11E-01
RN-219	Not Detected	-----	2.79E-01
PB-211	Not Detected	-----	6.33E-01
TL-207	Not Detected	-----	9.86E+00
AM-241	Not Detected	-----	2.55E-01
PU-239	Not Detected	-----	2.83E+02
NP-237	Not Detected	-----	1.89E-01
PA-233	Not Detected	-----	4.31E-02
TH-229	Not Detected	-----	1.61E-01

[Summary Report] - Sample ID: : 70052712

Nuclide Name	Activity (pCi/mL)	2-sigma Error	MDA (pCi/mL)
AG-108m	Not Detected	-----	2.48E-02
AG-110m	Not Detected	-----	2.28E-02
BA-133	Not Detected	-----	3.43E-02
BE-7	Not Detected	-----	1.87E-01
CD-109	Not Detected	-----	6.43E-01
CD-115	Not Detected	-----	5.46E-02
CE-139	Not Detected	-----	1.99E-02
CE-141	Not Detected	-----	3.46E-02
CE-144	Not Detected	-----	1.62E-01
CO-56	Not Detected	-----	3.30E-02
CO-57	Not Detected	-----	2.01E-02
CO-58	Not Detected	-----	2.45E-02
CO-60	Not Detected	-----	2.61E-02
CR-51	Not Detected	-----	1.77E-01
CS-134	Not Detected	-----	2.87E-02
CS-137	Not Detected	-----	2.24E-02
EU-152	Not Detected	-----	6.05E-02
EU-154	Not Detected	-----	1.16E-01
EU-155	Not Detected	-----	9.19E-02
FE-59	Not Detected	-----	4.33E-02
GD-153	Not Detected	-----	6.56E-02
HG-203	Not Detected	-----	2.34E-02
I-131	Not Detected	-----	2.27E-02
IR-192	Not Detected	-----	2.14E-02
K-40	Not Detected	-----	2.22E-01
MN-52	Not Detected	-----	2.86E-02
MN-54	Not Detected	-----	2.33E-02
MO-99	Not Detected	-----	2.21E-01
NA-22	Not Detected	-----	2.59E-02
NA-24	Not Detected	-----	9.17E-02
NB-95	Not Detected	-----	8.22E-02
ND-147	Not Detected	-----	1.49E-01
NI-57	Not Detected	-----	5.77E-02
PB-210	Not Detected	-----	1.52E+01
RU-103	Not Detected	-----	2.40E-02
RU-106	Not Detected	-----	2.47E-01
SB-122	Not Detected	-----	4.07E-02
SB-124	Not Detected	-----	2.68E-02
SB-125	Not Detected	-----	5.90E-02
SN-113	Not Detected	-----	2.92E-02
SR-85	Not Detected	-----	3.21E-02
TA-182	Not Detected	-----	7.48E-02
TA-183	Not Detected	-----	2.51E-01
TC-99m	Not Detected	-----	4.24E-01
TL-201	Not Detected	-----	1.20E-01
XE-133	Not Detected	-----	1.09E-01
Y-88	Not Detected	-----	2.71E-02
ZN-65	Not Detected	-----	4.74E-02
ZR-95	Not Detected	-----	3.65E-02

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-09-97 9:12:00 PM *

 * Analyzed by: *[Signature]* 4/11/97 Reviewed by: *[Signature]* 4/11/97 *

Customer : P.SLAVIN/R.NAGEL (6682/IT)
 Customer Sample ID : 032975-002
 Lab Sample ID : 70052713

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 890.000 gram
 Sample Date/Time : 4-08-97 3:30:00 PM
 Acquire Start Date/Time : 4-09-97 7:29:10 PM
 Detector Name : LAB02
 Elapsed Live/Real Time : 6000 / 6004 seconds

CY10-M4-S1

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	3.45E+00
TH-234	1.24E+00	6.39E-01	7.55E-01
RA-226	1.75E+00	6.49E-01	5.18E-01
PB-214	8.18E-01	1.42E-01	4.66E-02
BI-214	7.71E-01	1.82E-01	2.02E-01
TH-232	9.25E-01	4.37E-01	1.57E-01
RA-228	1.07E+00	2.92E-01	1.53E-01
AC-228	1.03E+00	2.15E-01	8.33E-02
TH-228	9.21E-01	2.69E-01	4.79E-01
RA-224	3.81E-01	1.11E-01	2.18E-02
PB-212	9.77E-01	1.67E-01	3.94E-02
BI-212	6.06E-01	1.97E-01	1.79E-01
TL-208	3.20E-01	1.53E-01	2.36E-02
U-235	Not Detected	-----	2.52E-01
TH-231	Not Detected	-----	1.34E+01
PA-231	Not Detected	-----	1.43E+00
TH-227	Not Detected	-----	3.55E-01
RA-223	Not Detected	-----	2.23E-01
RN-219	Not Detected	-----	3.65E-01
PB-211	Not Detected	-----	8.56E-01
TL-207	Not Detected	-----	1.39E+01
AM-241	Not Detected	-----	4.92E-01
PU-239	Not Detected	-----	4.65E+02
NP-237	5.47E-01	2.39E-01	3.16E-01
PA-233	Not Detected	-----	5.81E-02
TH-229	Not Detected	-----	2.62E-01

[Summary Report] - Sample ID: : 70052713

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.07E-02
AG-110m	Not Detected	-----	3.37E-02
BA-133	Not Detected	-----	6.57E-02
BE-7	Not Detected	-----	2.52E-01
CD-109	Not Detected	-----	1.07E+00
CD-115	Not Detected	-----	9.46E-02
CE-139	Not Detected	-----	3.00E-02
CE-141	Not Detected	-----	5.61E-02
CE-144	Not Detected	-----	2.55E-01
CO-56	Not Detected	-----	2.37E-02
CO-57	Not Detected	-----	3.17E-02
CO-58	Not Detected	-----	3.29E-02
CO-60	Not Detected	-----	3.79E-02
CR-51	Not Detected	-----	2.40E-01
CS-134	Not Detected	-----	4.86E-02
CS-137	2.69E-02	2.60E-02	2.16E-02
EU-152	Not Detected	-----	9.55E-02
EU-154	Not Detected	-----	1.87E-01
EU-155	Not Detected	-----	1.58E-01
FE-59	Not Detected	-----	7.37E-02
GD-153	Not Detected	-----	1.09E-01
HG-203	Not Detected	-----	3.22E-02
I-131	Not Detected	-----	3.13E-02
IR-192	Not Detected	-----	2.77E-02
K-40	2.58E+01	3.63E+00	2.48E-01
MN-52	Not Detected	-----	3.08E-02
MN-54	Not Detected	-----	1.94E-02
MO-99	Not Detected	-----	3.20E-01
NA-22	Not Detected	-----	4.39E-02
NA-24	Not Detected	-----	1.19E-01
NB-95	Not Detected	-----	2.04E-01
ND-147	Not Detected	-----	2.17E-01
NI-57	Not Detected	-----	4.93E-02
PB-210	Not Detected	-----	2.13E+01
RU-103	Not Detected	-----	2.81E-02
RU-106	Not Detected	-----	3.02E-01
SB-122	Not Detected	-----	5.33E-02
SB-124	Not Detected	-----	3.05E-02
SB-125	Not Detected	-----	8.17E-02
SN-113	Not Detected	-----	3.72E-02
SR-85	Not Detected	-----	3.72E-02
TA-182	Not Detected	-----	1.53E-01
TA-183	Not Detected	-----	4.93E-01
TC-99m	Not Detected	-----	7.51E-01
TL-201	Not Detected	-----	2.49E-01
XE-133	Not Detected	-----	2.18E-01
Y-88	Not Detected	-----	2.52E-02
ZN-65	Not Detected	-----	1.06E-01
ZR-95	Not Detected	-----	5.97E-02

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-10-97 9:08:11 AM *

* Analyzed by: *[Signature]* 4/11/97 Reviewed by: *[Signature]* 4/11/97 *

Customer : P.SLAVIN/R.NAGEL (6682/IT)
 Customer Sample ID : 032979-002
 Lab Sample ID : 70052714

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 942.000 gram
 Sample Date/Time : 4-08-97 3:35:00 PM
 Acquire Start Date/Time : 4-10-97 7:25:12 AM
 Detector Name : LAB02
 Elapsed Live/Real Time : 6000 / 6004 seconds

CY10-MS-S1

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	3.33E+00
TH-234	1.66E+00	5.57E-01	7.43E-01
RA-226	1.94E+00	7.72E-01	5.35E-01
PB-214	8.78E-01	1.73E-01	4.65E-02
BI-214	8.25E-01	1.86E-01	1.91E-01
TH-232	1.13E+00	5.31E-01	1.32E-01
RA-228	1.19E+00	3.21E-01	1.43E-01
AC-228	1.15E+00	2.32E-01	8.24E-02
TH-228	1.07E+00	2.92E-01	4.81E-01
RA-224	4.01E-01	1.14E-01	1.64E-02
PB-212	1.12E+00	1.74E-01	3.77E-02
BI-212	6.93E-01	5.60E-01	1.68E-01
TL-208	3.63E-01	6.09E-02	2.21E-02
U-235	Not Detected	-----	2.45E-01
TH-231	Not Detected	-----	1.31E+01
PA-231	Not Detected	-----	1.42E+00
TH-227	Not Detected	-----	3.67E-01
RA-223	Not Detected	-----	2.26E-01
RN-219	Not Detected	-----	3.63E-01
PB-211	Not Detected	-----	8.22E-01
TL-207	Not Detected	-----	1.38E+01
AM-241	Not Detected	-----	4.70E-01
PU-239	Not Detected	-----	4.52E+02
NP-237	7.23E-01	2.08E-01	3.08E-01
PA-233	Not Detected	-----	5.65E-02
TH-229	Not Detected	-----	2.60E-01

Not detected 4/11/97

[Summary Report] - Sample ID: : 70052714

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.01E-02
AG-110m	Not Detected	-----	3.07E-02
BA-133	Not Detected	-----	6.51E-02
BE-7	Not Detected	-----	2.41E-01
CD-109	Not Detected	-----	1.04E+00
CD-115	Not Detected	-----	1.10E-01
CE-139	Not Detected	-----	3.03E-02
CE-141	Not Detected	-----	5.51E-02
CE-144	Not Detected	-----	2.53E-01
CO-56	Not Detected	-----	2.51E-02
CO-57	Not Detected	-----	3.12E-02
CO-58	Not Detected	-----	3.20E-02
CO-60	Not Detected	-----	3.52E-02
CR-51	Not Detected	-----	2.34E-01
CS-134	Not Detected	-----	4.85E-02
CS-137	Not Detected	-----	3.30E-02
EU-152	Not Detected	-----	9.37E-02
EU-154	Not Detected	-----	1.85E-01
EU-155	Not Detected	-----	1.51E-01
FE-59	Not Detected	-----	7.37E-02
GD-153	Not Detected	-----	1.08E-01
HG-203	Not Detected	-----	3.21E-02
I-131	Not Detected	-----	3.22E-02
IR-192	Not Detected	-----	2.69E-02
K-40	2.40E+01	3.39E+00	2.18E-01
MN-52	Not Detected	-----	3.65E-02
MN-54	2.03E-02	1.50E-02	1.68E-02
MO-99	Not Detected	-----	3.44E-01
NA-22	Not Detected	-----	4.14E-02
NA-24	Not Detected	-----	1.90E-01
NB-95	Not Detected	-----	2.32E-01
ND-147	Not Detected	-----	2.11E-01
NI-57	1.05E-01	1.10E-01	6.01E-02
PB-210	Not Detected	-----	3.47E+01
RU-103	Not Detected	-----	2.85E-02
RU-106	Not Detected	-----	2.88E-01
SB-122	Not Detected	-----	5.80E-02
SB-124	Not Detected	-----	3.01E-02
SB-125	Not Detected	-----	7.93E-02
SN-113	Not Detected	-----	3.70E-02
SR-85	Not Detected	-----	3.51E-02
TA-182	Not Detected	-----	1.51E-01
TA-183	Not Detected	-----	5.03E-01
TC-99m	Not Detected	-----	2.88E+00
TL-201	Not Detected	-----	2.69E-01
XE-133	Not Detected	-----	2.45E-01
Y-88	Not Detected	-----	2.46E-02
ZN-65	Not Detected	-----	1.03E-01
ZR-95	Not Detected	-----	5.56E-02

not detected J 4/11/97

not detected J 4/11/97

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-10-97 10:54:15 AM *

 * Analyzed by: *[Signature]* 4/11/97. Reviewed by: *[Signature]* 4/11/97 *

 Customer : P.SLAVIN/R.NAGEL (6682/IT)
 Customer Sample ID : 032980-002
 Lab Sample ID : 70052715

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 945.000 gram
 Sample Date/Time : 4-08-97 3:55:00 PM
 Acquire Start Date/Time : 4-10-97 9:10:30 AM
 Detector Name : LAB02
 Elapsed Live/Real Time : 6000 / 6004 seconds

CY10-M5-S2

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	2.31E+00	1.94E+00	2.91E+00
TH-234	2.40E+00	6.69E-01	6.42E-01
RA-226	2.23E+00	7.09E-01	4.95E-01
PB-214	7.77E-01	1.49E-01	4.39E-02
BI-214	7.60E-01	1.21E+00	1.90E-01
TH-232	9.37E-01	4.66E-01	1.42E-01
RA-228	1.07E+00	2.64E-01	1.42E-01
AC-228	1.04E+00	2.25E-01	7.96E-02
TH-228	9.48E-01	2.60E-01	4.84E-01
RA-224	3.65E-01	9.78E-02	2.01E-02
PB-212	1.00E+00	2.69E-01	4.00E-02
BI-212	5.65E-01	1.86E-01	1.70E-01
TL-208	3.50E-01	6.56E-02	2.21E-02
U-235	Not Detected	-----	2.43E-01
TH-231	Not Detected	-----	1.32E+01
PA-231	Not Detected	-----	1.38E+00
TH-227	Not Detected	-----	3.50E-01
RA-223	Not Detected	-----	2.21E-01
RN-219	Not Detected	-----	3.52E-01
PB-211	Not Detected	-----	8.07E-01
TL-207	Not Detected	-----	1.37E+01
AM-241	Not Detected	-----	4.80E-01
PU-239	Not Detected	-----	4.45E+02
NP-237	Not Detected	-----	3.06E-01
PA-233	Not Detected	-----	5.75E-02
TH-229	Not Detected	-----	2.60E-01

[Summary Report] - Sample ID: : 70052715

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	3.96E-02
AG-110m	Not Detected	-----	3.48E-02
BA-133	Not Detected	-----	6.20E-02
BE-7	Not Detected	-----	2.50E-01
CD-109	1.86E+00	5.94E-01	1.04E+00
CD-115	Not Detected	-----	1.08E-01
CE-139	Not Detected	-----	2.89E-02
CE-141	Not Detected	-----	5.43E-02
CE-144	Not Detected	-----	2.44E-01
CO-56	Not Detected	-----	2.30E-02
CO-57	Not Detected	-----	3.09E-02
CO-58	Not Detected	-----	3.03E-02
CO-60	Not Detected	-----	3.56E-02
CR-51	Not Detected	-----	2.34E-01
CS-134	Not Detected	-----	4.62E-02
CS-137	6.26E-02	3.24E-02	2.23E-02
EU-152	Not Detected	-----	9.28E-02
EU-154	Not Detected	-----	1.81E-01
EU-155	Not Detected	-----	7.17E-02
FE-59	Not Detected	-----	7.07E-02
GD-153	Not Detected	-----	1.09E-01
HG-203	Not Detected	-----	3.14E-02
I-131	Not Detected	-----	3.23E-02
IR-192	Not Detected	-----	2.67E-02
K-40	2.54E+01	3.59E+00	2.29E-01
MN-52	Not Detected	-----	3.57E-02
MN-54	Not Detected	-----	1.97E-02
MO-99	Not Detected	-----	3.66E-01
NA-22	Not Detected	-----	4.10E-02
NA-24	Not Detected	-----	2.10E-01
NB-95	Not Detected	-----	2.24E-01
ND-147	Not Detected	-----	2.16E-01
NI-57	1.24E-01	7.95E-02	5.85E-02
PB-210	Not Detected	-----	3.52E+01
RU-103	Not Detected	-----	2.90E-02
RU-106	Not Detected	-----	2.81E-01
SB-122	1.88E-02	5.34E-03	3.18E-02
SB-124	Not Detected	-----	2.91E-02
SB-125	Not Detected	-----	7.87E-02
SN-113	Not Detected	-----	3.56E-02
SR-85	Not Detected	-----	3.61E-02
TA-182	Not Detected	-----	1.48E-01
TA-183	Not Detected	-----	5.19E-01
TC-99m	Not Detected	-----	3.42E+00
TL-201	Not Detected	-----	2.71E-01
XE-133	Not Detected	-----	2.55E-01
Y-88	Not Detected	-----	2.38E-02
ZN-65	Not Detected	-----	1.01E-01
ZR-95	Not Detected	-----	5.67E-02

not detected 7/11/57

not detected 7/11/57

not detected 7/11/57

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-10-97 12:58:36 PM *

* Analyzed by: *J* 4/11/97 Reviewed by: *X* 4/11/97 *

Customer : P.SLAVIN/R.NAGEL (6682/IT)
 Customer Sample ID : 034327-002
 Lab Sample ID : 70052716

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 736.000 gram
 Sample Date/Time : 4-07-97 4:20:00 PM
 Acquire Start Date/Time : 4-10-97 11:08:49 AM
 Detector Name : LAB02
 Elapsed Live/Real Time : 6000 / 6003 seconds

CY10-SB9-1

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	3.70E+00
TH-234	1.47E+00	5.71E-01	8.34E-01
RA-226	1.61E+00	9.80E-01	5.69E-01
PB-214	8.27E-01	1.44E-01	5.10E-02
BI-214	7.13E-01	2.12E-01	2.44E-01
TH-232	1.00E+00	4.68E-01	1.44E-01
RA-228	1.15E+00	1.89E+00	1.63E-01
AC-228	9.92E-01	2.11E-01	8.75E-02
TH-228	1.12E+00	3.32E-01	5.21E-01
RA-224	3.80E-01	1.05E-01	2.28E-02
PB-212	9.72E-01	1.56E-01	4.19E-02
BI-212	5.76E-01	2.73E-01	1.92E-01
TL-208	3.06E-01	7.07E-02	2.66E-02
U-235	Not Detected	-----	2.69E-01
TH-231	Not Detected	-----	1.41E+01
PA-231	Not Detected	-----	1.61E+00
TH-227	Not Detected	-----	3.89E-01
RA-223	Not Detected	-----	2.59E-01
RN-219	3.45E-01	3.46E-01	4.15E-01
PB-211	Not Detected	-----	9.49E-01
TL-207	Not Detected	-----	1.55E+01
AM-241	Not Detected	-----	5.28E-01
PU-239	Not Detected	-----	4.92E+02
NP-237	Not Detected	-----	2.80E-01
PA-233	Not Detected	-----	6.32E-02
TH-229	Not Detected	-----	2.77E-01

not detected J 4/11/97

[Summary Report] - Sample ID: : 70052716

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.42E-02
AG-110m	Not Detected	-----	4.57E-02
BA-133	Not Detected	-----	7.16E-02
BE-7	Not Detected	-----	2.83E-01
CD-109	1.87E+00	6.14E-01	9.51E-01
CD-115	Not Detected	-----	1.72E-01
CE-139	Not Detected	-----	3.31E-02
CE-141	Not Detected	-----	6.15E-02
CE-144	Not Detected	-----	2.71E-01
CO-56	Not Detected	-----	2.61E-02
CO-57	Not Detected	-----	3.37E-02
CO-58	Not Detected	-----	3.65E-02
CO-60	Not Detected	-----	4.21E-02
CR-51	Not Detected	-----	2.73E-01
CS-134	Not Detected	-----	5.24E-02
CS-137	1.36E-01	4.13E-02	2.67E-02
EU-152	Not Detected	-----	1.01E-01
EU-154	Not Detected	-----	2.04E-01
EU-155	Not Detected	-----	1.68E-01
FE-59	Not Detected	-----	8.67E-02
GD-153	Not Detected	-----	1.15E-01
HG-203	Not Detected	-----	3.65E-02
I-131	Not Detected	-----	3.86E-02
IR-192	Not Detected	-----	3.09E-02
K-40	2.49E+01	3.84E+00	2.90E-01
MN-52	Not Detected	-----	4.49E-02
MN-54	Not Detected	-----	1.48E-02
MO-99	Not Detected	-----	5.21E-01
NA-22	Not Detected	-----	4.85E-02
NA-24	Not Detected	-----	8.18E-01
NB-95	Not Detected	-----	3.05E-01
ND-147	Not Detected	-----	2.63E-01
NI-57	1.66E-01	1.70E-01	1.13E-01
PB-210	Not Detected	-----	3.91E+01
RU-103	Not Detected	-----	3.26E-02
RU-106	Not Detected	-----	3.09E-01
SB-122	Not Detected	-----	8.61E-02
SB-124	Not Detected	-----	3.44E-02
SB-125	Not Detected	-----	9.02E-02
SN-113	Not Detected	-----	4.17E-02
SR-85	Not Detected	-----	4.09E-02
TA-182	Not Detected	-----	1.68E-01
TA-183	Not Detected	-----	6.63E-01
TC-99m	Not Detected	-----	7.14E+01
TL-201	Not Detected	-----	3.72E-01
XE-133	Not Detected	-----	3.83E-01
Y-88	Not Detected	-----	2.71E-02
ZN-65	Not Detected	-----	1.13E-01
ZR-95	Not Detected	-----	6.49E-02

Not detected

4/11/15

Not detected

4/11/15

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-10-97 3:26:50 PM *

* Analyzed by: *[Signature]* 4/11/97 Reviewed by: *[Signature]* 4/11/97 *

Customer : P.SLAVIN/R.NAGEL (6682/IT)
 Customer Sample ID : 034328-002
 Lab Sample ID : 70052717

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 885.000 gram
 Sample Date/Time : 4-07-97 4:22:00 PM
 Acquire Start Date/Time : 4-10-97 1:01:24 PM
 Detector Name : LAB02
 Elapsed Live/Real Time : 8501 / 8506 seconds

CY10-SB9-2

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	2.88E+00
TH-234	1.32E+00	4.73E-01	6.81E-01
RA-226	1.99E+00	1.29E+00	5.12E-01
PB-214	8.82E-01	1.34E-01	3.78E-02
BI-214	8.25E-01	6.53E-01	2.01E-01
TH-232	1.14E+00	5.65E-01	1.24E-01
RA-228	1.20E+00	3.97E-01	1.21E-01
AC-228	1.15E+00	2.14E-01	6.68E-02
TH-228	1.14E+00	2.66E-01	3.99E-01
RA-224	4.13E-01	1.05E-01	1.96E-02
PB-212	1.13E+00	2.23E-01	3.30E-02
BI-212	7.40E-01	3.19E-01	1.47E-01
TL-208	3.84E-01	6.92E-02	1.78E-02
U-235	6.99E-02	1.68E-01	2.14E-01
TH-231	Not Detected	-----	1.13E+01
PA-231	Not Detected	-----	1.21E+00
TH-227	Not Detected	-----	3.19E-01
RA-223	Not Detected	-----	2.05E-01
RN-219	Not Detected	-----	3.16E-01
PB-211	Not Detected	-----	7.24E-01
TL-207	Not Detected	-----	1.15E+01
AM-241	Not Detected	-----	4.21E-01
PU-239	Not Detected	-----	3.93E+02
NP-237	6.79E-01	1.85E-01	2.66E-01
PA-233	Not Detected	-----	4.94E-02
TH-229	Not Detected	-----	2.21E-01

not detected 4/11/97

not detected 4/11/97

[Summary Report] - Sample ID: : 70052717

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	3.57E-02
AG-110m	Not Detected	-----	2.72E-02
BA-133	Not Detected	-----	5.60E-02
BE-7	Not Detected	-----	2.15E-01
CD-109	Not Detected	-----	9.04E-01
CD-115	Not Detected	-----	1.41E-01
CE-139	Not Detected	-----	2.58E-02
CE-141	Not Detected	-----	4.85E-02
CE-144	Not Detected	-----	2.16E-01
CO-56	Not Detected	-----	2.11E-02
CO-57	Not Detected	-----	2.71E-02
CO-58	Not Detected	-----	2.74E-02
CO-60	Not Detected	-----	3.00E-02
CR-51	Not Detected	-----	2.06E-01
CS-134	Not Detected	-----	4.19E-02
CS-137	Not Detected	-----	2.92E-02
EU-152	Not Detected	-----	8.12E-02
EU-154	Not Detected	-----	1.64E-01
EU-155	Not Detected	-----	5.57E-02
FE-59	Not Detected	-----	6.27E-02
GD-153	Not Detected	-----	9.34E-02
HG-203	Not Detected	-----	2.83E-02
I-131	Not Detected	-----	3.07E-02
IR-192	Not Detected	-----	2.34E-02
K-40	2.33E+01	3.26E+00	2.10E-01
MN-52	Not Detected	-----	3.36E-02
MN-54	Not Detected	-----	1.71E-02
MO-99	Not Detected	-----	3.99E-01
NA-22	Not Detected	-----	3.59E-02
NA-24	Not Detected	-----	6.16E-01
NB-95	Not Detected	-----	2.54E-01
ND-147	Not Detected	-----	2.05E-01
NI-57	Not Detected	-----	8.69E-02
PB-210	Not Detected	-----	3.02E+01
RU-103	Not Detected	-----	2.53E-02
RU-106	Not Detected	-----	2.45E-01
SB-122	3.20E-02	4.51E-02	3.89E-02
SB-124	Not Detected	-----	2.62E-02
SB-125	Not Detected	-----	6.86E-02
SN-113	Not Detected	-----	3.17E-02
SR-85	Not Detected	-----	3.18E-02
TA-182	Not Detected	-----	1.32E-01
TA-183	Not Detected	-----	5.27E-01
TC-99m	Not Detected	-----	7.02E+01
TL-201	Not Detected	-----	3.08E-01
XE-133	Not Detected	-----	3.10E-01
Y-88	Not Detected	-----	2.15E-02
ZN-65	Not Detected	-----	8.98E-02
ZR-95	Not Detected	-----	4.92E-02

not detected 7/11/97

Internal Lab
Batch No. 700530

ANALYSIS REQUEST AND CHAIN OF CUSTODY

PAGE 1 OF 1

AR/COC-06544

SF 2001-COC (6-95)

Dept. No./Mail Stop: 6682/85/MS-1147 Project/Task Manager: PAULA SLAVIN Project Name: SITE 10 CONF SMP LG Record Center Code: ER/1333/010/DAT Logbook Ref No: 206 Service Order No.: CF0394	Date Samples Shipped: 4/9/97 Carrier/Waybill No.: 4242 Lab Contact: FERNANDO DOMINGUEZ Lab Destination: RPSD, BLK 881 SMO Contact/Phone: TAM RUSSANT/844-3185 Send Report to SMO: PAULA SLAVIN/BROWN	Contract No. In House Case No. 8821.201200 SMO Authorization: [Signature] Bill to: Sandia National Laboratories Supplier Services Department P.O. Box 5800 MS 0154 Albuquerque, NM 87185-0154	Parameter & Method Requested GAMMA SPEC
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Location										Tech Area		Beginning Depth in Ft.	ER Site No.	Date/Time Collected	Sample Matrix	Reference LOV (available at SMO)					Lab Sample ID																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
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RMMA <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Ref. No. _____ Sample Disposal <input checked="" type="checkbox"/> Return to Client <input type="checkbox"/> Disposal by lab Turnaround Time <input type="checkbox"/> Normal <input checked="" type="checkbox"/> Rush Required Report Date 04-10-97	Sample Tracking Date Entered (mm/dd/yy) _____ Entered by: _____	Special Instructions/QC Requirements Please RUSH. These will release COCs 06542 and 06543 to LAS. Please Page C.C. when ready. Fax to Craig Brown at 284-2617.	Abnormal Conditions on Receipt _____ _____ _____
--	--	---	--

1. Relinquished by [Signature] Org. 6684 Date 4/9/97 Time 10:00	4. Relinquished by [Signature] Org. 5417578 Date 4/10/97 Time 0923
1. Received by [Signature] Org. IT/6684 Date 4-9-97 Time 10:00	4. Received by [Signature] Org. 8407578 Date 4/10/97 Time 0923
2. Relinquished by [Signature] Org. IT/6684 Date 4-9-97 Time 1230	5. Relinquished by [Signature] Org. 8407578 Date 5/7/97 Time 1336
2. Received by [Signature] Org. 8407578 Date 4/9/97 Time 1230	5. Received by [Signature] Org. 6684 Date 5/6/97 Time 1336
3. Relinquished by [Signature] Org. 8407578 Date 4/9/97 Time 1439	6. Relinquished by _____ Org. _____ Date _____ Time _____
3. Received by [Signature] Org. 7578 Date 4/9/97 Time 1440	6. Received by _____ Org. _____ Date _____ Time _____

WHITE - To Accompany Samples, Laboratory Copy BLUE - To Accompany Samples, Return to SMO YELLOW - SMO Suspense Copy PINK - Field Copy

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*****
*                               Sandia National Laboratories                               *
*   Radiation Protection Sample Diagnostics Program [881 Laboratory]   *
*                               4-09-97  5:08:54 PM                               *
*****
* Analyzed by: [Signature] 4/10/97 Reviewed by: [Signature] 4/10/97
*****
Customer      : P.SLAVIN/MAC (6682/SMO)
Customer Sample ID : 034325-002
Lab Sample ID  : 70053001

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Sample Description : MARINELLI FILLED WITH SOIL
Sample Quantity   : 503.000 gram
Sample Date/Time  : 4-07-97 2:49:00 PM
Acquire Start Date/Time : 4-09-97 3:25:08 PM
Detector Name     : LAB04
Elapsed Live/Real Time : 6000 / 6004 seconds

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CY10-PIT-1

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	3.15E+00
TH-234	3.44E+00	8.98E-01	6.87E-01
RA-226	1.55E+00	1.35E+00	8.24E-01
PB-214	1.70E+00	4.80E-01	6.59E-02
BI-214	1.51E+00	5.47E-01	6.47E-02
TH-232	2.29E+00	1.04E+00	2.17E-01
RA-228	2.26E+00	4.98E-01	2.06E-01
AC-228	2.43E+00	4.86E-01	1.11E-01
TH-228	2.17E+00	6.62E-01	6.70E-01
RA-224	8.49E-01	2.20E-01	4.31E-02
PB-212	2.35E+00	3.58E-01	5.60E-02
BI-212	1.37E+00	3.78E-01	2.45E-01
TL-208	7.72E-01	1.23E-01	3.35E-02
U-235	1.39E-01	1.30E-01	2.03E-01
TH-231	Not Detected	-----	1.52E+01
PA-231	Not Detected	-----	2.15E+00
TH-227	Not Detected	-----	6.41E-01
RA-223	Not Detected	-----	2.83E-01
RN-219	Not Detected	-----	5.97E-01
PB-211	Not Detected	-----	1.34E+00
TL-207	Not Detected	-----	1.86E+01
AM-241	Not Detected	-----	3.94E-01
PU-239	Not Detected	-----	5.65E+02
NP-237	Not Detected	-----	3.30E-01
PA-233	Not Detected	-----	8.73E-02
TH-229	Not Detected	-----	3.13E-01

[Summary Report] - Sample ID: : 70053001

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	6.48E-02
AG-110m	Not Detected	-----	7.00E-02
BA-133	Not Detected	-----	1.11E-01
BE-7	Not Detected	-----	3.83E-01
CD-109	5.46E-00	1.20E+00	1.12E+00
CD-115	Not Detected	-----	2.10E-01
CE-139	Not Detected	-----	4.12E-02
CE-141	Not Detected	-----	7.45E-02
CE-144	Not Detected	-----	3.05E-01
CO-56	Not Detected	-----	4.33E-02
CO-57	Not Detected	-----	3.89E-02
CO-58	Not Detected	-----	4.30E-02
CO-60	Not Detected	-----	4.36E-02
CR-51	Not Detected	-----	3.68E-01
CS-134	Not Detected	-----	8.14E-02
CS-137	3.36E-01	7.47E-02	3.46E-02
EU-152	Not Detected	-----	1.17E-01
EU-154	Not Detected	-----	3.00E-01
EU-155	Not Detected	-----	1.29E-01
FE-59	Not Detected	-----	8.48E-02
GD-153	Not Detected	-----	1.38E-01
HG-203	Not Detected	-----	4.75E-02
I-131	Not Detected	-----	4.81E-02
IR-192	Not Detected	-----	4.18E-02
K-40	1.14E+01	1.83E+00	3.47E-01
MN-52	Not Detected	-----	5.61E-02
MN-54	Not Detected	-----	2.73E-02
MO-99	Not Detected	-----	5.84E-01
NA-22	Not Detected	-----	4.86E-02
NA-24	Not Detected	-----	4.20E-01
NB-95	Not Detected	-----	4.35E-01
ND-147	Not Detected	-----	3.30E-01
NI-57	Not Detected	-----	1.79E-01
PB-210	Not Detected	-----	1.57E+01
RU-103	Not Detected	-----	4.46E-02
RU-106	Not Detected	-----	4.17E-01
SB-122	Not Detected	-----	1.02E-01
SB-124	Not Detected	-----	4.68E-02
SB-125	Not Detected	-----	1.23E-01
SN-113	Not Detected	-----	5.89E-02
SR-85	Not Detected	-----	6.00E-02
TA-182	Not Detected	-----	2.10E-01
TA-183	Not Detected	-----	4.35E-01
TC-99m	Not Detected	-----	1.00E+01
TL-201	Not Detected	-----	2.93E-01
XE-133	Not Detected	-----	3.68E-01
Y-88	Not Detected	-----	3.83E-02
ZN-65	Not Detected	-----	1.44E-01
ZR-95	Not Detected	-----	8.25E-02

not detected *4/10/*

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-09-97 5:33:41 PM *

 * Analyzed by: *J* 4/10/97 Reviewed by: *KK* 4/10/97 *

Customer : P.SLAVIN/MAC (6682/SMO)
 Customer Sample ID : 034326-002
 Lab Sample ID : 70053002

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 524.000 gram
 Sample Date/Time : 4-07-97 2:49:00 PM
 Acquire Start Date/Time : 4-09-97 3:49:09 PM
 Detector Name : LAB03
 Elapsed Live/Real Time : 6000 / 6004 seconds

D
 CY10-PIT-1-*D*

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	2.35E+00
TH-234	3.80E+00	8.04E-01	7.02E-01
RA-226	3.52E+00	1.04E+00	8.50E-01
PB-214	1.89E+00	2.96E-01	8.85E-02
BI-214	1.87E+00	1.18E+00	7.84E-02
TH-232	2.27E+00	1.06E+00	2.60E-01
RA-228	2.51E+00	6.59E-01	2.58E-01
AC-228	2.35E+00	4.35E-01	1.51E-01
TH-228	1.90E+00	7.36E-01	8.84E-01
RA-224	8.66E-01	1.42E+00	2.28E+00
PB-212	2.39E+00	4.74E-01	6.73E-02
BI-212	1.59E+00	6.15E-01	3.49E-01
TL-208	7.82E-01	1.54E-01	4.13E-02
U-235	3.03E-01	2.38E-01	3.31E-01
TH-231	2.94E+00	3.19E+00	9.92E+00
PA-231	Not Detected	-----	2.25E+00
TH-227	Not Detected	-----	7.20E-01
RA-223	Not Detected	-----	1.99E-01
RN-219	Not Detected	-----	6.95E-01
PB-211	Not Detected	-----	1.59E+00
TL-207	Not Detected	-----	2.43E+01
AM-241	Not Detected	-----	2.69E-01
PU-239	Not Detected	-----	6.08E+02
NP-237	2.84E+00	3.57E-01	3.22E-01
PA-233	Not Detected	-----	9.87E-02
TH-229	Not Detected	-----	3.15E-01

not detected *J* 4/10/97

[Summary Report] - Sample ID: : 70053002

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	7.95E-02
AG-110m	Not Detected	-----	8.74E-02
BA-133	Not Detected	-----	1.12E-01
BE-7	Not Detected	-----	4.61E-01
CD-109	Not Detected	-----	1.09E+00
CD-115	Not Detected	-----	2.41E-01
CE-139	Not Detected	-----	4.47E-02
CE-141	Not Detected	-----	7.38E-02
CE-144	Not Detected	-----	3.22E-01
CO-56	1.43E-02	1.59E-02	2.49E-02
CO-57	Not Detected	-----	4.00E-02
CO-58	Not Detected	-----	5.60E-02
CO-60	Not Detected	-----	5.64E-02
CR-51	Not Detected	-----	4.12E-01
CS-134	Not Detected	-----	8.00E-02
CS-137	Not Detected	-----	3.73E-02
EU-152	Not Detected	-----	1.20E-01
EU-154	Not Detected	-----	3.73E-01
EU-155	Not Detected	-----	1.83E-01
FE-59	Not Detected	-----	1.11E-01
GD-153	Not Detected	-----	1.30E-01
HG-203	Not Detected	-----	5.36E-02
I-131	Not Detected	-----	6.29E-02
IR-192	Not Detected	-----	4.68E-02
K-40	1.18E+01	2.18E+00	4.51E-01
MN-52	Not Detected	-----	7.19E-02
MN-54	Not Detected	-----	6.50E-02
MO-99	Not Detected	-----	7.31E-01
NA-22	Not Detected	-----	6.50E-02
NA-24	Not Detected	-----	5.14E-01
NB-95	Not Detected	-----	4.58E-01
ND-147	Not Detected	-----	3.89E-01
NI-57	Not Detected	-----	2.37E-01
PB-210	4.53E+00	3.47E+00	5.30E+00
RU-103	Not Detected	-----	5.27E-02
RU-106	Not Detected	-----	5.51E-01
SB-122	Not Detected	-----	1.15E-01
SB-124	Not Detected	-----	5.41E-02
SB-125	Not Detected	-----	1.46E-01
SN-113	Not Detected	-----	7.14E-02
SR-85	Not Detected	-----	7.28E-02
TA-182	Not Detected	-----	2.82E-01
TA-183	Not Detected	-----	3.00E-01
TC-99m	Not Detected	-----	1.08E+01
TL-201	Not Detected	-----	2.38E-01
XE-133	6.15E-02	6.50E-02	2.07E-01
Y-88	Not Detected	-----	5.41E-02
ZN-65	Not Detected	-----	1.88E-01
ZR-95	Not Detected	-----	1.06E-01

not detected 7/10/97

not detected 7/10/97

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-09-97 6:57:35 PM *

 * Analyzed by: *[Signature]* 4/10/97 Reviewed by: *[Signature]* 4/10/97 *

Customer : P.SLAVIN/MAC (6682/SMO)
 Customer Sample ID : 032962-002
 Lab Sample ID : 70053003

Sample Description : MARINELLI FILLED WITH SOIL
 Sample Quantity : 774.000 gram
 Sample Date/Time : 4-08-97 2:15:00 PM
 Acquire Start Date/Time : 4-09-97 5:10:10 PM
 Detector Name : LAB04
 Elapsed Live/Real Time : 6000 / 6005 seconds

CY10-M2-T1-M

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	2.09E+00
TH-234	1.69E+00	4.33E-01	5.17E-01
RA-226	2.32E+00	6.27E-01	5.96E-01
PB-214	1.11E+00	1.68E-01	4.41E-02
BI-214	1.03E+00	1.72E-01	4.22E-02
TH-232	1.21E+00	5.57E-01	1.51E-01
RA-228	1.37E+00	5.16E-01	1.45E-01
AC-228	1.22E+00	2.45E-01	8.03E-02
TH-228	1.10E+00	2.47E-01	5.21E-01
RA-224	4.58E-01	1.27E-01	2.75E-02
PB-212	1.23E+00	1.93E-01	4.17E-02
BI-212	7.35E-01	2.47E-01	1.61E-01
TL-208	4.19E-01	7.36E-02	2.25E-02
U-235	1.61E-01	1.91E-01	2.36E-01
TH-231	5.14E+00	2.85E+00	8.72E+00
PA-231	Not Detected	-----	1.53E+00
TH-227	Not Detected	-----	3.95E-01
RA-223	Not Detected	-----	1.41E-01
RN-219	Not Detected	-----	3.92E-01
PB-211	Not Detected	-----	8.98E-01
TL-207	Not Detected	-----	1.42E+01
AM-241	Not Detected	-----	2.65E-01
PU-239	Not Detected	-----	4.00E+02
NP-237	Not Detected	-----	2.38E-01
PA-233	Not Detected	-----	6.17E-02
TH-229	Not Detected	-----	2.29E-01

[Summary Report] - Sample ID: : 70053003

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.33E-02
AG-110m	Not Detected	-----	4.14E-02
BA-133	Not Detected	-----	7.39E-02
BE-7	Not Detected	-----	2.78E-01
CD-109	2.98E+00	6.55E-01	8.08E-01
CD-115	Not Detected	-----	1.01E-01
CE-139	Not Detected	-----	2.89E-02
CE-141	Not Detected	-----	5.16E-02
CE-144	Not Detected	-----	2.17E-01
CO-56	Not Detected	-----	3.24E-02
CO-57	Not Detected	-----	2.81E-02
CO-58	Not Detected	-----	3.22E-02
CO-60	Not Detected	-----	3.54E-02
CR-51	Not Detected	-----	2.49E-01
CS-134	Not Detected	-----	5.47E-02
CS-137	1.32E-01	6.72E-02	2.14E-02
EU-152	Not Detected	-----	8.45E-02
EU-154	Not Detected	-----	1.99E-01
EU-155	Not Detected	-----	1.33E-01
FE-59	Not Detected	-----	6.71E-02
GD-153	Not Detected	-----	9.56E-02
HG-203	Not Detected	-----	3.30E-02
I-131	Not Detected	-----	3.27E-02
IR-192	Not Detected	-----	2.86E-02
K-40	2.36E+01	3.42E+00	2.11E-01
MN-52	Not Detected	-----	3.77E-02
MN-54	Not Detected	-----	1.82E-02
MO-99	Not Detected	-----	3.25E-01
NA-22	Not Detected	-----	4.07E-02
NA-24	Not Detected	-----	1.20E-01
NB-95	Not Detected	-----	2.25E-01
ND-147	Not Detected	-----	2.27E-01
NI-57	9.70E-02	4.63E-02	4.45E-02
PB-210	Not Detected	-----	1.04E+01
RU-103	Not Detected	-----	3.06E-02
RU-106	Not Detected	-----	2.78E-01
SB-122	1.45E-02	1.43E-02	2.81E-02
SB-124	Not Detected	-----	3.17E-02
SB-125	Not Detected	-----	8.30E-02
SN-113	Not Detected	-----	3.94E-02
SR-85	Not Detected	-----	3.89E-02
TA-182	Not Detected	-----	1.59E-01
TA-183	Not Detected	-----	2.61E-01
TC-99m	Not Detected	-----	5.93E-01
TL-201	Not Detected	-----	1.68E-01
XE-133	6.03E-02	3.97E-02	1.36E-01
Y-88	Not Detected	-----	2.70E-02
ZN-65	Not Detected	-----	1.09E-01
ZR-95	Not Detected	-----	5.91E-02

Not detected 7/4/10/97

Not detected 7/4/10/97

Not detected 7/4/10/97

Not detected 7/4/10/97

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-09-97 7:25:41 PM *

* Analyzed by: *[Signature]* 4/10/97 Reviewed by: *[Signature]* 4/10/97 *

Customer : P.SLAVIN/MAC (6682/SMO)
 Customer Sample ID : 032968-002
 Lab Sample ID : 70053004

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 878.000 gram
 Sample Date/Time : 4-08-97 2:30:00 PM
 Acquire Start Date/Time : 4-09-97 5:32:45 PM
 Detector Name : LAB03
 Elapsed Live/Real Time : 6000 / 6005 seconds

CY10-M3-S1

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	8.41E+00	2.22E+00	1.21E+00
TH-234	8.29E+00	1.72E+00	5.10E-01
RA-226	3.40E+00	5.50E-01	6.01E-01
PB-214	1.04E+00	1.64E-01	5.35E-02
BI-214	1.01E+00	6.11E-01	5.45E-02
TH-232	1.20E+00	5.76E-01	1.72E-01
RA-228	1.14E+00	2.64E-01	1.75E-01
AC-228	1.10E+00	2.63E-01	1.01E-01
TH-228	9.55E-01	4.50E-01	5.19E-01
RA-224	Not Detected	-----	1.36E+00
PB-212	1.10E+00	1.84E-01	4.29E-02
BI-212	6.27E-01	2.95E-01	2.11E-01
TL-208	3.84E-01	8.90E-02	3.21E-02
U-235	2.91E-01	1.66E-01	2.27E-01
TH-231	Not Detected	-----	9.24E+00
PA-231	Not Detected	-----	1.46E+00
TH-227	Not Detected	-----	4.03E-01
RA-223	Not Detected	-----	1.61E-01
RN-219	Not Detected	-----	4.31E-01
PB-211	Not Detected	-----	9.92E-01
TL-207	Not Detected	-----	1.63E+01
AM-241	Not Detected	-----	1.92E-01
PU-239	Not Detected	-----	3.95E+02
NP-237	Not Detected	-----	2.36E-01
PA-233	Not Detected	-----	6.28E-02
TH-229	Not Detected	-----	2.26E-01

[Summary Report] - Sample ID: : 70053004

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.91E-02
AG-110m	Not Detected	-----	3.96E-02
BA-133	Not Detected	-----	6.45E-02
BE-7	Not Detected	-----	2.81E-01
CD-109	2.10E-02	1.92E-01	8.00E-01
CD-115	Not Detected	-----	1.06E-01
CE-139	Not Detected	-----	2.89E-02
CE-141	Not Detected	-----	4.94E-02
CE-144	Not Detected	-----	2.12E-01
CO-56	Not Detected	-----	3.75E-02
CO-57	Not Detected	-----	2.72E-02
CO-58	Not Detected	-----	3.65E-02
CO-60	Not Detected	-----	4.05E-02
CR-51	Not Detected	-----	2.64E-01
CS-134	Not Detected	-----	4.70E-02
CS-137	2.68E-02	1.75E-02	2.21E-02
EU-152	Not Detected	-----	8.17E-02
EU-154	Not Detected	-----	2.27E-01
EU-155	Not Detected	-----	1.26E-01
FE-59	Not Detected	-----	8.87E-02
GD-153	Not Detected	-----	9.43E-02
HG-203	Not Detected	-----	3.29E-02
I-131	Not Detected	-----	3.41E-02
IR-192	Not Detected	-----	3.00E-02
K-40	2.31E+01	3.45E+00	2.80E-01
MN-52	Not Detected	-----	4.44E-02
MN-54	Not Detected	-----	4.21E-02
MO-99	Not Detected	-----	3.69E-01
NA-22	Not Detected	-----	5.05E-02
NA-24	Not Detected	-----	1.23E-01
NB-95	Not Detected	-----	2.17E-01
ND-147	Not Detected	-----	2.48E-01
NI-57	Not Detected	-----	9.23E-02
PB-210	Not Detected	-----	5.22E+00
RU-103	Not Detected	-----	3.31E-02
RU-106	Not Detected	-----	3.41E-01
SB-122	Not Detected	-----	5.79E-02
SB-124	Not Detected	-----	3.35E-02
SB-125	Not Detected	-----	8.91E-02
SN-113	Not Detected	-----	4.25E-02
SR-85	Not Detected	-----	4.21E-02
TA-182	Not Detected	-----	1.87E-01
TA-183	Not Detected	-----	1.88E-01
TC-99m	Not Detected	-----	5.86E-01
TL-201	Not Detected	-----	1.37E-01
XE-133	Not Detected	-----	1.42E-01
Y-88	Not Detected	-----	3.19E-02
ZN-65	Not Detected	-----	1.27E-01
ZR-95	Not Detected	-----	6.82E-02

not detected 7/10/97

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-09-97 8:35:50 PM *

 * Analyzed by: *[Signature]* 4/10/97 Reviewed by: *[Signature]* 4/10/97 *

Customer : P.SLAVIN/MAC (6682/SMO)
 Customer Sample ID : 032969-002
 Lab Sample ID : 70053005

Sample Description : MARINELLI FILLED WITH SOIL
 Sample Quantity : 826.000 gram
 Sample Date/Time : 4-08-97 2:31:00 PM
 Acquire Start Date/Time : 4-09-97 6:51:23 PM
 Detector Name : LAB04
 Elapsed Live/Real Time : 6000 / 6005 seconds

CY10-M3-SI-D

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	5.92E+00	1.76E+00	1.38E+00
TH-234	5.94E+00	1.39E+00	4.78E-01
RA-226	9.96E-01	5.93E-01	4.98E-01
PB-214	8.84E-01	1.37E-01	3.92E-02
BI-214	8.06E-01	1.40E-01	4.40E-02
TH-232	1.05E+00	4.86E-01	1.37E-01
RA-228	1.00E+00	2.57E-01	1.46E-01
AC-228	1.01E+00	2.13E-01	7.87E-02
TH-228	8.41E-01	2.43E-01	4.68E-01
RA-224	3.82E-01	1.14E-01	2.53E-02
PB-212	1.04E+00	1.62E-01	3.61E-02
BI-212	7.05E-01	2.08E-01	1.72E-01
TL-208	3.56E-01	6.43E-02	2.31E-02
U-235	4.93E-02	7.54E-02	1.31E-01
TH-231	Not Detected	-----	1.02E+01
PA-231	Not Detected	-----	1.41E+00
TH-227	Not Detected	-----	3.51E-01
RA-223	Not Detected	-----	1.78E-01
RN-219	Not Detected	-----	3.50E-01
PB-211	Not Detected	-----	8.20E-01
TL-207	Not Detected	-----	1.33E+01
AM-241	Not Detected	-----	2.70E-01
PU-239	Not Detected	-----	3.78E+02
NP-237	Not Detected	-----	2.27E-01
PA-233	Not Detected	-----	5.80E-02
TH-229	Not Detected	-----	2.25E-01

[Summary Report] - Sample ID: : 70053005

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	3.91E-02
AG-110m	Not Detected	-----	3.21E-02
BA-133	Not Detected	-----	6.54E-02
BE-7	Not Detected	-----	2.45E-01
CD-109	2.58E+00	5.89E-01	7.71E-01
CD-115	Not Detected	-----	9.41E-02
CE-139	Not Detected	-----	2.78E-02
CE-141	Not Detected	-----	4.93E-02
CE-144	Not Detected	-----	2.06E-01
CO-56	Not Detected	-----	3.11E-02
CO-57	Not Detected	-----	2.69E-02
CO-58	Not Detected	-----	3.09E-02
CO-60	Not Detected	-----	3.46E-02
CR-51	Not Detected	-----	2.37E-01
CS-134	Not Detected	-----	4.76E-02
CS-137	3.30E-02	1.73E-02	1.97E-02
EU-152	Not Detected	-----	8.07E-02
EU-154	Not Detected	-----	1.81E-01
EU-155	Not Detected	-----	1.27E-01
FE-59	Not Detected	-----	6.92E-02
GD-153	Not Detected	-----	9.72E-02
HG-203	Not Detected	-----	2.98E-02
I-131	Not Detected	-----	3.01E-02
IR-192	Not Detected	-----	2.75E-02
K-40	2.51E+01	3.60E+00	2.28E-01
MN-52	Not Detected	-----	3.27E-02
MN-54	Not Detected	-----	3.41E-02
MO-99	Not Detected	-----	3.04E-01
NA-22	Not Detected	-----	4.10E-02
NA-24	Not Detected	-----	1.14E-01
NB-95	Not Detected	-----	2.02E-01
ND-147	Not Detected	-----	2.01E-01
NI-57	8.84E-02	6.98E-02	4.14E-02
PB-210	Not Detected	-----	1.03E+01
RU-103	Not Detected	-----	2.82E-02
RU-106	Not Detected	-----	2.64E-01
SB-122	Not Detected	-----	5.00E-02
SB-124	Not Detected	-----	2.93E-02
SB-125	Not Detected	-----	7.72E-02
SN-113	Not Detected	-----	3.62E-02
SR-85	Not Detected	-----	3.60E-02
TA-182	Not Detected	-----	1.44E-01
TA-183	Not Detected	-----	2.62E-01
TC-99m	Not Detected	-----	6.62E-01
TL-201	Not Detected	-----	1.63E-01
XE-133	Not Detected	-----	1.80E-01
Y-88	Not Detected	-----	2.47E-02
ZN-65	Not Detected	-----	9.83E-02
ZR-95	Not Detected	-----	5.49E-02

not detected 4/10/17

not detected 4/11

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-09-97 8:58:39 PM *

analyzed by: *J 4/10/97* Reviewed by: *K 4/10/97*

 Customer : P.SLAVIN/MAC (6682/SMO)
 Customer Sample ID : 032976-002
 Lab Sample ID : 70053006

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 659.000 gram
 Sample Date/Time : 4-08-97 3:40:00 PM
 Acquire Start Date/Time : 4-09-97 7:15:24 PM
 Detector Name : LAB03
 Elapsed Live/Real Time : 6000 / 6003 seconds

CY10-M4-S2

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	1.53E+00
TH-234	1.38E+00	3.98E-01	4.80E-01
RA-226	2.12E+00	8.13E-01	6.46E-01
PB-214	7.45E-01	1.49E-01	5.80E-02
BI-214	6.54E-01	1.41E-01	5.77E-02
TH-232	8.60E-01	4.30E-01	1.89E-01
228	7.59E-01	3.36E-01	2.23E-01
228	7.78E-01	2.57E-01	1.21E-01
228	2.12E-01	2.03E-01	4.02E-01
RA-224	Not Detected	-----	1.81E+00
PB-212	8.78E-01	1.51E-01	4.61E-02
BI-212	5.12E-01	1.82E-01	2.26E-01
TL-208	2.94E-01	7.10E-02	3.20E-02
U-235	Not Detected	-----	2.16E-01
TH-231	Not Detected	-----	8.58E+00
PA-231	Not Detected	-----	1.55E+00
TH-227	Not Detected	-----	4.15E-01
RA-223	Not Detected	-----	1.46E-01
RN-219	Not Detected	-----	4.76E-01
PB-211	Not Detected	-----	1.07E+00
TL-207	Not Detected	-----	1.91E+01
AM-241	Not Detected	-----	1.78E-01
PU-239	Not Detected	-----	3.90E+02
NP-237	5.78E-01	1.62E-01	2.09E-01
PA-233	Not Detected	-----	6.93E-02
TH-229	Not Detected	-----	2.11E-01

not detected J 4/10/97

[Summary Report] - Sample ID: : 70053006

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	5.16E-02
AG-110m	Not Detected	-----	6.25E-02
BA-133	Not Detected	-----	6.62E-02
BE-7	Not Detected	-----	3.20E-01
CD-109	Not Detected	-----	7.09E-01
CD-115	Not Detected	-----	1.12E-01
CE-139	Not Detected	-----	2.86E-02
CE-141	Not Detected	-----	4.87E-02
CE-144	Not Detected	-----	2.14E-01
CO-56	Not Detected	-----	4.44E-02
CO-57	Not Detected	-----	2.56E-02
CO-58	Not Detected	-----	4.53E-02
CO-60	Not Detected	-----	5.28E-02
CR-51	Not Detected	-----	2.76E-01
CS-134	Not Detected	-----	4.86E-02
CS-137	2.04E-01	6.93E-02	3.45E-02
EU-152	Not Detected	-----	7.70E-02
EU-154	Not Detected	-----	2.39E-01
EU-155	Not Detected	-----	1.23E-01
FE-59	Not Detected	-----	9.42E-02
GD-153	Not Detected	-----	8.63E-02
HG-203	Not Detected	-----	3.47E-02
I-131	Not Detected	-----	3.99E-02
IR-192	Not Detected	-----	3.25E-02
K-40	2.63E+01	3.98E+00	3.53E-01
MN-52	Not Detected	-----	4.78E-02
MN-54	Not Detected	-----	4.81E-02
MO-99	Not Detected	-----	4.21E-01
NA-22	Not Detected	-----	6.09E-02
NA-24	Not Detected	-----	1.57E-01
NB-95	Not Detected	-----	2.25E-01
ND-147	Not Detected	-----	2.70E-01
NI-57	Not Detected	-----	1.05E-01
PB-210	Not Detected	-----	5.16E+00
RU-103	Not Detected	-----	3.65E-02
RU-106	Not Detected	-----	4.00E-01
SB-122	Not Detected	-----	6.70E-02
SB-124	Not Detected	-----	3.64E-02
SB-125	Not Detected	-----	1.03E-01
SN-113	Not Detected	-----	4.76E-02
SR-85	Not Detected	-----	4.73E-02
TA-182	Not Detected	-----	2.12E-01
TA-183	Not Detected	-----	1.78E-01
TC-99m	Not Detected	-----	6.06E-01
TL-201	Not Detected	-----	1.26E-01
XE-133	Not Detected	-----	1.35E-01
Y-88	Not Detected	-----	3.53E-02
ZN-65	Not Detected	-----	1.42E-01
ZR-95	Not Detected	-----	7.66E-02

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-10-97 8:55:20 AM *

* Analyzed by: *[Signature]* 4/10/97 Reviewed by: *[Signature]* 4/16/97 *

Customer : P.SLAVIN/MAC (6682/SMO)
 Customer Sample ID : 032977-002
 Lab Sample ID : 70053007

Sample Description : MARINELLI FILLED WITH SOIL CY10-M4-S2-D
 Sample Quantity : 649.000 gram
 Sample Date/Time : 4-08-97 3:42:00 PM
 Acquire Start Date/Time : 4-10-97 7:12:38 AM
 Detector Name : LAB04
 Elapsed Live/Real Time : 6000 / 6004 seconds

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	2.08E+00
TH-234	1.27E+00	4.99E-01	4.91E-01
RA-226	1.32E+00	7.84E-01	5.80E-01
PB-214	7.35E-01	1.39E-01	4.74E-02
BI-214	7.05E-01	1.36E-01	4.56E-02
TH-232	7.80E-01	3.75E-01	1.54E-01
RA-228	7.92E-01	2.67E-01	1.73E-01
AC-228	7.50E-01	2.14E-01	9.41E-02
TH-228	8.79E-01	2.81E-01	5.21E-01
RA-224	3.15E-01	1.08E-01	2.94E-02
PB-212	8.60E-01	1.40E-01	4.23E-02
BI-212	5.10E-01	2.02E-01	1.87E-01
TL-208	2.81E-01	5.48E-02	2.43E-02
U-235	1.07E-01	1.85E-01	2.30E-01
TH-231	Not Detected	-----	1.02E+01
PA-231	Not Detected	-----	1.56E+00
TH-227	Not Detected	-----	3.71E-01
RA-223	Not Detected	-----	1.82E-01
RN-219	3.99E-01	3.33E-01	4.04E-01
PB-211	Not Detected	-----	8.81E-01
TL-207	Not Detected	-----	1.53E+01
AM-241	Not Detected	-----	2.57E-01
PU-239	Not Detected	-----	3.92E+02
NP-237	5.50E-01	1.54E-01	2.12E-01
PA-233	Not Detected	-----	6.54E-02
TH-229	Not Detected	-----	2.34E-01

not detected 4/10/97

not detected 4/10/97

[Summary Report] - Sample ID: : 70053007

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
-----	-----	-----	-----
AG-108m	Not Detected	-----	4.32E-02
AG-110m	Not Detected	-----	5.22E-02
BA-133	Not Detected	-----	6.87E-02
BE-7	Not Detected	-----	2.85E-01
CD-109	Not Detected	-----	7.19E-01
CD-115	Not Detected	-----	1.16E-01
CE-139	Not Detected	-----	2.86E-02
CE-141	Not Detected	-----	5.11E-02
CE-144	Not Detected	-----	2.14E-01
CO-56	Not Detected	-----	3.55E-02
CO-57	Not Detected	-----	2.76E-02
CO-58	Not Detected	-----	3.35E-02
CO-60	Not Detected	-----	4.14E-02
CR-51	Not Detected	-----	2.54E-01
CS-134	Not Detected	-----	5.14E-02
CS-137	2.49E-01	5.12E-02	2.35E-02
EU-152	Not Detected	-----	8.28E-02
EU-154	Not Detected	-----	1.99E-01
EU-155	Not Detected	-----	1.33E-01
FE-59	Not Detected	-----	8.44E-02
GD-153	Not Detected	-----	9.62E-02
HG-203	Not Detected	-----	3.36E-02
I-131	Not Detected	-----	3.52E-02
IR-192	Not Detected	-----	3.00E-02
K-40	2.96E+01	6.37E+00	2.92E-01
MN-52	Not Detected	-----	3.79E-02
MN-54	Not Detected	-----	3.65E-02
MO-99	Not Detected	-----	3.87E-01
NA-22	Not Detected	-----	4.65E-02
NA-24	Not Detected	-----	2.18E-01
NB-95	Not Detected	-----	2.34E-01
ND-147	Not Detected	-----	2.49E-01
NI-57	Not Detected	-----	1.12E-01
PB-210	Not Detected	-----	1.06E+01
RU-103	Not Detected	-----	3.29E-02
RU-106	Not Detected	-----	3.25E-01
SB-122	Not Detected	-----	6.65E-02
SB-124	Not Detected	-----	3.30E-02
SB-125	Not Detected	-----	8.88E-02
SN-113	Not Detected	-----	4.06E-02
SR-85	Not Detected	-----	4.01E-02
TA-182	Not Detected	-----	1.66E-01
TA-183	Not Detected	-----	2.73E-01
TC-99m	Not Detected	-----	2.49E+00
TL-201	Not Detected	-----	1.84E-01
XE-133	Not Detected	-----	2.11E-01
Y-88	Not Detected	-----	2.50E-02
ZN-65	Not Detected	-----	1.14E-01
ZR-95	Not Detected	-----	6.07E-02

ANALYSIS REQUEST AND CHAIN OF CUSTODY

PAGE 1 OF 3

Internal Lab

Batch No. 700549

AR/COC-06575

SF 2001-COC-06-29

Dept. No./Mail Stop: 6682/5 / 112-1147		Date Samples Shipped: 4/11/97		Contract No.: NA		Parameter & Method Requested															
Project/Task Manager: Paula Slavin		Carrier/Waybill No.: 112-1147		Case No.: 8821.201200																	
Project Name: Site 10 Cont. Sampling		Lab Contact: Fernando Dominguez		SMO Authorization: [Signature]		Gamma Spec															
Record Center Code: ER/1333/010/0AT		Lab Destination: RP5D Bldg 8B1		Bill to: Sandia National Laboratories																	
Logbook Ref No: 206		SMO Contact/Phone: Pam Puissant / 844-3125		Supplier Services Department		P.O. Box 5800 MS 0154 Albuquerque, NM 87185 0154															
Service Order No.: CF039A		Send Report to SMO: Paula Slavin / Craig Bma																			
Location		Tech Area		Reference LOV (available at SMO)																	
Building		Room																			
Sample No. - Fraction		ER Sample ID or Sample Location Detail		Beginning Depth in Ft.		ER Site No.		Date/Time Collected		Sample Matrix		Container		Preservative		Sample Collection Method		Sample Type		Lab Sample ID	
032983-002		CY10-M6-T1-B		1.0		10		4-9-97/1415		S		GP 500mL		None		Grab		SA		X	
032984-002		CY10-M6-T2-M		0.5				1418												X	
032985-002		CY10-M6-T2-B		1.0				1414													
032986-002		CY10-M6-T3-M		0.5				1409													
032987-002		CY10-M6-T3-B		1.0				1406		Water						EB		EB			
032991-002		CY10-RBC		NA				1355		S						Grab		SA			
032992-002		CY10-M7-T1-M		0.5				1443													
032993-002		CY10-M7-T1-B		1.0				1440													
032994-002		CY10-M7-T2-M		0.5				1448													
032994-002		CY10-M7-T2-B		1.0				1452													
RMMA <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No		Ref. No.		Sample Tracking		Date Entered (mm/dd/yy)		Entered by		Special Instructions/QC Requirements		Abnormal Conditions on Receipt									
Sample Disposal <input checked="" type="checkbox"/> Return to Client <input type="checkbox"/> Disposal by lab		Turnaround Time <input checked="" type="checkbox"/> Normal <input type="checkbox"/> Rush		Required Report Date 4-20-97																	
Sample Team Members		Name		Signature		Init		Company/Organization/Phone													
		Paula Slavin		[Signature]		PS		GRAM/6682/204-2496													
		Concetta Cacciatore		[Signature]		CC		Lambert/6682/204-5173													
		Michael M. McIsaac		[Signature]		MM		BRE/6682/204-2575													
1. Relinquished by [Signature]		Org. 6682		Date 4-10-97		Time 1545		4. Relinquished by		Org.		Date									
1. Received by [Signature]		Org. 6682		Date 4/10/97		Time 1546		4. Received by		Org.		Date									
2. Relinquished by [Signature]		Org. 6682		Date 4/11/97		Time 1456		5. Relinquished by		Org.		Date									
2. Received by [Signature]		Org. SUL 7578		Date 4/11/97		Time 1456		5. Received by		Org.		Date									
3. Relinquished by [Signature]		Org. SUL 7578		Date 4/17/97		Time 1455		6. Relinquished by		Org.		Date									
3. Received by [Signature]		Org. [Signature]		Date 4/17/97		Time 1455		6. Received by		Org.		Date									

WHITE - To Accompany Samples, Laboratory Copy

BLUE - To Accompany Samples, Return to SMO

YELLOW - SMO Suspense Copy

PINK - Field Copy

ANALYSIS REQUEST AND CHAIN OF CUSTODY CONTINUATION FORM

PAGE 2 OF 3

AR/COC- 06575

SF 3001-COD (12-98)
Supersedes (10-94) form

BATCH #700549

Project Name: Site 10 Cont Smp Project/Task Manager: Paula Glavin Case No.: 8821-201200

Location		Tech Area		Beginning Depth in Ft.	ER Site No.	Date/Time Collected	Reference LOV (available at SMO)						Lab Sample ID
Building		Room					Sample Matrix	Container		Preser- vative	Sample Collection Method	Sample Type	
Sample No. - Fraction		ER Sample ID or Sample Location Detail						Type	Volume				
✓	032995-002	CY10-M7-T2-B	1.0	10	4-1-97 1452	S	P	500ml	None	Grab	SA	X	
✓	032996-002	CY10-M7-T3-M	0.5		1435								
✓	032997-002	CY10-M7-T3-B	1.0		1445								
✓	032998-002	CY10-M8-T1-M	0.5		4-10-97 1020								
✓	032999-002	CY10-M8-T1-B	1.0		1030								
✓	033000-002	CY10-RBD	NA		1410	Water					EB		
✓	034311-002	CY10-M9-T1-B	1.0		4-10-97 1050	S					SA		
✓	034312-002	CY10-M9-T1-M	0.5		1100								
✓	034313-002	CY10-M9-T2-B	1.0		1110								
✓	034314-002	CY10-M9-T3-M	0.5		1120								
✓	034315-002	CY10-M9-T3-B	1.0		1130								
✓	034316-002	CY10-RBE	NA		1435 1430	Water					EB		
✓	034317-002	CY10-M10-T1-M	0.5		1142	S					SA		
✓	034318-002	CY10-M10-T2-M	0.5		1148								
✓	034321-002	CY10-M10-T2-B	1.0		1152								
✓	034322-002	CY10-M10-T3-M	0.5		1158								
✓	034323-002	CY10-M10-T3-B	1.0		1202								
✓	032972-002	CY10-M3-S4	0.5		1430								

WHITE - To Accompany Samples, Laboratory Copy BLUE - To Accompany Samples, Return to SMO YELLOW - SMO Suspense Copy PINK - Field Copy

PAGE 3 OF 3

AR/COC- 06575

F 2001-COD (12-96)
upgrades (10-94) leave

BATCH # 700549

Project Name: Site 10 Conf. Supp Project/Task Manager: Paula Slavin Case No.: 8821.201200

[illegible]

**WHITE - To Accompany Samples,
Laboratory Copy**

**BLUE- To Accompany Samples,
Return to SMO**

YELLOW- SMO Suspense Copy

PINK- Field Copy

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-11-97 8:22:00 PM *

 * Analyzed by: *[Signature]* 4/14/97. Reviewed by: *[Signature]* 4/14/97 *

Customer : P.SLAVIN/S.YOUNG (6682)
 Customer Sample ID : 032983-002
 Lab Sample ID : 70054901

Sample Description : MARINELLI SOIL SAMPLE
 Sample Quantity : 684.000 gram
 Sample Date/Time : 4-09-97 2:15:00 PM
 Acquire Start Date/Time : 4-11-97 6:39:25 PM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6002 seconds

CY10-M6-71-B

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	1.78E+00
TH-234	1.06E+00	3.69E-01	5.39E-01
RA-226	1.85E+00	5.76E-01	6.04E-01
PB-214	7.65E-01	1.38E-01	5.55E-02
BI-214	6.54E-01	1.44E-01	6.31E-02
TH-232	9.79E-01	4.69E-01	1.83E-01
RA-228	8.15E-01	3.59E-01	2.18E-01
AC-228	9.49E-01	2.69E-01	1.19E-01
TH-228	5.65E-01	4.78E-01	5.25E-01
RA-224	8.53E-01	3.04E-01	1.19E-01
PB-212	9.49E-01	1.62E-01	4.30E-02
BI-212	6.72E-01	3.85E-01	2.41E-01
TL-208	7.63E-01	1.77E-01	8.51E-02
U-235	Not Detected	-----	2.37E-01
TH-231	Not Detected	-----	9.89E+00
PA-231	Not Detected	-----	1.68E+00
TH-227	Not Detected	-----	4.25E-01
RA-223	Not Detected	-----	1.79E-01
RN-219	Not Detected	-----	4.66E-01
PB-211	Not Detected	-----	1.02E+00
TL-207	Not Detected	-----	1.94E+01
AM-241	Not Detected	-----	2.12E-01
PU-239	Not Detected	-----	4.07E+02
NP-237	Not Detected	-----	2.53E-01
PA-233	Not Detected	-----	6.60E-02
TH-229	Not Detected	-----	2.32E-01

[Summary Report] - Sample ID: : 70054901

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	5.53E-02
AG-110m	Not Detected	-----	3.78E-02
BA-133	Not Detected	-----	6.48E-02
BE-7	Not Detected	-----	3.10E-01
CD-109	1.79E+00	6.18E-01	8.60E-01
CD-115	Not Detected	-----	1.57E-01
CE-139	Not Detected	-----	3.05E-02
CE-141	Not Detected	-----	5.47E-02
CE-144	Not Detected	-----	2.20E-01
CO-56	Not Detected	-----	4.71E-02
CO-57	Not Detected	-----	2.82E-02
CO-58	Not Detected	-----	4.39E-02
CO-60	Not Detected	-----	5.45E-02
CR-51	Not Detected	-----	2.84E-01
CS-134	Not Detected	-----	5.15E-02
CS-137	Not Detected	-----	4.34E-02
EU-152	Not Detected	-----	8.41E-02
EU-154	Not Detected	-----	2.55E-01
EU-155	Not Detected	-----	1.28E-01
FE-59	Not Detected	-----	1.04E-01
GD-153	Not Detected	-----	9.32E-02
HG-203	Not Detected	-----	3.70E-02
I-131	Not Detected	-----	4.08E-02
IR-192	Not Detected	-----	3.19E-02
K-40	2.44E+01	3.67E+00	3.37E-01
MN-52	Not Detected	-----	5.40E-02
MN-54	Not Detected	-----	4.61E-02
MO-99	Not Detected	-----	5.50E-01
NA-22	Not Detected	-----	6.23E-02
NA-24	Not Detected	-----	5.11E-01
NB-95	Not Detected	-----	2.70E-01
ND-147	Not Detected	-----	2.76E-01
NI-57	Not Detected	-----	1.79E-01
PB-210	Not Detected	-----	8.66E+00
RU-103	Not Detected	-----	3.67E-02
RU-106	Not Detected	-----	3.61E-01
SB-122	Not Detected	-----	7.97E-02
SB-124	Not Detected	-----	3.77E-02
SB-125	Not Detected	-----	1.02E-01
SN-113	Not Detected	-----	4.42E-02
SR-85	Not Detected	-----	4.60E-02
TA-182	Not Detected	-----	2.01E-01
TA-183	Not Detected	-----	2.43E-01
TC-99m	Not Detected	-----	1.15E+01
TL-201	Not Detected	-----	2.02E-01
XE-133	Not Detected	-----	2.17E-01
Y-88	Not Detected	-----	3.49E-02
ZN-65	Not Detected	-----	1.37E-01
ZR-95	Not Detected	-----	7.85E-02

Not Detected 4/14/77

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-12-97 12:19:42 PM *

* Analyzed by: *[Signature]* 4/14/97 Reviewed by: *[Signature]* 4/14/97 *

Customer : P.SLAVIN/S.YOUNG (6682)
 Customer Sample ID : 032984-002
 Lab Sample ID : 70054902

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 753.000 gram
 Sample Date/Time : 4-09-97 2:18:00 PM
 Acquire Start Date/Time : 4-12-97 10:36:55 AM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6003 seconds

CY10-M6-T2M

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	1.55E+00	1.08E+00	1.49E+00
TH-234	2.24E+00	5.90E-01	5.74E-01
RA-226	6.91E-01	8.26E-01	6.55E-01
PB-214	8.68E-01	1.50E-01	5.51E-02
BI-214	8.25E-01	2.06E-01	6.26E-02
TH-232	9.86E-01	4.85E-01	1.72E-01
RA-228	9.94E-01	3.55E-01	2.20E-01
AC-228	1.03E+00	1.85E-01	1.18E-01
TH-228	7.84E-01	3.93E-01	5.37E-01
RA-224	1.13E+00	3.67E-01	8.55E-02
PB-212	1.13E+00	1.82E-01	4.45E-02
BI-212	7.78E-01	3.10E-01	2.36E-01
TL-208	1.05E+00	2.25E-01	8.52E-02
U-235	8.94E-02	9.61E-02	1.54E-01
TH-231	Not Detected	-----	1.03E+01
PA-231	Not Detected	-----	1.67E+00
TH-227	Not Detected	-----	4.46E-01
RA-223	Not Detected	-----	1.95E-01
RN-219	Not Detected	-----	4.90E-01
PB-211	Not Detected	-----	1.09E+00
TL-207	Not Detected	-----	1.81E+01
AM-241	Not Detected	-----	2.19E-01
PU-239	Not Detected	-----	4.19E+02
NP-237	7.86E-01	1.88E-01	2.33E-01
PA-233	Not Detected	-----	6.87E-02
TH-229	Not Detected	-----	2.40E-01

not detected *[Signature]* 4/14/97

[Summary Report] - Sample ID: : 70054902

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	5.51E-02
AG-110m	Not Detected	-----	4.33E-02
BA-133	Not Detected	-----	6.41E-02
BE-7	Not Detected	-----	3.02E-01
CD-109	Not Detected	-----	1.15E+00
CD-115	Not Detected	-----	1.92E-01
CE-139	Not Detected	-----	3.09E-02
CE-141	Not Detected	-----	5.60E-02
CE-144	Not Detected	-----	2.23E-01
CO-56	Not Detected	-----	3.13E-02
CO-57	Not Detected	-----	2.87E-02
CO-58	Not Detected	-----	4.29E-02
CO-60	Not Detected	-----	5.15E-02
CR-51	Not Detected	-----	2.89E-01
CS-134	Not Detected	-----	5.18E-02
CS-137	3.74E-02	5.17E-02	2.71E-02
EU-152	Not Detected	-----	8.57E-02
EU-154	Not Detected	-----	2.55E-01
EU-155	Not Detected	-----	1.34E-01
FE-59	Not Detected	-----	1.09E-01
GD-153	Not Detected	-----	9.77E-02
HG-203	Not Detected	-----	3.81E-02
I-131	Not Detected	-----	4.40E-02
IR-192	Not Detected	-----	3.28E-02
K-40	2.67E+01	3.96E+00	2.71E-01
MN-52	Not Detected	-----	6.08E-02
MN-54	Not Detected	-----	4.81E-02
MO-99	Not Detected	-----	6.78E-01
NA-22	Not Detected	-----	5.66E-02
NA-24	Not Detected	-----	1.02E+00
NB-95	Not Detected	-----	3.22E-01
ND-147	Not Detected	-----	2.92E-01
NI-57	Not Detected	-----	2.35E-01
PB-210	Not Detected	-----	9.41E+00
RU-103	Not Detected	-----	3.81E-02
RU-106	Not Detected	-----	3.53E-01
SB-122	Not Detected	-----	1.05E-01
SB-124	Not Detected	-----	3.71E-02
SB-125	Not Detected	-----	1.06E-01
SN-113	Not Detected	-----	4.55E-02
SR-85	Not Detected	-----	4.70E-02
TA-182	Not Detected	-----	2.17E-01
TA-183	Not Detected	-----	2.74E-01
TC-99m	Not Detected	-----	7.50E+01
TL-201	Not Detected	-----	2.34E-01
XE-133	Not Detected	-----	2.75E-01
Y-88	Not Detected	-----	3.59E-02
ZN-65	Not Detected	-----	1.46E-01
ZR-95	Not Detected	-----	7.71E-02

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-12-97 2:05:14 PM *

 * Analyzed by: *[Signature]* 4/14/97 Reviewed by: *[Signature]* 4/14/97 *

Customer : P.SLAVIN/S.YOUNG (6682)
 Customer Sample ID : 032985-002
 Lab Sample ID : 70054903

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 628.000 gram
 Sample Date/Time : 4-09-97 2:14:00 PM
 Acquire Start Date/Time : 4-12-97 12:22:39 PM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6002 seconds

CY10-M6-T2-B

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	1.79E+00
TH-234	Not Detected	-----	7.12E-01
RA-226	1.70E+00	6.05E-01	6.20E-01
PB-214	6.75E-01	1.45E-01	5.70E-02
BI-214	7.04E-01	3.08E-01	6.68E-02
TH-232	8.30E-01	9.92E-01	1.77E-01
RA-228	8.28E-01	2.57E-01	2.18E-01
AC-228	9.24E-01	2.35E-01	1.14E-01
TH-228	6.22E-01	5.06E-01	5.12E-01
RA-224	8.93E-01	3.30E-01	8.16E-02
PB-212	8.85E-01	2.11E-01	4.36E-02
BI-212	4.20E-01	2.27E-01	2.45E-01
TL-208	7.70E-01	1.41E+00	7.92E-02
U-235	Not Detected	-----	2.39E-01
TH-231	Not Detected	-----	1.02E+01
PA-231	Not Detected	-----	1.66E+00
TH-227	Not Detected	-----	4.32E-01
RA-223	Not Detected	-----	1.92E-01
RN-219	Not Detected	-----	4.79E-01
PB-211	Not Detected	-----	1.05E+00
TL-207	Not Detected	-----	1.86E+01
AM-241	Not Detected	-----	2.25E-01
PU-239	Not Detected	-----	4.11E+02
NP-237	3.46E-01	4.52E-01	2.34E-01
PA-233	Not Detected	-----	6.74E-02
TH-229	Not Detected	-----	2.27E-01

not detected *[Signature]* 4/14/97

[Summary Report] - Sample ID: : 70054903

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	5.24E-02
AG-110m	Not Detected	-----	3.87E-02
BA-133	Not Detected	-----	6.23E-02
BE-7	Not Detected	-----	2.95E-01
CD-109	Not Detected	-----	1.12E+00
CD-115	Not Detected	-----	1.91E-01
CE-139	Not Detected	-----	3.05E-02
CE-141	Not Detected	-----	5.64E-02
CE-144	Not Detected	-----	2.23E-01
CO-56	Not Detected	-----	3.76E-02
CO-57	Not Detected	-----	2.82E-02
CO-58	Not Detected	-----	4.14E-02
CO-60	Not Detected	-----	4.80E-02
CR-51	Not Detected	-----	2.87E-01
CS-134	Not Detected	-----	5.50E-02
CS-137	Not Detected	-----	4.41E-02
EU-152	Not Detected	-----	8.32E-02
EU-154	Not Detected	-----	2.46E-01
EU-155	Not Detected	-----	1.30E-01
FE-59	Not Detected	-----	1.02E-01
GD-153	Not Detected	-----	9.45E-02
HG-203	Not Detected	-----	3.62E-02
I-131	Not Detected	-----	4.51E-02
IR-192	Not Detected	-----	3.33E-02
K-40	1.83E+01	2.85E+00	3.35E-01
MN-52	Not Detected	-----	6.20E-02
MN-54	Not Detected	-----	4.64E-02
MO-99	Not Detected	-----	6.47E-01
NA-22	Not Detected	-----	5.55E-02
NA-24	Not Detected	-----	1.09E+00
NB-95	5.25E-02	5.11E-02	1.31E-01
ND-147	Not Detected	-----	2.98E-01
NI-57	Not Detected	-----	2.43E-01
PB-210	Not Detected	-----	9.01E+00
RU-103	Not Detected	-----	3.68E-02
RU-106	Not Detected	-----	3.52E-01
SB-122	Not Detected	-----	1.03E-01
SB-124	Not Detected	-----	3.91E-02
SB-125	Not Detected	-----	1.00E-01
SN-113	Not Detected	-----	4.65E-02
SR-85	Not Detected	-----	4.71E-02
TA-182	Not Detected	-----	2.05E-01
TA-183	Not Detected	-----	2.84E-01
TC-99m	Not Detected	-----	9.21E+01
TL-201	Not Detected	-----	2.35E-01
XE-133	Not Detected	-----	2.78E-01
Y-88	Not Detected	-----	3.35E-02
ZN-65	Not Detected	-----	1.42E-01
ZR-95	Not Detected	-----	7.48E-02

not detected 7

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-12-97 3:50:48 PM *

 * Analyzed by: *[Signature]* 4/14/97 Reviewed by: *[Signature]* 4/14/97 *

Customer : P.SLAVIN/S.YOUNG (6682)
 Customer Sample ID : 032986-002
 Lab Sample ID : 70054904

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 728.000 gram
 Sample Date/Time : 4-09-97 2:09:00 PM
 Acquire Start Date/Time : 4-12-97 2:08:03 PM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6003 seconds

CY10-M6-T3-M

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	1.11E+00	1.74E+00	1.56E+00
TH-234	1.70E+00	5.70E-01	5.77E-01
RA-226	6.69E-01	7.03E-01	6.56E-01
PB-214	1.02E+00	1.90E-01	5.92E-02
BI-214	9.36E-01	1.82E-01	6.28E-02
TH-232	1.29E+00	6.08E-01	1.79E-01
RA-228	1.32E+00	4.46E-01	2.28E-01
AC-228	1.20E+00	2.77E-01	1.15E-01
TH-228	9.60E-01	9.54E-01	5.73E-01
RA-224	1.23E+00	4.56E-01	1.01E-01
PB-212	1.32E+00	2.16E-01	4.77E-02
BI-212	9.11E-01	2.96E-01	2.09E-01
TL-208	1.21E+00	2.25E-01	9.05E-02
U-235	1.20E-01	9.15E-02	1.57E-01
TH-231	Not Detected	-----	1.09E+01
PA-231	Not Detected	-----	1.72E+00
TH-227	Not Detected	-----	4.77E-01
RA-223	Not Detected	-----	2.04E-01
RN-219	Not Detected	-----	4.82E-01
PB-211	Not Detected	-----	1.10E+00
TL-207	Not Detected	-----	1.95E+01
AM-241	Not Detected	-----	2.31E-01
PU-239	Not Detected	-----	4.38E+02
NP-237	Not Detected	-----	3.59E-01
PA-233	Not Detected	-----	7.34E-02
TH-229	Not Detected	-----	2.45E-01

[Summary Report] - Sample ID: : 70054904

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	5.72E-02
AG-110m	Not Detected	-----	4.34E-02
BA-133	Not Detected	-----	6.88E-02
BE-7	Not Detected	-----	3.20E-01
CD-109	2.43E+00	6.80E-01	9.57E-01
CD-115	Not Detected	-----	2.16E-01
CE-139	Not Detected	-----	3.23E-02
CE-141	Not Detected	-----	5.91E-02
CE-144	Not Detected	-----	2.37E-01
CO-56	Not Detected	-----	4.64E-02
CO-57	Not Detected	-----	2.99E-02
CO-58	Not Detected	-----	4.58E-02
CO-60	Not Detected	-----	5.04E-02
CR-51	Not Detected	-----	3.00E-01
CS-134	Not Detected	-----	5.53E-02
CS-137	3.16E-02	1.68E-02	2.40E-02
EU-152	Not Detected	-----	8.93E-02
EU-154	Not Detected	-----	2.65E-01
EU-155	Not Detected	-----	1.41E-01
FE-59	Not Detected	-----	1.09E-01
GD-153	Not Detected	-----	9.92E-02
HG-203	Not Detected	-----	3.93E-02
I-131	Not Detected	-----	4.64E-02
IR-192	Not Detected	-----	3.41E-02
K-40	2.39E+01	3.59E+00	3.10E-01
MN-52	Not Detected	-----	6.54E-02
MN-54	Not Detected	-----	4.86E-02
MO-99	Not Detected	-----	7.00E-01
NA-22	Not Detected	-----	5.81E-02
NA-24	Not Detected	-----	1.20E+00
NB-95	Not Detected	-----	3.55E-01
ND-147	Not Detected	-----	3.13E-01
NI-57	Not Detected	-----	2.74E-01
PB-210	Not Detected	-----	9.45E+00
RU-103	Not Detected	-----	3.80E-02
RU-106	Not Detected	-----	3.72E-01
SB-122	Not Detected	-----	1.14E-01
SB-124	Not Detected	-----	4.06E-02
SB-125	Not Detected	-----	1.09E-01
SN-113	Not Detected	-----	4.72E-02
SR-85	Not Detected	-----	4.98E-02
TA-182	Not Detected	-----	2.15E-01
TA-183	Not Detected	-----	2.95E-01
TC-99m	Not Detected	-----	1.21E+02
TL-201	Not Detected	-----	2.62E-01
XE-133	Not Detected	-----	3.04E-01
Y-88	Not Detected	-----	3.53E-02
ZN-65	Not Detected	-----	1.47E-01
ZR-95	Not Detected	-----	7.72E-02

not detected 7/14/97

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-12-97 5:36:00 PM *

 *
 * Analyzed by: *[Signature]* 4/14/97 Reviewed by: *[Signature]* 4/14/97 *

 Customer : P.SLAVIN/S.YOUNG (6682)
 Customer Sample ID : 032987-002
 Lab Sample ID : 70054905

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 854.000 gram
 Sample Date/Time : 4-09-97 2:06:00 PM
 Acquire Start Date/Time : 4-12-97 3:53:19 PM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6003 seconds

CY10-M6-73-B

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	1.46E+00	9.83E-01	1.41E+00
TH-234	1.49E+00	4.17E-01	4.99E-01
RA-226	Not Detected	-----	5.50E-01
PB-214	7.83E-01	2.09E-01	4.85E-02
BI-214	7.06E-01	1.43E-01	5.70E-02
TH-232	8.80E-01	4.34E-01	1.60E-01
RA-228	9.31E-01	3.31E-01	2.01E-01
AC-228	9.90E-01	1.13E+00	1.15E-01
TH-228	9.09E-01	4.38E-01	5.12E-01
RA-224	1.01E+00	3.71E-01	9.37E-02
PB-212	9.80E-01	1.70E-01	4.24E-02
BI-212	6.74E-01	3.59E-01	2.39E-01
TL-208	Not Detected	-----	7.67E-02
U-235	Not Detected	-----	1.01E-01
TH-231	Not Detected	-----	9.21E+00
PA-231	Not Detected	-----	1.47E+00
TH-227	Not Detected	-----	3.90E-01
RA-223	Not Detected	-----	1.77E-01
RN-219	Not Detected	-----	4.29E-01
PB-211	Not Detected	-----	9.61E-01
TL-207	Not Detected	-----	1.68E+01
AM-241	Not Detected	-----	1.97E-01
PU-239	Not Detected	-----	3.67E+02
NP-237	Not Detected	-----	3.06E-01
PA-233	Not Detected	-----	6.08E-02
TH-229	Not Detected	-----	2.12E-01

[Summary Report] - Sample ID: : 70054905

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.74E-02
AG-110m	Not Detected	-----	3.48E-02
BA-133	Not Detected	-----	5.78E-02
BE-7	Not Detected	-----	2.89E-01
CD-109	2.03E+00	5.54E-01	7.24E-01
CD-115	Not Detected	-----	1.81E-01
CE-139	Not Detected	-----	2.82E-02
CE-141	Not Detected	-----	5.14E-02
CE-144	Not Detected	-----	1.98E-01
CO-56	Not Detected	-----	4.19E-02
CO-57	Not Detected	-----	2.61E-02
CO-58	Not Detected	-----	4.12E-02
CO-60	Not Detected	-----	4.50E-02
CR-51	Not Detected	-----	2.59E-01
CS-134	Not Detected	-----	4.73E-02
CS-137	Not Detected	-----	4.05E-02
EU-152	Not Detected	-----	7.73E-02
EU-154	Not Detected	-----	2.20E-01
EU-155	Not Detected	-----	1.22E-01
FE-59	Not Detected	-----	1.00E-01
GD-153	Not Detected	-----	8.63E-02
HG-203	Not Detected	-----	3.46E-02
I-131	Not Detected	-----	3.97E-02
IR-192	Not Detected	-----	2.94E-02
K-40	2.56E+01	3.77E+00	2.73E-01
MN-52	Not Detected	-----	5.26E-02
MN-54	1.91E-02	1.91E-02	2.37E-02
MO-99	Not Detected	-----	5.97E-01
NA-22	Not Detected	-----	5.39E-02
NA-24	Not Detected	-----	1.24E+00
NB-95	Not Detected	-----	2.94E-01
ND-147	Not Detected	-----	2.80E-01
NI-57	Not Detected	-----	2.29E-01
PB-210	Not Detected	-----	8.07E+00
RU-103	Not Detected	-----	3.38E-02
RU-106	Not Detected	-----	3.24E-01
SB-122	Not Detected	-----	9.92E-02
SB-124	Not Detected	-----	3.56E-02
SB-125	Not Detected	-----	9.39E-02
SN-113	Not Detected	-----	4.07E-02
SR-85	Not Detected	-----	4.25E-02
TA-182	Not Detected	-----	1.90E-01
TA-183	Not Detected	-----	2.54E-01
TC-99m	Not Detected	-----	1.30E+02
TL-201	Not Detected	-----	2.28E-01
XE-133	Not Detected	-----	2.63E-01
Y-88	Not Detected	-----	3.08E-02
ZN-65	Not Detected	-----	1.30E-01
ZR-95	Not Detected	-----	7.15E-02

not detected 7/14/57

not detected 7/14/5

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-12-97 7:20:19 PM *

* Analyzed by: *J* 4/14/97 Reviewed by: *W* 4/14/97 *

Customer : P.SLAVIN/S.YOUNG (6682)
 Customer Sample ID : 032991-002
 Lab Sample ID : 70054906

Sample Description : MARINELLI LIQUID SAMPLE
 Sample Quantity : 450.000 mL
 Sample Date/Time : 4-09-97 1:55:00 PM
 Acquire Start Date/Time : 4-12-97 5:38:26 PM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6001 seconds

CY10-RSC

Comments:

Nuclide Name	Activity (pCi/mL)	2-sigma Error	MDA (pCi/mL)
U-238	Not Detected	-----	9.68E-01
TH-234	Not Detected	-----	3.65E-01
RA-226	Not Detected	-----	5.34E-01
PB-214	4.77E-02	6.05E-02	4.92E-02
BI-214	Not Detected	-----	8.00E-02
TH-232	Not Detected	-----	1.79E-01
RA-228	Not Detected	-----	1.81E-01
AC-228	Not Detected	-----	1.02E-01
TH-228	Not Detected	-----	5.40E-01
RA-224	Not Detected	-----	1.68E-01
PB-212	8.82E-03	1.69E-02	2.76E-02
BI-212	Not Detected	-----	2.36E-01
TL-208	Not Detected	-----	8.08E-02
U-235	Not Detected	-----	1.53E-01
TH-231	Not Detected	-----	5.32E+00
PA-231	Not Detected	-----	1.19E+00
TH-227	Not Detected	-----	1.75E-01
RA-223	Not Detected	-----	9.98E-02
RN-219	Not Detected	-----	3.34E-01
PB-211	Not Detected	-----	7.05E-01
TL-207	Not Detected	-----	1.25E+01
AM-241	Not Detected	-----	1.11E-01
PU-239	Not Detected	-----	2.41E+02
NP-237	Not Detected	-----	1.64E-01
PA-233	Not Detected	-----	4.64E-02
TH-229	Not Detected	-----	1.30E-01

[Summary Report] - Sample ID: : 70054906

Nuclide Name	Activity (pCi/mL)	2-sigma Error	MDA (pCi/mL)
AG-108m	Not Detected	-----	2.96E-02
AG-110m	Not Detected	-----	2.68E-02
BA-133	Not Detected	-----	3.72E-02
BE-7	Not Detected	-----	2.26E-01
CD-109	Not Detected	-----	5.41E-01
CD-115	Not Detected	-----	1.20E-01
CE-139	Not Detected	-----	2.01E-02
CE-141	Not Detected	-----	3.46E-02
CE-144	Not Detected	-----	1.35E-01
CO-56	Not Detected	-----	4.04E-02
CO-57	Not Detected	-----	1.85E-02
CO-58	Not Detected	-----	2.78E-02
CO-60	Not Detected	-----	3.15E-02
CR-51	Not Detected	-----	2.18E-01
CS-134	Not Detected	-----	3.41E-02
CS-137	Not Detected	-----	3.15E-02
EU-152	Not Detected	-----	5.55E-02
EU-154	Not Detected	-----	1.37E-01
EU-155	Not Detected	-----	7.32E-02
FE-59	Not Detected	-----	6.41E-02
GD-153	Not Detected	-----	5.66E-02
HG-203	Not Detected	-----	2.62E-02
I-131	Not Detected	-----	3.53E-02
IR-192	Not Detected	-----	2.40E-02
K-40	Not Detected	-----	4.28E-01
MN-52	Not Detected	-----	4.89E-02
MN-54	Not Detected	-----	3.17E-02
MO-99	Not Detected	-----	4.95E-01
NA-22	Not Detected	-----	3.38E-02
NA-24	Not Detected	-----	1.26E+00
NB-95	Not Detected	-----	1.47E-01
ND-147	Not Detected	-----	2.16E-01
NI-57	Not Detected	-----	2.18E-01
PB-210	Not Detected	-----	4.32E+00
RU-103	Not Detected	-----	2.98E-02
RU-106	Not Detected	-----	2.77E-01
SB-122	Not Detected	-----	7.54E-02
SB-124	Not Detected	-----	3.08E-02
SB-125	Not Detected	-----	7.86E-02
SN-113	Not Detected	-----	3.36E-02
SR-85	Not Detected	-----	3.93E-02
TA-182	Not Detected	-----	1.01E-01
TA-183	Not Detected	-----	1.45E-01
TC-99m	Not Detected	-----	1.21E+02
TL-201	Not Detected	-----	1.28E-01
XE-133	Not Detected	-----	1.61E-01
Y-88	Not Detected	-----	3.34E-02
ZN-65	Not Detected	-----	6.87E-02
ZR-95	Not Detected	-----	5.42E-02

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-12-97 9:05:20 PM *

 * Analyzed by: *J 4/14/97* Reviewed by: *W 4/14/97* *

 Customer : P.SLAVIN/S.YOUNG (6682)
 Customer Sample ID : 032992-002
 Lab Sample ID : 70054907

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 709.000 gram
 Sample Date/Time : 4-09-97 2:43:00 PM
 Acquire Start Date/Time : 4-12-97 7:22:38 PM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6003 seconds

CY10-M7-T1-M

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	1.97E+00
TH-234	1.63E+00	4.71E-01	5.81E-01
RA-226	2.02E+00	8.59E-01	7.18E-01
PB-214	1.11E+00	1.94E-01	6.46E-02
BI-214	9.15E-01	1.72E-01	6.18E-02
TH-232	1.46E+00	7.25E-01	2.02E-01
RA-228	1.36E+00	3.63E-01	2.19E-01
AC-228	1.37E+00	1.46E+00	1.29E-01
TH-228	1.31E+00	8.29E-01	5.73E-01
RA-224	1.60E+00	5.13E-01	9.36E-02
PB-212	1.39E+00	2.22E-01	4.75E-02
BI-212	8.89E-01	3.12E-01	2.60E-01
TL-208	1.39E+00	3.15E-01	9.18E-02
U-235	Not Detected	-----	2.71E-01
TH-231	Not Detected	-----	1.12E+01
PA-231	Not Detected	-----	1.79E+00
TH-227	Not Detected	-----	4.96E-01
RA-223	Not Detected	-----	2.15E-01
RN-219	Not Detected	-----	5.36E-01
PB-211	Not Detected	-----	1.19E+00
TL-207	Not Detected	-----	1.94E+01
AM-241	Not Detected	-----	2.43E-01
PU-239	Not Detected	-----	4.67E+02
NP-237	6.66E-01	2.61E-01	2.63E-01
PA-233	Not Detected	-----	7.39E-02
TH-229	Not Detected	-----	2.52E-01

not detected J 4/14/97

[Summary Report] - Sample ID: : 70054907

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	6.13E-02
AG-110m	Not Detected	-----	6.48E-02
BA-133	Not Detected	-----	7.31E-02
BE-7	Not Detected	-----	3.56E-01
CD-109	Not Detected	-----	8.95E-01
CD-115	Not Detected	-----	2.46E-01
CE-139	Not Detected	-----	3.38E-02
CE-141	Not Detected	-----	6.20E-02
CE-144	Not Detected	-----	2.49E-01
CO-56	Not Detected	-----	4.80E-02
CO-57	Not Detected	-----	3.16E-02
CO-58	Not Detected	-----	4.48E-02
CO-60	Not Detected	-----	4.37E-02
CR-51	Not Detected	-----	3.11E-01
CS-134	Not Detected	-----	5.63E-02
CS-137	2.99E-01	4.12E-01	3.21E-02
EU-152	Not Detected	-----	9.35E-02
EU-154	Not Detected	-----	2.85E-01
EU-155	Not Detected	-----	1.47E-01
FE-59	Not Detected	-----	1.06E-01
GD-153	Not Detected	-----	1.03E-01
HG-203	Not Detected	-----	4.17E-02
I-131	Not Detected	-----	4.91E-02
IR-192	Not Detected	-----	3.59E-02
K-40	2.35E+01	3.55E+00	3.50E-01
MN-52	Not Detected	-----	7.21E-02
MN-54	3.00E-02	3.72E-02	2.77E-02
MO-99	Not Detected	-----	7.47E-01
NA-22	Not Detected	-----	5.80E-02
NA-24	Not Detected	-----	1.57E+00
NB-95	Not Detected	-----	3.81E-01
ND-147	Not Detected	-----	3.36E-01
NI-57	Not Detected	-----	3.15E-01
PB-210	Not Detected	-----	9.95E+00
RU-103	Not Detected	-----	4.07E-02
RU-106	Not Detected	-----	3.98E-01
SB-122	Not Detected	-----	1.26E-01
SB-124	Not Detected	-----	4.26E-02
SB-125	Not Detected	-----	1.11E-01
SN-113	Not Detected	-----	5.27E-02
SR-85	Not Detected	-----	5.27E-02
TA-182	Not Detected	-----	2.23E-01
TA-183	Not Detected	-----	3.18E-01
TC-99m	Not Detected	-----	2.21E+02
TL-201	Not Detected	-----	2.84E-01
XE-133	Not Detected	-----	3.37E-01
Y-88	Not Detected	-----	3.63E-02
ZN-65	Not Detected	-----	1.54E-01
ZR-95	Not Detected	-----	8.13E-02

not detected 2/4/8/57

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-13-97 3:35:50 PM *

 * Analyzed by: *J* 4/14/97 Reviewed by: *W* 4/14/97 *

Customer : P.SLAVIN/S.YOUNG (6682)
 Customer Sample ID : 032993-002
 Lab Sample ID : 70054908

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 728.000 gram
 Sample Date/Time : 4-09-97 2:40:00 PM
 Acquire Start Date/Time : 4-13-97 1:53:07 PM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6003 seconds

CY10-M7-T1-B

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	1.92E+00
TH-234	9.91E-01	4.74E-01	6.16E-01
RA-226	5.61E-01	6.16E-01	7.07E-01
PB-214	9.20E-01	1.70E-01	5.88E-02
BI-214	8.00E-01	1.86E-01	6.51E-02
TH-232	1.57E+00	7.44E-01	1.97E-01
RA-228	1.62E+00	4.65E-01	2.29E-01
AC-228	1.60E+00	5.60E-01	1.19E-01
TH-228	7.34E-01	7.29E-01	6.41E-01
RA-224	1.64E+00	5.78E-01	1.05E-01
PB-212	1.56E+00	3.83E-01	4.81E-02
BI-212	1.02E+00	3.37E-01	2.61E-01
TL-208	1.46E+00	3.35E-01	9.26E-02
U-235	8.72E-02	1.02E-01	1.67E-01
TH-231	Not Detected	-----	1.11E+01
PA-231	Not Detected	-----	1.79E+00
TH-227	Not Detected	-----	5.14E-01
RA-223	Not Detected	-----	2.25E-01
RN-219	3.37E-01	4.10E-01	5.09E-01
PB-211	Not Detected	-----	1.14E+00
TL-207	Not Detected	-----	2.00E+01
AM-241	Not Detected	-----	2.38E-01
PU-239	Not Detected	-----	4.62E+02
NP-237	4.72E-01	1.99E-01	2.58E-01
PA-233	Not Detected	-----	7.11E-02
TH-229	Not Detected	-----	2.56E-01

not detected *J* 4/14/97

not detected *J* 4/14/97

[Summary Report] - Sample ID: : 70054908

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	6.03E-02
AG-110m	Not Detected	-----	4.84E-02
BA-133	Not Detected	-----	6.91E-02
BE-7	Not Detected	-----	3.43E-01
CD-109	Not Detected	-----	1.26E+00
CD-115	Not Detected	-----	3.13E-01
CE-139	Not Detected	-----	3.41E-02
CE-141	Not Detected	-----	6.29E-02
CE-144	Not Detected	-----	2.44E-01
CO-56	Not Detected	-----	4.72E-02
CO-57	Not Detected	-----	3.18E-02
CO-58	Not Detected	-----	4.54E-02
CO-60	Not Detected	-----	4.95E-02
CR-51	Not Detected	-----	3.29E-01
CS-134	Not Detected	-----	5.37E-02
CS-137	5.43E-02	2.58E-02	2.88E-02
EU-152	Not Detected	-----	9.44E-02
EU-154	Not Detected	-----	2.82E-01
EU-155	Not Detected	-----	1.48E-01
FE-59	Not Detected	-----	1.11E-01
GD-153	Not Detected	-----	1.04E-01
HG-203	Not Detected	-----	4.34E-02
I-131	Not Detected	-----	5.06E-02
IR-192	Not Detected	-----	3.50E-02
K-40	2.57E+01	3.94E+00	3.31E-01
MN-52	Not Detected	-----	6.62E-02
MN-54	Not Detected	-----	4.54E-02
MO-99	Not Detected	-----	9.13E-01
NA-22	Not Detected	-----	6.08E-02
NA-24	Not Detected	-----	4.01E+00
NB-95	1.35E-01	0.56E-02	1.83E-01
ND-147	Not Detected	-----	3.55E-01
NI-57	Not Detected	-----	4.34E-01
PB-210	Not Detected	-----	9.36E+00
RU-103	Not Detected	-----	4.16E-02
RU-106	Not Detected	-----	3.90E-01
SB-122	Not Detected	-----	1.49E-01
SB-124	Not Detected	-----	4.09E-02
SB-125	Not Detected	-----	1.06E-01
SN-113	Not Detected	-----	5.05E-02
SR-85	Not Detected	-----	5.18E-02
TA-182	Not Detected	-----	2.23E-01
TA-183	Not Detected	-----	3.46E-01
TC-99m	Not Detected	-----	1.83E+03
TL-201	Not Detected	-----	3.40E-01
XE-133	Not Detected	-----	4.25E-01
Y-88	Not Detected	-----	3.63E-02
ZN-65	Not Detected	-----	1.49E-01
ZR-95	Not Detected	-----	8.19E-02

not detected 7/11

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-13-97 5:21:01 PM *

 * Analyzed by: *[Signature]* 4/14/97 Reviewed by: *[Signature]* 4/14/97 *

 Customer : P.SLAVIN/S.YOUNG (6682)
 Customer Sample ID : 032994-002
 Lab Sample ID : 70054909

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 722.000 gram
 Sample Date/Time : 4-09-97 2:48:00 PM
 Acquire Start Date/Time : 4-13-97 3:38:18 PM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6003 seconds

CY10-M7-72-M

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	1.31E+00
TH-234	1.49E+00	4.41E-01	5.55E-01
RA-226	1.98E+00	9.71E-01	6.59E-01
PB-214	9.38E-01	1.69E-01	6.61E-02
BI-214	8.76E-01	1.72E-01	6.59E-02
TH-232	1.21E+00	5.79E-01	2.04E-01
RA-228	1.16E+00	4.13E-01	2.25E-01
AC-228	1.22E+00	3.04E-01	1.13E-01
TH-228	1.16E+00	8.09E-01	5.84E-01
RA-224	1.28E+00	4.33E-01	1.06E-01
PB-212	1.20E+00	3.73E-01	4.90E-02
BI-212	7.77E-01	2.68E-01	2.37E-01
TL-208	1.17E+00	2.48E-01	8.62E-02
U-235	1.60E-01	1.88E-01	2.61E-01
TH-231	Not Detected	-----	1.06E+01
PA-231	Not Detected	-----	1.79E+00
TH-227	Not Detected	-----	4.68E-01
RA-223	Not Detected	-----	2.15E-01
RN-219	Not Detected	-----	5.07E-01
PB-211	Not Detected	-----	1.13E+00
TL-207	Not Detected	-----	1.84E+01
AM-241	Not Detected	-----	2.32E-01
PU-239	Not Detected	-----	4.43E+02
NP-237	Not Detected	-----	3.60E-01
PA-233	Not Detected	-----	7.25E-02
TH-229	Not Detected	-----	2.47E-01

[Summary Report] - Sample ID: : 70054909

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	5.63E-02
AG-110m	Not Detected	-----	7.78E-02
BA-133	Not Detected	-----	7.08E-02
BE-7	Not Detected	-----	3.28E-01
CD-109	2.23E+00	6.48E-01	9.28E-01
CD-115	Not Detected	-----	3.02E-01
CE-139	Not Detected	-----	3.30E-02
CE-141	Not Detected	-----	6.15E-02
CE-144	Not Detected	-----	2.39E-01
CO-56	Not Detected	-----	3.39E-02
CO-57	Not Detected	-----	3.08E-02
CO-58	Not Detected	-----	4.46E-02
CO-60	Not Detected	-----	5.33E-02
CR-51	Not Detected	-----	3.17E-01
CS-134	Not Detected	-----	5.52E-02
CS-137	5.38E-01	9.45E-02	3.08E-02
EU-152	Not Detected	-----	9.15E-02
EU-154	Not Detected	-----	2.60E-01
EU-155	Not Detected	-----	1.38E-01
FE-59	Not Detected	-----	1.11E-01
GD-153	Not Detected	-----	1.01E-01
HG-203	Not Detected	-----	4.00E-02
I-131	Not Detected	-----	5.16E-02
IR-192	Not Detected	-----	3.52E-02
K-40	2.48E+01	3.77E+00	3.61E-01
MN-52	Not Detected	-----	7.11E-02
MN-54	Not Detected	-----	4.69E-02
MO-99	Not Detected	-----	9.20E-01
NA-22	Not Detected	-----	5.87E-02
NA-24	Not Detected	-----	3.82E+00
NB-95	Not Detected	-----	4.24E-01
ND-147	Not Detected	-----	3.42E-01
NI-57	Not Detected	-----	4.46E-01
PB-210	Not Detected	-----	9.64E+00
RU-103	Not Detected	-----	4.21E-02
RU-106	Not Detected	-----	3.63E-01
SB-122	Not Detected	-----	1.45E-01
SB-124	Not Detected	-----	4.02E-02
SB-125	Not Detected	-----	1.19E-01
SN-113	Not Detected	-----	5.00E-02
SR-85	Not Detected	-----	5.03E-02
TA-182	Not Detected	-----	2.21E-01
TA-183	Not Detected	-----	3.42E-01
TC-99m	Not Detected	-----	2.12E+03
TL-201	Not Detected	-----	3.29E-01
XE-133	Not Detected	-----	1.68E-01
Y-88	Not Detected	-----	3.78E-02
ZN-65	Not Detected	-----	1.51E-01
ZR-95	Not Detected	-----	8.64E-02

not detected 7/14/87

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-13-97 7:06:07 PM *

 * Analyzed by: *J 4/14/97* Reviewed by: *Y 4/14/97* *

Customer : P.SLAVIN/S.YOUNG (6682)
 Customer Sample ID : 032995-002
 Lab Sample ID : 70054910

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 816.000 gram
 Sample Date/Time : 4-09-97 2:52:00 PM
 Acquire Start Date/Time : 4-13-97 5:23:29 PM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6003 seconds

CY10-M7-T2-B

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	1.61E+00
TH-234	1.15E+00	3.65E-01	5.13E-01
RA-226	1.40E+00	5.52E-01	6.20E-01
PB-214	6.93E-01	1.34E-01	5.29E-02
BI-214	6.30E-01	1.49E-01	5.68E-02
TH-232	9.40E-01	4.57E-01	1.59E-01
RA-228	9.55E-01	3.64E-01	2.04E-01
AC-228	9.37E-01	1.01E+00	1.03E-01
TH-228	Not Detected	-----	5.29E-01
RA-224	9.70E-01	3.48E-01	1.13E-01
PB-212	8.92E-01	3.03E-01	4.33E-02
BI-212	5.74E-01	2.30E-01	2.08E-01
TL-208	Not Detected	-----	7.69E-02
U-235	Not Detected	-----	2.28E-01
TH-231	Not Detected	-----	9.02E+00
PA-231	Not Detected	-----	1.52E+00
TH-227	Not Detected	-----	3.83E-01
RA-223	Not Detected	-----	1.87E-01
RN-219	Not Detected	-----	4.36E-01
PB-211	Not Detected	-----	9.75E-01
TL-207	Not Detected	-----	1.77E+01
AM-241	Not Detected	-----	1.94E-01
PU-239	Not Detected	-----	3.72E+02
NP-237	5.45E-01	1.70E-01	2.17E-01
PA-233	Not Detected	-----	6.33E-02
TH-229	Not Detected	-----	2.07E-01

not detected J 4/14/97

[Summary Report] - Sample ID: : 70054910

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.73E-02
AG-110m	Not Detected	-----	4.29E-02
BA-133	Not Detected	-----	5.81E-02
BE-7	Not Detected	-----	2.90E-01
CD-109	Not Detected	-----	1.03E+00
CD-115	Not Detected	-----	2.56E-01
CE-139	Not Detected	-----	2.82E-02
CE-141	Not Detected	-----	5.35E-02
CE-144	Not Detected	-----	2.08E-01
CO-56	Not Detected	-----	2.86E-02
CO-57	Not Detected	-----	2.63E-02
CO-58	Not Detected	-----	4.17E-02
CO-60	Not Detected	-----	4.63E-02
CR-51	Not Detected	-----	2.75E-01
CS-134	Not Detected	-----	4.60E-02
CS-137	6.37E-02	2.64E-02	2.56E-02
EU-152	Not Detected	-----	7.83E-02
EU-154	Not Detected	-----	2.19E-01
EU-155	Not Detected	-----	1.24E-01
FE-59	Not Detected	-----	1.05E-01
GD-153	Not Detected	-----	8.58E-02
HG-203	Not Detected	-----	3.48E-02
I-131	Not Detected	-----	4.52E-02
IR-192	Not Detected	-----	3.00E-02
K-40	2.84E+01	4.19E+00	3.01E-01
MN-52	Not Detected	-----	6.61E-02
MN-54	Not Detected	-----	4.19E-02
MO-99	Not Detected	-----	8.35E-01
NA-22	Not Detected	-----	5.79E-02
NA-24	Not Detected	-----	4.04E+00
NB-95	Not Detected	-----	3.50E-01
ND-147	Not Detected	-----	2.90E-01
NI-57	Not Detected	-----	3.89E-01
PB-210	Not Detected	-----	8.01E+00
RU-103	Not Detected	-----	3.49E-02
RU-106	Not Detected	-----	3.38E-01
SB-122	Not Detected	-----	1.28E-01
SB-124	Not Detected	-----	3.55E-02
SB-125	Not Detected	-----	9.62E-02
SN-113	Not Detected	-----	4.21E-02
SR-85	Not Detected	-----	4.18E-02
TA-182	Not Detected	-----	1.99E-01
TA-183	Not Detected	-----	2.89E-01
TC-99m	Not Detected	-----	2.28E+03
TL-201	Not Detected	-----	2.86E-01
XE-133	Not Detected	-----	3.65E-01
Y-88	Not Detected	-----	2.84E-02
ZN-65	Not Detected	-----	1.33E-01
ZR-95	Not Detected	-----	7.37E-02

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-13-97 8:51:19 PM *

 * Analyzed by: *J* 4/14/97 Reviewed by: *WJ* 4/14/97 *

Customer : P.SLAVIN/S.YOUNG (6682)
 Customer Sample ID : 032996-002
 Lab Sample ID : 70054911

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 763.000 gram
 Sample Date/Time : 4-09-97 2:35:00 PM
 Acquire Start Date/Time : 4-13-97 7:08:30 PM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6003 seconds

CY10-M7-T3-M

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	1.92E+00
TH-234	2.01E+00	5.91E-01	5.67E-01
RA-226	2.62E+00	7.17E-01	7.01E-01
PB-214	1.22E+00	2.15E-01	6.41E-02
BI-214	1.04E+00	2.07E-01	6.57E-02
TH-232	1.43E+00	6.71E-01	1.88E-01
RA-228	1.48E+00	3.48E-01	2.32E-01
AC-228	1.55E+00	4.06E-01	1.19E-01
TH-228	1.01E+00	4.93E-01	6.70E-01
RA-224	1.41E+00	4.47E-01	8.90E-02
PB-212	1.45E+00	2.29E-01	4.79E-02
BI-212	9.27E-01	3.10E-01	2.23E-01
TL-208	1.37E+00	2.82E-01	9.48E-02
U-235	1.29E-01	1.90E-01	2.64E-01
TH-231	Not Detected	-----	1.09E+01
PA-231	Not Detected	-----	1.79E+00
TH-227	Not Detected	-----	4.88E-01
RA-223	Not Detected	-----	2.23E-01
RN-219	Not Detected	-----	5.01E-01
PB-211	Not Detected	-----	1.15E+00
TL-207	Not Detected	-----	1.97E+01
AM-241	Not Detected	-----	2.43E-01
PU-239	Not Detected	-----	4.55E+02
NP-237	7.80E-01	2.11E-01	2.80E-01
PA-233	Not Detected	-----	7.30E-02
TH-229	Not Detected	-----	2.49E-01

not detected J 4/14/97

not detected J 4/14/97

[Summary Report] - Sample ID: : 70054911

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	5.77E-02
AG-110m	Not Detected	-----	4.25E-02
BA-133	Not Detected	-----	7.34E-02
BE-7	Not Detected	-----	3.27E-01
CD-109	Not Detected	-----	1.24E+00
CD-115	Not Detected	-----	3.23E-01
CE-139	Not Detected	-----	3.30E-02
CE-141	Not Detected	-----	6.21E-02
CE-144	Not Detected	-----	2.42E-01
CO-56	Not Detected	-----	3.44E-02
CO-57	Not Detected	-----	3.12E-02
CO-58	Not Detected	-----	4.44E-02
CO-60	Not Detected	-----	5.21E-02
CR-51	Not Detected	-----	3.13E-01
CS-134	Not Detected	-----	5.80E-02
CS-137	Not Detected	-----	5.05E-02
EU-152	Not Detected	-----	9.30E-02
EU-154	Not Detected	-----	2.70E-01
EU-155	Not Detected	-----	1.48E-01
FE-59	Not Detected	-----	1.07E-01
GD-153	Not Detected	-----	1.02E-01
HG-203	Not Detected	-----	4.16E-02
I-131	Not Detected	-----	5.23E-02
IR-192	Not Detected	-----	3.39E-02
K-40	2.58E+01	3.86E+00	3.59E-01
MN-52	Not Detected	-----	7.58E-02
MN-54	Not Detected	-----	2.90E-02
MO-99	Not Detected	-----	9.48E-01
NA-22	Not Detected	-----	6.25E-02
NA-24	Not Detected	-----	4.90E+00
NB-95	Not Detected	-----	4.53E-01
ND-147	Not Detected	-----	3.55E-01
NI-57	Not Detected	-----	4.89E-01
PB-210	Not Detected	-----	9.65E+00
RU-103	Not Detected	-----	4.12E-02
RU-106	Not Detected	-----	3.78E-01
SB-122	Not Detected	-----	1.49E-01
SB-124	Not Detected	-----	4.23E-02
SB-125	Not Detected	-----	1.10E-01
SN-113	Not Detected	-----	5.08E-02
SR-85	Not Detected	-----	5.05E-02
TA-182	Not Detected	-----	2.31E-01
TA-183	Not Detected	-----	3.66E-01
TC-99m	Not Detected	-----	3.40E+03
TL-201	Not Detected	-----	3.52E-01
XE-133	Not Detected	-----	4.48E-01
Y-88	Not Detected	-----	3.61E-02
ZN-65	Not Detected	-----	1.54E-01
ZR-95	Not Detected	-----	7.99E-02

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-13-97 10:36:33 PM *

* Analyzed by: *J 4/14/97* Reviewed by: *YS 4/14/97* *

Customer : P.SLAVIN/S.YOUNG (6682)
 Customer Sample ID : 032997-002
 Lab Sample ID : 70054912

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 801.000 gram
 Sample Date/Time : 4-09-97 2:45:00 PM
 Acquire Start Date/Time : 4-13-97 8:53:49 PM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6004 seconds

CY10-M7-T3-B

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	1.85E+00
TH-234	1.66E+00	4.34E-01	5.27E-01
RA-226	Not Detected	-----	5.99E-01
PB-214	1.04E+00	1.76E-01	5.87E-02
BI-214	9.29E-01	1.82E-01	5.99E-02
TH-232	1.47E+00	7.01E-01	1.80E-01
RA-228	1.45E+00	4.01E-01	2.11E-01
AC-228	1.25E+00	2.83E-01	1.17E-01
TH-228	9.48E-01	6.94E-01	5.49E-01
RA-224	1.59E+00	4.88E-01	8.87E-02
PB-212	1.47E+00	1.07E+00	5.14E-02
BI-212	8.38E-01	2.79E-01	2.35E-01
TL-208	1.33E+00	2.54E-01	8.79E-02
U-235	1.49E-01	1.85E-01	2.57E-01
TH-231	Not Detected	-----	1.06E+01
PA-231	Not Detected	-----	1.64E+00
TH-227	Not Detected	-----	4.63E-01
RA-223	Not Detected	-----	1.73E-01
RN-219	Not Detected	-----	4.81E-01
PB-211	Not Detected	-----	1.10E+00
TL-207	Not Detected	-----	1.91E+01
AM-241	Not Detected	-----	2.27E-01
PU-239	Not Detected	-----	4.29E+02
NP-237	9.26E-01	2.30E-01	2.54E-01
PA-233	Not Detected	-----	6.81E-02
TH-229	Not Detected	-----	2.48E-01

not detected J 4/14/97

not detected J 4/14/97

[Summary Report] - Sample ID: : 70054912

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	5.58E-02
AG-110m	Not Detected	-----	4.08E-02
BA-133	Not Detected	-----	6.78E-02
BE-7	Not Detected	-----	3.30E-01
CD-109	Not Detected	-----	1.18E+00
CD-115	Not Detected	-----	3.13E-01
CE-139	Not Detected	-----	3.21E-02
CE-141	Not Detected	-----	6.02E-02
CE-144	Not Detected	-----	2.35E-01
CO-56	Not Detected	-----	4.69E-02
CO-57	Not Detected	-----	2.98E-02
CO-58	Not Detected	-----	4.29E-02
CO-60	Not Detected	-----	4.76E-02
CR-51	Not Detected	-----	3.24E-01
CS-134	Not Detected	-----	5.29E-02
CS-137	Not Detected	-----	4.75E-02
EU-152	Not Detected	-----	8.90E-02
EU-154	Not Detected	-----	2.61E-01
EU-155	Not Detected	-----	1.41E-01
FE-59	Not Detected	-----	1.03E-01
GD-153	Not Detected	-----	1.00E-01
HG-203	Not Detected	-----	3.94E-02
I-131	Not Detected	-----	5.17E-02
IR-192	Not Detected	-----	3.42E-02
K-40	2.79E+01	4.12E+00	2.93E-01
MN-52	Not Detected	-----	7.48E-02
MN-54	Not Detected	-----	4.73E-02
MO-99	Not Detected	-----	9.22E-01
NA-22	Not Detected	-----	5.85E-02
NA-24	Not Detected	-----	4.99E+00
NB-95	Not Detected	-----	4.35E-01
ND-147	Not Detected	-----	3.46E-01
NI-57	Not Detected	-----	4.61E-01
PB-210	Not Detected	-----	9.32E+00
RU-103	Not Detected	-----	3.87E-02
RU-106	Not Detected	-----	3.63E-01
SB-122	Not Detected	-----	1.54E-01
SB-124	Not Detected	-----	3.89E-02
SB-125	Not Detected	-----	1.07E-01
SN-113	Not Detected	-----	4.72E-02
SR-85	Not Detected	-----	4.80E-02
TA-182	Not Detected	-----	2.15E-01
TA-183	Not Detected	-----	3.45E-01
TC-99m	Not Detected	-----	3.92E+03
TL-201	Not Detected	-----	3.38E-01
XE-133	Not Detected	-----	1.82E-01
Y-88	Not Detected	-----	3.64E-02
ZN-65	Not Detected	-----	1.46E-01
ZR-95	Not Detected	-----	7.96E-02

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-14-97 12:21:40 AM *

* Analyzed by: *J* 4/14/97 Reviewed by: *

Customer : P.SLAVIN/S.YOUNG (6682)
 Customer Sample ID : 032998-002
 Lab Sample ID : 70054913

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 759.000 gram
 Sample Date/Time : 4-10-97 10:20:00 AM
 Acquire Start Date/Time : 4-13-97 10:39:00 PM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6003 seconds

CY10-M8-T1-M

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	8.40E-01	9.11E-01	1.35E+00
TH-234	Not Detected	-----	6.55E-01
RA-226	2.01E+00	7.85E-01	6.65E-01
PB-214	7.89E-01	1.41E-01	5.60E-02
BI-214	7.67E-01	1.58E-01	5.87E-02
TH-232	9.67E-01	5.00E-01	1.82E-01
RA-228	8.74E-01	3.57E-01	1.99E-01
AC-228	9.07E-01	2.12E-01	1.08E-01
TH-228	7.42E-01	4.07E-01	4.96E-01
RA-224	9.53E-01	3.78E-01	8.81E-02
PB-212	9.39E-01	1.66E-01	4.35E-02
BI-212	4.99E-01	2.28E-01	2.22E-01
TL-208	8.80E-01	1.77E-01	7.93E-02
U-235	1.26E-01	1.69E-01	2.36E-01
TH-231	Not Detected	-----	9.88E+00
PA-231	Not Detected	-----	1.60E+00
TH-227	Not Detected	-----	4.03E-01
RA-223	Not Detected	-----	1.93E-01
RN-219	2.38E-01	3.57E-01	4.44E-01
PB-211	Not Detected	-----	9.84E-01
TL-207	Not Detected	-----	1.68E+01
AM-241	Not Detected	-----	2.04E-01
PU-239	Not Detected	-----	3.81E+02
NP-237	Not Detected	-----	2.16E-01
PA-233	Not Detected	-----	6.28E-02
TH-229	Not Detected	-----	2.15E-01

not detected *J* 4/14/97

not detected *J* 4/14/97

[Summary Report] - Sample ID: : 70054913

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.84E-02
AG-110m	Not Detected	-----	3.51E-02
BA-133	Not Detected	-----	6.16E-02
BE-7	Not Detected	-----	2.97E-01
CD-109	1.66E+00	6.42E-01	7.35E-01
CD-115	Not Detected	-----	2.21E-01
CE-139	Not Detected	-----	2.82E-02
CE-141	Not Detected	-----	5.38E-02
CE-144	Not Detected	-----	2.07E-01
CO-56	Not Detected	-----	2.50E-02
CO-57	Not Detected	-----	2.66E-02
CO-58	Not Detected	-----	3.78E-02
CO-60	Not Detected	-----	4.90E-02
CR-51	Not Detected	-----	2.85E-01
CS-134	Not Detected	-----	4.95E-02
CS-137	Not Detected	-----	4.12E-02
EU-152	Not Detected	-----	7.90E-02
EU-154	Not Detected	-----	2.24E-01
EU-155	Not Detected	-----	1.29E-01
FE-59	Not Detected	-----	9.63E-02
GD-153	Not Detected	-----	8.96E-02
HG-203	Not Detected	-----	3.62E-02
I-131	Not Detected	-----	4.32E-02
IR-192	Not Detected	-----	3.17E-02
K-40	2.28E+01	3.43E+00	2.55E-01
MN-52	Not Detected	-----	5.94E-02
MN-54	Not Detected	-----	1.85E-02
MO-99	Not Detected	-----	7.32E-01
NA-22	Not Detected	-----	5.57E-02
NA-24	Not Detected	-----	2.05E+00
NB-95	Not Detected	-----	3.30E-01
ND-147	Not Detected	-----	2.90E-01
NI-57	Not Detected	-----	3.02E-01
PB-210	Not Detected	-----	8.57E+00
RU-103	Not Detected	-----	3.60E-02
RU-106	Not Detected	-----	3.46E-01
SB-122	Not Detected	-----	1.18E-01
SB-124	Not Detected	-----	3.55E-02
SB-125	Not Detected	-----	1.01E-01
SN-113	Not Detected	-----	4.46E-02
SR-85	Not Detected	-----	4.42E-02
TA-182	Not Detected	-----	2.10E-01
TA-183	Not Detected	-----	2.80E-01
TC-99m	Not Detected	-----	4.65E+02
TL-201	Not Detected	-----	2.61E-01
XE-133	Not Detected	-----	3.30E-01
Y-88	Not Detected	-----	3.29E-02
ZN-65	Not Detected	-----	1.39E-01
ZR-95	Not Detected	-----	7.32E-02

not detected 7/14/97

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-12-97 2:26:42 PM *

* Analyzed by: *[Signature]* 4/14/97. Reviewed by: *[Signature]* 4/14/97 *

Customer : P.SLAVIN/S.YOUNG (6682)
 Customer Sample ID : 032999-002
 Lab Sample ID : 70054914

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 924.000 gram
 Sample Date/Time : 4-10-97 10:30:00 AM
 Acquire Start Date/Time : 4-12-97 12:43:44 PM
 Detector Name : LAB02
 Elapsed Live/Real Time : 6000 / 6005 seconds

CY10-M8-T1-B

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	3.73E+00
TH-234	1.35E+00	5.61E-01	7.51E-01
RA-226	2.94E+00	9.02E-01	6.57E-01
PB-214	1.39E+00	2.05E-01	4.82E-02
BI-214	1.26E+00	2.35E-01	1.95E-01
TH-232	1.13E+00	5.24E-01	1.61E-01
RA-228	1.33E+00	2.65E-01	1.49E-01
AC-228	1.25E+00	2.93E-01	8.62E-02
TH-228	1.10E+00	2.85E-01	5.34E-01
RA-224	1.34E+00	3.60E-01	6.71E-02
PB-212	1.26E+00	2.03E-01	4.31E-02
BI-212	8.09E-01	2.15E-01	1.69E-01
TL-208	1.20E+00	2.24E-01	6.99E-02
U-235	Not Detected	-----	2.72E-01
TH-231	Not Detected	-----	1.44E+01
PA-231	Not Detected	-----	1.54E+00
TH-227	Not Detected	-----	3.92E-01
RA-223	Not Detected	-----	2.55E-01
RN-219	Not Detected	-----	4.08E-01
PB-211	Not Detected	-----	9.32E-01
TL-207	Not Detected	-----	1.46E+01
AM-241	Not Detected	-----	5.27E-01
PU-239	Not Detected	-----	5.04E+02
NP-237	Not Detected	-----	3.37E-01
PA-233	Not Detected	-----	6.29E-02
TH-229	Not Detected	-----	2.88E-01

[Summary Report] - Sample ID: : 70054914

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.43E-02
AG-110m	Not Detected	-----	3.33E-02
BA-133	Not Detected	-----	7.86E-02
BE-7	Not Detected	-----	2.75E-01
CD-109	2.23E+00	7.11E-01	1.14E+00
CD-115	Not Detected	-----	1.37E-01
CE-139	Not Detected	-----	3.32E-02
CE-141	Not Detected	-----	6.12E-02
CE-144	Not Detected	-----	2.76E-01
CO-56	Not Detected	-----	3.67E-02
CO-57	Not Detected	-----	3.38E-02
CO-58	Not Detected	-----	3.49E-02
CO-60	Not Detected	-----	3.75E-02
CR-51	Not Detected	-----	2.61E-01
CS-134	Not Detected	-----	5.68E-02
CS-137	Not Detected	-----	3.60E-02
EU-152	Not Detected	-----	1.02E-01
EU-154	Not Detected	-----	2.04E-01
EU-155	Not Detected	-----	1.70E-01
FE-59	Not Detected	-----	7.72E-02
GD-153	Not Detected	-----	1.19E-01
HG-203	Not Detected	-----	3.55E-02
I-131	Not Detected	-----	3.46E-02
IR-192	Not Detected	-----	2.95E-02
K-40	2.57E+01	3.63E+00	2.49E-01
MN-52	Not Detected	-----	3.65E-02
MN-54	Not Detected	-----	3.69E-02
MO-99	Not Detected	-----	4.29E-01
NA-22	Not Detected	-----	4.58E-02
NA-24	Not Detected	-----	3.33E-01
NB-95	Not Detected	-----	2.69E-01
ND-147	Not Detected	-----	2.42E-01
NI-57	2.04E-01	1.26E-01	7.82E-02
PB-210	Not Detected	-----	3.83E+01
RU-103	Not Detected	-----	3.03E-02
RU-106	Not Detected	-----	3.09E-01
SB-122	Not Detected	-----	7.29E-02
SB-124	Not Detected	-----	3.13E-02
SB-125	Not Detected	-----	9.03E-02
SN-113	Not Detected	-----	4.02E-02
SR-85	Not Detected	-----	3.82E-02
TA-182	Not Detected	-----	1.71E-01
TA-183	Not Detected	-----	5.95E-01
TC-99m	Not Detected	-----	1.05E+01
TL-201	Not Detected	-----	3.27E-01
XE-133	Not Detected	-----	3.10E-01
Y-88	Not Detected	-----	2.61E-02
ZN-65	Not Detected	-----	1.17E-01
ZR-95	Not Detected	-----	6.08E-02

not detected 7/14/97

not detected 7/14/97

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-12-97 4:10:53 PM *

 * Analyzed by: *J* 4/14/97 Reviewed by: *SL* 4/14/97 *

Customer : P.SLAVIN/S.YOUNG (6682)
 Customer Sample ID : 033000-002
 Lab Sample ID : 70054915

Sample Description : MARINELLI LIQUID SAMPLE
 Sample Quantity : 450.000 mL
 Sample Date/Time : 4-10-97 2:10:00 PM
 Acquire Start Date/Time : 4-12-97 2:28:54 PM
 Detector Name : LAB02
 Elapsed Live/Real Time : 6000 / 6001 seconds

CY10-RSD

Comments:

Nuclide Name	Activity (pCi/mL)	2-sigma Error	MDA (pCi/mL)
U-238	Not Detected	-----	2.01E+00
TH-234	Not Detected	-----	4.75E-01
RA-226	Not Detected	-----	5.40E-01
PB-214	Not Detected	-----	5.97E-02
BI-214	Not Detected	-----	6.64E-02
TH-232	Not Detected	-----	1.73E-01
RA-228	Not Detected	-----	1.55E-01
AC-228	Not Detected	-----	8.77E-02
TH-228	Not Detected	-----	5.52E-01
RA-224	Not Detected	-----	1.46E-01
PB-212	Not Detected	-----	4.20E-02
BI-212	Not Detected	-----	2.14E-01
TL-208	Not Detected	-----	7.09E-02
U-235	Not Detected	-----	1.77E-01
TH-231	Not Detected	-----	7.77E+00
PA-231	Not Detected	-----	1.15E+00
TH-227	Not Detected	-----	1.60E-01
RA-223	Not Detected	-----	1.36E-01
RN-219	Not Detected	-----	2.83E-01
PB-211	Not Detected	-----	6.27E-01
TL-207	Not Detected	-----	1.04E+01
AM-241	Not Detected	-----	2.97E-01
PU-239	Not Detected	-----	2.93E+02
NP-237	Not Detected	-----	2.14E-01
PA-233	Not Detected	-----	4.95E-02
TH-229	Not Detected	-----	1.73E-01

[Summary Report] - Sample ID: : 70054915

Nuclide Name	Activity (pCi/mL)	2-sigma Error	MDA (pCi/mL)
AG-108m	Not Detected	-----	2.62E-02
AG-110m	Not Detected	-----	2.35E-02
BA-133	Not Detected	-----	3.73E-02
BE-7	Not Detected	-----	2.22E-01
CD-109	Not Detected	-----	7.18E-01
CD-115	Not Detected	-----	7.57E-02
CE-139	Not Detected	-----	2.25E-02
CE-141	Not Detected	-----	3.96E-02
CE-144	Not Detected	-----	1.76E-01
CO-56	Not Detected	-----	3.54E-02
CO-57	Not Detected	-----	2.13E-02
CO-58	Not Detected	-----	2.66E-02
CO-60	Not Detected	-----	2.56E-02
CR-51	Not Detected	-----	1.99E-01
CS-134	Not Detected	-----	3.08E-02
CS-137	Not Detected	-----	2.60E-02
EU-152	Not Detected	-----	6.40E-02
EU-154	Not Detected	-----	1.22E-01
EU-155	Not Detected	-----	9.95E-02
FE-59	Not Detected	-----	4.73E-02
GD-153	Not Detected	-----	7.18E-02
HG-203	Not Detected	-----	2.51E-02
I-131	Not Detected	-----	3.00E-02
IR-192	Not Detected	-----	2.40E-02
K-40	Not Detected	-----	3.36E-01
MN-52	Not Detected	-----	3.48E-02
MN-54	Not Detected	-----	2.57E-02
MO-99	Not Detected	-----	3.22E-01
NA-22	Not Detected	-----	2.78E-02
NA-24	Not Detected	-----	2.53E-01
NB-95	Not Detected	-----	1.08E-01
ND-147	Not Detected	-----	1.84E-01
NI-57	Not Detected	-----	8.72E-02
PB-210	Not Detected	-----	1.62E+01
RU-103	Not Detected	-----	2.59E-02
RU-106	Not Detected	-----	2.59E-01
SB-122	Not Detected	-----	5.51E-02
SB-124	Not Detected	-----	2.82E-02
SB-125	Not Detected	-----	6.30E-02
SN-113	Not Detected	-----	2.95E-02
SR-85	Not Detected	-----	3.58E-02
TA-182	Not Detected	-----	9.47E-02
TA-183	Not Detected	-----	3.29E-01
TC-99m	Not Detected	-----	4.88E+00
TL-201	Not Detected	-----	1.73E-01
XE-133	Not Detected	-----	1.62E-01
Y-88	Not Detected	-----	3.07E-02
ZN-65	Not Detected	-----	6.33E-02
ZR-95	Not Detected	-----	4.31E-02

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-12-97 5:55:53 PM *

 * Analyzed by: *[Signature]* 4/14/97 Reviewed by: *[Signature]* 4/14/97 *

Customer : P.SLAVIN/S.YOUNG (6682)
 Customer Sample ID : 034311-002
 Lab Sample ID : 70054916

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 923.000 gram
 Sample Date/Time : 4-10-97 10:50:00 AM
 Acquire Start Date/Time : 4-12-97 4:12:54 PM
 Detector Name : LAB02
 Elapsed Live/Real Time : 6000 / 6004 seconds

CY10-M9-T1-B

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	3.51E+00
TH-234	1.54E+00	5.62E-01	7.54E-01
RA-226	2.09E+00	7.54E-01	5.74E-01
PB-214	1.07E+00	3.19E-01	4.72E-02
BI-214	9.56E-01	2.15E-01	1.96E-01
TH-232	1.15E+00	5.18E-01	1.62E-01
RA-228	1.30E+00	3.65E-01	1.34E-01
AC-228	1.22E+00	2.44E-01	8.91E-02
TH-228	9.82E-01	2.68E-01	4.88E-01
RA-224	1.14E+00	3.76E-01	6.70E-02
PB-212	1.19E+00	1.95E-01	4.09E-02
BI-212	7.36E-01	2.14E-01	1.57E-01
TL-208	1.04E+00	1.80E-01	6.36E-02
U-235	1.32E-01	2.02E-01	2.59E-01
TH-231	Not Detected	-----	1.34E+01
PA-231	Not Detected	-----	1.48E+00
TH-227	Not Detected	-----	3.76E-01
RA-223	Not Detected	-----	2.37E-01
RN-219	Not Detected	-----	3.83E-01
PB-211	Not Detected	-----	8.58E-01
TL-207	Not Detected	-----	1.41E+01
AM-241	Not Detected	-----	5.15E-01
PU-239	Not Detected	-----	4.77E+02
NP-237	Not Detected	-----	3.08E-01
PA-233	Not Detected	-----	5.85E-02
TH-229	Not Detected	-----	2.71E-01

not detected *[Signature]* 4/14/97

[Summary Report] - Sample ID: : 70054916

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.14E-02
AG-110m	Not Detected	-----	3.13E-02
BA-133	Not Detected	-----	7.07E-02
BE-7	Not Detected	-----	2.56E-01
CD-109	2.39E+00	6.94E-01	1.05E+00
CD-115	Not Detected	-----	1.39E-01
CE-139	Not Detected	-----	3.13E-02
CE-141	Not Detected	-----	5.87E-02
CE-144	Not Detected	-----	2.60E-01
CO-56	Not Detected	-----	2.21E-02
CO-57	Not Detected	-----	3.24E-02
CO-58	Not Detected	-----	3.31E-02
CO-60	Not Detected	-----	3.68E-02
CR-51	Not Detected	-----	2.50E-01
CS-134	Not Detected	-----	5.17E-02
CS-137	Not Detected	-----	3.49E-02
EU-152	Not Detected	-----	9.72E-02
EU-154	Not Detected	-----	1.91E-01
EU-155	Not Detected	-----	1.60E-01
FE-59	Not Detected	-----	7.40E-02
GD-153	Not Detected	-----	1.12E-01
HG-203	Not Detected	-----	3.39E-02
I-131	Not Detected	-----	3.40E-02
IR-192	Not Detected	-----	2.85E-02
K-40	2.49E+01	3.53E+00	2.58E-01
MN-52	Not Detected	-----	3.72E-02
MN-54	Not Detected	-----	1.82E-02
MO-99	Not Detected	-----	4.17E-01
NA-22	Not Detected	-----	4.33E-02
NA-24	Not Detected	-----	3.76E-01
NB-95	Not Detected	-----	2.65E-01
ND-147	Not Detected	-----	2.31E-01
NI-57	1.85E-01	1.38E-01	8.44E-02
PB-210	Not Detected	-----	3.62E+01
RU-103	Not Detected	-----	2.96E-02
RU-106	Not Detected	-----	2.82E-01
SB-122	Not Detected	-----	6.96E-02
SB-124	Not Detected	-----	3.11E-02
SB-125	Not Detected	-----	8.17E-02
SN-113	Not Detected	-----	3.76E-02
SR-85	Not Detected	-----	3.72E-02
TA-182	Not Detected	-----	1.55E-01
TA-183	Not Detected	-----	5.97E-01
TC-99m	Not Detected	-----	1.44E+01
TL-201	Not Detected	-----	3.20E-01
XE-133	Not Detected	-----	3.07E-01
Y-88	Not Detected	-----	2.50E-02
ZN-65	Not Detected	-----	1.05E-01
ZR-95	Not Detected	-----	5.72E-02

not detected 7/14/57

not detected 7/11/57

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-13-97 3:27:52 PM *

 *
 * Analyzed by: *[Signature]* 4/14/97 Reviewed by: *[Signature]* 4/14/97 *

Customer : P.SLAVIN/S.YOUNG (6682)
 Customer Sample ID : 034312-002
 Lab Sample ID : 70054917

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 891.000 gram
 Sample Date/Time : 4-10-97 11:00:00 AM
 Acquire Start Date/Time : 4-13-97 1:44:53 PM
 Detector Name : LAB02
 Elapsed Live/Real Time : 6000 / 6004 seconds

CY10-M9-T1-M

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	3.45E+00
TH-234	1.12E+00	4.93E-01	7.56E-01
RA-226	2.02E+00	3.45E-01	5.69E-01
PB-214	9.41E-01	1.35E-01	4.51E-02
BI-214	8.36E-01	1.89E-01	2.02E-01
TH-232	1.10E+00	5.86E-01	1.52E-01
RA-228	1.19E+00	2.53E-01	1.37E-01
AC-228	1.10E+00	2.26E-01	8.46E-02
TH-228	1.15E+00	3.66E-01	4.91E-01
RA-224	1.21E+00	3.27E-01	5.35E-02
PB-212	1.13E+00	1.99E-01	4.19E-02
BI-212	6.88E-01	2.15E-01	1.79E-01
TL-208	1.03E+00	1.97E-01	6.53E-02
U-235	Not Detected	-----	2.51E-01
TH-231	Not Detected	-----	1.34E+01
PA-231	Not Detected	-----	1.46E+00
TH-227	Not Detected	-----	3.77E-01
RA-223	Not Detected	-----	2.50E-01
RN-219	Not Detected	-----	3.80E-01
PB-211	Not Detected	-----	8.57E-01
TL-207	Not Detected	-----	1.43E+01
AM-241	Not Detected	-----	4.91E-01
PU-239	Not Detected	-----	4.70E+02
NP-237	Not Detected	-----	3.11E-01
PA-233	Not Detected	-----	5.78E-02
TH-229	Not Detected	-----	2.74E-01

[Summary Report] - Sample ID: : 70054917

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.20E-02
AG-110m	Not Detected	-----	3.42E-02
BA-133	Not Detected	-----	6.76E-02
BE-7	Not Detected	-----	2.59E-01
CD-109	1.76E-06	6.35E-01	1.06E+00
CD-115	Not Detected	-----	1.80E-01
CE-139	Not Detected	-----	3.10E-02
CE-141	Not Detected	-----	5.77E-02
CE-144	Not Detected	-----	2.58E-01
CO-56	Not Detected	-----	2.51E-02
CO-57	Not Detected	-----	3.21E-02
CO-58	Not Detected	-----	3.41E-02
CO-60	Not Detected	-----	3.65E-02
CR-51	Not Detected	-----	2.54E-01
CS-134	Not Detected	-----	4.98E-02
CS-137	2.65E-02	1.38E-02	1.91E-02
EU-152	Not Detected	-----	9.61E-02
EU-154	Not Detected	-----	1.93E-01
EU-155	Not Detected	-----	1.59E-01
FE-59	Not Detected	-----	7.50E-02
GD-153	Not Detected	-----	1.14E-01
HG-203	Not Detected	-----	3.35E-02
I-131	Not Detected	-----	3.77E-02
IR-192	Not Detected	-----	2.77E-02
K-40	2.54E+01	3.58E+00	2.46E-01
MN-52	Not Detected	-----	4.63E-02
MN-54	Not Detected	-----	2.03E-02
MO-99	Not Detected	-----	5.07E-01
NA-22	Not Detected	-----	4.27E-02
NA-24	Not Detected	-----	1.00E+00
NB-95	Not Detected	-----	3.15E-01
ND-147	Not Detected	-----	2.43E-01
NI-57	Not Detected	-----	9.69E-02
PB-210	Not Detected	-----	3.60E+01
RU-103	Not Detected	-----	3.12E-02
RU-106	Not Detected	-----	2.93E-01
SB-122	Not Detected	-----	8.68E-02
SB-124	Not Detected	-----	3.08E-02
SB-125	Not Detected	-----	8.15E-02
SN-113	Not Detected	-----	3.88E-02
SR-85	Not Detected	-----	3.78E-02
TA-182	Not Detected	-----	1.60E-01
TA-183	Not Detected	-----	6.45E-01
TC-99m	Not Detected	-----	1.68E+02
TL-201	Not Detected	-----	3.86E-01
XE-133	Not Detected	-----	4.00E-01
Y-88	Not Detected	-----	2.56E-02
ZN-65	Not Detected	-----	1.09E-01
ZR-95	Not Detected	-----	5.91E-02

not detected 2/4/1

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-14-97 8:59:41 AM *

* Analyzed by: *[Signature]* 4/14/97 Reviewed by: *[Signature]* 4/14/97 *

Customer : P.SLAVIN/S.YOUNG (6682)
 Customer Sample ID : 034313-002
 Lab Sample ID : 70054918

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 972.000 gram
 Sample Date/Time : 4-10-97 11:10:00 AM
 Acquire Start Date/Time : 4-14-97 7:11:34 AM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6003 seconds

CY10-M9-T2-B

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	1.66E+00	9.51E-01	1.42E+00
TH-234	1.55E+00	4.13E-01	4.69E-01
RA-226	1.74E+00	5.81E-01	5.39E-01
PB-214	8.26E-01	1.40E-01	4.54E-02
BI-214	7.44E-01	1.64E-01	5.08E-02
TH-232	1.01E+00	1.10E+00	1.39E-01
RA-228	1.01E+00	2.47E-01	1.81E-01
AC-228	1.01E+00	2.37E-01	1.04E-01
TH-228	4.16E-01	3.80E-01	4.82E-01
RA-224	1.03E+00	3.49E-01	6.06E-02
PB-212	9.40E-01	1.51E-01	3.89E-02
BI-212	5.60E-01	3.29E-01	1.90E-01
TL-208	9.54E-01	1.31E+00	6.65E-02
U-235	2.34E-01	1.53E-01	2.11E-01
TH-231	Not Detected	-----	8.60E+00
PA-231	Not Detected	-----	1.41E+00
TH-227	Not Detected	-----	3.61E-01
RA-223	Not Detected	-----	1.72E-01
RN-219	Not Detected	-----	4.07E-01
PB-211	Not Detected	-----	9.13E-01
TL-207	Not Detected	-----	1.57E+01
AM-241	Not Detected	-----	1.87E-01
PU-239	Not Detected	-----	3.61E+02
NP-237	6.16E-01	1.76E-01	2.32E-01
PA-233	Not Detected	-----	5.72E-02
TH-229	Not Detected	-----	1.97E-01

Not detected 4/14/97

[Summary Report] - Sample ID: : 70054918

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.43E-02
AG-110m	Not Detected	-----	3.45E-02
BA-133	Not Detected	-----	5.52E-02
BE-7	Not Detected	-----	2.63E-01
CD-109	Not Detected	-----	9.80E-01
CD-115	Not Detected	-----	2.17E-01
CE-139	Not Detected	-----	2.59E-02
CE-141	Not Detected	-----	4.85E-02
CE-144	Not Detected	-----	1.93E-01
CO-56	Not Detected	-----	3.78E-02
CO-57	Not Detected	-----	2.48E-02
CO-58	Not Detected	-----	3.42E-02
CO-60	Not Detected	-----	4.22E-02
CR-51	Not Detected	-----	2.46E-01
CS-134	Not Detected	-----	4.23E-02
CS-137	2.42E-02	1.47E-02	1.85E-02
EU-152	Not Detected	-----	7.43E-02
EU-154	Not Detected	-----	2.04E-01
EU-155	Not Detected	-----	1.13E-01
FE-59	Not Detected	-----	8.84E-02
GD-153	Not Detected	-----	8.16E-02
HG-203	Not Detected	-----	3.32E-02
I-131	Not Detected	-----	3.84E-02
IR-192	Not Detected	-----	2.70E-02
K-40	2.46E+01	3.63E+00	2.52E-01
MN-52	Not Detected	-----	5.55E-02
MN-54	Not Detected	-----	3.81E-02
MO-99	Not Detected	-----	6.88E-01
NA-22	Not Detected	-----	5.08E-02
NA-24	Not Detected	-----	2.39E+00
NB-95	Not Detected	-----	3.18E-01
ND-147	Not Detected	-----	2.77E-01
NI-57	Not Detected	-----	3.18E-01
PB-210	Not Detected	-----	7.64E+00
RU-103	Not Detected	-----	3.26E-02
RU-106	Not Detected	-----	2.91E-01
SB-122	Not Detected	-----	1.09E-01
SB-124	Not Detected	-----	3.09E-02
SB-125	Not Detected	-----	8.80E-02
SN-113	Not Detected	-----	3.83E-02
SR-85	Not Detected	-----	3.78E-02
TA-182	Not Detected	-----	1.76E-01
TA-183	Not Detected	-----	2.68E-01
TC-99m	Not Detected	-----	9.97E+02
TL-201	Not Detected	-----	2.52E-01
XE-133	Not Detected	-----	3.22E-01
Y-88	Not Detected	-----	2.88E-02
ZN-65	Not Detected	-----	1.20E-01
ZR-95	Not Detected	-----	6.92E-02

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-14-97 8:59:08 AM *

* Analyzed by: *J* 4/14/97 Reviewed by: *SL* 4/14/97 *

Customer : P.SLAVIN/S.YOUNG (6682)
 Customer Sample ID : 034314-002
 Lab Sample ID : 70054919

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 957.000 gram
 Sample Date/Time : 4-10-97 11:20:00 AM
 Acquire Start Date/Time : 4-14-97 7:16:17 AM
 Detector Name : LAB02
 Elapsed Live/Real Time : 6000 / 6004 seconds

CY10-M9-73-M

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	3.43E+00
TH-234	1.61E+00	5.50E-01	7.64E-01
RA-226	1.96E+00	8.25E-01	5.97E-01
PB-214	9.15E-01	1.82E-01	4.45E-02
BI-214	8.60E-01	1.90E-01	1.89E-01
TH-232	1.09E+00	5.17E-01	1.40E-01
RA-228	1.16E+00	2.43E-01	1.49E-01
AC-228	1.19E+00	2.44E-01	8.17E-02
TH-228	1.16E+00	1.54E+00	4.75E-01
RA-224	1.18E+00	3.20E-01	6.12E-02
PB-212	1.12E+00	1.76E-01	4.00E-02
BI-212	7.52E-01	2.77E-01	1.52E-01
TL-208	1.10E+00	3.88E-01	6.51E-02
U-235	Not Detected	-----	2.50E-01
TH-231	Not Detected	-----	1.36E+01
PA-231	Not Detected	-----	1.41E+00
TH-227	Not Detected	-----	3.67E-01
RA-223	Not Detected	-----	2.67E-01
RN-219	2.53E-01	3.16E-01	3.75E-01
PB-211	Not Detected	-----	8.39E-01
TL-207	Not Detected	-----	1.36E+01
AM-241	Not Detected	-----	4.85E-01
PU-239	Not Detected	-----	4.67E+02
NP-237	Not Detected	-----	3.34E-01
PA-233	Not Detected	-----	5.67E-02
TH-229	Not Detected	-----	2.65E-01


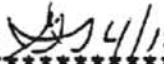
not detected *J* 4/14/97

[Summary Report] - Sample ID: : 70054919

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.06E-02
AG-110m	Not Detected	-----	3.06E-02
BA-133	Not Detected	-----	6.58E-02
BE-7	Not Detected	-----	2.58E-01
CD-109	2.46E+00	6.87E-01	1.14E+00
CD-115	Not Detected	-----	2.17E-01
CE-139	Not Detected	-----	3.08E-02
CE-141	Not Detected	-----	5.89E-02
CE-144	Not Detected	-----	2.57E-01
CO-56	Not Detected	-----	3.30E-02
CO-57	Not Detected	-----	3.19E-02
CO-58	Not Detected	-----	3.28E-02
CO-60	Not Detected	-----	3.50E-02
CR-51	Not Detected	-----	2.46E-01
CS-134	Not Detected	-----	4.87E-02
CS-137	Not Detected	-----	3.31E-02
EU-152	Not Detected	-----	9.53E-02
EU-154	Not Detected	-----	1.88E-01
EU-155	Not Detected	-----	1.57E-01
FE-59	Not Detected	-----	7.50E-02
GD-153	Not Detected	-----	1.10E-01
HG-203	Not Detected	-----	3.25E-02
I-131	Not Detected	-----	3.86E-02
IR-192	Not Detected	-----	2.71E-02
K-40	2.51E+01	3.56E+00	2.25E-01
MN-52	Not Detected	-----	4.26E-02
MN-54	Not Detected	-----	2.02E-02
MO-99	Not Detected	-----	6.14E-01
NA-22	Not Detected	-----	4.35E-02
NA-24	Not Detected	-----	2.22E+00
NB-95	Not Detected	-----	3.52E-01
ND-147	Not Detected	-----	2.52E-01
NI-57	Not Detected	-----	1.50E-01
PB-210	Not Detected	-----	3.53E+01
RU-103	Not Detected	-----	3.14E-02
RU-106	Not Detected	-----	2.88E-01
SB-122	Not Detected	-----	1.02E-01
SB-124	Not Detected	-----	2.98E-02
SB-125	Not Detected	-----	8.11E-02
SN-113	Not Detected	-----	3.73E-02
SR-85	Not Detected	-----	3.60E-02
TA-182	Not Detected	-----	1.52E-01
TA-183	Not Detected	-----	6.97E-01
TC-99m	Not Detected	-----	1.21E+03
TL-201	Not Detected	-----	4.52E-01
XE-133	Not Detected	-----	5.01E-01
Y-88	Not Detected	-----	2.40E-02
ZN-65	Not Detected	-----	1.03E-01
ZR-95	Not Detected	-----	5.80E-02

not detected J 4/14/97

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-14-97 11:35:39 AM *

* Analyzed by:  4/15/97 Reviewed by:  4/15/97 *

 Customer : P.SLAVIN/S.YOUNG (6682)
 Customer Sample ID : 034315-002
 Lab Sample ID : 70054920

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 927.000 gram
 Sample Date/Time : 4-10-97 11:30:00 AM
 Acquire Start Date/Time : 4-14-97 9:52:41 AM
 Detector Name : LAB02
 Elapsed Live/Real Time : 6000 / 6004 seconds

CY10-M9-T3-B

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	3.39E+00
TH-234	1.76E+00	5.91E-01	7.76E-01
RA-226	2.03E+00	3.56E+00	5.68E-01
PB-214	8.74E-01	1.42E-01	4.52E-02
BI-214	8.06E-01	1.84E-01	1.94E-01
TH-232	9.90E-01	4.61E-01	1.43E-01
RA-228	1.02E+00	2.28E-01	1.47E-01
AC-228	1.03E+00	2.22E-01	8.31E-02
TH-228	1.17E+00	3.01E-01	4.65E-01
RA-224	1.10E+00	3.02E-01	5.12E-02
PB-212	1.02E+00	1.62E-01	4.07E-02
BI-212	6.51E-01	2.20E-01	1.71E-01
TL-208	9.17E-01	1.62E-01	6.30E-02
U-235	Not Detected	-----	2.45E-01
TH-231	Not Detected	-----	1.32E+01
PA-231	Not Detected	-----	1.40E+00
TH-227	Not Detected	-----	3.57E-01
RA-223	Not Detected	-----	2.57E-01
RN-219	Not Detected	-----	3.63E-01
PB-211	Not Detected	-----	8.31E-01
TL-207	Not Detected	-----	1.36E+01
AM-241	Not Detected	-----	4.77E-01
PU-239	Not Detected	-----	4.57E+02
NP-237	Not Detected	-----	3.32E-01
PA-233	Not Detected	-----	5.68E-02
TH-229	Not Detected	-----	2.57E-01

[Summary Report] - Sample ID: : 70054920

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.05E-02
AG-110m	Not Detected	-----	3.37E-02
BA-133	Not Detected	-----	6.47E-02
BE-7	Not Detected	-----	2.60E-01
CD-109	2.28E-00	6.52E-01	1.13E+00
CD-115	Not Detected	-----	2.25E-01
CE-139	Not Detected	-----	3.09E-02
CE-141	Not Detected	-----	5.76E-02
CE-144	Not Detected	-----	2.49E-01
CO-56	Not Detected	-----	2.05E-02
CO-57	Not Detected	-----	3.13E-02
CO-58	Not Detected	-----	3.31E-02
CO-60	Not Detected	-----	3.64E-02
CR-51	Not Detected	-----	2.56E-01
CS-134	Not Detected	-----	4.74E-02
CS-137	2.20E-02	1.72E-02	2.04E-02
EU-152	Not Detected	-----	9.36E-02
EU-154	Not Detected	-----	1.88E-01
EU-155	Not Detected	-----	1.54E-01
FE-59	Not Detected	-----	7.57E-02
GD-153	Not Detected	-----	1.08E-01
HG-203	Not Detected	-----	3.29E-02
I-131	Not Detected	-----	3.96E-02
IR-192	Not Detected	-----	2.78E-02
K-40	2.63E+01	3.70E+00	2.52E-01
MN-52	Not Detected	-----	4.72E-02
MN-54	Not Detected	-----	1.90E-02
MO-99	Not Detected	-----	6.31E-01
NA-22	Not Detected	-----	4.43E-02
NA-24	Not Detected	-----	2.43E+00
NB-95	Not Detected	-----	3.50E-01
ND-147	Not Detected	-----	2.50E-01
NI-57	2.65E-01	1.16E-01	1.62E-01
PB-210	Not Detected	-----	3.52E+01
RU-103	Not Detected	-----	2.96E-02
RU-106	Not Detected	-----	2.80E-01
SB-122	Not Detected	-----	1.06E-01
SB-124	Not Detected	-----	2.96E-02
SB-125	Not Detected	-----	8.15E-02
SN-113	Not Detected	-----	3.77E-02
SR-85	Not Detected	-----	3.76E-02
TA-182	Not Detected	-----	1.56E-01
TA-183	Not Detected	-----	6.91E-01
TC-99m	Not Detected	-----	1.56E+03
TL-201	Not Detected	-----	4.56E-01
XE-133	Not Detected	-----	5.11E-01
Y-88	Not Detected	-----	2.27E-02
ZN-65	Not Detected	-----	1.05E-01
ZR-95	Not Detected	-----	5.73E-02

not detected 7/15/77

not detected 7/11/77

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-14-97 11:36:46 AM *

 * Analyzed by: *J* 4/15/97 Reviewed by: *WY* 4/15/97 *

 Customer : P.SLAVIN/S.YOUNG (6682)
 Customer Sample ID : 034316-002
 Lab Sample ID : 70054921

Sample Description : MARINELLI LIQUID SAMPLE
 Sample Quantity : 500.000 mL
 Sample Date/Time : 4-10-97 2:35:00 PM
 Acquire Start Date/Time : 4-14-97 9:53:57 AM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6001 seconds

CY10 - RBE

Comments:

Nuclide Name	Activity (pCi/mL)	2-sigma Error	MDA (pCi/mL)
U-238	Not Detected	-----	7.98E-01
TH-234	Not Detected	-----	3.18E-01
RA-226	Not Detected	-----	4.58E-01
PB-214	Not Detected	-----	5.35E-02
BI-214	Not Detected	-----	5.93E-02
TH-232	Not Detected	-----	1.58E-01
RA-228	Not Detected	-----	1.63E-01
AC-228	Not Detected	-----	1.04E-01
TH-228	Not Detected	-----	4.90E-01
RA-224	Not Detected	-----	1.35E-01
PB-212	8.05E-03	8.95E-03	2.71E-02
BI-212	Not Detected	-----	2.03E-01
TL-208	Not Detected	-----	8.04E-02
U-235	Not Detected	-----	1.42E-01
TH-231	Not Detected	-----	4.50E+00
PA-231	Not Detected	-----	1.07E+00
TH-227	Not Detected	-----	1.57E-01
RA-223	Not Detected	-----	8.74E-02
RN-219	Not Detected	-----	3.01E-01
PB-211	Not Detected	-----	6.56E-01
TL-207	Not Detected	-----	1.13E+01
AM-241	Not Detected	-----	9.80E-02
PU-239	Not Detected	-----	2.23E+02
NP-237	Not Detected	-----	1.36E-01
PA-233	Not Detected	-----	4.29E-02
TH-229	Not Detected	-----	1.20E-01

[Summary Report] - Sample ID: : 70054921

Nuclide Name	Activity (pCi/mL)	2-sigma Error	MDA (pCi/mL)
AG-108m	Not Detected	-----	2.66E-02
AG-110m	Not Detected	-----	2.22E-02
BA-133	Not Detected	-----	3.18E-02
BE-7	Not Detected	-----	1.98E-01
CD-109	Not Detected	-----	4.54E-01
CD-115	Not Detected	-----	1.20E-01
CE-139	Not Detected	-----	1.73E-02
CE-141	Not Detected	-----	3.21E-02
CE-144	Not Detected	-----	1.23E-01
CO-56	Not Detected	-----	3.67E-02
CO-57	Not Detected	-----	1.57E-02
CO-58	Not Detected	-----	2.52E-02
CO-60	Not Detected	-----	2.89E-02
CR-51	Not Detected	-----	1.89E-01
CS-134	Not Detected	-----	2.47E-02
CS-137	Not Detected	-----	2.52E-02
EU-152	Not Detected	-----	4.73E-02
EU-154	Not Detected	-----	1.25E-01
EU-155	Not Detected	-----	6.65E-02
FE-59	Not Detected	-----	4.72E-02
GD-153	Not Detected	-----	5.01E-02
HG-203	Not Detected	-----	2.20E-02
I-131	Not Detected	-----	3.35E-02
IR-192	Not Detected	-----	1.99E-02
K-40	Not Detected	-----	3.39E-01
MN-52	Not Detected	-----	5.33E-02
MN-54	Not Detected	-----	2.62E-02
MO-99	Not Detected	-----	5.09E-01
NA-22	Not Detected	-----	2.73E-02
NA-24	Not Detected	-----	1.67E+00
NB-95	Not Detected	-----	1.43E-01
ND-147	Not Detected	-----	2.09E-01
NI-57	Not Detected	-----	2.32E-01
PB-210	Not Detected	-----	3.82E+00
RU-103	Not Detected	-----	2.55E-02
RU-106	Not Detected	-----	2.45E-01
SB-122	Not Detected	-----	8.28E-02
SB-124	Not Detected	-----	2.64E-02
SB-125	Not Detected	-----	7.08E-02
SN-113	Not Detected	-----	2.91E-02
SR-85	Not Detected	-----	3.44E-02
TA-182	Not Detected	-----	8.35E-02
TA-183	Not Detected	-----	1.39E-01
TC-99m	Not Detected	-----	6.51E+02
TL-201	Not Detected	-----	1.38E-01
XE-133	Not Detected	-----	1.66E-01
Y-88	Not Detected	-----	3.36E-02
ZN-65	Not Detected	-----	6.13E-02
ZR-95	Not Detected	-----	5.09E-02

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-14-97 1:39:18 PM *

 * Analyzed by: *[Signature]* 4/15/97 Reviewed by: *[Signature]* 4/15/97 *

Customer : P.SLAVIN/S.YOUNG (6682)
 Customer Sample ID : 034317-002.
 Lab Sample ID : 70054922

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 930.000 gram
 Sample Date/Time : 4-10-97 11:42:00 AM
 Acquire Start Date/Time : 4-14-97 11:51:26 AM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6003 seconds

CY10 - MID-TI-M

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	5.48E-01	6.39E-01	1.39E+00
TH-234	6.53E-01	3.80E-01	4.58E-01
RA-226	1.12E+00	4.71E-01	4.98E-01
PB-214	5.69E-01	1.12E-01	4.23E-02
BI-214	5.15E-01	1.11E-01	4.84E-02
TH-232	6.68E-01	3.26E-01	1.33E-01
RA-228	6.26E-01	2.27E-01	1.66E-01
AC-228	7.01E-01	2.11E-01	8.86E-02
TH-228	5.44E-01	4.68E-01	4.42E-01
RA-224	6.70E-01	2.21E-01	7.51E-02
PB-212	6.68E-01	1.55E-01	3.80E-02
BI-212	4.78E-01	2.13E-01	1.83E-01
TL-208	6.29E-01	1.37E-01	7.24E-02
U-235	Not Detected	-----	1.89E-01
TH-231	Not Detected	-----	7.90E+00
PA-231	Not Detected	-----	1.27E+00
TH-227	Not Detected	-----	3.16E-01
RA-223	Not Detected	-----	1.58E-01
RN-219	2.09E-01	2.97E-01	3.69E-01
PB-211	Not Detected	-----	8.31E-01
TL-207	Not Detected	-----	1.52E+01
AM-241	Not Detected	-----	1.68E-01
PU-239	Not Detected	-----	3.24E+02
NP-237	3.46E-01	1.69E-01	1.83E-01
PA-233	Not Detected	-----	5.28E-02
TH-229	Not Detected	-----	1.80E-01

not detected *[Signature]* 4/15/97

not detected *[Signature]* 4/15/97

[Summary Report] - Sample ID: : 70054922

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.19E-02
AG-110m	Not Detected	-----	3.14E-02
BA-133	Not Detected	-----	4.84E-02
BE-7	Not Detected	-----	2.45E-01
CD-109	Not Detected	-----	8.60E-01
CD-115	Not Detected	-----	2.04E-01
CE-139	Not Detected	-----	2.38E-02
CE-141	Not Detected	-----	4.45E-02
CE-144	Not Detected	-----	1.76E-01
CO-56	Not Detected	-----	3.90E-02
CO-57	Not Detected	-----	2.21E-02
CO-58	Not Detected	-----	3.23E-02
CO-60	Not Detected	-----	4.19E-02
CR-51	Not Detected	-----	2.34E-01
CS-134	Not Detected	-----	3.92E-02
CS-137	Not Detected	-----	3.54E-02
EU-152	Not Detected	-----	6.65E-02
EU-154	Not Detected	-----	1.94E-01
EU-155	Not Detected	-----	1.02E-01
FE-59	Not Detected	-----	9.07E-02
GD-153	Not Detected	-----	7.32E-02
HG-203	Not Detected	-----	2.98E-02
I-131	Not Detected	-----	3.88E-02
IR-192	Not Detected	-----	2.62E-02
K-40	2.44E+01	3.62E+00	2.77E-01
MN-52	Not Detected	-----	4.87E-02
MN-54	Not Detected	-----	3.56E-02
MO-99	Not Detected	-----	6.65E-01
NA-22	Not Detected	-----	4.91E-02
NA-24	Not Detected	-----	2.86E+00
NB-95	Not Detected	-----	2.88E-01
ND-147	Not Detected	-----	2.45E-01
NI-57	Not Detected	-----	3.13E-01
PB-210	Not Detected	-----	6.99E+00
RU-103	Not Detected	-----	3.02E-02
RU-106	Not Detected	-----	2.88E-01
SB-122	Not Detected	-----	1.15E-01
SB-124	Not Detected	-----	3.01E-02
SB-125	Not Detected	-----	8.05E-02
SN-113	Not Detected	-----	3.57E-02
SR-85	Not Detected	-----	3.70E-02
TA-182	Not Detected	-----	1.80E-01
TA-183	Not Detected	-----	2.46E-01
TC-99m	Not Detected	-----	1.44E+03
TL-201	Not Detected	-----	2.44E-01
XE-133	Not Detected	-----	3.08E-01
Y-88	Not Detected	-----	2.35E-02
ZN-65	Not Detected	-----	1.22E-01
ZR-95	Not Detected	-----	6.44E-02

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-14-97 1:37:46 PM *
 * *****
 * Analyzed by: *J* 4/15/97 Reviewed by: *Y* 4/15/97 *
 * *****

Customer : P.SLAVIN/S.YOUNG (6682)
 Customer Sample ID : 034320-002
 Lab Sample ID : 70054923

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 710.000 gram
 Sample Date/Time : 4-10-97 11:48:00 AM
 Acquire Start Date/Time : 4-14-97 11:54:55 AM
 Detector Name : LAB02
 Elapsed Live/Real Time : 6000 / 6004 seconds

CY10-M10-T2-M

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	4.06E+00
TH-234	1.64E+00	6.21E-01	8.98E-01
RA-226	2.27E+00	9.42E-01	7.01E-01
PB-214	1.09E+00	1.90E-01	5.69E-02
BI-214	9.28E-01	3.47E-01	2.54E-01
TH-232	1.34E+00	8.73E-01	1.73E-01
RA-228	1.41E+00	3.87E-01	1.85E-01
AC-228	1.41E+00	1.38E+00	8.98E-02
TH-228	1.42E+00	1.88E+00	5.53E-01
RA-224	1.42E+00	3.86E-01	6.73E-02
PB-212	1.33E+00	2.73E-01	4.97E-02
BI-212	8.44E-01	3.01E-01	2.09E-01
TL-208	1.19E+00	2.08E-01	7.44E-02
U-235	1.78E-01	2.32E-01	2.98E-01
TH-231	Not Detected	-----	1.58E+01
PA-231	Not Detected	-----	1.74E+00
TH-227	Not Detected	-----	4.52E-01
RA-223	Not Detected	-----	3.15E-01
FN-219	Not Detected	-----	4.55E-01
PB-211	Not Detected	-----	1.03E+00
TL-207	Not Detected	-----	1.62E+01
AM-241	Not Detected	-----	5.94E-01
PU-239	Not Detected	-----	5.40E+02
NP-237	Not Detected	-----	3.66E-01
PA-233	Not Detected	-----	6.96E-02
TH-229	Not Detected	-----	3.10E-01

not detected J 4/15/97

[Summary Report] - Sample ID: : 70054923

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.96E-02
AG-110m	Not Detected	-----	3.66E-02
BA-133	Not Detected	-----	8.10E-02
BE-7	Not Detected	-----	3.21E-01
CD-109	3.25E+00	5.21E-01	1.25E+00
CD-115	Not Detected	-----	2.84E-01
CE-139	Not Detected	-----	3.63E-02
CE-141	Not Detected	-----	6.91E-02
CE-144	Not Detected	-----	2.96E-01
CO-56	Not Detected	-----	2.81E-02
CO-57	Not Detected	-----	3.68E-02
CO-58	Not Detected	-----	4.01E-02
CO-60	Not Detected	-----	4.17E-02
CR-51	Not Detected	-----	3.06E-01
CS-134	Not Detected	-----	5.93E-02
CS-137	Not Detected	-----	3.94E-02
EU-152	Not Detected	-----	1.10E-01
EU-154	Not Detected	-----	2.28E-01
EU-155	Not Detected	-----	1.79E-01
FE-59	Not Detected	-----	9.20E-02
GD-153	Not Detected	-----	1.30E-01
HG-203	Not Detected	-----	4.03E-02
I-131	Not Detected	-----	4.92E-02
IR-192	Not Detected	-----	3.42E-02
K-40	2.64E+01	3.80E+00	2.98E-01
MN-52	Not Detected	-----	5.72E-02
MN-54	Not Detected	-----	4.18E-02
MO-99	Not Detected	-----	7.49E-01
NA-22	Not Detected	-----	5.01E-02
NA-24	Not Detected	-----	3.08E+00
NB-95	Not Detected	-----	4.48E-01
ND-147	Not Detected	-----	3.07E-01
NI-57	Not Detected	-----	2.35E-01
PB-210	Not Detected	-----	4.30E+01
RU-103	Not Detected	-----	3.56E-02
RU-106	Not Detected	-----	3.38E-01
SB-122	Not Detected	-----	1.33E-01
SB-124	Not Detected	-----	3.73E-02
SB-125	Not Detected	-----	9.68E-02
SN-113	Not Detected	-----	4.44E-02
SR-85	Not Detected	-----	4.66E-02
TA-182	Not Detected	-----	1.91E-01
TA-183	Not Detected	-----	8.69E-01
TC-99m	Not Detected	-----	2.30E+03
TL-201	Not Detected	-----	5.53E-01
XE-133	Not Detected	-----	6.19E-01
Y-88	Not Detected	-----	3.12E-02
ZN-65	Not Detected	-----	1.30E-01
ZR-95	Not Detected	-----	7.20E-02

not detected 7/15/97

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-14-97 4:22:00 PM *

 * Analyzed by: *[Signature]* 4/15/97 Reviewed by: *[Signature]* 4/15/97 *

Customer : P.SLAVIN/S.YOUNG (6682)
 Customer Sample ID : 034321-002
 Lab Sample ID : 70054924

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 881.000 gram
 Sample Date/Time : 4-10-97 11:52:00 AM
 Acquire Start Date/Time : 4-14-97 2:31:57 PM
 Detector Name : LAB02
 Elapsed Live/Real Time : 6000 / 6004 seconds

CYD-MID-72-5

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	3.38E+00
TH-234	1.36E+00	5.37E-01	7.66E-01
RA-226	1.76E+00	1.53E+00	5.64E-01
PB-214	7.77E-01	2.62E-01	4.57E-02
BI-214	7.35E-01	2.07E-01	2.04E-01
TH-232	1.02E+00	4.78E-01	1.42E-01
RA-228	1.02E+00	1.45E+00	1.32E-01
AC-228	1.02E+00	2.13E-01	8.31E-02
TH-228	9.10E-01	2.57E-01	4.47E-01
RA-224	1.14E+00	3.25E-01	5.82E-02
PB-212	1.01E+00	2.57E-01	4.12E-02
BI-212	6.38E-01	2.34E-01	1.74E-01
TL-208	9.49E-01	1.70E-01	6.38E-02
U-235	1.43E-01	1.90E-01	2.44E-01
TH-231	Not Detected	-----	1.28E+01
PA-231	Not Detected	-----	1.39E+00
TH-227	Not Detected	-----	3.60E-01
RA-223	Not Detected	-----	2.55E-01
RN-219	Not Detected	-----	3.70E-01
PB-211	Not Detected	-----	8.44E-01
TL-207	Not Detected	-----	1.34E+01
AM-241	Not Detected	-----	4.83E-01
PU-239	Not Detected	-----	4.52E+02
NP-237	Not Detected	-----	2.75E-01
PA-233	Not Detected	-----	5.62E-02
TH-229	Not Detected	-----	2.58E-01

not detected 4/15/97

[Summary Report] - Sample ID: : 70054924

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.14E-02
AG-110m	Not Detected	-----	2.96E-02
BA-133	Not Detected	-----	6.39E-02
BE-7	Not Detected	-----	2.58E-01
CD-109	2.05E+00	6.40E-01	9.36E-01
CD-115	Not Detected	-----	2.36E-01
CE-139	Not Detected	-----	2.95E-02
CE-141	Not Detected	-----	5.69E-02
CE-144	Not Detected	-----	2.47E-01
CO-56	Not Detected	-----	2.67E-02
CO-57	Not Detected	-----	3.06E-02
CO-58	Not Detected	-----	3.14E-02
CO-60	Not Detected	-----	3.69E-02
CR-51	Not Detected	-----	2.57E-01
CS-134	Not Detected	-----	4.72E-02
CS-137	Not Detected	-----	3.16E-02
EU-152	Not Detected	-----	9.14E-02
EU-154	Not Detected	-----	1.90E-01
EU-155	Not Detected	-----	1.53E-01
FE-59	Not Detected	-----	7.58E-02
GD-153	Not Detected	-----	1.09E-01
HG-203	Not Detected	-----	3.25E-02
I-131	Not Detected	-----	3.95E-02
IR-192	Not Detected	-----	2.77E-02
K-40	2.26E+01	3.23E+00	2.62E-01
MN-52	Not Detected	-----	4.52E-02
MN-54	1.70E-02	1.50E-02	1.84E-02
MO-99	Not Detected	-----	6.55E-01
NA-22	Not Detected	-----	4.05E-02
NA-24	Not Detected	-----	2.94E+00
NB-95	Not Detected	-----	3.65E-01
ND-147	Not Detected	-----	2.54E-01
NI-57	3.35E-01	2.62E-01	1.80E-01
PB-210	Not Detected	-----	3.45E+01
RU-103	Not Detected	-----	2.96E-02
RU-106	Not Detected	-----	2.87E-01
SB-122	Not Detected	-----	1.08E-01
SB-124	Not Detected	-----	2.90E-02
SB-125	Not Detected	-----	7.99E-02
SN-113	Not Detected	-----	3.68E-02
SR-85	Not Detected	-----	3.73E-02
TA-182	Not Detected	-----	1.50E-01
TA-183	Not Detected	-----	7.20E-01
TC-99m	Not Detected	-----	2.56E+03
TL-201	Not Detected	-----	4.65E-01
XE-133	Not Detected	-----	5.29E-01
Y-88	Not Detected	-----	2.49E-02
ZN-65	Not Detected	-----	1.02E-01
ZR-95	Not Detected	-----	5.57E-02

not detected 7/15/97

not detected 7/15/97

not detected 7/15/97

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-14-97 4:23:35 PM *

* Analyzed by: *J 4/15/97* Reviewed by: *J 4/15/97* *

Customer : P.SLAVIN/S.YOUNG (6682)
 Customer Sample ID : 034322-002
 Lab Sample ID : 70054925

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 825.000 gram
 Sample Date/Time : 4-10-97 11:58:00 AM
 Acquire Start Date/Time : 4-14-97 2:35:48 PM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6003 seconds

~~CYD-ABO~~
 CYD-MID-T3-M

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	1.61E+00
TH-234	1.05E+00	4.79E-01	5.13E-01
RA-226	1.84E+00	7.80E-01	6.41E-01
PB-214	8.21E-01	1.53E-01	4.83E-02
BI-214	7.26E-01	1.55E-01	5.49E-02
TH-232	1.00E+00	4.99E-01	1.76E-01
RA-228	1.02E+00	1.45E+00	1.96E-01
AC-228	1.06E+00	9.11E-01	9.63E-02
TH-228	8.52E-01	5.12E-01	5.23E-01
RA-224	1.04E+00	3.58E-01	6.22E-02
PB-212	1.01E+00	1.88E-01	4.25E-02
BI-212	7.55E-01	4.02E-01	2.22E-01
TL-208	9.57E-01	1.81E-01	7.78E-02
U-235	2.00E-01	1.61E-01	2.24E-01
TH-231	Not Detected	-----	9.46E+00
PA-231	Not Detected	-----	1.48E+00
TH-227	Not Detected	-----	4.03E-01
RA-223	Not Detected	-----	1.91E-01
RN-219	2.83E-01	3.62E-01	4.48E-01
PB-211	Not Detected	-----	1.00E+00
TL-207	Not Detected	-----	1.75E+01
AM-241	Not Detected	-----	1.96E-01
PU-239	Not Detected	-----	3.85E+02
NP-237	3.06E-01	4.12E-01	1.86E-01
PA-233	Not Detected	-----	6.00E-02
TH-229	Not Detected	-----	2.10E-01

not detected J 4/15/97

not detected J 4/15/97

not detected J 4/15/97

[Summary Report] - Sample ID: : 70054925

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.81E-02
AG-110m	Not Detected	-----	3.52E-02
BA-133	Not Detected	-----	5.83E-02
BE-7	Not Detected	-----	2.94E-01
CD-109	Not Detected	-----	1.02E+00
CD-115	Not Detected	-----	2.67E-01
CE-139	Not Detected	-----	2.79E-02
CE-141	Not Detected	-----	5.37E-02
CE-144	Not Detected	-----	2.09E-01
CO-56	Not Detected	-----	2.99E-02
CO-57	Not Detected	-----	2.67E-02
CO-58	Not Detected	-----	3.87E-02
CO-60	Not Detected	-----	4.66E-02
CR-51	Not Detected	-----	2.70E-01
CS-134	Not Detected	-----	4.77E-02
CS-137	Not Detected	-----	4.25E-02
EU-152	Not Detected	-----	7.88E-02
EU-154	Not Detected	-----	2.25E-01
EU-155	Not Detected	-----	1.19E-01
FE-59	Not Detected	-----	1.03E-01
GD-153	Not Detected	-----	8.60E-02
HG-203	Not Detected	-----	3.62E-02
I-131	Not Detected	-----	4.38E-02
IR-192	Not Detected	-----	2.97E-02
K-40	2.48E+01	3.70E+00	2.74E-01
MN-52	Not Detected	-----	5.94E-02
MN-54	Not Detected	-----	4.21E-02
MO-99	Not Detected	-----	8.09E-01
NA-22	Not Detected	-----	5.35E-02
NA-24	Not Detected	-----	3.66E+00
NB-95	Not Detected	-----	3.69E-01
ND-147	Not Detected	-----	2.95E-01
NI-57	Not Detected	-----	3.88E-01
PB-210	Not Detected	-----	8.22E+00
RU-103	Not Detected	-----	3.37E-02
RU-106	Not Detected	-----	3.22E-01
SB-122	Not Detected	-----	1.30E-01
SB-124	Not Detected	-----	3.56E-02
SB-125	Not Detected	-----	9.79E-02
SN-113	Not Detected	-----	4.18E-02
SR-85	Not Detected	-----	4.34E-02
TA-182	Not Detected	-----	1.92E-01
TA-183	Not Detected	-----	2.92E-01
TC-99m	Not Detected	-----	2.23E+03
TL-201	Not Detected	-----	2.97E-01
XE-133	Not Detected	-----	3.77E-01
Y-88	Not Detected	-----	3.14E-02
ZN-65	Not Detected	-----	1.30E-01
ZR-95	Not Detected	-----	7.10E-02

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-14-97 4:27:23 PM *

 * Analyzed by: *[Signature]* 4/15/97 Reviewed by: *[Signature]* 4/15/97 *

Customer : P.SLAVIN/S.YOUNG (6682)
 Customer Sample ID : 034323-002
 Lab Sample ID : 70054926

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 873.000 gram
 Sample Date/Time : 4-10-97 12:02:00 PM
 Acquire Start Date/Time : 4-14-97 2:38:50 PM
 Detector Name : LAB03
 Elapsed Live/Real Time : 6000 / 6004 seconds

CY10-M10-T3-B

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	1.41E+00
TH-234	1.86E+00	4.90E-01	4.45E-01
RA-226	1.81E+00	5.43E-01	5.53E-01
PB-214	8.95E-01	1.59E-01	5.28E-02
BI-214	7.71E-01	8.84E-01	5.22E-02
TH-232	1.00E+00	4.72E-01	1.55E-01
RA-228	1.11E+00	3.69E-01	1.86E-01
AC-228	1.15E+00	1.86E+00	9.80E-02
TH-228	6.46E-01	2.99E-01	5.74E-01
RA-224	Not Detected	-----	3.90E+00
PB-212	1.11E+00	1.82E-01	4.02E-02
BI-212	7.35E-01	5.54E-01	2.18E-01
TL-208	1.03E+00	2.10E-01	7.45E-02
U-235	9.50E-02	1.40E-01	2.06E-01
TH-231	Not Detected	-----	7.86E+00
PA-231	Not Detected	-----	1.40E+00
TH-227	Not Detected	-----	3.89E-01
RA-223	Not Detected	-----	1.63E-01
RN-219	2.77E-01	3.30E-01	4.18E-01
PB-211	Not Detected	-----	9.32E-01
TL-207	Not Detected	-----	1.57E+01
AM-241	Not Detected	-----	1.64E-01
PU-239	Not Detected	-----	3.76E+02
NP-237	Not Detected	-----	2.72E-01
PA-233	Not Detected	-----	6.23E-02
TH-229	Not Detected	-----	1.98E-01

not detected *[Signature]* 4/15/97

not detected *[Signature]* 4/15/97

[Summary Report] - Sample ID: : 70054926

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.69E-02
AG-110m	Not Detected	-----	3.70E-02
BA-133	Not Detected	-----	6.50E-02
BE-7	Not Detected	-----	2.82E-01
CD-109	2.67E-00	6.07E-01	7.37E-01
CD-115	Not Detected	-----	2.53E-01
CE-139	Not Detected	-----	2.71E-02
CE-141	Not Detected	-----	4.87E-02
CE-144	Not Detected	-----	2.01E-01
CO-56	Not Detected	-----	3.68E-02
CO-57	Not Detected	-----	2.57E-02
CO-58	Not Detected	-----	3.72E-02
CO-60	Not Detected	-----	4.21E-02
CR-51	Not Detected	-----	2.74E-01
CS-134	Not Detected	-----	4.27E-02
CS-137	Not Detected	-----	3.89E-02
EU-152	Not Detected	-----	7.65E-02
EU-154	Not Detected	-----	2.19E-01
EU-155	Not Detected	-----	1.15E-01
FE-59	Not Detected	-----	9.47E-02
GD-153	Not Detected	-----	8.25E-02
HG-203	Not Detected	-----	3.34E-02
I-131	Not Detected	-----	4.35E-02
IR-192	Not Detected	-----	3.00E-02
K-40	2.41E+01	3.66E+00	2.77E-01
MN-52	Not Detected	-----	6.00E-02
MN-54	Not Detected	-----	3.84E-02
MO-99	Not Detected	-----	7.73E-01
NA-22	Not Detected	-----	5.18E-02
NA-24	Not Detected	-----	3.62E+00
NB-95	Not Detected	-----	3.64E-01
ND-147	Not Detected	-----	2.77E-01
NI-57	Not Detected	-----	3.58E-01
PB-210	Not Detected	-----	2.06E+00
RU-103	Not Detected	-----	3.23E-02
RU-106	Not Detected	-----	3.36E-01
SB-122	Not Detected	-----	1.20E-01
SB-124	Not Detected	-----	3.36E-02
SB-125	Not Detected	-----	8.89E-02
SN-113	Not Detected	-----	4.18E-02
SR-85	Not Detected	-----	4.20E-02
TA-182	Not Detected	-----	1.74E-01
TA-183	Not Detected	-----	2.42E-01
TC-99m	Not Detected	-----	2.08E+03
TL-201	Not Detected	-----	2.34E-01
XE-133	Not Detected	-----	3.15E-01
Y-88	Not Detected	-----	3.19E-02
ZN-65	Not Detected	-----	1.19E-01
ZR-95	Not Detected	-----	6.69E-02

not detected 7/4/5/57

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-14-97 2:06:43 AM *

 *
 * Analyzed by: *J 4/15/97* Reviewed by: *AM 4/15/97* *

 Customer : P.SLAVIN/S.YOUNG (6682)
 Customer Sample ID : 032972-002
 Lab Sample ID : 70054927

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 760.000 gram
 Sample Date/Time : 4-10-97 2:30:00 PM
 Acquire Start Date/Time : 4-14-97 12:24:04 AM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6003 seconds

CY10-M3-S4

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	1.70E+00
TH-234	1.39E+00	4.03E-01	5.04E-01
RA-226	1.52E+00	9.22E-01	5.92E-01
PB-214	8.10E-01	1.57E-01	5.25E-02
BI-214	7.69E-01	1.78E-01	5.53E-02
TH-232	9.72E-01	4.92E-01	1.73E-01
RA-228	8.65E-01	2.58E-01	1.84E-01
AC-228	9.47E-01	2.33E-01	1.16E-01
TH-228	8.03E-01	5.85E-01	5.27E-01
RA-224	1.00E+00	3.59E-01	6.75E-02
PB-212	9.86E-01	1.73E-01	4.23E-02
BI-212	4.94E-01	3.67E-01	2.29E-01
TL-208	9.84E-01	4.98E-01	7.87E-02
U-235	1.76E-01	1.66E-01	2.31E-01
TH-231	Not Detected	-----	9.85E+00
PA-231	Not Detected	-----	1.60E+00
TH-227	Not Detected	-----	4.11E-01
RA-223	Not Detected	-----	1.89E-01
RN-219	Not Detected	-----	4.48E-01
PB-211	Not Detected	-----	1.02E+00
TL-207	Not Detected	-----	1.81E+01
AM-241	Not Detected	-----	2.12E-01
PU-239	Not Detected	-----	3.93E+02
NP-237	Not Detected	-----	2.21E-01
PA-233	Not Detected	-----	6.22E-02
TH-229	Not Detected	-----	2.22E-01

Not Detected J 4/15/97

[Summary Report] - Sample ID: : 70054927

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	5.16E-02
AG-110m	Not Detected	-----	3.75E-02
BA-133	Not Detected	-----	6.15E-02
BE-7	Not Detected	-----	2.92E-01
CD-109	1.98E+00	5.67E-01	7.53E-01
CD-115	Not Detected	-----	2.18E-01
CE-139	Not Detected	-----	2.93E-02
CE-141	Not Detected	-----	5.32E-02
CE-144	Not Detected	-----	2.16E-01
CO-56	Not Detected	-----	4.29E-02
CO-57	Not Detected	-----	2.70E-02
CO-58	Not Detected	-----	4.19E-02
CO-60	Not Detected	-----	4.59E-02
CR-51	Not Detected	-----	2.74E-01
CS-134	Not Detected	-----	4.93E-02
CS-137	Not Detected	-----	4.18E-02
EU-152	Not Detected	-----	8.08E-02
EU-154	Not Detected	-----	2.38E-01
EU-155	Not Detected	-----	8.58E-02
FE-59	Not Detected	-----	1.01E-01
GD-153	Not Detected	-----	9.14E-02
HG-203	Not Detected	-----	3.67E-02
I-131	Not Detected	-----	4.32E-02
IR-192	Not Detected	-----	3.06E-02
K-40	2.42E+01	3.67E+00	3.64E-01
MN-52	Not Detected	-----	5.83E-02
MN-54	Not Detected	-----	1.94E-02
MO-99	Not Detected	-----	6.76E-01
NA-22	Not Detected	-----	5.36E-02
NA-24	Not Detected	-----	1.94E+00
NB-95	Not Detected	-----	3.28E-01
ND-147	Not Detected	-----	2.92E-01
NI-57	Not Detected	-----	3.04E-01
PB-210	Not Detected	-----	8.53E+00
RU-103	Not Detected	-----	3.45E-02
RU-106	Not Detected	-----	3.42E-01
SB-122	2.64E-02	3.37E-02	5.99E-02
SB-124	Not Detected	-----	3.70E-02
SB-125	Not Detected	-----	1.02E-01
SN-113	Not Detected	-----	4.27E-02
SR-85	Not Detected	-----	4.68E-02
TA-182	Not Detected	-----	2.05E-01
TA-183	Not Detected	-----	2.87E-01
TC-99m	Not Detected	-----	3.34E+02
TL-201	Not Detected	-----	2.61E-01
XE-133	Not Detected	-----	3.19E-01
Y-88	Not Detected	-----	3.50E-02
ZN-65	Not Detected	-----	1.40E-01
ZR-95	Not Detected	-----	7.51E-02

not detected 7/15/97

not detected 7/15/97

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-14-97 3:51:46 AM *

 * Analyzed by: *J 4/15/97* Reviewed by: *SA 4/15/97* *

Customer : P.SLAVIN/S.YOUNG (6682)
 Customer Sample ID : 032988-002
 Lab Sample ID : 70054928

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 819.000 gram
 Sample Date/Time : 4-10-97 2:00:00 PM
 Acquire Start Date/Time : 4-14-97 2:09:03 AM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6003 seconds

CY10-M6-S1

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	1.17E+00	8.69E-01	1.41E+00
TH-234	1.48E+00	4.17E-01	5.09E-01
RA-226	1.93E+00	1.10E+00	6.52E-01
PB-214	8.18E-01	2.59E-01	5.42E-02
BI-214	8.42E-01	1.98E-01	5.51E-02
TH-232	1.21E+00	5.70E-01	1.60E-01
RA-228	1.02E+00	3.08E-01	2.04E-01
AC-228	1.14E+00	2.40E-01	9.83E-02
TH-228	7.86E-01	4.19E-01	5.69E-01
RA-224	1.03E+00	6.16E-01	1.17E-01
PB-212	1.09E+00	1.76E-01	4.36E-02
BI-212	6.24E-01	2.44E-01	2.08E-01
TL-208	1.09E+00	2.09E-01	7.68E-02
U-235	Not Detected	-----	2.32E-01
TH-231	Not Detected	-----	9.60E+00
PA-231	Not Detected	-----	1.59E+00
TH-227	Not Detected	-----	4.13E-01
RA-223	Not Detected	-----	1.92E-01
RN-219	Not Detected	-----	4.38E-01
PB-211	Not Detected	-----	1.00E+00
TL-207	Not Detected	-----	1.72E+01
AM-241	Not Detected	-----	2.05E-01
PU-239	Not Detected	-----	4.05E+02
NP-237	Not Detected	-----	3.22E-01
PA-233	Not Detected	-----	6.09E-02
TH-229	Not Detected	-----	2.24E-01

[Summary Report] - Sample ID: : 70054928

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.87E-02
AG-110m	Not Detected	-----	3.98E-02
BA-133	Not Detected	-----	6.02E-02
BE-7	Not Detected	-----	2.95E-01
CD-109	2.10E+00	5.74E-01	8.26E-01
CD-115	Not Detected	-----	2.29E-01
CE-139	Not Detected	-----	3.04E-02
CE-141	Not Detected	-----	5.44E-02
CE-144	Not Detected	-----	2.14E-01
CO-56	Not Detected	-----	4.24E-02
CO-57	Not Detected	-----	2.77E-02
CO-58	Not Detected	-----	4.14E-02
CO-60	Not Detected	-----	4.60E-02
CR-51	Not Detected	-----	2.76E-01
CS-134	Not Detected	-----	4.89E-02
CS-137	2.80E-02	2.12E-02	2.61E-02
EU-152	Not Detected	-----	8.24E-02
EU-154	Not Detected	-----	2.26E-01
EU-155	Not Detected	-----	1.27E-01
FE-59	Not Detected	-----	9.89E-02
GD-153	Not Detected	-----	9.18E-02
HG-203	Not Detected	-----	3.64E-02
I-131	Not Detected	-----	4.22E-02
IR-192	Not Detected	-----	2.95E-02
K-40	2.37E+01	3.53E+00	3.02E-01
MN-52	Not Detected	-----	5.82E-02
MN-54	Not Detected	-----	4.47E-02
MO-99	Not Detected	-----	6.88E-01
NA-22	Not Detected	-----	5.54E-02
NA-24	Not Detected	-----	2.05E+00
NB-95	Not Detected	-----	3.38E-01
ND-147	Not Detected	-----	2.94E-01
NI-57	Not Detected	-----	3.17E-01
PB-210	Not Detected	-----	8.65E+00
RU-103	Not Detected	-----	3.58E-02
RU-106	Not Detected	-----	3.39E-01
SB-122	Not Detected	-----	1.15E-01
SB-124	Not Detected	-----	3.49E-02
SB-125	Not Detected	-----	9.89E-02
SN-113	Not Detected	-----	4.23E-02
SR-85	Not Detected	-----	4.57E-02
TA-182	Not Detected	-----	1.95E-01
TA-183	Not Detected	-----	2.81E-01
TC-99m	Not Detected	-----	4.43E+02
TL-201	Not Detected	-----	2.67E-01
XE-133	Not Detected	-----	3.16E-01
Y-88	Not Detected	-----	3.01E-02
ZN-65	Not Detected	-----	1.33E-01
ZR-95	Not Detected	-----	7.09E-02

not detected 7/15/57

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-14-97 5:36:50 AM *

 * Analyzed by: *[Signature]* 4/15/97 Reviewed by: *[Signature]* 4/15/97 *

Customer : P.SLAVIN/S.YOUNG (6682)
 Customer Sample ID : 032989-002
 Lab Sample ID : 70054929

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 660.000 gram
 Sample Date/Time : 4-10-97 2:03:00 PM
 Acquire Start Date/Time : 4-14-97 3:54:09 AM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6002 seconds

CYD-M6-S2

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	2.92E+00	1.53E+00	1.68E+00
TH-234	3.37E+00	8.84E-01	5.71E-01
RA-226	1.04E+00	6.45E-01	6.44E-01
PB-214	7.34E-01	1.43E-01	5.26E-02
BI-214	7.56E-01	1.70E-01	6.40E-02
TH-232	9.58E-01	4.64E-01	1.76E-01
RA-228	9.04E-01	2.56E-01	2.17E-01
AC-228	9.55E-01	2.54E-01	1.12E-01
TH-228	7.49E-01	4.42E-01	5.06E-01
RA-224	1.00E+00	3.87E-01	8.98E-02
PB-212	9.21E-01	1.53E-01	4.34E-02
BI-212	4.74E-01	3.72E-01	2.54E-01
TL-208	8.70E-01	1.89E-01	8.48E-02
U-235	6.81E-02	7.25E-02	1.39E-01
TH-231	Not Detected	-----	1.07E+01
PA-231	Not Detected	-----	1.60E+00
TH-227	Not Detected	-----	4.32E-01
RA-223	Not Detected	-----	2.08E-01
RN-219	2.31E-01	3.87E-01	4.81E-01
PB-211	Not Detected	-----	1.06E+00
TL-207	Not Detected	-----	1.92E+01
AM-241	Not Detected	-----	2.27E-01
PU-239	Not Detected	-----	4.10E+02
NP-237	Not Detected	-----	3.44E-01
PA-233	Not Detected	-----	6.80E-02
TH-229	Not Detected	-----	2.35E-01

Not Detected 7/15/97

ANALYSIS REQUEST AND CHAIN OF CUSTODY

PAGE 1 OF 1

AR/COC-03350

SF 2001-COC (9-94)

Dept. No./Mail Stop: 6682/BS/MS-1147
 Project/Task Manager: PAULA SLAVIN
 Project Name: SITE 10 CAMP SMP
 Record Center Code: ER/1333/010/DAT
 Logbook Ref No: 206
 SMO Reference No.: CF0394

Date Sample Shipped: 4/10/97
 Lab Contact: FERNANDO DOMINGUEZ
 Lab Destination: RPSD, BUDGBI
 SMO Contact/Phone: PAM PLUSANT 644-3185
 Send Report to SMO: PAULA SLAVIN (CRAIG BROWN)

Contract No.: N/A
 Case No.: 8321-201722
 SMO Authorization: [Signature]
 Bill to: Senda National Laboratories
 Supplier Services Department
 P.O. Box 5800 MS 0154
 Albuquerque, NM 87185-0154

Parameter & Method Requested

Location		Tech Area		Reference LOV (available at SMO)		Container		Preservative	Sample Collection Method	Sample Type	Lab Sample ID
Building	Room	Beginning Depth in Ft.	ER Site No.	Date/Time Collected	Sample Matrix	Type	Volume				
Sample No. - Fraction		ER Sample ID or Sample Location Detail									
032981	-002	CY10-M6-TI-M	0.5	10	4.9.97 1228	S	P	98ml	None	GRAB SA	X
034309	-002	CY10-M9-TI-M			1303						
034318	-002	CY10-M10-TI-B			1245						
034329	-002	CY10-VM-1			1220						

RMMA ☒ Yes ☐ No Ref. No. _____Sample Disposal ☒ Return to Client ☐ Disposal by labTurnaround Time ☐ Normal ☒ Rush Required Report Date 4-10-97

Sample Team Members	Name	Signature	Init	Company/Organization
	PAULA SLAVIN	[Signature]	PS	GRAM/6682/284-2430
	Corveta Carriato	[Signature]	CC	Lamb/6682/229-5778

Special Instructions/QC Requirements

RUSH. This COC releases
 COC #06566 to LAS.
 Please fax results to Craig Brown
 at 284-2617. Please page CC
 at 229-5778 when complete.

Abnormal
 Conditions or
 Receipts

1. Relinquished by	[Signature]	Org. 6682	Date 4-10-97	Time 1427
1. Received by	[Signature]	Org. SMO 7578	Date 4/10/97	Time 1427
2. Relinquished by	[Signature]	Org. SMO 7578	Date 4/10/97	Time 1450
2. Received by	[Signature]	Org. SMO 7578	Date 4/10/97	Time 1450
3. Relinquished by	[Signature]	Org. SMO 7578	Date 4/11/97	Time 1028
3. Received by	[Signature]	Org. SMO 7578	Date 4/11/97	Time 1028

4. Relinquished by	[Signature]	Org. SMO 7578	Date 5/7/97	Time 1336
4. Received by	[Signature]	Org. 6682	Date 5/6/97	Time 1336
5. Relinquished by		Org.	Date	Time
5. Received by		Org.	Date	Time
6. Relinquished by		Org.	Date	Time
6. Received by		Org.	Date	Time

WHITE - To Accompany Samples, Laboratory Copy

BLUE - To Accompany Samples, Return to SMO

YELLOW - SMO Suspense Copy

PINK - Field Copy

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-10-97 5:24:24 PM *

 * Analyzed by: *J 4/11/97* Reviewed by: *J 4/11/97* *

 Customer : P. SLAVIN/MAC (6682/SMO)
 Customer Sample ID : 032981-002
 Lab Sample ID : 70054001 *CY10-M6-T1-M*

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 698.000 gram
 Sample Date/Time : 4-09-97 12:28:00 PM
 Acquire Start Date/Time : 4-10-97 3:40:18 PM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6002 seconds

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	1.68E+00
TH-234	Not Detected	-----	6.38E-01
RA-226	1.36E+00	5.01E-01	5.62E-01
PB-214	7.58E-01	1.69E-01	5.59E-02
BI-214	6.66E-01	1.34E-01	5.39E-02
TH-232	8.28E-01	4.01E-01	1.45E-01
RA-228	7.86E-01	6.95E-01	1.84E-01
AC-228	7.56E-01	2.13E-01	1.08E-01
TH-228	4.94E-01	3.75E-01	5.22E-01
RA-224	2.85E-01	1.27E-01	3.85E-02
PB-212	8.54E-01	1.43E-01	4.29E-02
BI-212	5.51E-01	3.35E-01	2.04E-01
TL-208	2.82E-01	5.85E-02	2.87E-02
U-235	1.44E-01	1.61E-01	2.26E-01
TH-231	Not Detected	-----	9.16E+00
PA-231	Not Detected	-----	1.48E+00
TH-227	Not Detected	-----	3.97E-01
RA-223	Not Detected	-----	1.56E-01
RN-219	Not Detected	-----	4.49E-01
PB-211	Not Detected	-----	1.05E+00
TL-207	Not Detected	-----	1.75E+01
AM-241	Not Detected	-----	2.07E-01
PU-239	Not Detected	-----	3.81E+02
NP-237	3.36E-01	1.72E-01	2.09E-01
PA-233	Not Detected	-----	6.15E-02
TH-229	Not Detected	-----	2.10E-01

not detected J 4/11/97

not detected J 4/11/97

[Summary Report] - Sample ID: : 70054001

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	5.06E-02
AG-110m	Not Detected	-----	3.46E-02
BA-133	Not Detected	-----	6.23E-02
BE-7	Not Detected	-----	2.90E-01
CD-109	Not Detected	-----	1.03E+00
CD-115	Not Detected	-----	1.03E-01
CE-139	Not Detected	-----	2.78E-02
CE-141	Not Detected	-----	5.00E-02
CE-144	Not Detected	-----	1.98E-01
CO-56	Not Detected	-----	4.42E-02
CO-57	Not Detected	-----	2.58E-02
CO-58	Not Detected	-----	3.82E-02
CO-60	Not Detected	-----	4.40E-02
CR-51	Not Detected	-----	2.61E-01
CS-134	Not Detected	-----	4.96E-02
CS-137	Not Detected	-----	4.01E-02
EU-152	Not Detected	-----	7.76E-02
EU-154	Not Detected	-----	2.35E-01
EU-155	Not Detected	-----	1.24E-01
FE-59	Not Detected	-----	9.12E-02
GD-153	Not Detected	-----	8.55E-02
HG-203	Not Detected	-----	3.36E-02
I-131	Not Detected	-----	3.38E-02
IR-192	Not Detected	-----	2.93E-02
K-40	1.73E+01	2.67E+00	3.45E-01
MN-52	Not Detected	-----	4.95E-02
MN-54	Not Detected	-----	4.02E-02
MO-99	Not Detected	-----	3.68E-01
NA-22	Not Detected	-----	5.28E-02
NA-24	Not Detected	-----	1.34E-01
NB-95	Not Detected	-----	2.05E-01
ND-147	Not Detected	-----	2.41E-01
NI-57	Not Detected	-----	9.88E-02
PB-210	Not Detected	-----	8.54E+00
RU-103	Not Detected	-----	3.44E-02
RU-106	Not Detected	-----	3.21E-01
SB-122	Not Detected	-----	6.33E-02
SB-124	Not Detected	-----	3.53E-02
SB-125	Not Detected	-----	9.36E-02
SN-113	Not Detected	-----	4.17E-02
SR-85	Not Detected	-----	4.39E-02
TA-182	Not Detected	-----	1.83E-01
TA-183	Not Detected	-----	2.06E-01
TC-99m	Not Detected	-----	5.90E-01
TL-201	Not Detected	-----	1.48E-01
XE-133	Not Detected	-----	1.45E-01
Y-88	Not Detected	-----	3.12E-02
ZN-65	Not Detected	-----	1.31E-01
ZR-95	Not Detected	-----	6.87E-02

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-10-97 7:10:05 PM *

 * Analyzed by: *[Signature]* 4/11/97 Reviewed by: *[Signature]* 4/11/97 *

 Customer : P. SLAVIN/MAC (6682/SMO)
 Customer Sample ID : 034309-002
 Lab Sample ID : 70054002

CY10-M9-T1-M

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 792.000 gram
 Sample Date/Time : 4-09-97 1:03:00 PM
 Acquire Start Date/Time : 4-10-97 5:27:18 PM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6003 seconds

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	1.73E+00
TH-234	1.35E+00	4.23E-01	5.20E-01
RA-226	1.90E+00	5.70E-01	6.27E-01
PB-214	9.98E-01	1.75E-01	5.74E-02
BI-214	9.17E-01	1.79E-01	6.02E-02
TH-232	1.09E+00	6.57E-01	1.75E-01
RA-228	1.16E+00	3.18E-01	2.16E-01
AC-228	1.05E+00	2.44E-01	1.08E-01
TH-228	1.00E+00	5.98E-01	5.04E-01
RA-224	4.28E-01	1.44E-01	3.58E-02
PB-212	1.16E+00	1.97E-01	4.44E-02
BI-212	8.02E-01	3.01E-01	2.18E-01
TL-208	3.91E-01	7.21E-02	2.72E-02
U-235	1.06E-01	1.77E-01	2.45E-01
TH-231	Not Detected	-----	1.01E+01
PA-231	Not Detected	-----	1.62E+00
TH-227	Not Detected	-----	4.34E-01
RA-223	Not Detected	-----	1.70E-01
RN-219	Not Detected	-----	4.56E-01
PB-211	Not Detected	-----	1.07E+00
TL-207	Not Detected	-----	1.77E+01
AM-241	Not Detected	-----	2.07E-01
PU-239	Not Detected	-----	4.02E+02
NP-237	6.68E-01	1.88E-01	2.49E-01
PA-233	Not Detected	-----	6.70E-02
TH-229	Not Detected	-----	2.26E-01

not detected 7/11/97

not detected 7/11/97

[Summary Report] - Sample ID: : 70054002

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	5.40E-02
AG-110m	Not Detected	-----	3.91E-02
BA-133	Not Detected	-----	6.57E-02
BE-7	Not Detected	-----	3.07E-01
CD-109	Not Detected	-----	8.46E-01
CD-115	Not Detected	-----	1.13E-01
CE-139	Not Detected	-----	3.08E-02
CE-141	Not Detected	-----	5.36E-02
CE-144	Not Detected	-----	2.20E-01
CO-56	Not Detected	-----	3.28E-02
CO-57	Not Detected	-----	2.75E-02
CO-58	Not Detected	-----	4.23E-02
CO-60	Not Detected	-----	4.93E-02
CR-51	Not Detected	-----	2.80E-01
CS-134	Not Detected	-----	5.39E-02
CS-137	Not Detected	-----	4.51E-02
EU-152	Not Detected	-----	8.22E-02
EU-154	Not Detected	-----	2.48E-01
EU-155	Not Detected	-----	1.29E-01
FE-59	Not Detected	-----	9.75E-02
GD-153	Not Detected	-----	9.25E-02
HG-203	Not Detected	-----	3.69E-02
I-131	Not Detected	-----	3.77E-02
IR-192	Not Detected	-----	3.17E-02
K-40	2.47E+01	3.66E+00	2.72E-01
MN-52	Not Detected	-----	4.80E-02
MN-54	Not Detected	-----	2.55E-02
MO-99	Not Detected	-----	4.11E-01
NA-22	Not Detected	-----	5.56E-02
NA-24	Not Detected	-----	1.58E-01
NB-95	Not Detected	-----	2.29E-01
ND-147	Not Detected	-----	2.64E-01
NI-57	Not Detected	-----	1.12E-01
PB-210	Not Detected	-----	8.70E+00
RU-103	Not Detected	-----	3.52E-02
RU-106	Not Detected	-----	3.58E-01
SB-122	Not Detected	-----	6.57E-02
SB-124	Not Detected	-----	3.63E-02
SB-125	Not Detected	-----	1.04E-01
SN-113	Not Detected	-----	4.43E-02
SR-85	Not Detected	-----	4.48E-02
TA-182	Not Detected	-----	2.06E-01
TA-183	Not Detected	-----	2.06E-01
TC-99m	Not Detected	-----	7.44E-01
TL-201	Not Detected	-----	1.62E-01
XE-133	Not Detected	-----	1.60E-01
Y-88	Not Detected	-----	3.76E-02
ZN-65	Not Detected	-----	1.42E-01
ZR-95	Not Detected	-----	7.23E-02

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-10-97 8:55:23 PM *

 * Analyzed by: *J 4/11/97* Reviewed by: *W 4/11/97* *

Customer : P. SLAVIN/MAC (6682/SMO)
 Customer Sample ID : 034318-002
 Lab Sample ID : 70054003

CY10-M10-T1-6

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 906.000 gram
 Sample Date/Time : 4-09-97 12:45:00 PM
 Acquire Start Date/Time : 4-10-97 7:12:37 PM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6003 seconds

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	1.59E+00
TH-234	1.16E+00	3.41E-01	4.74E-01
RA-226	1.69E+00	5.18E-01	5.46E-01
PB-214	8.34E-01	2.90E-01	5.02E-02
BI-214	7.57E-01	1.37E-01	4.78E-02
TH-232	1.06E+00	4.99E-01	1.54E-01
RA-228	1.11E+00	4.13E-01	1.84E-01
AC-228	1.03E+00	1.70E+00	9.79E-02
TH-228	5.17E-01	3.31E-01	4.59E-01
RA-224	3.90E-01	1.25E-01	2.91E-02
PB-212	1.06E+00	1.70E-01	3.96E-02
BI-212	7.05E-01	2.47E-01	2.15E-01
TL-208	3.71E-01	1.76E-01	2.44E-02
U-235	Not Detected	-----	2.22E-01
TH-231	Not Detected	-----	9.13E+00
PA-231	Not Detected	-----	1.47E+00
TH-227	Not Detected	-----	3.85E-01
RA-223	Not Detected	-----	1.55E-01
RN-219	Not Detected	-----	4.24E-01
PB-211	Not Detected	-----	9.47E-01
TL-207	Not Detected	-----	1.59E+01
AM-241	Not Detected	-----	2.00E-01
PU-239	Not Detected	-----	3.72E+02
NP-237	6.86E-01	2.01E-01	2.25E-01
PA-233	Not Detected	-----	5.79E-02
TH-229	Not Detected	-----	2.10E-01

not detected J 4/11/97

[Summary Report] - Sample ID: : 70054003

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.79E-02
AG-110m	Not Detected	-----	3.41E-02
BA-133	Not Detected	-----	5.67E-02
BE-7	Not Detected	-----	2.71E-01
CD-109	Not Detected	-----	1.03E+00
CD-115	Not Detected	-----	1.04E-01
CE-139	Not Detected	-----	2.76E-02
CE-141	Not Detected	-----	4.94E-02
CE-144	Not Detected	-----	1.98E-01
CO-56	Not Detected	-----	2.69E-02
CO-57	Not Detected	-----	2.58E-02
CO-58	Not Detected	-----	3.68E-02
CO-60	Not Detected	-----	3.89E-02
CR-51	Not Detected	-----	2.52E-01
CS-134	Not Detected	-----	4.60E-02
CS-137	Not Detected	-----	4.01E-02
EU-152	Not Detected	-----	7.81E-02
EU-154	Not Detected	-----	2.22E-01
EU-155	Not Detected	-----	1.20E-01
FE-59	Not Detected	-----	8.78E-02
GD-153	Not Detected	-----	8.60E-02
HG-203	Not Detected	-----	3.22E-02
I-131	Not Detected	-----	3.47E-02
IR-192	Not Detected	-----	2.82E-02
K-40	2.26E+01	3.31E+00	3.01E-01
MN-52	Not Detected	-----	3.98E-02
MN-54	Not Detected	-----	4.03E-02
MO-99	Not Detected	-----	3.62E-01
NA-22	Not Detected	-----	5.12E-02
NA-24	Not Detected	-----	1.46E-01
NB-95	Not Detected	-----	2.06E-01
ND-147	Not Detected	-----	2.40E-01
NI-57	Not Detected	-----	9.78E-02
PB-210	Not Detected	-----	8.07E+00
RU-103	Not Detected	-----	3.27E-02
RU-106	Not Detected	-----	3.13E-01
SB-122	Not Detected	-----	6.05E-02
SB-124	Not Detected	-----	3.23E-02
SB-125	Not Detected	-----	9.07E-02
SN-113	Not Detected	-----	4.02E-02
SR-85	Not Detected	-----	4.00E-02
TA-182	Not Detected	-----	1.85E-01
TA-183	Not Detected	-----	2.03E-01
TC-99m	Not Detected	-----	8.64E-01
TL-201	Not Detected	-----	1.54E-01
XE-133	Not Detected	-----	1.51E-01
Y-88	Not Detected	-----	2.99E-02
ZN-65	Not Detected	-----	1.29E-01
ZR-95	Not Detected	-----	6.52E-02

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-10-97 10:41:06 PM *

 * Analyzed by: *J 4/11/97* Reviewed by: *JS 4/11/97* *

Customer : P. SLAVIN/MAC (6682/SMO)
 Customer Sample ID : 034329-002
 Lab Sample ID : 70054004

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 907.000 gram
 Sample Date/Time : 4-09-97 12:20:00 PM
 Acquire Start Date/Time : 4-10-97 8:58:16 PM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6004 seconds

CY10-VM-1

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	1.15E+00	9.23E-01	1.44E+00
TH-234	1.89E+00	4.86E-01	5.31E-01
RA-226	2.73E+00	6.53E-01	6.11E-01
PB-214	1.26E+00	2.07E-01	5.09E-02
BI-214	1.10E+00	2.02E-01	5.80E-02
TH-232	1.22E+00	5.75E-01	1.75E-01
RA-228	1.14E+00	2.70E-01	1.97E-01
AC-228	1.19E+00	2.91E-01	1.10E-01
TH-228	1.11E+00	4.09E-01	5.09E-01
RA-224	4.89E-01	1.75E-01	3.13E-02
PB-212	1.20E+00	1.88E-01	4.30E-02
BI-212	6.44E-01	2.38E-01	2.22E-01
TL-208	4.08E-01	2.39E-01	3.03E-02
U-235	1.04E-01	1.76E-01	2.43E-01
TH-231	Not Detected	-----	9.92E+00
PA-231	Not Detected	-----	1.58E+00
TH-227	Not Detected	-----	4.24E-01
RA-223	Not Detected	-----	1.69E-01
RN-219	2.94E-01	3.59E-01	4.42E-01
PB-211	Not Detected	-----	9.95E-01
TL-207	Not Detected	-----	1.75E+01
AM-241	Not Detected	-----	2.11E-01
PU-239	Not Detected	-----	4.03E+02
NP-237	8.10E-01	2.06E-01	2.25E-01
PA-233	Not Detected	-----	6.43E-02
TH-229	Not Detected	-----	2.28E-01

not detected J 4/11/97

not detected J 4/11/97

[Summary Report] - Sample ID: : 70054004

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	5.23E-02
AG-110m	Not Detected	-----	3.77E-02
BA-133	Not Detected	-----	6.64E-02
BE-7	Not Detected	-----	2.87E-01
CD-109	Not Detected	-----	1.11E+00
CD-115	Not Detected	-----	1.16E-01
CE-139	Not Detected	-----	2.96E-02
CE-141	Not Detected	-----	5.40E-02
CE-144	Not Detected	-----	2.17E-01
CO-56	Not Detected	-----	2.97E-02
CO-57	Not Detected	-----	2.81E-02
CO-58	Not Detected	-----	3.87E-02
CO-60	Not Detected	-----	4.65E-02
CR-51	Not Detected	-----	2.66E-01
CS-134	Not Detected	-----	5.26E-02
CS-137	Not Detected	-----	4.48E-02
EU-152	Not Detected	-----	8.39E-02
EU-154	Not Detected	-----	2.42E-01
EU-155	Not Detected	-----	1.32E-01
FE-59	Not Detected	-----	9.41E-02
GD-153	Not Detected	-----	9.38E-02
HG-203	Not Detected	-----	3.60E-02
I-131	Not Detected	-----	3.68E-02
IR-192	Not Detected	-----	3.01E-02
K-40	2.53E+01	3.74E+00	2.99E-01
MN-52	Not Detected	-----	4.82E-02
MN-54	Not Detected	-----	4.23E-02
MO-99	Not Detected	-----	4.25E-01
NA-22	Not Detected	-----	5.30E-02
NA-24	Not Detected	-----	1.83E-01
NB-95	Not Detected	-----	2.30E-01
ND-147	Not Detected	-----	2.58E-01
NI-57	Not Detected	-----	1.22E-01
PB-210	Not Detected	-----	8.65E+00
RU-103	Not Detected	-----	3.46E-02
RU-106	Not Detected	-----	3.40E-01
SB-122	3.17E-02	3.78E-02	4.21E-02
SB-124	Not Detected	-----	3.51E-02
SB-125	Not Detected	-----	9.95E-02
SN-113	Not Detected	-----	4.35E-02
SR-85	Not Detected	-----	4.34E-02
TA-182	Not Detected	-----	1.97E-01
TA-183	Not Detected	-----	2.16E-01
TC-99m	Not Detected	-----	1.22E+00
TL-201	Not Detected	-----	1.69E-01
XE-133	Not Detected	-----	1.68E-01
Y-88	Not Detected	-----	3.10E-02
ZN-65	Not Detected	-----	1.36E-01
ZR-95	Not Detected	-----	7.29E-02

not detected 7/4/11/97

KUSH PAGE 1 OF 1
AR/COC- 06570

Batch No. 700601

SF 201 CLK (6.95)

Date Samples Shipped: 4/17/97
Carrier/Waybill No.: HC
Lab Contact: FERNANDO DOMINGUEZ
Lab Destination: PPSD, Bldg 881
SMO Contact/Phone: PAM PUSSANT / 844-3183
Send Report to SMO: PAM PUSSANT

Case No. 8821, 2013.

SMD Authorization: [Signature]
 Bill to: Sandia National Laboratories
 Supplier Services Department
 P.O. Box 5800 MS 0154
 Albuquerque, NM 87185-0154

Parameter & Method Requested

[illegible]

RMMA ☒ Yes ☐ No Ref. No. _____

Sample Disposal ☒ Return to Client ☐ Disposal by lab

Turnaround Time ☐ Normal ☒ Rush Required Report Date

Sample Tracking

Date Entered (mm/dd/yy)

Entered by:

Special Instructions/QC Requirements

RUSH. This releases
COC # 06574 to LAS
for isotopic uranium.

Abnormal

Conditions on

Receipt of Original

4102 01/01/06

1991-1992

[illegible]

1990-1991

1997年12月15日

10/10/1954

Sample Team Members	Name	Signature	Init	Company/Organization/Phone
	PAULA SLAVIN	<i>Paula Slavin</i>	PS	GRAM/6682/284-2424
	CONCETTA ACCIATO	<i>Concetta Acciato</i>	CC	MDM-LS units/6684/229-5777

1. Relinquished by <i>Conrado Camacho</i>	Org. <i>6684</i>	Date <i>4/17/97</i>	Time <i>1420</i>
1. Received by <i>C. Stefanov</i>	Org. <i>7518</i>	Date <i>4/17/97</i>	Time <i>1420</i>
2. Relinquished by <i>C. Stefanov</i>	Org. <i>7518</i>	Date <i>4/17/97</i>	Time <i>15:15</i>
2. Received by <i>[Signature]</i>	Org. <i>227578</i>	Date <i>4/12/97</i>	Time <i>1515</i>
3. Relinquished by <i>[Signature]</i>	Org. <i>SN 27578</i>	Date <i>4/18/97</i>	Time <i>1135</i>
3. Received by <i>C. Stefanov</i>	Org. <i>7518</i>	Date <i>4/18/97</i>	Time <i>11:35</i>

4. Relinquished by	Org. SMO 7578	Date 5/7/97	Time 1336
4. Received by	Org. 6604	Date 5/07/97	Time 1336
5. Relinquished by	Org.	Date	Time
5. Received by	Org.	Date	Time
6. Relinquished by	Org.	Date	Time
6. Received by	Org.	Date	Time

**WHITE - To Accompany Samples,
Laboratory Copy**

**BLUE- To Accompany Samples,
Return to SMO**

YELLOW- SMO Suspense Copy

PINK- Field Copy

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*****
*                               Sandia National Laboratories                               *
*   Radiation Protection Sample Diagnostics Program [881 Laboratory]   *
*                               4-17-97  6:08:18 PM                               *
*****
*
* Analyzed by: [Signature] 4/17/97      Reviewed by: MDJ 4/18/97
*****
Customer      : P.SLAVIN/C.STEFANOV (6682/SMO)
Customer Sample ID : 033373-002
Lab Sample ID   : 70060101

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Sample Description      : MARINELLI SOLID SAMPLE
Sample Quantity        : 798.000 gram
Sample Date/Time       : 4-16-97  2:00:00 PM
Acquire Start Date/Time : 4-17-97  3:35:08 PM
Detector Name         : LAB03
Elapsed Live/Real Time : 6000 / 6004 seconds

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CY10-M9-T2-4

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	3.47E+00	1.01E+00	1.36E+00
TH-234	4.19E+00	9.96E-01	5.06E-01
RA-226	2.55E+00	8.95E-01	5.61E-01
PB-214	9.40E-01	1.55E-01	5.54E-02
BI-214	8.95E-01	1.75E-01	6.03E-02
TH-232	1.05E+00	5.02E-01	1.75E-01
RA-228	1.17E+00	3.50E-01	1.87E-01
AC-228	1.26E+00	2.03E-01	1.06E-01
TH-228	1.01E+00	3.02E-01	5.69E-01
RA-224	1.26E+00	3.90E-01	7.94E-02
PB-212	1.22E+00	2.02E-01	4.33E-02
BI-212	6.69E-01	3.93E-01	2.53E-01
TL-208	1.14E+00	2.09E-01	8.03E-02
U-235	Not Detected	-----	2.25E-01
TH-231	3.05E+00	3.14E+00	8.89E+00
PA-231	Not Detected	-----	1.49E+00
TH-227	Not Detected	-----	4.32E-01
RA-223	Not Detected	-----	1.54E-01
RN-219	Not Detected	-----	4.57E-01
PB-211	Not Detected	-----	1.04E+00
TL-207	Not Detected	-----	1.78E+01
AM-241	Not Detected	-----	1.88E-01
PU-239	Not Detected	-----	4.02E+02
NP-237	Not Detected	-----	2.41E-01
PA-233	Not Detected	-----	6.54E-02
TH-229	Not Detected	-----	2.23E-01

not detected 4/17/97

[Summary Report] - Sample ID: : 70060101

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	5.26E-02
AG-110m	Not Detected	-----	4.07E-02
BA-133	Not Detected	-----	6.76E-02
BE-7	Not Detected	-----	3.00E-01
CD-109	2.74E+00	6.27E-01	8.16E-01
CD-115	Not Detected	-----	1.08E-01
CE-139	Not Detected	-----	2.98E-02
CE-141	Not Detected	-----	4.99E-02
CE-144	Not Detected	-----	2.14E-01
CO-56	Not Detected	-----	3.99E-02
CO-57	Not Detected	-----	2.80E-02
CO-58	Not Detected	-----	4.23E-02
CO-60	Not Detected	-----	4.77E-02
CR-51	Not Detected	-----	2.73E-01
CS-134	Not Detected	-----	4.70E-02
CS-137	Not Detected	-----	4.48E-02
EU-152	Not Detected	-----	8.40E-02
EU-154	Not Detected	-----	2.43E-01
EU-155	Not Detected	-----	1.26E-01
FE-59	Not Detected	-----	9.44E-02
GD-153	Not Detected	-----	9.30E-02
HG-203	Not Detected	-----	3.44E-02
I-131	Not Detected	-----	3.67E-02
IR-192	Not Detected	-----	3.14E-02
K-40	2.57E+01	3.83E+00	3.04E-01
MN-52	Not Detected	-----	4.65E-02
MN-54	Not Detected	-----	4.26E-02
MO-99	Not Detected	-----	3.79E-01
NA-22	Not Detected	-----	5.63E-02
NA-24	Not Detected	-----	1.38E-01
NB-95	Not Detected	-----	2.29E-01
ND-147	Not Detected	-----	2.43E-01
NI-57	Not Detected	-----	1.02E-01
PB-210	Not Detected	-----	5.24E+00
RU-103	Not Detected	-----	3.41E-02
RU-106	Not Detected	-----	3.71E-01
SB-122	Not Detected	-----	6.16E-02
SB-124	Not Detected	-----	3.48E-02
SB-125	Not Detected	-----	9.73E-02
SN-113	Not Detected	-----	4.42E-02
SR-85	Not Detected	-----	4.55E-02
TA-182	Not Detected	-----	1.97E-01
TA-183	Not Detected	-----	1.84E-01
TC-99m	Not Detected	-----	4.97E-01
TL-201	Not Detected	-----	1.33E-01
XE-133	Not Detected	-----	1.36E-01
Y-88	Not Detected	-----	3.22E-02
ZN-65	Not Detected	-----	1.33E-01
ZR-95	Not Detected	-----	7.41E-02

not detected 7/4/17/5

ANALYSIS REQUEST AND CHAIN OF CUSTODY

PAGE 1 OF 2

Internal Lab

Batch No. 700600

AR/COC-06569

SF 2001-COC (6-95)

Dept. No./Mail Stop: 6682/BSMS-1147		Date Sample Shipped: 4/17/97		Contract No.: -		Parameter & Method Requested											
Project/Task Manager: PAULA SLAVIN		Carrier/Waybill No.: 700600		Case No.: 700600													
Project Name: SITE 10 CONF. SMLG		Lab Contact: FERNANDO DOMINIQUEZ		SMO Authorization: [Signature]		GAMMA SPEC											
Record Center Code: ER/1333/010/DAT		Lab Destination: RPSD - Bloc 801		Bill to: Sandia National Laboratories Supplier Services Department P.O. Box 5800 MS 0154 Albuquerque, NM 87185-0154													
Logbook Ref No: 206		SMO Contact/Phone: PAUL PUSSANT/844-318															
Service Order No.: CF0394		Send Report to SMO PAULA SLAVIN															
Location		Tech Area		Reference LOV (available at SMO)													
Building Room		Beginning Depth in Ft. ER Site No.		Date/Time Collected		Sample Matrix		Container Type Volume		Preservative		Sample Collection Method		Sample Type		Lab Sample ID	
Sample No. - Fraction		ER Sample ID or Sample Location Detail															
034331-002		CY10-SS-N2		0.5 10		4-16-97 1008		SOIL P 500ml		None		GRAB		SA		X	
034332-002		CY10-SS-N3				1015											
034333-002		CY10-SS-NE1				1030											
034334-002		CY10-SS-NE3				1035											
034335-002		CY10-SS-E2				0958											
034336-002		CY10-SS-E4				0955											
034337-002		CY10-SS-SE1				1053											
034338-002		CY10-SS-SE3				1135											
034339-002		CY10-SS-S2				1115											
034342-002		CY10-SS-S4				1120											
RMMA <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Ref. No. _____				Sample Tracking				Special Instructions/QC Requirements				Abnormal Conditions on Receipt					
Sample Disposal <input checked="" type="checkbox"/> Return to Client <input type="checkbox"/> Disposal by lab				Date Entered (mm/dd/yy)				Normal turnaround time				Upon completion, please send hard copy report to Paula Slavin @ MS-1147					
Turnaround Time <input checked="" type="checkbox"/> Normal <input type="checkbox"/> Rush Required Report Date 5-2-97				Entered by: [Signature]													
Sample Team Members		Name		Signature		Init		Company/Organization/Phone									
		PAULA SLAVIN		[Signature]		MS		6682/294-2496									
		CONCEITA CACCIATO		[Signature]		LL		MDM-6684/229-5770									
1. Relinquished by [Signature]		Org. 6684		Date 4/17/97		Time 1450		4. Relinquished by		Org.		Date		Time			
1. Received by [Signature]		Org. SML 7578		Date 4/17/97		Time 1450		4. Received by		Org.		Date		Time			
2. Relinquished by		Org.		Date		Time		5. Relinquished by		Org.		Date		Time			
2. Received by		Org.		Date		Time		5. Received by		Org.		Date		Time			
3. Relinquished by		Org.		Date		Time		6. Relinquished by		Org.		Date		Time			
3. Received by		Org.		Date		Time		6. Received by		Org.		Date		Time			

WHITE - To Accompany Samples, Laboratory Copy

BLUE - To Accompany Samples, Return to SMO

YELLOW - SMO Suspense Copy

PINK - Field Copy

ANALYSIS REQUEST AND CHAIN OF CUSTODY
CONTINUATION FORM

PAGE 2 OF 2

AR/COC-06569

BATCH # 700600

Project Name: SITE 10 CONF SEMPLG Project/Task Manager: PAULA SLAVIN Case No.: 8821-201200

Location		Tech Area		Beginning Depth in Ft.	ER Site No.	Date/Time Collected	Reference LOV (available at SMO)					Lab Sample ID	
Building	Room	Sample No. - Fraction	ER Sample ID or Sample Location Detail				Sample Matrix	Type	Volume	Preservative	Sample Collection Method		Sample Type
034343	-002	CY10-SS-SW1	0.5	10	4.16.97 1110	SOIL	P	500ml	None	GRAB	SA	X	
034344	-002	CY10-SS-SW4			1125								
034345	-002	CY10-SS-W2			1055								
034346	-002	CY10-SS-W4			1045								
034347	-002	CY10-SS-NW1			1058								
034348	-002	CY10-SS-NW4			1050								
034349	-002	CY10-SS-ARY-1			1305								
034351	-002	CY10-SS-ARY-3			1308								
034353	-002	CY10-SS-ARY-4			1310								
034354	-002	CY10-SS-ARY-5			1315								
034355	-002	CY10-SS-ARY-6			1317								
034356	-002	CY10-SS-ARY-7	✓		1320	✓					✓		
034324	-002	CY10-RBF	NA		0845	WATER					EB		
034330	-002	CY10-RBG	NA		1200	✓					EB		
		4.16.97 1110											
		4.16.97 1110											
		4.16.97 1110											
		4.16.97 1110	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	

Abnormal Conditions on Receipt

Recipient Initials

WHITE - To Accompany Samples,
Laboratory CopyBLUE - To Accompany Samples,
Return to SMO

YELLOW - SMO Suspense Copy

PINK - Field Copy

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-17-97 5:56:36 PM *

* Analyzed by: *J* 4/18/97 Reviewed by: *K* 4/21/97 *

 Customer : P.SLAVIN/C.C. (6682/IT)
 Customer Sample ID : 034331-002
 Lab Sample ID : 70060001

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 895.000 gram
 Sample Date/Time : 4-16-97 10:08:00 AM
 Acquire Start Date/Time : 4-17-97 4:12:13 PM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6003 seconds

CY10-SS-N2

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	1.16E+00	1.01E+00	1.55E+00
TH-234	1.97E+00	5.07E-01	5.14E-01
RA-226	2.08E+00	5.68E-01	6.08E-01
PB-214	9.58E-01	1.69E-01	5.04E-02
BI-214	8.48E-01	3.69E-01	5.45E-02
TH-232	1.07E+00	5.25E-01	1.55E-01
RA-228	1.14E+00	5.30E-01	1.86E-01
AC-228	1.05E+00	2.66E-01	9.83E-02
TH-228	1.01E+00	4.23E-01	5.02E-01
RA-224	1.19E+00	3.69E-01	7.93E-02
PB-212	1.17E+00	1.93E-01	4.25E-02
BI-212	7.45E-01	3.04E-01	2.13E-01
TL-208	1.03E+00	1.89E-01	7.89E-02
U-235	Not Detected	-----	2.26E-01
TH-231	Not Detected	-----	9.29E+00
PA-231	Not Detected	-----	1.50E+00
TH-227	Not Detected	-----	4.12E-01
RA-223	Not Detected	-----	1.60E-01
RN-219	Not Detected	-----	4.40E-01
PB-211	Not Detected	-----	9.76E-01
TL-207	Not Detected	-----	1.57E+01
AM-241	Not Detected	-----	2.04E-01
PU-239	Not Detected	-----	3.94E+02
NP-237	7.96E-01	2.14E-01	2.44E-01
PA-233	Not Detected	-----	5.99E-02
TH-229	Not Detected	-----	2.15E-01

not detected *J* 4/18/97

[Summary Report] - Sample ID: : 70060001

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	5.03E-02
AG-110m	Not Detected	-----	3.69E-02
BA-133	Not Detected	-----	5.90E-02
BE-7	Not Detected	-----	2.69E-01
CD-109	Not Detected	-----	8.28E-01
CD-115	Not Detected	-----	1.07E-01
CE-139	Not Detected	-----	2.81E-02
CE-141	Not Detected	-----	5.08E-02
CE-144	Not Detected	-----	2.06E-01
CO-56	Not Detected	-----	3.99E-02
CO-57	Not Detected	-----	2.61E-02
CO-58	Not Detected	-----	4.01E-02
CO-60	Not Detected	-----	4.45E-02
CR-51	Not Detected	-----	2.52E-01
CS-134	Not Detected	-----	4.71E-02
CS-137	2.61E-02	1.89E-02	2.48E-02
EU-152	Not Detected	-----	7.80E-02
EU-154	Not Detected	-----	2.31E-01
EU-155	Not Detected	-----	1.25E-01
FE-59	Not Detected	-----	8.91E-02
GD-153	Not Detected	-----	8.84E-02
HG-203	Not Detected	-----	3.38E-02
I-131	Not Detected	-----	3.34E-02
IR-192	Not Detected	-----	2.89E-02
K-40	2.39E+01	3.62E+00	3.06E-01
MN-52	Not Detected	-----	4.25E-02
MN-54	Not Detected	-----	2.26E-02
MO-99	Not Detected	-----	4.04E-01
NA-22	Not Detected	-----	5.03E-02
NA-24	Not Detected	-----	1.48E-01
NB-95	Not Detected	-----	2.19E-01
ND-147	Not Detected	-----	2.43E-01
NI-57	Not Detected	-----	9.97E-02
PB-210	Not Detected	-----	8.08E+00
RU-103	Not Detected	-----	3.20E-02
RU-106	Not Detected	-----	3.31E-01
SB-122	Not Detected	-----	6.00E-02
SB-124	Not Detected	-----	3.24E-02
SB-125	Not Detected	-----	9.40E-02
SN-113	Not Detected	-----	4.20E-02
SR-85	Not Detected	-----	4.18E-02
TA-182	Not Detected	-----	1.83E-01
TA-183	Not Detected	-----	2.06E-01
TC-99m	Not Detected	-----	8.53E-01
TL-201	Not Detected	-----	1.52E-01
XE-133	Not Detected	-----	1.53E-01
Y-88	Not Detected	-----	3.33E-02
ZN-65	Not Detected	-----	1.24E-01
ZR-95	Not Detected	-----	6.65E-02

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-17-97 7:43:51 PM *

* Analyzed by: *[Signature]* 4/18/97 Reviewed by: *[Signature]* 4/21/97

Customer : P.SLAVIN/C.C. (6682/IT)
 Customer Sample ID : 034332-002
 Lab Sample ID : 70060002

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 899.000 gram
 Sample Date/Time : 4-16-97 10:15:00 AM
 Acquire Start Date/Time : 4-17-97 5:59:21 PM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6003 seconds

CY10-SS-N3

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	1.43E+00
TH-234	1.52E+00	4.03E-01	4.96E-01
RA-226	1.93E+00	8.92E-01	5.76E-01
PB-214	8.83E-01	1.80E-01	5.19E-02
BI-214	8.07E-01	2.14E-01	5.47E-02
TH-232	1.20E+00	5.80E-01	1.69E-01
RA-228	1.13E+00	3.33E-01	2.03E-01
AC-228	1.06E+00	2.66E-01	1.01E-01
TH-228	8.68E-01	4.72E-01	4.68E-01
RA-224	1.18E+00	3.72E-01	8.39E-02
PB-212	1.16E+00	1.84E-01	4.01E-02
BI-212	7.51E-01	3.63E-01	2.18E-01
TL-208	1.11E+00	3.43E-01	7.36E-02
U-235	2.43E-01	1.67E-01	2.30E-01
TH-231	Not Detected	-----	9.17E+00
PA-231	Not Detected	-----	1.48E+00
TH-227	Not Detected	-----	4.08E-01
RA-223	Not Detected	-----	1.59E-01
RN-219	Not Detected	-----	4.31E-01
PB-211	Not Detected	-----	9.50E-01
TL-207	Not Detected	-----	1.58E+01
AM-241	Not Detected	-----	1.96E-01
PU-239	Not Detected	-----	3.77E+02
NP-237	7.22E-01	1.91E-01	2.43E-01
PA-233	Not Detected	-----	6.12E-02
TH-229	Not Detected	-----	2.15E-01

not detected 7/4/8/97

not detected 7/4/18/97

[Summary Report] - Sample ID: : 70060002

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.91E-02
AG-110m	Not Detected	-----	4.31E-02
BA-133	Not Detected	-----	5.94E-02
BE-7	Not Detected	-----	2.79E-01
CD-109	Not Detected	-----	1.04E+00
CD-115	Not Detected	-----	1.12E-01
CE-139	Not Detected	-----	2.80E-02
CE-141	Not Detected	-----	5.00E-02
CE-144	Not Detected	-----	2.08E-01
CO-56	Not Detected	-----	2.60E-02
CO-57	Not Detected	-----	2.66E-02
CO-58	Not Detected	-----	3.59E-02
CO-60	Not Detected	-----	4.54E-02
CR-51	Not Detected	-----	2.48E-01
CS-134	Not Detected	-----	4.63E-02
CS-137	9.10E-02	3.95E-02	2.84E-02
EU-152	Not Detected	-----	7.94E-02
EU-154	Not Detected	-----	2.26E-01
EU-155	Not Detected	-----	1.24E-01
FE-59	Not Detected	-----	9.18E-02
GD-153	Not Detected	-----	8.70E-02
HG-203	Not Detected	-----	3.32E-02
I-131	Not Detected	-----	3.50E-02
IR-192	Not Detected	-----	2.89E-02
K-40	2.38E+01	3.49E+00	2.71E-01
MN-52	Not Detected	-----	4.15E-02
MN-54	Not Detected	-----	2.17E-02
MO-99	Not Detected	-----	3.96E-01
NA-22	Not Detected	-----	5.23E-02
NA-24	Not Detected	-----	1.66E-01
NB-95	Not Detected	-----	2.19E-01
ND-147	Not Detected	-----	2.49E-01
NI-57	Not Detected	-----	1.01E-01
PB-210	Not Detected	-----	8.26E+00
RU-103	Not Detected	-----	3.23E-02
RU-106	Not Detected	-----	3.14E-01
SB-122	Not Detected	-----	6.58E-02
SB-124	Not Detected	-----	3.28E-02
SB-125	Not Detected	-----	9.23E-02
SN-113	Not Detected	-----	4.16E-02
SR-85	Not Detected	-----	4.09E-02
TA-182	Not Detected	-----	1.88E-01
TA-183	Not Detected	-----	1.99E-01
TC-99m	Not Detected	-----	1.03E+00
TL-201	Not Detected	-----	1.55E-01
XE-133	Not Detected	-----	1.52E-01
Y-88	Not Detected	-----	3.23E-02
ZN-65	Not Detected	-----	1.27E-01
ZR-95	Not Detected	-----	6.75E-02

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-17-97 9:30:50 PM *

* Analyzed by: *P 4/18/97* Reviewed by: *K 4/21/97* *

Customer : P.SLAVIN/C.C. (6682/IT)
 Customer Sample ID : 034333-002
 Lab Sample ID : 70060003

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 995.000 gram
 Sample Date/Time : 4-16-97 10:30:00 AM
 Acquire Start Date/Time : 4-17-97 7:46:32 PM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6004 seconds

CY10-SS-NE1

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	1.52E+00
TH-234	1.18E+00	3.45E-01	4.79E-01
RA-226	1.97E+00	8.17E-01	5.82E-01
PB-214	8.93E-01	2.57E-01	4.68E-02
BI-214	8.05E-01	1.48E-01	4.90E-02
TH-232	9.88E-01	6.63E-01	1.52E-01
RA-228	1.09E+00	3.53E-01	1.74E-01
AC-228	1.08E+00	2.50E-01	9.12E-02
TH-228	5.75E-01	3.53E-01	4.40E-01
RA-224	1.21E+00	4.01E-01	5.15E-02
PB-212	1.06E+00	1.73E-01	3.82E-02
BI-212	Not Detected	-----	2.02E-01
TL-208	9.78E-01	4.82E-01	6.75E-02
U-235	Not Detected	-----	2.15E-01
TH-231	Not Detected	-----	8.68E+00
PA-231	Not Detected	-----	1.39E+00
TH-227	Not Detected	-----	3.73E-01
RA-223	Not Detected	-----	1.51E-01
RN-219	Not Detected	-----	4.04E-01
PB-211	Not Detected	-----	9.02E-01
TL-207	Not Detected	-----	1.55E+01
AM-241	Not Detected	-----	1.86E-01
PU-239	Not Detected	-----	3.59E+02
NP-237	Not Detected	-----	2.90E-01
PA-233	Not Detected	-----	5.73E-02
TH-229	Not Detected	-----	2.00E-01

[Summary Report] - Sample ID: : 70060003

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.51E-02
AG-110m	Not Detected	-----	3.31E-02
BA-133	Not Detected	-----	5.57E-02
BE-7	Not Detected	-----	2.49E-01
CD-109	2.00E+00	5.55E-01	6.86E-01
CD-115	Not Detected	-----	1.03E-01
CE-139	Not Detected	-----	2.68E-02
CE-141	Not Detected	-----	4.74E-02
CE-144	Not Detected	-----	1.94E-01
CO-56	Not Detected	-----	3.67E-02
CO-57	Not Detected	-----	2.53E-02
CO-58	Not Detected	-----	3.46E-02
CO-60	Not Detected	-----	4.02E-02
CR-51	Not Detected	-----	2.33E-01
CS-134	Not Detected	-----	4.45E-02
CS-137	Not Detected	-----	3.82E-02
EU-152	Not Detected	-----	7.58E-02
EU-154	Not Detected	-----	2.10E-01
EU-155	Not Detected	-----	1.17E-01
FE-59	Not Detected	-----	8.17E-02
GD-153	Not Detected	-----	8.23E-02
HG-203	Not Detected	-----	3.16E-02
I-131	Not Detected	-----	3.23E-02
IR-192	Not Detected	-----	2.75E-02
K-40	2.33E+01	3.43E+00	2.45E-01
MN-52	Not Detected	-----	3.71E-02
MN-54	Not Detected	-----	2.04E-02
MO-99	Not Detected	-----	3.71E-01
NA-22	Not Detected	-----	5.03E-02
NA-24	Not Detected	-----	1.68E-01
NB-95	Not Detected	-----	2.03E-01
ND-147	Not Detected	-----	2.30E-01
NI-57	Not Detected	-----	1.05E-01
PB-210	Not Detected	-----	7.63E+00
RU-103	Not Detected	-----	3.11E-02
RU-106	Not Detected	-----	3.01E-01
SB-122	Not Detected	-----	5.88E-02
SB-124	Not Detected	-----	3.01E-02
SB-125	Not Detected	-----	8.82E-02
SN-113	Not Detected	-----	3.79E-02
SR-85	Not Detected	-----	3.77E-02
TA-182	Not Detected	-----	1.73E-01
TA-183	Not Detected	-----	1.91E-01
TC-99m	Not Detected	-----	1.16E+00
TL-201	Not Detected	-----	1.48E-01
XE-133	1.69E-02	7.54E-03	6.09E-02
Y-88	Not Detected	-----	2.90E-02
ZN-65	Not Detected	-----	1.15E-01
ZR-95	Not Detected	-----	6.66E-02

not detected J4/18/97

not detected J4/18/97

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-17-97 11:17:45 PM *

* Analyzed by: *[Signature]* 4/18/97 Reviewed by: *[Signature]* 4/18/97

Customer : P.SLAVIN/C.C. (6682/IT)
 Customer Sample ID : 034334-002
 Lab Sample ID : 70060004

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 876.000 gram
 Sample Date/Time : 4-16-97 10:35:00 AM
 Acquire Start Date/Time : 4-17-97 9:33:23 PM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6003 seconds

CY10-SSNE3

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	1.52E+00
TH-234	1.38E+00	4.94E-01	4.65E-01
RA-226	1.59E+00	7.49E-01	5.63E-01
PB-214	7.55E-01	1.32E-01	4.62E-02
BI-214	7.23E-01	1.43E-01	5.40E-02
TH-232	8.71E-01	4.18E-01	1.49E-01
RA-228	9.05E-01	2.71E-01	1.79E-01
AC-228	8.99E-01	2.04E-01	8.47E-02
TH-228	5.05E-01	3.38E-01	4.53E-01
RA-224	9.60E-01	3.22E-01	8.30E-02
PB-212	9.44E-01	3.23E-01	3.80E-02
BI-212	6.44E-01	3.27E-01	2.02E-01
TL-208	8.45E-01	1.13E+00	7.42E-02
U-235	1.54E-01	1.53E-01	2.13E-01
TH-231	Not Detected	-----	8.79E+00
PA-231	Not Detected	-----	1.43E+00
TH-227	Not Detected	-----	3.73E-01
RA-223	Not Detected	-----	1.54E-01
RN-219	Not Detected	-----	4.04E-01
PB-211	Not Detected	-----	9.15E-01
TL-207	Not Detected	-----	1.52E+01
AM-241	Not Detected	-----	1.90E-01
PU-239	Not Detected	-----	3.58E+02
NP-237	Not Detected	-----	2.94E-01
PA-233	Not Detected	-----	5.74E-02
TH-229	Not Detected	-----	1.98E-01

not detected 4/18/97

[Summary Report] - Sample ID: : 70060004

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.61E-02
AG-110m	Not Detected	-----	4.32E-02
BA-133	Not Detected	-----	5.51E-02
BE-7	Not Detected	-----	2.68E-01
CD-109	2.04E+00	5.71E-01	7.15E-01
CD-115	Not Detected	-----	1.04E-01
CE-139	Not Detected	-----	2.62E-02
CE-141	Not Detected	-----	4.70E-02
CE-144	Not Detected	-----	1.94E-01
CO-56	Not Detected	-----	2.54E-02
CO-57	Not Detected	-----	2.47E-02
CO-58	Not Detected	-----	3.59E-02
CO-60	Not Detected	-----	3.97E-02
CR-51	Not Detected	-----	2.39E-01
CS-134	Not Detected	-----	4.49E-02
CS-137	1.28E-01	5.72E-02	2.45E-02
EU-152	Not Detected	-----	7.39E-02
EU-154	Not Detected	-----	2.13E-01
EU-155	Not Detected	-----	1.15E-01
FE-59	Not Detected	-----	8.49E-02
GD-153	Not Detected	-----	8.17E-02
HG-203	Not Detected	-----	3.18E-02
I-131	Not Detected	-----	3.24E-02
IR-192	Not Detected	-----	2.66E-02
K-40	1.99E+01	2.97E+00	2.79E-01
MN-52	Not Detected	-----	4.18E-02
MN-54	Not Detected	-----	2.14E-02
MO-99	Not Detected	-----	3.88E-01
NA-22	Not Detected	-----	4.86E-02
NA-24	Not Detected	-----	1.91E-01
NB-95	Not Detected	-----	2.06E-01
ND-147	Not Detected	-----	2.31E-01
NI-57	Not Detected	-----	1.14E-01
PB-210	Not Detected	-----	7.70E+00
RU-103	Not Detected	-----	3.20E-02
RU-106	Not Detected	-----	2.96E-01
SB-122	Not Detected	-----	6.05E-02
SB-124	Not Detected	-----	3.20E-02
SB-125	Not Detected	-----	8.59E-02
SN-113	Not Detected	-----	3.96E-02
SR-85	Not Detected	-----	3.89E-02
TA-182	Not Detected	-----	1.77E-01
TA-183	Not Detected	-----	1.97E-01
TC-99m	Not Detected	-----	1.37E+00
TL-201	Not Detected	-----	1.49E-01
XE-133	Not Detected	-----	1.55E-01
Y-88	Not Detected	-----	2.91E-02
ZN-65	Not Detected	-----	1.19E-01
ZR-95	Not Detected	-----	6.18E-02

not detected 7/18/97

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-18-97 1:04:52 AM *

* Analyzed by: *J 4/18/97* Reviewed by: *K 4/18/97*

Customer : P.SLAVIN/C.C. (6682/IT)
 Customer Sample ID : 034335-002
 Lab Sample ID : 70060005

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 838.000 gram
 Sample Date/Time : 4-16-97 9:58:00 AM
 Acquire Start Date/Time : 4-17-97 11:20:25 PM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6004 seconds

CY10-SS-E2

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	1.82E+00
TH-234	1.98E+00	5.36E-01	5.54E-01
RA-226	2.34E+00	9.15E-01	6.17E-01
PB-214	1.01E+00	1.78E-01	5.34E-02
BI-214	9.53E-01	3.45E-01	6.15E-02
TH-232	1.39E+00	6.67E-01	1.89E-01
RA-228	1.48E+00	5.00E-01	2.18E-01
AC-228	1.43E+00	1.45E+00	1.10E-01
TH-228	1.42E+00	8.15E-01	5.42E-01
RA-224	1.64E+00	4.62E-01	7.14E-02
PB-212	1.48E+00	2.31E-01	4.61E-02
BI-212	9.43E-01	3.19E-01	2.33E-01
TL-208	1.37E+00	2.70E-01	8.43E-02
U-235	Not Detected	-----	2.45E-01
TH-231	Not Detected	-----	1.04E+01
PA-231	Not Detected	-----	1.61E+00
TH-227	Not Detected	-----	4.70E-01
RA-223	Not Detected	-----	1.83E-01
RN-219	Not Detected	-----	4.80E-01
PB-211	Not Detected	-----	1.09E+00
TL-207	Not Detected	-----	1.70E+01
AM-241	Not Detected	-----	2.24E-01
PU-239	Not Detected	-----	4.22E+02
NP-237	9.24E-01	2.22E-01	2.72E-01
PA-233	Not Detected	-----	6.67E-02
TH-229	Not Detected	-----	2.35E-01

not detected J 4/18/97

[Summary Report] - Sample ID: : 70060005

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	5.59E-02
AG-110m	Not Detected	-----	3.97E-02
BA-133	Not Detected	-----	6.54E-02
BE-7	Not Detected	-----	3.09E-01
CD-109	Not Detected	-----	1.17E+00
CD-115	Not Detected	-----	1.32E-01
CE-139	Not Detected	-----	3.10E-02
CE-141	Not Detected	-----	5.49E-02
CE-144	4.38E-02	2.74E-02	1.13E-01
CO-56	Not Detected	-----	4.17E-02
CO-57	Not Detected	-----	2.96E-02
CO-58	Not Detected	-----	4.23E-02
CO-60	Not Detected	-----	4.49E-02
CR-51	Not Detected	-----	2.86E-01
CS-134	Not Detected	-----	5.32E-02
CS-137	2.81E-02	3.75E-02	2.97E-02
EU-152	Not Detected	-----	8.81E-02
EU-154	Not Detected	-----	2.59E-01
EU-155	Not Detected	-----	1.37E-01
FE-59	Not Detected	-----	9.23E-02
GD-153	Not Detected	-----	9.58E-02
HG-203	Not Detected	-----	3.76E-02
I-131	Not Detected	-----	3.82E-02
IR-192	Not Detected	-----	3.21E-02
K-40	2.41E+01	3.58E+00	3.11E-01
MN-52	Not Detected	-----	4.89E-02
MN-54	Not Detected	-----	2.13E-02
MO-99	Not Detected	-----	4.41E-01
NA-22	Not Detected	-----	5.37E-02
NA-24	Not Detected	-----	2.32E-01
NB-95	Not Detected	-----	2.62E-01
ND-147	Not Detected	-----	2.85E-01
NI-57	Not Detected	-----	1.22E-01
PB-210	Not Detected	-----	8.85E+00
RU-103	Not Detected	-----	3.67E-02
RU-106	Not Detected	-----	3.46E-01
SB-122	Not Detected	-----	7.24E-02
SB-124	Not Detected	-----	3.58E-02
SB-125	Not Detected	-----	1.02E-01
SN-113	Not Detected	-----	4.48E-02
SR-85	Not Detected	-----	4.52E-02
TA-182	Not Detected	-----	2.00E-01
TA-183	Not Detected	-----	2.35E-01
TC-99m	Not Detected	-----	2.19E+00
TL-201	Not Detected	-----	1.82E-01
XE-133	Not Detected	-----	1.85E-01
Y-88	Not Detected	-----	3.33E-02
ZN-65	Not Detected	-----	1.38E-01
ZR-95	Not Detected	-----	7.43E-02

not detected 7/18/97

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-18-97 2:50:10 AM *

* Analyzed by: *J 4/18/97* Reviewed by: *K 4/18/97* *

Customer : P.SLAVIN/C.C. (6682/IT)
 Customer Sample ID : 034336-002
 Lab Sample ID : 70060006

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 788.000 gram
 Sample Date/Time : 4-16-97 9:55:00 AM
 Acquire Start Date/Time : 4-18-97 1:07:32 AM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6003 seconds

CY10-SS-E4

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	1.62E+00
TH-234	Not Detected	-----	6.21E-01
RA-226	1.48E+00	4.90E-01	5.20E-01
PB-214	6.64E-01	1.21E-01	5.07E-02
BI-214	6.63E-01	2.05E-01	5.76E-02
TH-232	8.36E-01	4.07E-01	1.54E-01
RA-228	8.93E-01	3.77E-01	2.02E-01
AC-228	9.09E-01	2.82E-01	9.52E-02
TH-228	8.36E-01	6.01E-01	4.89E-01
RA-224	8.13E-01	3.58E-01	7.37E-02
PB-212	8.96E-01	1.60E-01	4.37E-02
BI-212	4.49E-01	2.26E-01	2.01E-01
TL-208	8.24E-01	1.05E+00	7.26E-02
U-235	Not Detected	-----	2.19E-01
TH-231	Not Detected	-----	9.13E+00
PA-231	Not Detected	-----	1.47E+00
TH-227	Not Detected	-----	3.85E-01
RA-223	Not Detected	-----	1.60E-01
RN-219	Not Detected	-----	4.14E-01
PB-211	Not Detected	-----	9.36E-01
TL-207	Not Detected	-----	1.67E+01
AM-241	Not Detected	-----	1.97E-01
PU-239	Not Detected	-----	3.70E+02
NP-237	Not Detected	-----	3.03E-01
PA-233	Not Detected	-----	6.10E-02
TH-229	Not Detected	-----	2.05E-01

[Summary Report] - Sample ID: : 70060006

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.86E-02
AG-110m	Not Detected	-----	3.62E-02
BA-133	Not Detected	-----	5.81E-02
BE-7	Not Detected	-----	2.76E-01
CD-109	2.10E+00	5.07E-01	6.78E-01
CD-115	Not Detected	-----	1.16E-01
CE-139	Not Detected	-----	2.78E-02
CE-141	Not Detected	-----	4.86E-02
CE-144	Not Detected	-----	1.97E-01
CO-56	Not Detected	-----	4.08E-02
CO-57	Not Detected	-----	2.53E-02
CO-58	Not Detected	-----	3.80E-02
CO-60	Not Detected	-----	4.59E-02
CR-51	Not Detected	-----	2.51E-01
CS-134	Not Detected	-----	4.71E-02
CS-137	Not Detected	-----	4.21E-02
EU-152	Not Detected	-----	7.59E-02
EU-154	Not Detected	-----	2.22E-01
EU-155	Not Detected	-----	1.20E-01
FE-59	Not Detected	-----	9.61E-02
GD-153	Not Detected	-----	8.43E-02
HG-203	Not Detected	-----	3.38E-02
I-131	Not Detected	-----	3.65E-02
IR-192	Not Detected	-----	2.83E-02
K-40	2.30E+01	3.41E+00	2.58E-01
MN-52	Not Detected	-----	4.23E-02
MN-54	1.11E-02	1.29E-02	2.16E-02
MO-99	Not Detected	-----	4.51E-01
NA-22	Not Detected	-----	5.48E-02
NA-24	Not Detected	-----	2.26E-01
NB-95	Not Detected	-----	2.21E-01
ND-147	Not Detected	-----	2.54E-01
NI-57	Not Detected	-----	1.20E-01
PB-210	Not Detected	-----	8.12E+00
RU-103	Not Detected	-----	3.33E-02
RU-106	Not Detected	-----	3.27E-01
SB-122	Not Detected	-----	6.74E-02
SB-124	Not Detected	-----	3.35E-02
SB-125	Not Detected	-----	9.15E-02
SN-113	Not Detected	-----	3.99E-02
SR-85	Not Detected	-----	4.20E-02
TA-182	Not Detected	-----	1.90E-01
TA-183	Not Detected	-----	2.09E-01
TC-99m	Not Detected	-----	2.36E+00
TL-201	Not Detected	-----	1.60E-01
XE-133	Not Detected	-----	1.66E-01
Y-88	Not Detected	-----	3.24E-02
ZN-65	Not Detected	-----	1.29E-01
ZR-95	Not Detected	-----	7.13E-02

not detected 7/18/57

not detected 7/18/57

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-18-97 4:35:21 AM *

* Analyzed by: *J 4/18/97* Reviewed by: *K 4/18/97*

Customer : P.SLAVIN/C.C. (6682/IT)
 Customer Sample ID : 034337-002
 Lab Sample ID : 70060007

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 673.000 gram
 Sample Date/Time : 4-16-97 10:53:00 AM
 Acquire Start Date/Time : 4-18-97 2:52:37 AM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6003 seconds

CY10-SS-SE1

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	1.25E+00
TH-234	2.01E+00	5.21E-01	6.07E-01
RA-226	2.28E+00	1.10E+00	7.06E-01
PB-214	1.24E+00	2.03E-01	6.19E-02
BI-214	1.04E+00	7.80E-01	7.37E-02
TH-232	Not Detected	-----	2.17E-01
RA-228	1.25E+00	3.69E-01	2.27E-01
AC-228	1.38E+00	3.36E-01	1.08E-01
TH-228	1.31E+00	5.88E-01	6.39E-01
RA-224	1.26E+00	5.20E-01	1.14E-01
PB-212	1.32E+00	2.26E-01	5.65E-02
BI-212	6.71E-01	2.84E-01	2.71E-01
TL-208	1.14E+00	5.01E-01	9.83E-02
U-235	Not Detected	-----	2.75E-01
TH-231	Not Detected	-----	1.17E+01
PA-231	Not Detected	-----	1.89E+00
TH-227	Not Detected	-----	5.01E-01
RA-223	Not Detected	-----	2.02E-01
RN-219	2.22E-01	4.40E-01	5.42E-01
PB-211	Not Detected	-----	1.19E+00
TL-207	Not Detected	-----	2.06E+01
AM-241	Not Detected	-----	2.52E-01
PU-239	Not Detected	-----	4.58E+02
NP-237	Not Detected	-----	3.83E-01
PA-233	Not Detected	-----	7.60E-02
TH-229	Not Detected	-----	2.65E-01

not detected J 4/18/97

[Summary Report] - Sample ID: : 70060007

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	6.05E-02
AG-110m	Not Detected	-----	4.71E-02
BA-133	Not Detected	-----	7.70E-02
BE-7	Not Detected	-----	3.47E-01
CD-109	3.20E+00	7.84E-01	1.03E+00
CD-115	Not Detected	-----	1.55E-01
CE-139	Not Detected	-----	3.43E-02
CE-141	Not Detected	-----	6.21E-02
CE-144	Not Detected	-----	2.48E-01
CO-56	Not Detected	-----	5.09E-02
CO-57	Not Detected	-----	3.21E-02
CO-58	Not Detected	-----	4.91E-02
CO-60	Not Detected	-----	5.21E-02
CR-51	Not Detected	-----	3.16E-01
CS-134	Not Detected	-----	6.10E-02
CS-137	2.22E-02	2.29E-02	3.11E-02
EU-152	Not Detected	-----	9.61E-02
EU-154	Not Detected	-----	2.78E-01
EU-155	Not Detected	-----	1.52E-01
FE-59	Not Detected	-----	1.11E-01
GD-153	Not Detected	-----	1.08E-01
HG-203	Not Detected	-----	4.23E-02
I-131	Not Detected	-----	4.50E-02
IR-192	Not Detected	-----	3.54E-02
K-40	2.76E+01	4.20E+00	3.63E-01
MN-52	Not Detected	-----	5.95E-02
MN-54	Not Detected	-----	5.24E-02
MO-99	Not Detected	-----	5.41E-01
NA-22	Not Detected	-----	6.63E-02
NA-24	Not Detected	-----	3.22E-01
NB-95	Not Detected	-----	2.85E-01
ND-147	Not Detected	-----	3.15E-01
NI-57	Not Detected	-----	1.66E-01
PB-210	Not Detected	-----	1.00E+01
RU-103	Not Detected	-----	4.25E-02
RU-106	Not Detected	-----	4.10E-01
SB-122	Not Detected	-----	8.65E-02
SB-124	Not Detected	-----	4.34E-02
SB-125	Not Detected	-----	1.20E-01
SN-113	Not Detected	-----	5.29E-02
SR-85	Not Detected	-----	5.27E-02
TA-182	Not Detected	-----	2.34E-01
TA-183	Not Detected	-----	2.68E-01
TC-99m	Not Detected	-----	3.18E+00
TL-201	Not Detected	-----	2.05E-01
XE-133	Not Detected	-----	2.17E-01
Y-88	Not Detected	-----	3.79E-02
ZN-65	Not Detected	-----	1.60E-01
ZR-95	Not Detected	-----	9.02E-02

not detected 7/18/77

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-18-97 6:20:30 AM *

* Analyzed by: *J 4/18/97* Reviewed by: *K 4/18/97*

Customer : P.SLAVIN/C.C. (6682/IT)
 Customer Sample ID : 034338-002
 Lab Sample ID : 70060008

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 779.000 gram
 Sample Date/Time : 4-16-97 11:35:00 AM
 Acquire Start Date/Time : 4-18-97 4:37:50 AM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6003 seconds

CY10-SS SE3

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	1.61E+00
TH-234	1.42E+00	5.05E-01	5.59E-01
RA-226	2.24E+00	7.63E-01	7.27E-01
PB-214	9.91E-01	2.57E-01	5.73E-02
BI-214	9.28E-01	1.94E-01	5.69E-02
TH-232	1.33E+00	6.19E-01	1.81E-01
RA-228	1.44E+00	3.88E-01	2.05E-01
AC-228	1.35E+00	3.84E-01	1.19E-01
TH-228	8.62E-01	4.44E-01	5.80E-01
RA-224	1.38E+00	7.00E-01	1.11E-01
PB-212	1.38E+00	2.19E-01	4.77E-02
BI-212	7.79E-01	3.89E-01	2.62E-01
TL-208	1.36E+00	2.98E-01	9.10E-02
U-235	Not Detected	-----	2.51E-01
TH-231	Not Detected	-----	1.07E+01
PA-231	Not Detected	-----	1.66E+00
TH-227	Not Detected	-----	4.72E-01
RA-223	Not Detected	-----	1.88E-01
RN-219	3.97E-01	3.95E-01	4.91E-01
PB-211	Not Detected	-----	1.13E+00
TL-207	Not Detected	-----	1.83E+01
AM-241	Not Detected	-----	2.24E-01
PU-239	Not Detected	-----	4.35E+02
NP-237	6.98E-01	2.08E-01	2.71E-01
PA-233	Not Detected	-----	7.07E-02
TH-229	Not Detected	-----	2.46E-01

not detected 4/18/97

not detected 4/18/97

[Summary Report] - Sample ID: : 70060008

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	5.71E-02
AG-110m	Not Detected	-----	3.98E-02
BA-133	Not Detected	-----	6.85E-02
BE-7	Not Detected	-----	3.10E-01
CD-109	Not Detected	-----	1.20E+00
CD-115	Not Detected	-----	1.41E-01
CE-139	Not Detected	-----	3.12E-02
CE-141	Not Detected	-----	5.62E-02
CE-144	Not Detected	-----	2.29E-01
CO-56	Not Detected	-----	4.63E-02
CO-57	Not Detected	-----	2.98E-02
CO-58	Not Detected	-----	4.16E-02
CO-60	Not Detected	-----	4.67E-02
CR-51	Not Detected	-----	2.87E-01
CS-134	Not Detected	-----	5.25E-02
CS-137	Not Detected	-----	4.73E-02
EU-152	Not Detected	-----	8.86E-02
EU-154	Not Detected	-----	2.62E-01
EU-155	Not Detected	-----	1.39E-01
FE-59	Not Detected	-----	1.08E-01
GD-153	Not Detected	-----	9.93E-02
HG-203	Not Detected	-----	3.83E-02
I-131	Not Detected	-----	3.99E-02
IR-192	Not Detected	-----	3.22E-02
K-40	2.61E+01	3.82E+00	3.63E-01
MN-52	Not Detected	-----	5.35E-02
MN-54	Not Detected	-----	2.44E-02
MO-99	Not Detected	-----	5.06E-01
NA-22	Not Detected	-----	5.77E-02
NA-24	Not Detected	-----	3.10E-01
NB-95	Not Detected	-----	2.69E-01
ND-147	Not Detected	-----	2.82E-01
NI-57	Not Detected	-----	1.50E-01
PB-210	Not Detected	-----	9.32E+00
RU-103	Not Detected	-----	3.87E-02
RU-106	Not Detected	-----	3.70E-01
SB-122	Not Detected	-----	7.63E-02
SB-124	Not Detected	-----	3.76E-02
SB-125	Not Detected	-----	1.08E-01
SN-113	Not Detected	-----	4.61E-02
SR-85	Not Detected	-----	4.89E-02
TA-182	Not Detected	-----	2.15E-01
TA-183	Not Detected	-----	2.40E-01
TC-99m	Not Detected	-----	3.37E+00
TL-201	Not Detected	-----	1.89E-01
XE-133	Not Detected	-----	1.99E-01
Y-88	Not Detected	-----	3.42E-02
ZN-65	Not Detected	-----	1.45E-01
ZR-95	Not Detected	-----	7.78E-02

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-18-97 8:05:39 AM *

 * Analyzed by: *J 4/18/97* Reviewed by: *K 4/18/97* *

Customer : P.SLAVIN/C.C. (6682/IT)
 Customer Sample ID : 034339-002
 Lab Sample ID : 70060009

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 1002.000 gram
 Sample Date/Time : 4-16-97 11:15:00 AM
 Acquire Start Date/Time : 4-18-97 6:22:56 AM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6003 seconds

CY10-SS-S2

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	1.47E+00
TH-234	8.97E-01	3.76E-01	4.58E-01
RA-226	1.60E+00	5.70E-01	5.30E-01
PB-214	8.46E-01	1.39E-01	4.47E-02
BI-214	7.51E-01	1.52E-01	4.67E-02
TH-232	1.05E+00	4.89E-01	1.44E-01
RA-228	7.83E-01	2.09E-01	1.78E-01
AC-228	1.07E+00	2.55E-01	8.44E-02
TH-228	9.07E-01	4.31E-01	4.11E-01
RA-224	1.07E+00	3.42E-01	7.35E-02
PB-212	1.01E+00	2.28E-01	3.74E-02
BI-212	6.46E-01	2.36E-01	1.84E-01
TL-208	9.59E-01	4.96E-01	7.24E-02
U-235	1.13E-01	1.50E-01	2.09E-01
TH-231	Not Detected	-----	8.55E+00
PA-231	Not Detected	-----	1.37E+00
TH-227	Not Detected	-----	3.64E-01
RA-223	Not Detected	-----	1.52E-01
RN-219	Not Detected	-----	3.97E-01
PB-211	Not Detected	-----	8.84E-01
TL-207	Not Detected	-----	1.53E+01
AM-241	Not Detected	-----	1.86E-01
PU-239	Not Detected	-----	3.46E+02
NP-237	Not Detected	-----	2.80E-01
PA-233	Not Detected	-----	5.62E-02
TH-229	Not Detected	-----	1.99E-01

not detected J 4/18/97

[Summary Report] - Sample ID: : 70060009

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.40E-02
AG-110m	Not Detected	-----	3.33E-02
BA-133	Not Detected	-----	5.48E-02
BE-7	Not Detected	-----	2.50E-01
CD-109	Not Detected	-----	5.80E-01
CD-115	Not Detected	-----	1.17E-01
CE-139	Not Detected	-----	2.57E-02
CE-141	Not Detected	-----	4.65E-02
CE-144	Not Detected	-----	1.92E-01
CO-56	Not Detected	-----	3.55E-02
CO-57	Not Detected	-----	2.43E-02
CO-58	Not Detected	-----	3.56E-02
CO-60	Not Detected	-----	3.93E-02
CR-51	7.31E-02	6.61E-02	9.35E-02
CS-134	Not Detected	-----	4.31E-02
CS-137	2.07E-02	1.33E-02	2.13E-02
EU-152	Not Detected	-----	7.31E-02
EU-154	Not Detected	-----	2.04E-01
EU-155	Not Detected	-----	1.13E-01
FE-59	Not Detected	-----	8.24E-02
GD-153	Not Detected	-----	7.98E-02
HG-203	Not Detected	-----	3.15E-02
I-131	Not Detected	-----	3.26E-02
IR-192	Not Detected	-----	2.59E-02
K-40	2.19E+01	3.19E+00	2.60E-01
MN-52	Not Detected	-----	4.34E-02
MN-54	Not Detected	-----	1.73E-02
MO-99	Not Detected	-----	3.97E-01
NA-22	Not Detected	-----	4.65E-02
NA-24	Not Detected	-----	2.43E-01
NB-95	Not Detected	-----	2.14E-01
ND-147	Not Detected	-----	2.27E-01
NI-57	Not Detected	-----	1.22E-01
PB-210	Not Detected	-----	7.62E+00
RU-103	Not Detected	-----	3.06E-02
RU-106	Not Detected	-----	2.80E-01
SB-122	Not Detected	-----	6.17E-02
SB-124	Not Detected	-----	3.21E-02
SB-125	Not Detected	-----	8.47E-02
SN-113	Not Detected	-----	3.72E-02
SR-85	Not Detected	-----	3.71E-02
TA-182	Not Detected	-----	1.70E-01
TA-183	Not Detected	-----	2.01E-01
TC-99m	Not Detected	-----	3.47E+00
TL-201	Not Detected	-----	1.62E-01
XE-133	Not Detected	-----	1.65E-01
Y-88	Not Detected	-----	2.81E-02
ZN-65	Not Detected	-----	1.15E-01
ZR-95	Not Detected	-----	6.16E-02

not detected 7/18/97

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-18-97 3:19:29 PM *

 * Analyzed by: *J 4/18/97* Reviewed by: *K 4/21/97* *

Customer : P.SLAVIN/C.C. (6682/IT)
 Customer Sample ID : 034342-002
 Lab Sample ID : 70060010

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 925.000 gram
 Sample Date/Time : 4-16-97 11:20:00 AM
 Acquire Start Date/Time : 4-18-97 8:23:25 AM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6003 seconds

CYD-SS-S4

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	2.12E+00	1.66E+00	1.72E+00
TH-234	1.47E+00	1.98E+00	4.84E-01
RA-226	2.10E+00	7.47E-01	5.76E-01
PB-214	9.48E-01	1.32E-01	4.66E-02
BI-214	8.90E-01	1.42E-01	5.33E-02
TH-232	1.18E+00	5.55E-01	1.56E-01
RA-228	1.26E+00	3.15E-01	1.66E-01
AC-228	1.05E+00	2.53E-01	1.07E-01
TH-228	1.06E+00	8.88E-01	4.65E-01
RA-224	1.22E+00	5.26E-01	7.83E-02
PB-212	1.09E+00	1.73E-01	4.07E-02
BI-212	7.17E-01	2.42E-01	1.96E-01
TL-208	1.03E+00	1.89E-01	7.30E-02
U-235	Not Detected	-----	2.20E-01
TH-231	2.23E-00	3.55E+00	9.25E+00
PA-231	Not Detected	-----	1.43E+00
TH-227	Not Detected	-----	3.93E-01
RA-223	Not Detected	-----	1.61E-01
RN-219	Not Detected	-----	4.13E-01
PB-211	Not Detected	-----	9.31E-01
TL-207	Not Detected	-----	1.53E+01
AM-241	Not Detected	-----	1.93E-01
PU-239	Not Detected	-----	3.75E+02
NP-237	Not Detected	-----	3.04E-01
PA-233	Not Detected	-----	5.91E-02
TH-229	Not Detected	-----	2.12E-01

not detected J 4/18/97

[Summary Report] - Sample ID: : 70060010

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.77E-02
AG-110m	Not Detected	-----	3.47E-02
BA-133	Not Detected	-----	5.90E-02
BE-7	Not Detected	-----	2.59E-01
CD-109	Not Detected	-----	8.35E-01
CD-115	Not Detected	-----	1.29E-01
CE-139	Not Detected	-----	2.76E-02
CE-141	Not Detected	-----	4.89E-02
CE-144	Not Detected	-----	2.00E-01
CO-56	Not Detected	-----	3.64E-02
CO-57	Not Detected	-----	2.52E-02
CO-58	Not Detected	-----	3.53E-02
CO-60	Not Detected	-----	4.29E-02
CR-51	Not Detected	-----	2.48E-01
CS-134	Not Detected	-----	4.72E-02
CS-137	Not Detected	-----	4.02E-02
EU-152	Not Detected	-----	7.57E-02
EU-154	Not Detected	-----	2.22E-01
EU-155	Not Detected	-----	1.21E-01
FE-59	Not Detected	-----	8.53E-02
GD-153	Not Detected	-----	8.61E-02
HG-203	Not Detected	-----	3.33E-02
I-131	Not Detected	-----	3.63E-02
IR-192	Not Detected	-----	2.73E-02
K-40	2.07E+01	3.07E+00	2.89E-01
MN-52	Not Detected	-----	4.51E-02
MN-54	Not Detected	-----	4.02E-02
MO-99	Not Detected	-----	4.52E-01
NA-22	Not Detected	-----	4.60E-02
NA-24	Not Detected	-----	2.93E-01
NB-95	Not Detected	-----	2.34E-01
ND-147	Not Detected	-----	2.46E-01
NI-57	Not Detected	-----	1.26E-01
PB-210	Not Detected	-----	7.86E+00
RU-103	Not Detected	-----	3.21E-02
RU-106	Not Detected	-----	3.01E-01
SB-122	Not Detected	-----	6.99E-02
SB-124	Not Detected	-----	3.28E-02
SB-125	Not Detected	-----	9.16E-02
SN-113	Not Detected	-----	3.89E-02
SR-85	Not Detected	-----	4.05E-02
TA-182	Not Detected	-----	1.80E-01
TA-183	Not Detected	-----	2.12E-01
TC-99m	Not Detected	-----	4.66E+00
TL-201	Not Detected	-----	1.75E-01
XE-133	Not Detected	-----	1.85E-01
Y-88	Not Detected	-----	2.96E-02
ZN-65	Not Detected	-----	1.24E-01
ZR-95	Not Detected	-----	6.62E-02

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-18-97 11:51:33 AM *

* Analyzed by: *J 4/18/97* Reviewed by: *K 4/21/97* *

Customer : P.SLAVIN/C.C. (6682/IT)
 Customer Sample ID : 034343-002
 Lab Sample ID : 70060011

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 989.000 gram
 Sample Date/Time : 4-16-97 11:10:00 AM
 Acquire Start Date/Time : 4-18-97 10:08:48 AM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6004 seconds

CY10-SS-SWT

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	1.54E+00
TH-234	7.96E-01	3.53E-01	4.72E-01
RA-226	1.99E+00	6.24E-01	5.99E-01
PB-214	8.27E-01	1.35E-01	4.69E-02
BI-214	7.87E-01	1.93E-01	5.11E-02
TH-232	1.05E+00	4.92E-01	1.49E-01
RA-228	1.09E+00	3.74E-01	1.55E-01
AC-228	1.08E+00	7.52E-01	9.18E-02
TH-228	7.80E-01	4.80E-01	4.31E-01
RA-224	1.08E+00	3.98E-01	6.75E-02
PE-212	1.07E+00	1.69E-01	3.95E-02
BI-212	5.94E-01	2.09E-01	1.79E-01
TL-208	9.29E-01	1.79E-01	7.18E-02
U-235	Not Detected	-----	2.12E-01
TH-231	Not Detected	-----	8.66E+00
PA-231	Not Detected	-----	1.39E+00
TH-227	Not Detected	-----	3.75E-01
RA-223	Not Detected	-----	1.55E-01
RN-219	Not Detected	-----	4.01E-01
PB-211	Not Detected	-----	9.11E-01
TL-207	Not Detected	-----	1.53E+01
AM-241	Not Detected	-----	1.82E-01
PU-239	Not Detected	-----	3.55E+02
NP-237	3.62E-01	1.74E-01	2.04E-01
PA-233	Not Detected	-----	5.70E-02
TH-229	Not Detected	-----	2.03E-01

not detected J 4/18/97

[Summary Report] - Sample ID: : 70060011

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.61E-02
AG-110m	Not Detected	-----	4.12E-02
BA-133	Not Detected	-----	5.44E-02
BE-7	Not Detected	-----	2.63E-01
CD-109	Not Detected	-----	9.76E-01
CD-115	Not Detected	-----	1.23E-01
CE-139	Not Detected	-----	2.65E-02
CE-141	Not Detected	-----	4.85E-02
CE-144	Not Detected	-----	1.90E-01
CO-56	Not Detected	-----	3.66E-02
CO-57	Not Detected	-----	2.53E-02
CO-58	Not Detected	-----	3.38E-02
CO-60	Not Detected	-----	3.97E-02
CR-51	Not Detected	-----	2.36E-01
CS-134	Not Detected	-----	4.43E-02
CS-137	1.04E-01	1.98E-01	2.30E-02
EU-152	Not Detected	-----	7.57E-02
EU-154	Not Detected	-----	2.12E-01
EU-155	Not Detected	-----	1.15E-01
FE-59	Not Detected	-----	8.57E-02
GD-153	Not Detected	-----	8.35E-02
HG-203	Not Detected	-----	3.13E-02
I-131	Not Detected	-----	3.53E-02
IR-192	Not Detected	-----	2.69E-02
K-40	2.32E+01	3.40E+00	2.80E-01
MN-52	Not Detected	-----	4.33E-02
MN-54	Not Detected	-----	2.61E-02
MO-99	Not Detected	-----	4.28E-01
NA-22	Not Detected	-----	4.75E-02
NA-24	Not Detected	-----	3.25E-01
NB-95	Not Detected	-----	2.28E-01
ND-147	Not Detected	-----	2.32E-01
NI-57	Not Detected	-----	1.38E-01
PB-210	Not Detected	-----	7.57E+00
RU-103	Not Detected	-----	3.17E-02
RU-106	Not Detected	-----	3.05E-01
SB-122	2.25E-02	2.66E-02	4.16E-02
SB-124	Not Detected	-----	3.13E-02
SB-125	Not Detected	-----	8.96E-02
SN-113	Not Detected	-----	3.77E-02
SR-85	Not Detected	-----	3.80E-02
TA-182	Not Detected	-----	1.80E-01
TA-183	Not Detected	-----	2.02E-01
TC-99m	Not Detected	-----	5.59E+00
TL-201	Not Detected	-----	1.68E-01
XE-133	Not Detected	-----	1.78E-01
Y-88	Not Detected	-----	3.00E-02
ZN-65	Not Detected	-----	1.21E-01
ZR-95	Not Detected	-----	6.64E-02

not detected 7/4/18/97

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-18-97 1:36:50 PM *

* Analyzed by: *[Signature]* 4/18/97 Reviewed by: *[Signature]* 4/21/97 *

Customer : P.SLAVIN/C.C. (6682/IT)
 Customer Sample ID : 034344-002
 Lab Sample ID : 70060012

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 963.000 gram
 Sample Date/Time : 4-16-97 11:25:00 AM
 Acquire Start Date/Time : 4-18-97 11:54:10 AM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6003 seconds

CY10-SS-SW4

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	1.49E+00
TH-234	1.07E+00	3.74E-01	4.43E-01
RA-226	1.41E+00	4.36E-01	4.72E-01
PB-214	7.61E-01	1.27E-01	4.79E-02
BI-214	6.47E-01	1.36E-01	4.76E-02
TH-232	1.08E+00	6.43E-01	1.44E-01
RA-228	1.04E+00	3.48E-01	1.78E-01
AC-228	1.08E+00	2.45E-01	9.19E-02
TH-228	2.09E-01	2.73E-01	3.64E-01
RA-224	1.08E+00	3.40E-01	7.95E-02
PB-212	9.51E-01	1.52E-01	3.64E-02
BI-212	4.71E-01	2.25E-01	1.90E-01
TL-208	9.61E-01	7.85E-01	6.98E-02
U-235	Not Detected	-----	2.01E-01
TH-231	Not Detected	-----	8.42E+00
PA-231	Not Detected	-----	1.34E+00
TH-227	Not Detected	-----	3.62E-01
RA-223	Not Detected	-----	1.51E-01
RN-219	Not Detected	-----	3.98E-01
PB-211	Not Detected	-----	8.98E-01
TL-207	Not Detected	-----	1.44E+01
AM-241	Not Detected	-----	1.79E-01
PU-239	Not Detected	-----	3.51E+02
NP-237	Not Detected	-----	2.78E-01
PA-233	Not Detected	-----	5.56E-02
TH-229	Not Detected	-----	1.99E-01

[Summary Report] - Sample ID: : 70060012

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.29E-02
AG-110m	Not Detected	-----	3.48E-02
BA-133	Not Detected	-----	5.32E-02
BE-7	Not Detected	-----	2.44E-01
CD-109	1.71E+00	4.90E-01	7.12E-01
CD-115	Not Detected	-----	1.27E-01
CE-139	Not Detected	-----	2.56E-02
CE-141	Not Detected	-----	4.59E-02
CE-144	Not Detected	-----	1.84E-01
CO-56	Not Detected	-----	3.52E-02
CO-57	Not Detected	-----	2.39E-02
CO-58	Not Detected	-----	3.30E-02
CO-60	Not Detected	-----	3.98E-02
CR-51	Not Detected	-----	2.32E-01
CS-134	Not Detected	-----	4.08E-02
CS-137	2.83E-02	1.78E-02	2.16E-02
EU-152	Not Detected	-----	7.13E-02
EU-154	Not Detected	-----	1.98E-01
EU-155	Not Detected	-----	1.14E-01
FE-59	Not Detected	-----	7.84E-02
GD-153	Not Detected	-----	7.99E-02
HG-203	Not Detected	-----	3.10E-02
I-131	Not Detected	-----	3.36E-02
IR-192	Not Detected	-----	2.67E-02
K-40	2.12E+01	3.19E+00	3.05E-01
MN-52	Not Detected	-----	4.17E-02
MN-54	Not Detected	-----	3.68E-02
MO-99	Not Detected	-----	4.28E-01
NA-22	Not Detected	-----	4.83E-02
NA-24	Not Detected	-----	3.42E-01
NB-95	Not Detected	-----	2.22E-01
ND-147	Not Detected	-----	2.30E-01
NI-57	Not Detected	-----	1.44E-01
PB-210	Not Detected	-----	7.45E+00
RU-103	Not Detected	-----	3.02E-02
RU-106	Not Detected	-----	2.96E-01
SB-122	Not Detected	-----	6.97E-02
SB-124	Not Detected	-----	3.01E-02
SB-125	Not Detected	-----	8.85E-02
SN-113	Not Detected	-----	3.78E-02
SR-85	Not Detected	-----	3.78E-02
TA-182	Not Detected	-----	1.68E-01
TA-183	Not Detected	-----	2.01E-01
TC-99m	Not Detected	-----	6.33E+00
TL-201	Not Detected	-----	1.67E-01
XE-133	Not Detected	-----	1.74E-01
Y-88	Not Detected	-----	2.80E-02
ZN-65	Not Detected	-----	1.13E-01
ZR-95	Not Detected	-----	6.38E-02

not detected 7/18/97

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-18-97 3:24:21 PM *

 * Analyzed by: *J 4/18/97* Reviewed by: *KS 4/21/97* *

Customer : P.SLAVIN/C.C. (6682/IT)
 Customer Sample ID : 034345-002
 Lab Sample ID : 70060013

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 955.000 gram
 Sample Date/Time : 4-16-97 10:55:00 AM
 Acquire Start Date/Time : 4-18-97 1:39:13 PM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6004 seconds

CY10-SS-W2

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	1.73E+00	1.01E+00	1.41E+00
TH-234	2.00E+00	5.17E-01	4.56E-01
RA-226	Not Detected	-----	5.76E-01
PB-214	8.64E-01	1.40E-01	4.39E-02
BI-214	8.02E-01	1.57E-01	4.99E-02
TH-232	1.07E+00	5.13E-01	1.54E-01
RA-228	1.01E+00	1.87E+00	1.82E-01
AC-228	1.11E+00	2.68E-01	1.03E-01
TH-228	1.00E+00	4.70E-01	4.60E-01
RA-224	1.16E+00	3.63E-01	7.87E-02
PB-212	1.08E+00	3.27E-01	4.24E-02
BI-212	7.55E-01	7.59E-01	1.93E-01
TL-208	1.00E+00	1.60E-01	7.62E-02
U-235	9.88E-02	1.81E-01	1.45E-01
TH-231	Not Detected	-----	9.21E+00
PA-231	Not Detected	-----	1.40E+00
TH-227	Not Detected	-----	3.86E-01
RA-223	Not Detected	-----	1.64E-01
RN-219	3.37E-01	3.39E-01	4.20E-01
PB-211	Not Detected	-----	9.36E-01
TL-207	Not Detected	-----	1.60E+01
AM-241	Not Detected	-----	1.94E-01
PU-239	Not Detected	-----	3.68E+02
NP-237	Not Detected	-----	2.99E-01
PA-233	Not Detected	-----	5.78E-02
TH-229	Not Detected	-----	2.11E-01

not detected J 4/18/97

not detected J 4/18/97

[Summary Report] - Sample ID: : 70060013

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.84E-02
AG-110m	Not Detected	-----	3.59E-02
BA-133	Not Detected	-----	5.54E-02
BE-7	Not Detected	-----	2.58E-01
CD-109	1.73E+00	4.79E-01	7.91E-01
CD-115	Not Detected	-----	1.35E-01
CE-139	Not Detected	-----	2.72E-02
CE-141	Not Detected	-----	4.93E-02
CE-144	Not Detected	-----	2.03E-01
CO-56	Not Detected	-----	3.82E-02
CO-57	Not Detected	-----	2.58E-02
CO-58	Not Detected	-----	3.65E-02
CO-60	Not Detected	-----	4.27E-02
CR-51	Not Detected	-----	2.42E-01
CS-134	Not Detected	-----	4.45E-02
CS-137	3.33E-02	1.89E-02	2.30E-02
EU-152	Not Detected	-----	7.77E-02
EU-154	Not Detected	-----	2.24E-01
EU-155	Not Detected	-----	1.19E-01
FE-59	Not Detected	-----	8.64E-02
GD-153	Not Detected	-----	8.55E-02
HG-203	Not Detected	-----	3.24E-02
I-131	Not Detected	-----	3.65E-02
IR-192	Not Detected	-----	2.76E-02
K-40	2.28E+01	3.38E+00	2.64E-01
MN-52	Not Detected	-----	4.68E-02
MN-54	1.93E-02	5.93E-03	2.65E-02
MO-99	Not Detected	-----	4.48E-01
NA-22	Not Detected	-----	5.18E-02
NA-24	Not Detected	-----	3.85E-01
NB-95	Not Detected	-----	2.42E-01
ND-147	Not Detected	-----	2.44E-01
NI-57	Not Detected	-----	1.46E-01
PB-210	Not Detected	-----	7.91E+00
RU-103	Not Detected	-----	3.15E-02
RU-106	Not Detected	-----	3.08E-01
SB-122	Not Detected	-----	7.27E-02
SB-124	Not Detected	-----	3.22E-02
SB-125	Not Detected	-----	8.86E-02
SN-113	Not Detected	-----	3.86E-02
SR-85	Not Detected	-----	3.98E-02
TA-182	Not Detected	-----	1.77E-01
TA-183	Not Detected	-----	2.20E-01
TC-99m	Not Detected	-----	8.72E+00
TL-201	Not Detected	-----	1.81E-01
XE-133	Not Detected	-----	1.96E-01
Y-88	Not Detected	-----	3.01E-02
ZN-65	Not Detected	-----	1.22E-01
ZR-95	Not Detected	-----	6.78E-02

not detected J 4/18/97

not detected J 4/18/97

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-18-97 5:27:03 PM *

* Analyzed by: *J 4/19/97* Reviewed by: *J 4/19/97* *

Customer : P.SLAVIN/C.C. (6682/IT)
 Customer Sample ID : 034346-002
 Lab Sample ID : 70060014

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 934.000 gram
 Sample Date/Time : 4-16-97 10:45:00 AM
 Acquire Start Date/Time : 4-18-97 3:43:12 PM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6004 seconds

CY10-SS-W4

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	1.60E+00
TH-234	1.25E+00	3.66E-01	4.93E-01
RA-226	1.99E+00	7.41E-01	5.34E-01
PB-214	9.44E-01	1.60E-01	5.04E-02
BI-214	8.48E-01	1.77E-01	5.12E-02
TH-232	1.06E+00	5.09E-01	1.59E-01
RA-228	1.07E+00	3.11E-01	1.75E-01
AC-228	1.11E+00	9.53E-01	9.42E-02
TH-228	9.42E-01	5.40E-01	5.38E-01
RA-224	1.09E+00	3.86E-01	6.85E-02
PB-212	1.10E+00	2.92E-01	4.13E-02
BI-212	7.55E-01	2.39E-01	1.81E-01
TL-208	1.09E+00	2.11E-01	7.01E-02
U-235	1.70E-01	1.63E-01	2.26E-01
TH-231	Not Detected	-----	9.14E+00
PA-231	Not Detected	-----	1.49E+00
TH-227	Not Detected	-----	3.89E-01
RA-223	Not Detected	-----	1.64E-01
RN-219	Not Detected	-----	4.33E-01
PB-211	Not Detected	-----	9.72E-01
TL-207	Not Detected	-----	1.54E+01
AM-241	Not Detected	-----	2.00E-01
PU-239	Not Detected	-----	3.72E+02
NP-237	8.35E-01	2.57E-01	2.29E-01
PA-233	Not Detected	-----	5.94E-02
TH-229	Not Detected	-----	2.08E-01

not detected J 4/19/97

not detected J 4/19/97

[Summary Report] - Sample ID: : 70060014

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.78E-02
AG-110m	Not Detected	-----	4.24E-02
BA-133	Not Detected	-----	5.80E-02
BE-7	Not Detected	-----	2.76E-01
CD-109	Not Detected	-----	1.02E+00
CD-115	Not Detected	-----	1.40E-01
CE-139	Not Detected	-----	2.74E-02
CE-141	Not Detected	-----	5.02E-02
CE-144	Not Detected	-----	2.03E-01
CO-56	Not Detected	-----	2.65E-02
CO-57	Not Detected	-----	2.57E-02
CO-58	Not Detected	-----	3.60E-02
CO-60	Not Detected	-----	4.36E-02
CR-51	Not Detected	-----	2.52E-01
CS-134	Not Detected	-----	4.54E-02
CS-137	1.15E-01	7.55E-02	2.56E-02
EU-152	Not Detected	-----	7.69E-02
EU-154	Not Detected	-----	2.22E-01
EU-155	Not Detected	-----	1.18E-01
FE-59	Not Detected	-----	8.93E-02
GD-153	Not Detected	-----	8.63E-02
HG-203	Not Detected	-----	3.43E-02
I-131	Not Detected	-----	3.64E-02
IR-192	Not Detected	-----	2.87E-02
K-40	2.30E+01	3.38E+00	2.48E-01
MN-52	Not Detected	-----	4.78E-02
MN-54	Not Detected	-----	3.93E-02
MO-99	Not Detected	-----	4.85E-01
NA-22	Not Detected	-----	4.86E-02
NA-24	Not Detected	-----	4.54E-01
NB-95	Not Detected	-----	2.49E-01
ND-147	Not Detected	-----	2.49E-01
NI-57	Not Detected	-----	1.62E-01
PB-210	Not Detected	-----	8.12E+00
RU-103	Not Detected	-----	3.28E-02
RU-106	Not Detected	-----	3.08E-01
SB-122	1.70E-02	1.69E-02	4.26E-02
SB-124	Not Detected	-----	3.27E-02
SB-125	Not Detected	-----	9.17E-02
SN-113	Not Detected	-----	4.03E-02
SR-85	Not Detected	-----	4.03E-02
TA-182	Not Detected	-----	1.81E-01
TA-183	Not Detected	-----	2.30E-01
TC-99m	Not Detected	-----	1.17E+01
TL-201	Not Detected	-----	1.82E-01
XE-133	Not Detected	-----	2.01E-01
Y-88	Not Detected	-----	3.10E-02
ZN-65	Not Detected	-----	1.24E-01
ZR-95	Not Detected	-----	6.88E-02

not detected 7/19/57

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-18-97 7:13:12 PM *

* Analyzed by: *[Signature]* 4/19/97 Reviewed by: *[Signature]* 4/21/97 *

Customer : P.SLAVIN/C.C. (6682/IT)
 Customer Sample ID : 034347-002
 Lab Sample ID : 70060015

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 924.000 gram
 Sample Date/Time : 4-16-97 10:58:00 AM
 Acquire Start Date/Time : 4-18-97 5:30:26 PM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6004 seconds

CY10 SS- NW1

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	1.60E+00
TH-234	1.86E+00	4.83E-01	4.87E-01
RA-226	2.03E+00	7.42E-01	5.16E-01
PB-214	9.44E-01	1.69E-01	5.16E-02
BI-214	8.27E-01	6.21E-01	5.62E-02
TH-232	1.10E+00	5.17E-01	1.65E-01
RA-228	1.32E+00	1.91E+00	1.76E-01
AC-228	1.18E+00	3.07E-01	9.45E-02
TH-228	4.93E-01	1.43E-01	3.93E-01
RA-224	1.25E+00	4.06E-01	7.98E-02
PB-212	1.21E+00	3.57E-01	4.12E-02
BI-212	8.78E-01	2.89E-01	2.12E-01
TL-208	1.15E+00	3.60E-01	7.17E-02
U-235	Not Detected	-----	2.27E-01
TH-231	Not Detected	-----	9.37E+00
PA-231	Not Detected	-----	1.45E+00
TH-227	Not Detected	-----	4.10E-01
RA-223	Not Detected	-----	1.68E-01
RN-219	Not Detected	-----	4.09E-01
PB-211	Not Detected	-----	9.37E-01
TL-207	Not Detected	-----	1.55E+01
AM-241	Not Detected	-----	2.01E-01
PU-239	Not Detected	-----	3.84E+02
NP-237	6.24E-01	2.27E-01	2.36E-01
PA-233	Not Detected	-----	5.92E-02
TH-229	Not Detected	-----	2.14E-01

Not detected 4/19/97

[Summary Report] - Sample ID: : 70060015

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.85E-02
AG-110m	Not Detected	-----	3.98E-02
BA-133	Not Detected	-----	6.10E-02
BE-7	Not Detected	-----	2.61E-01
CD-109	Not Detected	-----	1.04E+00
CD-115	Not Detected	-----	1.46E-01
CE-139	Not Detected	-----	2.82E-02
CE-141	Not Detected	-----	5.05E-02
CE-144	Not Detected	-----	2.07E-01
CO-56	Not Detected	-----	2.53E-02
CO-57	Not Detected	-----	2.62E-02
CO-58	Not Detected	-----	3.62E-02
CO-60	Not Detected	-----	4.06E-02
CR-51	Not Detected	-----	2.62E-01
CS-134	Not Detected	-----	4.71E-02
CS-137	5.19E-02	2.44E-02	2.28E-02
EU-152	Not Detected	-----	7.82E-02
EU-154	Not Detected	-----	2.26E-01
EU-155	Not Detected	-----	1.23E-01
FE-59	Not Detected	-----	8.50E-02
GD-153	Not Detected	-----	8.67E-02
HG-203	Not Detected	-----	3.33E-02
I-131	Not Detected	-----	3.77E-02
IR-192	Not Detected	-----	2.90E-02
K-40	2.19E+01	3.24E+00	2.72E-01
MN-52	Not Detected	-----	5.11E-02
MN-54	Not Detected	-----	1.63E-02
MO-99	Not Detected	-----	4.75E-01
NA-22	Not Detected	-----	5.07E-02
NA-24	Not Detected	-----	4.36E-01
NB-95	Not Detected	-----	2.64E-01
ND-147	Not Detected	-----	2.48E-01
NI-57	Not Detected	-----	1.52E-01
PB-210	Not Detected	-----	8.14E+00
RU-103	Not Detected	-----	3.21E-02
RU-106	Not Detected	-----	3.09E-01
SB-122	Not Detected	-----	7.67E-02
SB-124	Not Detected	-----	3.24E-02
SB-125	Not Detected	-----	9.18E-02
SN-113	Not Detected	-----	4.07E-02
SR-85	Not Detected	-----	4.12E-02
TA-182	Not Detected	-----	1.78E-01
TA-183	Not Detected	-----	2.33E-01
TC-99m	Not Detected	-----	1.44E+01
TL-201	Not Detected	-----	1.91E-01
XE-133	Not Detected	-----	2.09E-01
Y-88	Not Detected	-----	3.11E-02
ZN-65	Not Detected	-----	1.19E-01
ZR-95	Not Detected	-----	6.45E-02

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-18-97 8:58:24 PM *

 *
 * Analyzed by: *J 4/19/97* Reviewed by: *K 4/21/97* *

Customer : P.SLAVIN/C.C. (6682/IT)
 Customer Sample ID : 034348-002
 Lab Sample ID : 70060016

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 994.000 gram
 Sample Date/Time : 4-16-97 10:50:00 AM
 Acquire Start Date/Time : 4-18-97 7:15:45 PM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6003 seconds

CY10-SS-NW4

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	1.41E+00
TH-234	9.77E-01	3.05E-01	4.36E-01
RA-226	1.55E+00	4.72E-01	5.16E-01
PB-214	6.83E-01	1.22E-01	4.28E-02
BI-214	6.03E-01	1.16E-01	4.51E-02
TH-232	7.31E-01	3.72E-01	1.35E-01
RA-228	9.22E-01	3.30E-01	1.65E-01
AC-228	8.87E-01	2.00E-01	8.41E-02
TH-228	6.17E-01	4.29E-01	4.69E-01
RA-224	1.03E+00	3.58E-01	6.23E-02
PB-212	8.13E-01	1.59E-01	3.50E-02
BI-212	5.27E-01	3.16E-01	1.71E-01
TL-208	8.22E-01	1.69E-01	6.85E-02
U-235	Not Detected	-----	1.91E-01
TH-231	Not Detected	-----	8.15E+00
PA-231	Not Detected	-----	1.28E+00
TH-227	Not Detected	-----	3.31E-01
RA-223	Not Detected	-----	1.47E-01
RN-219	2.99E-01	3.05E-01	3.78E-01
PB-211	Not Detected	-----	8.44E-01
TL-207	Not Detected	-----	1.50E+01
AM-241	Not Detected	-----	1.68E-01
PU-239	Not Detected	-----	3.27E+02
NP-237	4.10E-01	1.30E-01	2.03E-01
PA-233	Not Detected	-----	5.31E-02
TH-229	Not Detected	-----	1.83E-01

not detected J 4/19/97

not detected J 4/19/97

[Summary Report] - Sample ID: : 70060016

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.01E-02
AG-110m	Not Detected	-----	3.51E-02
BA-133	Not Detected	-----	4.97E-02
BE-7	Not Detected	-----	2.34E-01
CD-109	Not Detected	-----	6.91E-01
CD-115	Not Detected	-----	1.24E-01
CE-139	Not Detected	-----	2.43E-02
CE-141	Not Detected	-----	4.38E-02
CE-144	Not Detected	-----	1.79E-01
CO-56	Not Detected	-----	2.47E-02
CO-57	Not Detected	-----	2.31E-02
CO-58	Not Detected	-----	3.42E-02
CO-60	Not Detected	-----	3.96E-02
CR-51	Not Detected	-----	2.24E-01
CS-134	Not Detected	-----	3.93E-02
CS-137	4.44E-02	2.67E-02	2.00E-02
EU-152	Not Detected	-----	6.92E-02
EU-154	Not Detected	-----	1.87E-01
EU-155	Not Detected	-----	1.08E-01
FE-59	Not Detected	-----	8.51E-02
GD-153	Not Detected	-----	7.43E-02
HG-203	Not Detected	-----	2.99E-02
I-131	Not Detected	-----	3.26E-02
IR-192	Not Detected	-----	2.52E-02
K-40	2.21E+01	3.31E+00	2.49E-01
MN-52	Not Detected	-----	4.17E-02
MN-54	Not Detected	-----	3.32E-02
MO-99	Not Detected	-----	4.31E-01
NA-22	Not Detected	-----	4.71E-02
NA-24	Not Detected	-----	4.63E-01
NB-95	Not Detected	-----	2.17E-01
ND-147	Not Detected	-----	2.28E-01
NI-57	Not Detected	-----	1.50E-01
PB-210	Not Detected	-----	7.08E+00
RU-103	Not Detected	-----	2.93E-02
RU-106	Not Detected	-----	2.79E-01
SB-122	Not Detected	-----	6.87E-02
SB-124	Not Detected	-----	3.02E-02
SB-125	Not Detected	-----	8.09E-02
SN-113	Not Detected	-----	3.47E-02
SR-85	Not Detected	-----	3.66E-02
TA-182	Not Detected	-----	1.65E-01
TA-183	Not Detected	-----	1.97E-01
TC-99m	Not Detected	-----	1.51E+01
TL-201	Not Detected	-----	1.66E-01
XE-133	Not Detected	-----	1.91E-01
Y-88	Not Detected	-----	2.49E-02
ZN-65	Not Detected	-----	1.13E-01
ZR-95	Not Detected	-----	6.18E-02

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-21-97 5:20:23 PM *

* Analyzed by: *[Signature]* 4/22/97 Reviewed by: *[Signature]* 4/22/97 *

Customer : P.SLAVIN/C.C. (6682/IT)
 Customer Sample ID : 034330-002
 Lab Sample ID : 70060024

Sample Description : MARINELLI WATER SAMPLE
 Sample Quantity : 500.000 mL
 Sample Date/Time : 4-16-97 12:00:00 PM
 Acquire Start Date/Time : 4-21-97 3:38:33 PM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6001 seconds

CY10-RB6

Comments:

Nuclide Name	Activity (pCi/mL)	2-sigma Error	MDA (pCi/mL)
U-238	Not Detected	-----	8.96E-01
TH-234	Not Detected	-----	3.21E-01
RA-226	Not Detected	-----	4.12E-01
PB-214	Not Detected	-----	5.72E-02
BI-214	Not Detected	-----	6.68E-02
TH-232	Not Detected	-----	1.54E-01
RA-228	Not Detected	-----	1.46E-01
AC-228	Not Detected	-----	9.81E-02
TH-228	Not Detected	-----	5.21E-01
RA-224	Not Detected	-----	1.35E-01
PB-212	Not Detected	-----	4.12E-02
BI-212	Not Detected	-----	3.63E-01
TL-208	Not Detected	-----	8.23E-02
U-235	Not Detected	-----	1.46E-01
TH-231	Not Detected	-----	4.91E+00
PA-231	Not Detected	-----	1.10E+00
TH-227	Not Detected	-----	1.59E-01
RA-223	Not Detected	-----	1.06E-01
RN-219	Not Detected	-----	3.13E-01
PB-211	Not Detected	-----	7.36E-01
TL-207	Not Detected	-----	1.23E+01
AM-241	Not Detected	-----	9.27E-02
PU-239	Not Detected	-----	2.16E+02
NP-237	Not Detected	-----	1.41E-01
PA-233	Not Detected	-----	4.18E-02
TH-229	Not Detected	-----	1.23E-01

[Summary Report] - Sample ID: : 70060024

Nuclide Name	Activity (pCi/mL)	2-sigma Error	MDA (pCi/mL)
AG-108m	Not Detected	-----	2.93E-02
AG-110m	Not Detected	-----	2.82E-02
BA-133	Not Detected	-----	3.44E-02
BE-7	Not Detected	-----	2.02E-01
CD-109	Not Detected	-----	4.51E-01
CD-115	Not Detected	-----	1.77E-01
CE-139	Not Detected	-----	1.95E-02
CE-141	Not Detected	-----	3.53E-02
CE-144	Not Detected	-----	1.28E-01
CO-56	Not Detected	-----	3.70E-02
CO-57	Not Detected	-----	1.61E-02
CO-58	Not Detected	-----	2.67E-02
CO-60	Not Detected	-----	2.79E-02
CR-51	Not Detected	-----	2.13E-01
CS-134	Not Detected	-----	2.98E-02
CS-137	Not Detected	-----	2.90E-02
EU-152	Not Detected	-----	4.75E-02
EU-154	Not Detected	-----	1.34E-01
EU-155	Not Detected	-----	7.44E-02
FE-59	Not Detected	-----	4.89E-02
GD-153	Not Detected	-----	4.99E-02
HG-203	Not Detected	-----	2.39E-02
I-131	Not Detected	-----	3.60E-02
IR-192	Not Detected	-----	2.23E-02
K-40	Not Detected	-----	3.59E-01
MN-52	Not Detected	-----	5.22E-02
MN-54	Not Detected	-----	2.74E-02
MO-99	Not Detected	-----	6.26E-01
NA-22	Not Detected	-----	3.17E-02
NA-24	Not Detected	-----	7.59E+00
NB-95	Not Detected	-----	1.92E-01
ND-147	Not Detected	-----	2.39E-01
NI-57	Not Detected	-----	4.42E-01
PB-210	Not Detected	-----	3.75E+00
RU-103	Not Detected	-----	2.83E-02
RU-106	Not Detected	-----	2.59E-01
SB-122	Not Detected	-----	1.33E-01
SB-124	Not Detected	-----	2.91E-02
SB-125	Not Detected	-----	7.14E-02
SN-113	Not Detected	-----	3.05E-02
SR-85	Not Detected	-----	3.57E-02
TA-182	Not Detected	-----	9.20E-02
TA-183	Not Detected	-----	1.58E-01
TC-99m	Not Detected	-----	2.66E+04
TL-201	Not Detected	-----	1.84E-01
XE-133	Not Detected	-----	2.72E-01
Y-88	Not Detected	-----	4.00E-02
ZN-65	Not Detected	-----	6.28E-02
ZR-95	Not Detected	-----	4.75E-02

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-10-97 5:37:15 PM *

* Analyzed by: *[Signature]* 4/11/97 Reviewed by: *[Signature]* 4/11/97 *

 Customer : P. SLAVIN/MAC (6682/SMO)
 Customer Sample ID : 034340-002
 Lab Sample ID : 70054101

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 847.000 gram
 Sample Date/Time : 4-10-97 9:00:00 AM
 Acquire Start Date/Time : 4-10-97 3:49:21 PM
 Detector Name : LAB02
 Elapsed Live/Real Time : 6000 / 6004 seconds

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	3.66E+00
TH-234	1.67E+00	5.91E-01	7.86E-01
RA-226	1.91E+00	6.37E-01	6.29E-01
PB-214	1.04E+00	1.70E-01	5.05E-02
BI-214	9.12E-01	1.95E-01	2.12E-01
TH-232	1.13E+00	5.26E-01	1.48E-01
RA-228	1.20E+00	4.31E-01	1.44E-01
AC-228	1.19E+00	2.53E-01	8.51E-02
TH-228	1.33E+00	3.46E-01	5.38E-01
RA-224	4.41E-01	1.18E-01	2.16E-02
PB-212	1.19E+00	2.18E-01	4.15E-02
BI-212	7.57E-01	2.50E-01	1.71E-01
TL-208	4.23E-01	1.13E-01	2.42E-02
U-235	2.22E-01	2.00E-01	2.66E-01
TH-231	Not Detected	-----	1.39E+01
PA-231	Not Detected	-----	1.54E+00
TH-227	Not Detected	-----	3.99E-01
RA-223	Not Detected	-----	2.17E-01
RN-219	Not Detected	-----	4.00E-01
PB-211	Not Detected	-----	9.14E-01
TL-207	Not Detected	-----	1.41E+01
AM-241	Not Detected	-----	5.10E-01
PU-239	Not Detected	-----	4.93E+02
NP-237	6.83E-01	2.05E-01	3.18E-01
PA-233	Not Detected	-----	6.13E-02
TH-229	Not Detected	-----	2.74E-01

CY10-SS-S3

not detected 7/11/97

not detected 7/11/97

[Summary Report] - Sample ID: : 70054101

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.46E-02
AG-110m	Not Detected	-----	3.42E-02
BA-133	Not Detected	-----	7.22E-02
BE-7	Not Detected	-----	2.58E-01
CD-109	Not Detected	-----	1.08E+00
CD-115	Not Detected	-----	7.80E-02
CE-139	Not Detected	-----	3.19E-02
CE-141	Not Detected	-----	5.67E-02
CE-144	Not Detected	-----	2.67E-01
CO-56	Not Detected	-----	2.40E-02
CO-57	Not Detected	-----	3.35E-02
CO-58	Not Detected	-----	3.48E-02
CO-60	Not Detected	-----	3.76E-02
CR-51	Not Detected	-----	2.45E-01
CS-134	Not Detected	-----	5.32E-02
CS-137	3.51E-02	2.18E-02	2.13E-02
EU-152	Not Detected	-----	1.01E-01
EU-154	Not Detected	-----	2.05E-01
EU-155	Not Detected	-----	1.65E-01
FE-59	Not Detected	-----	7.50E-02
GD-153	Not Detected	-----	1.14E-01
HG-203	Not Detected	-----	3.42E-02
I-131	Not Detected	-----	3.06E-02
IR-192	Not Detected	-----	2.84E-02
K-40	2.38E+01	3.38E+00	2.37E-01
MN-52	Not Detected	-----	3.08E-02
MN-54	Not Detected	-----	1.93E-02
MO-99	Not Detected	-----	2.67E-01
NA-22	Not Detected	-----	4.60E-02
NA-24	Not Detected	-----	4.70E-02
NB-95	Not Detected	-----	1.94E-01
ND-147	Not Detected	-----	2.13E-01
NI-57	Not Detected	-----	5.59E-02
PB-210	Not Detected	-----	3.80E+01
RU-103	Not Detected	-----	3.10E-02
RU-106	Not Detected	-----	3.03E-01
SB-122	Not Detected	-----	4.40E-02
SB-124	Not Detected	-----	3.26E-02
SB-125	Not Detected	-----	8.57E-02
SN-113	Not Detected	-----	3.91E-02
SR-85	Not Detected	-----	3.82E-02
TA-182	Not Detected	-----	1.57E-01
TA-183	Not Detected	-----	4.57E-01
TC-99m	Not Detected	-----	6.97E-02
TL-201	Not Detected	-----	2.13E-01
XE-133	Not Detected	-----	1.70E-01
Y-88	Not Detected	-----	2.63E-02
ZN-65	Not Detected	-----	1.08E-01
ZR-95	Not Detected	-----	5.89E-02

ANALYSIS REQUEST AND CHAIN OF CUSTODY

PAGE 1 OF 2

Internal Lab

Batch No. 700600

AR/COC- 06569

SF 2001-COC-6-20

Dept. No./Mail Stop: 6682/85 MS-1147
 Project/Task Manager: PAULA SLAVIN
 Project Name: SITE 10 CONT. SMRG
 Record Center Code: ER/1333/010/DAT
 Logbook Ref No: 206
 Service Order No.: CF0394

Date Sample Shipped: 4/17/97
 Carrier/Vehicle No.: 142
 Lab Contact: FERNANDO DOMINGUEZ
 Lab Destination: RPSD - Bloc 801
 SMO Contact/Phone: Rm Puissant/844-318
 Send Report to SMO: PAULA SLAVIN

Contract No.:
 Case No.: 8821-201203
 SMO Authorization: [Signature]
 Bill to: Sandia National Laboratories
 Supplier Services Department
 P.O. Box 5800 MS 0154
 Albuquerque, NM 87185-0154

Parameter & Method Requested

Location		Tech Area		Beginning Depth in Ft.	ER Site No.	Date/Time Collected	Reference LOV (available at SMO)						GAMMA																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
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RMMA ☒ Yes ☐ No Ref. No. _____

Sample Disposal ☒ Return to Client ☐ Disposal by lab

Turnaround Time ☒ Normal ☐ Rush Required Report Date 5.2.97

Sample Team Members

Name	Signature	Init	Company/Organization/Phone
PAULA SLAVIN	[Signature]	NS	GRAM/6082/294-2496
CONCETTA CACCIATO	[Signature]	CL	MDM/244/684/223-5738

Special Instructions/QC Requirements

- Normal turnaround time
- Upon completion, please send hardcopy report to Paula Slavin @ MS-1147

Abnormal Conditions on Receipt

1. Relinquished by [Signature] Org. 6684 Date 4/17/97 Time 1450	4. Relinquished by	Org.	Date	Time
1. Received by Org. SNL 7578 Date 4/17/97 Time 1450	4. Received by	Org.	Date	Time
2. Relinquished by	5. Relinquished by	Org.	Date	Time
2. Received by	5. Received by	Org.	Date	Time
3. Relinquished by	6. Relinquished by	Org.	Date	Time
3. Received by	6. Received by	Org.	Date	Time

WHITE - To Accompany Samples, Laboratory Copy

BLUE - To Accompany Samples, Return to SMO

YELLOW - SMO Suspense Copy

PINK - Field Copy

57 2001-COD (12-96)
 Superseded (10-94) issue

AR/COC-06569

BATCH # 700600

[illegible]

**WHITE - To Accompany Samples,
Laboratory Copy**

**BLUE- To Accompany Samples,
Return to SMO**

YELLOW- SMO Suspense Copy

PINK- Field Copy

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-18-97 10:43:36 PM *

* Analyzed by: *[Signature]* 4/19/97 Reviewed by: *[Signature]* 4/21/97 *

 Customer : P.SLAVIN/C.C. (6682/IT)
 Customer Sample ID : 034349-002
 Lab Sample ID : 70060017

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 962.000 gram
 Sample Date/Time : 4-16-97 1:05:00 PM
 Acquire Start Date/Time : 4-18-97 9:00:54 PM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6003 seconds

CY10-SS-ARY-1

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	9.43E-01	1.84E+00	1.26E+00
TH-234	1.31E+00	3.70E-01	4.51E-01
RA-226	1.82E+00	7.74E-01	5.67E-01
PB-214	8.41E-01	1.46E-01	4.74E-02
BI-214	8.32E-01	1.67E-01	5.21E-02
TH-232	1.04E+00	5.02E-01	1.50E-01
RA-228	9.81E-01	2.60E-01	1.86E-01
AC-228	1.03E+00	3.21E-01	9.65E-02
TH-228	9.71E-01	4.65E-01	4.25E-01
RA-224	1.04E+00	3.50E-01	8.58E-02
PB-212	9.95E-01	1.60E-01	3.94E-02
BI-212	6.28E-01	3.21E-01	2.13E-01
TL-208	9.58E-01	1.82E-01	7.44E-02
U-235	Not Detected	-----	2.17E-01
TH-231	Not Detected	-----	4.38E+00
PA-231	Not Detected	-----	1.45E+00
TH-227	Not Detected	-----	3.73E-01
RA-223	Not Detected	-----	7.81E-02
RN-219	Not Detected	-----	4.10E-01
PB-211	Not Detected	-----	9.16E-01
TL-207	Not Detected	-----	1.64E+01
AM-241	Not Detected	-----	1.87E-01
PU-239	Not Detected	-----	3.66E+02
NP-237	5.84E-01	1.89E-01	2.29E-01
PA-233	Not Detected	-----	5.66E-02
TH-229	Not Detected	-----	2.01E-01

not detected 7/19/97

[Summary Report] - Sample ID: : 70060017

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.68E-02
AG-110m	Not Detected	-----	4.45E-02
BA-133	Not Detected	-----	5.66E-02
BE-7	Not Detected	-----	2.71E-01
CD-109	Not Detected	-----	9.82E-01
CD-115	Not Detected	-----	1.38E-01
CE-139	Not Detected	-----	2.73E-02
CE-141	Not Detected	-----	4.89E-02
CE-144	Not Detected	-----	2.00E-01
CO-56	Not Detected	-----	3.68E-02
CO-57	Not Detected	-----	2.54E-02
CO-58	Not Detected	-----	3.54E-02
CO-60	Not Detected	-----	4.28E-02
CR-51	Not Detected	-----	2.44E-01
CS-134	Not Detected	-----	4.65E-02
CS-137	1.22E-01	3.71E-02	2.66E-02
EU-152	Not Detected	-----	7.60E-02
EU-154	Not Detected	-----	2.17E-01
EU-155	Not Detected	-----	1.16E-01
FE-59	Not Detected	-----	8.56E-02
GD-153	Not Detected	-----	8.11E-02
HG-203	Not Detected	-----	3.25E-02
I-131	Not Detected	-----	3.56E-02
IR-192	Not Detected	-----	2.86E-02
K-40	2.26E+01	3.35E+00	2.57E-01
MN-52	Not Detected	-----	4.62E-02
MN-54	Not Detected	-----	3.76E-02
MO-99	Not Detected	-----	4.61E-01
NA-22	Not Detected	-----	5.05E-02
NA-24	Not Detected	-----	4.61E-01
NB-95	Not Detected	-----	2.46E-01
ND-147	Not Detected	-----	2.42E-01
NI-57	Not Detected	-----	1.66E-01
PB-210	Not Detected	-----	7.57E+00
RU-103	Not Detected	-----	3.24E-02
RU-106	Not Detected	-----	3.12E-01
SB-122	Not Detected	-----	7.71E-02
SB-124	Not Detected	-----	3.28E-02
SB-125	Not Detected	-----	9.12E-02
SN-113	Not Detected	-----	3.73E-02
SR-85	Not Detected	-----	3.86E-02
TA-182	Not Detected	-----	1.81E-01
TA-183	Not Detected	-----	2.18E-01
TC-99m	Not Detected	-----	1.61E+01
TL-201	Not Detected	-----	1.86E-01
XE-133	Not Detected	-----	1.00E-01
Y-88	Not Detected	-----	2.60E-02
ZN-65	Not Detected	-----	1.25E-01
ZR-95	Not Detected	-----	6.62E-02

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-19-97 12:28:51 AM *

* Analyzed by: *J 4/19/97* Reviewed by: *JS 4/21/97* *

 Customer : P.SLAVIN/C.C. (6682/IT)
 Customer Sample ID : 034351-002
 Lab Sample ID : 70060018

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 661.000 gram
 Sample Date/Time : 4-16-97 1:08:00 PM
 Acquire Start Date/Time : 4-18-97 10:46:09 PM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6003 seconds

CYID-SS-ARY-3

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	2.12E+00
TH-234	1.14E+00	5.17E-01	7.02E-01
RA-226	Not Detected	-----	7.77E-01
PB-214	1.31E+00	2.10E-01	6.33E-02
BI-214	1.18E+00	2.19E-01	6.87E-02
TH-232	1.61E+00	7.48E-01	2.23E-01
RA-228	1.64E+00	5.02E-01	2.52E-01
AC-228	1.62E+00	3.88E-01	1.39E-01
TH-228	1.32E+00	8.03E-01	6.10E-01
RA-224	1.66E+00	4.65E-01	1.30E-01
PB-212	1.72E+00	2.81E-01	5.18E-02
BI-212	9.70E-01	3.35E-01	2.58E-01
TL-208	1.62E+00	2.93E-01	9.77E-02
U-235	Not Detected	-----	2.98E-01
TH-231	Not Detected	-----	1.24E+01
PA-231	Not Detected	-----	1.98E+00
TH-227	Not Detected	-----	5.62E-01
RA-223	Not Detected	-----	2.25E-01
RN-219	4.95E-01	4.62E-01	5.75E-01
PB-211	Not Detected	-----	1.27E+00
TL-207	Not Detected	-----	2.18E+01
AM-241	Not Detected	-----	2.63E-01
PU-239	Not Detected	-----	4.99E+02
NP-237	6.17E-01	2.32E-01	2.79E-01
PA-233	Not Detected	-----	8.18E-02
TH-229	Not Detected	-----	2.80E-01

not detected J 4/19/97

not detected J 4/19/97

[Summary Report] - Sample ID: : 70060018

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	6.59E-02
AG-110m	Not Detected	-----	5.23E-02
BA-133	Not Detected	-----	7.96E-02
BE-7	Not Detected	-----	3.79E-01
CD-109	Not Detected	-----	9.48E-01
CD-115	Not Detected	-----	2.09E-01
CE-139	Not Detected	-----	3.61E-02
CE-141	Not Detected	-----	3.10E-02
CE-144	Not Detected	-----	2.68E-01
CO-56	Not Detected	-----	5.07E-02
CO-57	Not Detected	-----	3.35E-02
CO-58	Not Detected	-----	4.75E-02
CO-60	Not Detected	-----	5.49E-02
CR-51	Not Detected	-----	3.40E-01
CS-134	Not Detected	-----	6.29E-02
CS-137	5.77E-02	3.32E-02	3.55E-02
EU-152	Not Detected	-----	1.00E-01
EU-154	Not Detected	-----	3.03E-01
EU-155	Not Detected	-----	1.59E-01
FE-59	Not Detected	-----	1.16E-01
GD-153	Not Detected	-----	1.15E-01
HG-203	Not Detected	-----	4.47E-02
I-131	Not Detected	-----	5.02E-02
IR-192	Not Detected	-----	3.93E-02
K-40	2.72E+01	4.03E+00	4.73E-01
MN-52	Not Detected	-----	6.45E-02
MN-54	Not Detected	-----	3.29E-02
MO-99	Not Detected	-----	7.03E-01
NA-22	Not Detected	-----	6.53E-02
NA-24	Not Detected	-----	7.24E-01
NB-95	Not Detected	-----	3.69E-01
ND-147	Not Detected	-----	3.55E-01
NI-57	Not Detected	-----	2.42E-01
PB-210	Not Detected	-----	1.09E+01
RU-103	Not Detected	-----	4.45E-02
RU-106	6.14E-02	8.67E-02	2.41E-01
SB-122	Not Detected	-----	1.13E-01
SB-124	Not Detected	-----	4.40E-02
SB-125	Not Detected	-----	1.22E-01
SN-113	Not Detected	-----	5.48E-02
SR-85	Not Detected	-----	5.71E-02
TA-182	Not Detected	-----	2.39E-01
TA-183	Not Detected	-----	3.09E-01
TC-99m	Not Detected	-----	2.65E+01
TL-201	Not Detected	-----	2.51E-01
XE-133	Not Detected	-----	1.19E-01
Y-88	Not Detected	-----	4.57E-02
ZN-65	Not Detected	-----	1.68E-01
ZR-95	Not Detected	-----	9.39E-02

not detected 7/1/95

* Analyzed by: *[Signature]* 4/19/97 Reviewed by: *[Signature]* 4/19/97 *
 Customer : P.SLAVIN/C.C. (6682/IT)
 Customer Sample ID : 034353-002
 Lab Sample ID : 70060019

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 984.000 gram
 Sample Date/Time : 4-16-97 1:10:00 PM
 Acquire Start Date/Time : 4-19-97 12:31:25 AM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6004 seconds

CY10-SS-ARY-4

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	7.51E+00	1.74E+00	1.40E+00
TH-234	1.76E+00	4.48E-01	5.12E-01
RA-226	2.73E+00	6.44E-01	6.12E-01
PB-214	1.30E+00	1.96E-01	4.95E-02
BI-214	1.22E+00	2.03E-01	5.41E-02
TH-232	1.24E+00	5.78E-01	1.65E-01
RA-228	1.55E+00	3.10E-01	1.59E-01
AC-228	1.53E+00	9.22E-01	9.51E-02
TH-228	7.14E-01	3.63E-01	5.26E-01
RA-224	1.53E+00	4.12E-01	8.72E-02
PB-212	1.50E+00	2.23E-01	4.71E-02
BI-212	8.29E-01	2.62E-01	1.93E-01
TL-208	1.41E+00	2.69E-01	7.78E-02
U-235	1.65E-01	1.73E-01	2.39E-01
TH-231	Not Detected	-----	9.82E+00
PA-231	Not Detected	-----	1.52E+00
TH-227	Not Detected	-----	4.33E-01
RA-223	Not Detected	-----	1.81E-01
RN-219	Not Detected	-----	4.38E-01
PB-211	Not Detected	-----	1.01E+00
TL-207	Not Detected	-----	1.52E+01
AM-241	Not Detected	-----	2.00E-01
PU-239	Not Detected	-----	4.05E+02
NP-237	8.61E-01	2.18E-01	2.26E-01
PA-233	Not Detected	-----	6.41E-02
TH-229	Not Detected	-----	2.24E-01

not detected 4/19/97

not detected 4/19/97

[Summary Report] - Sample ID: : 70060019

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	5.00E-02
AG-110m	Not Detected	-----	3.50E-02
BA-133	Not Detected	-----	6.42E-02
BE-7	Not Detected	-----	2.87E-01
CD-109	Not Detected	-----	7.69E-01
CD-115	Not Detected	-----	1.61E-01
CE-139	Not Detected	-----	2.94E-02
CE-141	Not Detected	-----	5.45E-02
CE-144	Not Detected	-----	2.20E-01
CO-56	Not Detected	-----	3.88E-02
CO-57	Not Detected	-----	2.75E-02
CO-58	Not Detected	-----	3.75E-02
CO-60	Not Detected	-----	4.30E-02
CR-51	Not Detected	-----	2.63E-01
CS-134	Not Detected	-----	5.17E-02
CS-137	Not Detected	-----	4.13E-02
EU-152	Not Detected	-----	8.22E-02
EU-154	Not Detected	-----	2.30E-01
EU-155	Not Detected	-----	1.28E-01
FE-59	Not Detected	-----	8.73E-02
GD-153	Not Detected	-----	9.36E-02
HG-203	Not Detected	-----	3.62E-02
I-131	Not Detected	-----	3.76E-02
IR-192	Not Detected	-----	3.02E-02
K-40	1.87E+01	2.91E+00	3.03E-01
MN-52	Not Detected	-----	5.14E-02
MN-54	Not Detected	-----	2.62E-02
MO-99	Not Detected	-----	5.28E-01
NA-22	Not Detected	-----	4.96E-02
NA-24	Not Detected	-----	5.84E-01
NB-95	Not Detected	-----	2.89E-01
ND-147	Not Detected	-----	2.63E-01
NI-57	Not Detected	-----	1.85E-01
PB-210	Not Detected	-----	8.61E+00
RU-103	Not Detected	-----	3.51E-02
RU-106	Not Detected	-----	3.15E-01
SB-122	Not Detected	-----	8.62E-02
SB-124	Not Detected	-----	3.41E-02
SB-125	Not Detected	-----	9.53E-02
SN-113	Not Detected	-----	4.29E-02
SR-85	Not Detected	-----	4.28E-02
TA-182	Not Detected	-----	1.90E-01
TA-183	Not Detected	-----	2.38E-01
TC-99m	Not Detected	-----	2.56E+01
TL-201	Not Detected	-----	2.05E-01
XE-133	Not Detected	-----	2.36E-01
Y-88	Not Detected	-----	3.49E-02
ZN-65	Not Detected	-----	1.27E-01
ZR-95	Not Detected	-----	6.89E-02

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-21-97 10:11:15 AM *

 *
 * Analyzed by: *JS 4/22/97* Reviewed by: *K 4/21/97* *

Customer : P.SLAVIN/C.C. (6682/IT)
 Customer Sample ID : 034354-002
 Lab Sample ID : 70060020

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 951.000 gram
 Sample Date/Time : 4-16-97 1:15:00 PM
 Acquire Start Date/Time : 4-21-97 8:22:31 AM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6004 seconds

CY10-SS-ARY-5

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	1.20E+00
TH-234	1.03E+00	3.26E-01	4.54E-01
RA-226	1.83E+00	7.90E-01	5.63E-01
PB-214	9.70E-01	2.30E-01	5.09E-02
BI-214	8.41E-01	1.57E-01	5.30E-02
TH-232	1.06E+00	5.00E-01	1.54E-01
RA-228	1.12E+00	3.41E-01	1.74E-01
AC-228	1.05E+00	2.60E-01	9.47E-02
TH-228	4.75E-01	8.42E-01	4.41E-01
RA-224	1.10E+00	3.37E-01	8.18E-02
PB-212	1.06E+00	1.70E-01	4.14E-02
BI-212	6.82E-01	2.41E-01	2.05E-01
TL-208	9.94E-01	1.92E-01	7.45E-02
U-235	Not Detected	-----	2.16E-01
TH-231	Not Detected	-----	9.29E+00
PA-231	Not Detected	-----	1.47E+00
TH-227	Not Detected	-----	3.81E-01
RA-223	Not Detected	-----	1.95E-01
RN-219	Not Detected	-----	4.15E-01
PB-211	Not Detected	-----	9.44E-01
TL-207	Not Detected	-----	1.54E+01
AM-241	Not Detected	-----	1.94E-01
PU-239	Not Detected	-----	3.65E+02
NP-237	Not Detected	-----	2.95E-01
PA-233	Not Detected	-----	5.79E-02
TH-229	Not Detected	-----	2.03E-01

[Summary Report] - Sample ID: : 70060020

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.50E-02
AG-110m	Not Detected	-----	4.42E-02
BA-133	Not Detected	-----	6.10E-02
BE-7	Not Detected	-----	2.77E-01
CD-109	1.41E+00	4.69E-01	7.87E-01
CD-115	Not Detected	-----	3.09E-01
CE-139	Not Detected	-----	2.76E-02
CE-141	Not Detected	-----	5.15E-02
CE-144	Not Detected	-----	1.96E-01
CO-56	Not Detected	-----	2.56E-02
CO-57	Not Detected	-----	2.58E-02
CO-58	Not Detected	-----	3.79E-02
CO-60	Not Detected	-----	4.21E-02
CR-51	Not Detected	-----	2.67E-01
CS-134	Not Detected	-----	4.34E-02
CS-137	1.12E-01	1.06E-01	2.57E-02
EU-152	Not Detected	-----	7.70E-02
EU-154	Not Detected	-----	2.10E-01
EU-155	Not Detected	-----	1.18E-01
FE-59	Not Detected	-----	8.89E-02
GD-153	Not Detected	-----	8.39E-02
HG-203	Not Detected	-----	3.38E-02
I-131	Not Detected	-----	4.49E-02
IR-192	Not Detected	-----	2.85E-02
K-40	2.30E+01	3.39E+00	2.53E-01
MN-52	Not Detected	-----	6.37E-02
MN-54	Not Detected	-----	3.93E-02
MO-99	Not Detected	-----	9.34E-01
NA-22	Not Detected	-----	4.79E-02
NA-24	Not Detected	-----	7.31E+00
NB-95	Not Detected	-----	3.97E-01
ND-147	Not Detected	-----	2.93E-01
NI-57	Not Detected	-----	5.35E-01
PB-210	Not Detected	-----	7.62E+00
RU-103	Not Detected	-----	3.32E-02
RU-106	Not Detected	-----	3.00E-01
SB-122	Not Detected	-----	1.48E-01
SB-124	Not Detected	-----	3.30E-02
SB-125	Not Detected	-----	9.18E-02
SN-113	Not Detected	-----	4.23E-02
SR-85	Not Detected	-----	4.10E-02
TA-182	Not Detected	-----	1.90E-01
TA-183	Not Detected	-----	3.17E-01
TC-99m	Not Detected	-----	1.49E+04
TL-201	Not Detected	-----	3.30E-01
XE-133	Not Detected	-----	4.58E-01
Y-88	Not Detected	-----	2.83E-02
ZN-65	Not Detected	-----	1.26E-01
ZR-95	Not Detected	-----	6.69E-02

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-21-97 12:03:14 PM *

 * Analyzed by: *[Signature]* 4/21/97 Reviewed by: *[Signature]* 4/22/97 *

Customer : P.SLAVIN/C.C. (6682/IT)
 Customer Sample ID : 034355-002
 Lab Sample ID : 70060021

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 969.000 gram
 Sample Date/Time : 4-16-97 1:17:00 PM
 Acquire Start Date/Time : 4-21-97 10:14:10 AM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6004 seconds

CY10-SS-ARY-6

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	1.53E+00
TH-234	1.19E+00	3.51E-01	4.69E-01
RA-226	Not Detected	-----	5.26E-01
PB-214	8.34E-01	1.36E-01	4.73E-02
BI-214	8.18E-01	2.54E-01	4.91E-02
TH-232	9.40E-01	4.49E-01	1.59E-01
RA-228	1.01E+00	2.91E-01	1.90E-01
AC-228	1.03E+00	2.22E-01	9.97E-02
TH-228	5.03E-01	2.51E-01	3.46E-01
RA-224	1.22E+00	4.41E-01	7.74E-02
PB-212	1.09E+00	1.79E-01	4.14E-02
BI-212	5.83E-01	2.19E-01	2.09E-01
TL-208	9.70E-01	1.76E-01	7.66E-02
U-235	1.15E-01	8.04E-02	1.98E-01
TH-231	Not Detected	-----	8.94E+00
PA-231	Not Detected	-----	1.45E+00
TH-227	Not Detected	-----	3.77E-01
RA-223	Not Detected	-----	1.92E-01
RN-219	2.36E-01	2.35E-01	4.13E-01
PB-211	Not Detected	-----	9.18E-01
TL-207	Not Detected	-----	1.60E+01
AM-241	Not Detected	-----	1.84E-01
PU-239	Not Detected	-----	3.58E+02
NP-237	Not Detected	-----	2.92E-01
PA-233	Not Detected	-----	5.84E-02
TH-229	Not Detected	-----	2.10E-01

not detected 4/22/97

[Summary Report] - Sample ID: : 70060021

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.55E-02
AG-110m	Not Detected	-----	4.03E-02
BA-133	Not Detected	-----	5.79E-02
BE-7	Not Detected	-----	2.78E-01
CD-109	1.77E+00	5.10E-01	7.60E-01
CD-115	Not Detected	-----	3.12E-01
CE-139	Not Detected	-----	2.71E-02
CE-141	Not Detected	-----	5.29E-02
CE-144	Not Detected	-----	1.97E-01
CO-56	Not Detected	-----	2.67E-02
CO-57	Not Detected	-----	2.54E-02
CO-58	Not Detected	-----	3.57E-02
CO-60	Not Detected	-----	4.54E-02
CR-51	Not Detected	-----	2.58E-01
CS-134	Not Detected	-----	4.39E-02
CS-137	8.08E-02	2.62E-02	2.45E-02
EU-152	Not Detected	-----	7.55E-02
EU-154	Not Detected	-----	2.11E-01
EU-155	Not Detected	-----	1.16E-01
FE-59	Not Detected	-----	8.94E-02
GD-153	Not Detected	-----	8.56E-02
HG-203	Not Detected	-----	3.34E-02
I-131	Not Detected	-----	4.51E-02
IR-192	Not Detected	-----	2.87E-02
K-40	2.68E+01	3.92E+00	2.56E-01
MN-52	Not Detected	-----	6.43E-02
MN-54	Not Detected	-----	1.49E-02
MO-99	Not Detected	-----	9.25E-01
NA-22	Not Detected	-----	5.14E-02
NA-24	Not Detected	-----	8.51E+00
NB-95	Not Detected	-----	3.97E-01
ND-147	Not Detected	-----	2.91E-01
NI-57	Not Detected	-----	5.46E-01
PB-210	Not Detected	-----	7.80E+00
RU-103	Not Detected	-----	3.46E-02
RU-106	Not Detected	-----	3.19E-01
SB-122	Not Detected	-----	1.47E-01
SB-124	Not Detected	-----	3.32E-02
SB-125	Not Detected	-----	8.95E-02
SN-113	Not Detected	-----	3.92E-02
SR-85	Not Detected	-----	4.22E-02
TA-182	Not Detected	-----	1.84E-01
TA-183	Not Detected	-----	3.03E-01
TC-99m	Not Detected	-----	1.80E+04
TL-201	Not Detected	-----	3.30E-01
XE-133	Not Detected	-----	4.57E-01
Y-88	Not Detected	-----	2.41E-02
ZN-65	Not Detected	-----	1.24E-01
ZR-95	Not Detected	-----	6.95E-02

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-21-97 1:50:38 PM *

* Analyzed by: *KS 4/21/97* Reviewed by: *SL 4/22/97* *

Customer : P.SLAVIN/C.C. (6682/IT)
 Customer Sample ID : 034356-002
 Lab Sample ID : 70060022

CY10-SS-ARY-7

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 972.000 gram
 Sample Date/Time : 4-16-97 1:20:00 PM
 Acquire Start Date/Time : 4-21-97 12:06:15 PM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6003 seconds

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	1.44E+00
TH-234	1.04E+00	3.61E-01	4.39E-01
RA-226	Not Detected	-----	5.58E-01
PB-214	7.56E-01	1.36E-01	4.39E-02
BI-214	6.47E-01	1.23E-01	4.77E-02
TH-232	8.56E-01	4.74E-01	1.47E-01
RA-228	9.58E-01	2.77E-01	1.72E-01
AC-228	8.66E-01	7.56E-01	9.76E-02
TH-228	7.21E-01	6.14E-01	4.55E-01
RA-224	8.78E-01	3.38E-01	7.97E-02
PB-212	8.72E-01	1.40E-01	3.92E-02
BI-212	9.80E-01	5.86E-01	3.59E-01
TL-208	7.93E-01	3.54E-01	7.06E-02
U-235	Not Detected	-----	2.02E-01
TH-231	Not Detected	-----	8.47E+00
PA-231	Not Detected	-----	1.33E+00
TH-227	Not Detected	-----	3.50E-01
RA-223	Not Detected	-----	1.80E-01
RN-219	Not Detected	-----	3.77E-01
PB-211	Not Detected	-----	8.80E-01
TL-207	Not Detected	-----	1.53E+01
AM-241	Not Detected	-----	1.77E-01
PU-239	Not Detected	-----	3.50E+02
NP-237	Not Detected	-----	2.79E-01
PA-233	Not Detected	-----	5.27E-02
TH-229	Not Detected	-----	1.95E-01

[Summary Report] - Sample ID: : 70060022

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.51E-02
AG-110m	Not Detected	-----	3.43E-02
BA-133	Not Detected	-----	5.31E-02
BE-7	Not Detected	-----	2.56E-01
CD-109	1.90E+00	5.52E-01	7.16E-01
CD-115	Not Detected	-----	2.95E-01
CE-139	Not Detected	-----	2.55E-02
CE-141	Not Detected	-----	4.88E-02
CE-144	Not Detected	-----	1.91E-01
CO-56	Not Detected	-----	3.72E-02
CO-57	Not Detected	-----	2.40E-02
CO-58	Not Detected	-----	3.56E-02
CO-60	Not Detected	-----	4.26E-02
CR-51	Not Detected	-----	2.55E-01
CS-134	Not Detected	-----	3.98E-02
CS-137	1.99E-02	1.33E-02	2.17E-02
EU-152	Not Detected	-----	7.13E-02
EU-154	Not Detected	-----	2.10E-01
EU-155	Not Detected	-----	1.12E-01
FE-59	Not Detected	-----	9.05E-02
GD-153	Not Detected	-----	7.89E-02
HG-203	Not Detected	-----	3.19E-02
I-131	Not Detected	-----	4.20E-02
IR-192	Not Detected	-----	2.66E-02
K-40	2.44E+01	3.54E+00	2.31E-01
MN-52	Not Detected	-----	5.91E-02
MN-54	Not Detected	-----	3.68E-02
MO-99	Not Detected	-----	9.36E-01
NA-22	Not Detected	-----	4.80E-02
NA-24	Not Detected	-----	8.38E+00
NB-95	Not Detected	-----	3.78E-01
ND-147	Not Detected	-----	2.66E-01
NI-57	Not Detected	-----	5.51E-01
PB-210	Not Detected	-----	7.17E+00
RU-103	Not Detected	-----	3.20E-02
RU-106	Not Detected	-----	2.93E-01
SB-122	4.05E-02	4.01E-02	6.52E-02
SB-124	Not Detected	-----	3.11E-02
SB-125	Not Detected	-----	8.54E-02
SN-113	Not Detected	-----	3.78E-02
SR-85	Not Detected	-----	3.82E-02
TA-182	Not Detected	-----	1.79E-01
TA-183	Not Detected	-----	2.94E-01
TC-99m	Not Detected	-----	2.16E+04
TL-201	Not Detected	-----	3.18E-01
XE-133	Not Detected	-----	1.81E-01
Y-88	Not Detected	-----	2.80E-02
ZN-65	Not Detected	-----	1.21E-01
ZR-95	Not Detected	-----	6.46E-02

NOT DETECTED 4/21/97 JKA

NOT DETECTED 4/21/97 JKA

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-21-97 4:25:35 PM *

* Analyzed by *JK 4/22/97* Reviewed by: *JS 4/22/97* *

Customer : P.SLAVIN/C.C. (6682/IT)
 Customer Sample ID : 034324-002
 Lab Sample ID : 70060023

CY10-RBF

Sample Description : MARINELLI WATER SAMPLE
 Sample Quantity : 475.000 mL
 Sample Date/Time : 4-16-97 8:45:00 AM
 Acquire Start Date/Time : 4-21-97 1:53:18 PM
 Detector Name : LAB01
 Elapsed Live/Real Time : 6000 / 6001 seconds

Comments:

Nuclide Name	Activity (pCi/mL)	2-sigma Error	MDA (pCi/mL)
U-238	Not Detected	-----	8.86E-01
TH-234	Not Detected	-----	3.58E-01
RA-226	Not Detected	-----	5.28E-01
PB-214	Not Detected	-----	5.45E-02
BI-214	Not Detected	-----	6.35E-02
TH-232	Not Detected	-----	1.67E-01
RA-228	Not Detected	-----	1.62E-01
AC-228	Not Detected	-----	8.73E-02
TH-228	Not Detected	-----	5.33E-01
RA-224	Not Detected	-----	1.78E-01
PB-212	Not Detected	-----	3.17E-02
BI-212	Not Detected	-----	4.32E-01
TL-208	Not Detected	-----	4.98E-02
U-235	Not Detected	-----	1.42E-01
TH-231	Not Detected	-----	5.04E+00
PA-231	Not Detected	-----	1.14E+00
TH-227	Not Detected	-----	1.74E-01
RA-223	Not Detected	-----	1.14E-01
RN-219	Not Detected	-----	3.06E-01
PB-211	Not Detected	-----	6.94E-01
TL-207	Not Detected	-----	1.12E+01
AM-241	Not Detected	-----	1.02E-01
PU-239	Not Detected	-----	2.38E+02
NP-237	Not Detected	-----	1.49E-01
PA-233	Not Detected	-----	4.60E-02
TH-229	Not Detected	-----	1.28E-01

[Summary Report] - Sample ID: : 70060023

Nuclide Name	Activity (pCi/mL)	2-sigma Error	MDA (pCi/mL)
AG-108m	Not Detected	-----	2.96E-02
AG-110m	Not Detected	-----	2.30E-02
BA-133	Not Detected	-----	3.26E-02
BE-7	Not Detected	-----	2.29E-01
CD-109	Not Detected	-----	4.91E-01
CD-115	Not Detected	-----	2.07E-01
CE-139	Not Detected	-----	1.94E-02
CE-141	Not Detected	-----	3.55E-02
CE-144	Not Detected	-----	1.36E-01
CO-56	Not Detected	-----	3.91E-02
CO-57	Not Detected	-----	1.69E-02
CO-58	Not Detected	-----	2.74E-02
CO-60	Not Detected	-----	2.88E-02
CR-51	Not Detected	-----	2.10E-01
CS-134	Not Detected	-----	2.98E-02
CS-137	Not Detected	-----	2.67E-02
EU-152	Not Detected	-----	4.84E-02
EU-154	Not Detected	-----	1.40E-01
EU-155	Not Detected	-----	7.29E-02
FE-59	Not Detected	-----	6.01E-02
GD-153	Not Detected	-----	5.26E-02
HG-203	Not Detected	-----	2.50E-02
I-131	Not Detected	-----	3.53E-02
IR-192	Not Detected	-----	2.31E-02
K-40	Not Detected	-----	3.70E-01
MN-52	Not Detected	-----	5.65E-02
MN-54	Not Detected	-----	2.66E-02
MO-99	Not Detected	-----	7.59E-01
NA-22	Not Detected	-----	2.50E-02
NA-24	Not Detected	-----	1.05E+01
NB-95	Not Detected	-----	2.08E-01
ND-147	Not Detected	-----	2.32E-01
NI-57	Not Detected	-----	4.87E-01
PB-210	Not Detected	-----	4.02E+00
RU-103	Not Detected	-----	2.82E-02
RU-106	Not Detected	-----	2.60E-01
SB-122	Not Detected	-----	1.42E-01
SB-124	Not Detected	-----	3.17E-02
SB-125	Not Detected	-----	7.14E-02
SN-113	Not Detected	-----	3.39E-02
SR-85	Not Detected	-----	3.76E-02
TA-182	Not Detected	-----	9.99E-02
TA-183	Not Detected	-----	1.76E-01
TC-99m	Not Detected	-----	3.26E+04
TL-201	Not Detected	-----	2.00E-01
XE-133	Not Detected	-----	2.87E-01
Y-88	Not Detected	-----	3.10E-02
ZN-65	Not Detected	-----	6.41E-02
ZR-95	Not Detected	-----	5.36E-02

 * Sandia National Laboratories *
 * Radiation Protection Sample Diagnostics Program [881 Laboratory] *
 * 4-10-97 7:22:54 PM *

 * Analyzed by: *[Signature]* 4/11/97 Reviewed by: *[Signature]* 4/11/97 *

Customer : P. SLAVIN/MAC (6682/SMO)
 Customer Sample ID : 034350-002
 Lab Sample ID : 70054102

Sample Description : MARINELLI SOLID SAMPLE
 Sample Quantity : 980.000 gram
 Sample Date/Time : 4-10-97 9:15:00 AM
 Acquire Start Date/Time : 4-10-97 5:39:50 PM
 Detector Name : LAB02
 Elapsed Live/Real Time : 6000 / 6005 seconds

CY10-SS-ALY-2

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	-----	3.82E+00
TH-234	2.06E+00	6.62E-01	8.11E-01
RA-226	3.26E+00	7.28E-01	6.49E-01
PB-214	1.49E+00	2.18E-01	4.75E-02
BI-214	1.37E+00	2.55E-01	1.85E-01
TH-232	1.62E+00	7.51E-01	1.66E-01
RA-228	1.73E+00	3.73E-01	1.48E-01
AC-228	1.76E+00	3.25E-01	8.02E-02
TH-228	1.65E+00	7.64E-01	5.42E-01
RA-224	6.94E-01	1.74E-01	2.19E-02
PB-212	1.67E+00	3.17E-01	4.31E-02
BI-212	8.85E-01	2.54E-01	1.99E-01
TL-208	5.64E-01	1.00E-01	2.47E-02
U-235	Not Detected	-----	2.81E-01
TH-231	Not Detected	-----	1.45E+01
PA-231	Not Detected	-----	1.59E+00
TH-227	Not Detected	-----	4.33E-01
RA-223	Not Detected	-----	2.33E-01
RN-219	Not Detected	-----	4.14E-01
PB-211	Not Detected	-----	9.47E-01
TL-207	Not Detected	-----	1.33E+01
AM-241	Not Detected	-----	5.42E-01
PU-239	Not Detected	-----	5.24E+02
NP-237	Not Detected	-----	3.38E-01
PA-233	Not Detected	-----	6.56E-02
TH-229	Not Detected	-----	2.93E-01

[Summary Report] - Sample ID: : 70054102

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	-----	4.56E-02
AG-110m	Not Detected	-----	4.15E-02
BA-133	Not Detected	-----	7.94E-02
BE-7	Not Detected	-----	2.72E-01
CD-109	3.21E+00	8.46E-01	1.14E+00
CD-115	Not Detected	-----	8.54E-02
CE-139	6.75E-02	8.98E-02	1.79E-02
CE-141	Not Detected	-----	6.09E-02
CE-144	Not Detected	-----	2.83E-01
CO-56	Not Detected	-----	2.45E-02
CO-57	Not Detected	-----	3.56E-02
CO-58	Not Detected	-----	3.21E-02
CO-60	Not Detected	-----	3.51E-02
CR-51	Not Detected	-----	2.53E-01
CS-134	Not Detected	-----	5.84E-02
CS-137	1.30E-01	1.10E-01	2.37E-02
EU-152	Not Detected	-----	1.07E-01
EU-154	Not Detected	-----	2.10E-01
EU-155	Not Detected	-----	1.76E-01
FE-59	Not Detected	-----	7.09E-02
GD-153	Not Detected	-----	1.23E-01
HG-203	Not Detected	-----	3.60E-02
I-131	Not Detected	-----	3.19E-02
IR-192	Not Detected	-----	3.04E-02
K-40	2.16E+01	3.09E+00	2.51E-01
MN-52	Not Detected	-----	3.31E-02
MN-54	Not Detected	-----	2.13E-02
MO-99	Not Detected	-----	2.78E-01
NA-22	Not Detected	-----	4.33E-02
NA-24	Not Detected	-----	4.74E-02
NB-95	Not Detected	-----	2.13E-01
ND-147	Not Detected	-----	2.17E-01
NI-57	1.06E-01	4.95E-02	3.77E-02
PB-210	Not Detected	-----	3.95E+01
RU-103	Not Detected	-----	3.11E-02
RU-106	Not Detected	-----	3.02E-01
SB-122	1.78E-02	2.13E-02	2.33E-02
SB-124	Not Detected	-----	3.23E-02
SB-125	Not Detected	-----	8.99E-02
SN-113	Not Detected	-----	4.17E-02
SR-85	Not Detected	-----	3.99E-02
TA-182	Not Detected	-----	1.66E-01
TA-183	Not Detected	-----	4.85E-01
TC-99m	Not Detected	-----	8.91E-02
TL-201	Not Detected	-----	2.25E-01
XE-133	Not Detected	-----	1.82E-01
Y-88	Not Detected	-----	2.61E-02
ZN-65	Not Detected	-----	1.14E-01
ZR-95	Not Detected	-----	6.10E-02

not detected 7/11/97

not detected 7/11/97

not detected 7/11/97

not detected 7/11/97

ANNEX 3-C

Data Validation Results



5301 Central Avenue N.E.—Suite 700
Albuquerque, New Mexico 87106-1511
505-262-8800
Fax 505-262-8855

March 3, 1998

Project No. 301462.183.03.000

Ms. Sharissa Young
Sandia National Laboratories/New Mexico
Department 6133
P.O. Box 5800, M/S 1147
Albuquerque, New Mexico 87185-1147

Data Validation Results for ER Site 10, ARCOCs 06542, 06543, 06566, and 06567

Dear Ms. Young:

Data validation review of off-site laboratory analysis results for soil samples collected at ER Site 10 was completed by IT Corporation on February 27, 1998. The subject samples were collected during April 1997 and recorded on the Analysis Request and Chain of Custody (ARCOc) forms listed above. This letter and the attached Data Verification/Validation Level 3 DV-3 forms transmits the review results.

Analytical results for Resource Conservation and Recovery Act (RCRA) list metals plus beryllium and explosives residue analyses were reported by LAS Laboratories, Las Vegas, Nevada in the documents numbered L9168, L9169, L9180, and L9182.

Data review and validation are documented in this letter and on *Data Verification/Validation Level 3 - DV3*, forms which are attached. Data validation followed Sandia procedures outlined in *Verification and Validation of Chemical and Radiochemical Data, TOP 94-03, rev.0*, July 1994.

RCRA List Metals + Beryllium, Methods 6010 and 7471

Data validation qualifiers were not assigned to any metals analysis result during review. The analytical results are acceptable without qualification.

The following occurrences were noted, however. An estimated low concentration of chromium reported in the method preparation blank was found not significant when compared to the chromium concentrations in the soil samples. No action was taken in regard to the chromium results. Positive bias was observed for arsenic and selenium in the Method 6010 interference check solution (ICS), solution A. However, the low microgram per liter (part per billion) levels reported were not considered significant enough to qualify soil sample analysis results in the milligram per kilogram (part per million) range. Interference check results for ICS solution AB were all acceptable.

Ms. Sharissa Young

2

March 3, 1998

Explosives Residues, Method 8330

Data validation qualifiers were not assigned to any explosives compound analysis result. The analytical results showed all compounds as "not detected." Analysis results are acceptable without qualification. Positive bias was observed for some explosives compounds in the matrix spike or matrix spike duplicate results, which also resulted in precision measures exceeding acceptance limits. However, because none of the analyses showed positive results greater than the lower limit of detection, the positive biases were not a cause for result qualification.

Thank you for the opportunity to be of service in this matter. Please contact me by telephone at 262-8920 with any questions.

Respectfully submitted,

IT CORPORATION



Mark Lyon
Project Chemist

ML:dlr
Attachments

cc: D. Jercinovic, IT
Project File

Site: Site 10

AR/COC: 6003/6

Data Classification: Inorganic

Sample Fraction No.	Analysis	DV Qualifiers	Comments
	No data were qualified		
	Data is acceptable		
	QC measures appear to be adequate		

Sample No./Fraction No. - This value is located on the Chain of Custody in the ER Sample Id field.

Analysis - Use valid test methods provided below or if the result applies to an individual analyte within a test method, use the CAS number from the analytical data sheet.

DV Qualifiers - The entry will be taken from the list of valid qualifiers and associated comments. If other qualifiers not on the list are needed, contact Tina Sanchez to coordinate adding them to the list.

Comments - This is only to be used if a comment associated with the qualifier is not appropriate, needs modification because of an unusual circumstance, or additional clarification is warranted.

Test Methods - Anions_CE, EPA6010, EPA6020, EPA7470-1, EPA8015B, EPA8081, EPA8260, EPA8260-M3, EPA8270, HACH_ALK, HACH_NO2, HACH_NO3, MEKC_HE, PCBRISC

Reviewed by: Kevin A. Lambert Date: 7/16/98

List of Data Qualifiers used in Data Validation and Associated Comment Responses

Qualifier	Comment
A	Laboratory accuracy and/or bias measurements for the associated Laboratory Control Sample (LCS) do not meet acceptance criteria.
A1	Laboratory accuracy and/or bias measurements for the associated Surrogate Spike do not meet acceptance criteria.
A2	Laboratory accuracy and/or bias measurements for the associated Matrix Spike (MS) do not meet acceptance criteria.
B	Analyte present in laboratory method blank
B1	Analyte present in trip blank.
B2	Analyte present in equipment blank.
B3	Analyte present in continuing calibration blank.
J	The associated value is an estimated quantity. (Note: this qualifier may be used in conjunction with other qualifiers (i.e., A,J)
J1	The method requirements for sample preservation/temperature were not met for the sample analysis. The associated value is an estimated quantity.
J2	The holding time was exceeded for the associated sample analysis. The associated value is an estimated quantity.
P	Laboratory precision measurements for the Laboratory Control Sample and duplicate (LCS/LCSD) do not meet acceptance criteria.
P1	Laboratory precision measurements for the Matrix Spike Sample and associated duplicate (MS/MSD) do not meet acceptance criteria.
P2	Insufficient quality control data to determine laboratory precision.
Q	Quantitation limit reported does not meet Data Quality Objective (DQO) requirements.
R	The data are unusable for their intended purpose (Note: Analyte may or may not be present.)
U	The analyte is a common laboratory contaminant. The associated result is less than ten times the concentration in any blank.
U1	The analyte was also detected in a blank. The associated result is less than five times the concentration in any blank.
UJ	The analyte was analyzed for but was not detected. The associated value is an estimate and may be inaccurate or imprecise.

* This is not a definitive list. Other qualifiers are potentially available, see TOP 94-03. Notify Tina Sanchez to revise list.

Updated: March 10, 1998

INORGANIC DATA ASSESSMENT SUMMARY FORM
(Data Verification/Validation Level 3—DV3)

Page- 1 of 16

SITE OR PROJECT Site 10
ANALYTICAL LABORATORY GEL
LABORATORY REPORT # 9805793
TASK LEADER ARCOC# 600316
NO. OF SAMPLES 3. soil

CASE NO. 7214.1300
SAMPLE IDS CY10-052698-GR-001-SS
CY10-052698-GR-001-DU
CY10-052698-GR-002-SS

DATA ASSESSMENT SUMMARY

	ICP	AA	MERCURY	CYANIDE
1. HOLDING TIMES	✓	NA	✓	NA
2. CALIBRATIONS	✓		✓	
3. BLANKS	✓		✓	
4. ICS	✓			
5. LCS	✓			
6. DUPLICATE ANALYSIS	✓		✓	
7. MATRIX SPIKE	NA		NA	
8. MSA				
9. SERIAL DILUTION	✓			
10. SAMPLE VERIFICATION	✓		✓	
11. OTHER QC	✓		✓	
12. OVERALL ASSESSMENT	✓	↓	✓	↓

✓ (check mark) — Acceptable

Other — Qualified:

J - Estimate

UJ - Undetected, estimated

R - Unusable (analyte may or may not be present)

NA - Not Applicable

KHL 7/16/98

ACTION ITEMS:

All samples were prepared and analyzed with accepted procedures and specified methods. All parameters were successfully analyzed. No major

KHL 7/16/98

AREAS OF CONCERN:

problems were encountered during data package review. A few minor problems were observed with data package that minimally affect the data and are discussed below

REVIEWED BY: _____

DATE REVIEWED: _____

INORGANIC DATA ASSESSMENT SUMMARY FORM
(Data Verification/Validation Level 3—DV3)

Page 2 of 16

KHL 7/16/98

ACTION ITEMS:

- ② Case narrative incorrectly states no analytes were detected above DL in the MB; however Ba & Sc were observed at estimated values ("J" coded) in raw data QC report. Case narrative should read NO target analytes were detected above the RL. No data were qualified since samples results are > 5X the blank concentration.
- ③ No MS/MSD was run on ARCO group. The acceptability was not addressed for the batch from another ARCO group. LCS/LCSD met acceptance criteria, no data were qualified.
- ④ No FB or EB were submitted on ARCO.

KHL 7/16/98

AREAS OF CONCERN:

- ⑤ All other QC measures met acceptance criteria
- ⑥ Data is acceptable
- ⑦ QC measures are adequate

OVERALL DATA QUALITY ASSESSMENT

Reviewed By:

Kevin A. Lambert

Date:

7/16/98

INORGANIC DATA ASSESSMENT SUMMARY FORM
(Data Verification/Validation Level 3—DV3)

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1.0 HOLDING TIMES

List holding time criteria used to evaluate samples, indicating which samples exceed the holding time. Holding time begins with validated time of sample collection.

Parameter	Holding Time Criteria	Sample ID	Days Holding Time was Exceeded	Action

SEE CVP Form

Were the correct preservatives used? Yes ☐ No ☐

List below samples that were incorrectly preserved.

Sample No.	Type of Samples	Deficiency	Action

Reviewed By: Kevin A. Lambert

Date: 7/16/98

INORGANIC DATA ASSESSMENT SUMMARY FORM
(Data Verification/Validation Level 3—DV3)

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2.0 INSTRUMENT CALIBRATION

2.1 Percent Recovery Criteria

Indicate %Recovery (%R) criteria used to evaluate calibration standards:

Metals: _____
Mercury: _____
Cyanide: _____
Other: _____

List below the analytes which did not meet %R criteria for initial and continuing calibration standards:

Analysis Date	ICV/CCV #	Analyte	%R	Action	Samples Affected
			<i>Met</i>		
			<i>Criteria</i>		

2.2 Analytical Sequence

Did the laboratory use the proper number of standards for calibration as described in the EPA method? Yes

☒ No ☐

Have initial calibrations been performed at the beginning of each analysis and at the frequency indicated by the EPA method? Yes ☒ No ☐

Have continuing calibration standards been analyzed at the beginning of sample analysis and at a minimum frequency indicated by the EPA method and at the end of the analysis sequence? Yes ☒ No ☐

If no for any of the above, outline deviations and actions taken below:

Reviewed By: Kevin A Lambert Date: 7/16/98

INORGANIC DATA ASSESSMENT SUMMARY FORM
(Data Verification/Validation Level 3—DV3)

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Were the correlation coefficients for the calibration curves for AA, Hg, CN, and other spectrophotometric methods ≥ 0.995 ? (Check calculations performed for calibration curves.) Yes ☒ No ☐

If no, list: _____

Date	Analyte	Coefficient	Action	Samples Affected
		<i>Met</i>		
		<i>Criteria</i>		

Check for transcription and calculation errors involving calibration summary forms and raw data. Briefly summarize errors and associated actions when data quality might have been affected.

3.0 BLANK ANALYSIS

3.1 Initial and Continuing Calibration Blanks

Have Initial and Continuing Calibration Blanks (ICB/CCB) been analyzed at the frequency required in the EPA method? Yes ☒ No ☐

If no, summarize problems and resolutions in the narrative report.

List analytes detected in ICB and CCBs below:

NOTE: For soil samples, convert blank values to mg/kg using digestion weights and volumes.

Analysis Date	ICB/CCB No.	Analyte	Conc.	Required Detection Limits	Action Level	Samples Affected

Reviewed By: Kevin A. Lambert

Date: 7/16/98

INORGANIC DATA ASSESSMENT SUMMARY FORM
(Data Verification/Validation Level 3—DV3)

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3.2 Method Blank

Was one method blank analyzed for:

Each of 20 samples? Yes ☒ No ☐

Each digestion batch? Yes ☒ No ☐

Each matrix type? Yes ☒ No ☐

Both AA and ICP when both are used for the same analyte? Yes ☐ No ☐ *Not Applicable*

or

At the frequency indicated in the EPA method or QAPJP? Yes ☒ No ☐

NOTE: Method blank is the same as the calibration blank for mercury and for wet chemistry analysis.

List analytes detected in method blank samples below. NOTE: For soil samples, be sure to calculate blank values using digestion weights and volumes.

Preparation Date	Analyte	Conc.	Required Detection Limits	Action Level	Samples Affected
<i>No target analytes detected above RL</i>					

Is concentration in the method blank below the detection limit? Yes ☐ No ☒ *See below*

Affected samples: Barium and Selenium were observed at
estimated values ("J" coded). Sample results are > 10x 5x
the blank concentration. No data were qualified

Note: Case narrative should state *no target analytes above RL*
instead of no analytes were detected above DL.

Reviewed By: Kevin A. Lambert Date: 7/16/98

INORGANIC DATA ASSESSMENT SUMMARY FORM
(Data Verification/Validation Level 3—DV3)

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3.3 Field/Rinse/Equipment Blanks

Was a field/equipment blank analyzed as required by the EPA method or QAPjP? Yes ☐ No ☒

List below analytes detected in the field blanks. NOTE: For soil samples, calculate blank values using digestion weights and volumes.

Collection Date	Blank ID	Analyte	Conc.	Required Detection Limits	Action Level	Samples Affected

Not submitted on ARCO

4.0 ICP INTERFERENCE CHECK SAMPLE ANALYSIS

Was an ICP interference check sample (ICS) analyzed at the beginning and end of a run or at least twice every 8 hours? (Not required for Ca, Mg, K, and Na) Yes ☒ No ☐

Samples affected: _____

Are the values of the ICS for solution AB within 80-120%R? Yes ☒ No ☐

If no, is the concentration of Al, Ca, Fe, or Mg lower than in ICS? Yes ☐ No ☐ *Not Applicable*

Reviewed By: Kevin A. Lambert Date: 7/16/98

INORGANIC DATA ASSESSMENT SUMMARY FORM
(Data Verification/Validation Level 3—DV3)

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If no, list below all analytes which did not meet %R criteria and in which the concentration of Al, Ca, Fe, or Mg is higher than in the ICS: *Not Applicable*

Date	Analyte	%R	Action	Samples Affected

Are any results > IDL for those analytes which are not present in the ICS solution A? Yes ☐ No ☒

If yes, results >2 (absolute value of the IDL) indicate either a positive or negative interference and must be qualified.

Samples affected: _____

Check for transcription/calculation errors. Briefly summarize errors and associated actions when data quality might have been affected.

5.0 LABORATORY CONTROL SAMPLES (LCS)

Was an LCS analyzed at required frequency? Yes ☒ No ☐

Samples affected: _____

Reviewed By: Kevin A. Lambert Date: 7/16/98

INORGANIC DATA ASSESSMENT SUMMARY FORM
(Data Verification/Validation Level 3—DV3)

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List below any LCS recoveries not within limits.

Preparation Date	Analyte	%R	Action	Samples Affected

Met specified limits

6.0 LABORATORY DUPLICATE ANALYSIS

Were laboratory duplicates analyzed at required frequency? Yes ☒ No ☐

Samples affected: _____

Was laboratory duplicate analysis performed on field or equipment blanks? Yes ☐ No ☒

Samples affected: _____

Is any value for sample duplicate pair $<PQL$ and the other value $>10 \times PQL$? Yes ☐ No ☒

Samples affected: _____

Reviewed By: Kevin A Lambert Date: 7/16/98

INORGANIC DATA ASSESSMENT SUMMARY FORM
(Data Verification/Validation Level 3—DV3)

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List below concentrations of any analyte that did not meet criteria for duplicate precision:

Sample ID	Matrix	Preparation Date	Analyte	PQL	RPD	Action	Samples Affected

Check for transcription/calculation errors. Briefly summarize errors and associated actions when data quality might have been affected.

7.0 FIELD DUPLICATE SAMPLE ANALYSIS

Were field duplicates collected at the frequency indicated in the EPA method or QAPjP?

Yes ☒ No ☐

If yes, quality data associated only with the field duplicate pair. Calculate RPDs for each analyte in which both values are greater than the IDL.

Is any value for sample duplicate < practical quantitation limit (PQL) and other value >10xPQL? Yes ☐ No ☒

Reviewed By: Kevin A. Lambert

Date: 7/16/98

INORGANIC DATA ASSESSMENT SUMMARY FORM
(Data Verification/Validation Level 3—DV3)

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Samples affected: _____

List below the analytes that do not meet RPD or PQL criteria. Use the same criteria as those used for laboratory duplicate analysis or criteria specified in EPA method or sampling plan.

Sample ID	Matrix	Collection Date	RPD	Control Limit	Action	Samples Affected

*Met
criteria*

Check for transcription/calculation errors. Briefly summarize errors and associated actions when data quality might have been affected.

8.0 MATRIX SPIKE ANALYSIS

NOTE: This matrix spike is a predigestion/predistillation spike.

Was a matrix spike prepared and analyzed at the required frequency? Yes ☐ No ☐ *No + Applicable*
No MS/MSD was run on ARCO group. The acceptability is not addressed for the batch from another ARCO group.

Reviewed By: *Kevin A. Lambert* Date: *7/16/98*

INORGANIC DATA ASSESSMENT SUMMARY FORM
(Data Verification/Validation Level 3—DV3)

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Were matrix spikes performed at the concentrations specified by the EPA method? Yes ☐ No ☐ *Not Applicable*

Samples affected: _____

Was matrix spike analysis performed on field or equipment blanks? Yes ☐ No ☒

If equipment or field blanks are the only aqueous samples, matrix spike analysis may be performed; however, matrix spike samples must be present for the other matrices.

Samples affected: _____

List below the % recoveries for analytes that did not meet the criteria:

Sample ID	Matrix	Preparation Date	Analyte	%R	Action	Samples Affected

No MS/MSD was run on ARCOL group

Check for transcription/calculation errors. Also check to ensure matrix spike concentrations are not affected by sample dilutions performed. If matrix spike concentrations are diluted below or close to IDL based on sample dilutions performed, use professional judgment in qualifying data. Ensure that the laboratory performed sample dilutions only when necessary as indicated by QA/QC requirements. Briefly summarize errors and associated actions when data quality might have been affected.

Reviewed By: Kevin A. Lambert Date: 7/16/98

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NOTE: If preparation blank spikes are analyzed, evaluate recoveries. These recoveries can indicate whether excursions in matrix spike recovery are caused by sample matrix effects or poor digestion efficiencies and/or problems with matrix spike solution. For example, if matrix spike recovery for selenium is 0% and preparation blank spike recovery for selenium is 92%, this may indicate sample matrix effects.

9.0 FURNACE ATOMIC ABSORPTION ANALYSIS

Not Applicable

Were duplicate injections present for each sample, including required QC analyses (not required if MSA is done)? Yes ☐ No ☐

Samples affected: _____

Were postdigestion spikes analyzed for samples, including QC samples? Yes ☐ No ☐

Were postdigestion spikes analyzed at the required concentration? Yes ☐ No ☐

Samples affected: _____

Was a dilution analyzed for samples with postdigestion spike recovery <40%? Yes ☐ No ☐

Samples affected: _____

MSA Analysis (Method of Standard Additions)—MSA is required when serial dilutions are not within $\pm 10\%$. Was MSA required for any sample but not performed? Yes ☐ No ☐

Are MSA calculations outside the linear range of the calibration curve? Yes ☐ No ☐

Reviewed By: Kevin A. Lambert Date: 7/16/98

INORGANIC DATA ASSESSMENT SUMMARY FORM
(Data Verification/Validation Level 3—DV3)

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NOTE: Ensure the spiking concentrations used for MSA analysis were at 50–100% and 150% of sample concentration or absorbance.

Not Applicable

Samples affected: _____

10.0 SERIAL DILUTION ANALYSIS

NOTE: Serial dilution analysis (ICP) is required only for initial concentrations equal to or greater than 10xIDL.

If applicable, was a serial dilution performed for:

Each 20 samples? Yes ☒ No ☐

Each matrix type? Yes ☒ No ☐

Samples affected: _____

List below results which did not meet criteria of %D <10% for analyte concentrations greater than 50xIDL before dilution:

Analysis Date	Sample ID	Analyte	IDL	%D	Action	Samples Affected

Met Criteria

Check for calculation errors and negative interferences.

Reviewed By: Kevin A. Lambert Date: 7/16/98

INORGANIC DATA ASSESSMENT SUMMARY FORM
(Data Verification/Validation Level 3—DV3)

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11.0 SAMPLE RESULT VERIFICATION

11.1 Verification of Instrumental Parameters

Are instrument detection limits present and verified on a quarterly basis? Yes ☐ No ☐ *Not Applicable*

Are IDLs present for each analyte and each instrument used? Yes ☒ No ☐

Is the IDL greater than the required detection limits for any analyte? Yes ☐ No ☒
(If IDL > required detection limits, flag values less than 5xIDL.)

Samples affected: _____

Are ICP Interelement Correction Factors established and verified annually? Yes ☐ No ☐ *Not Applicable*

Are ICP Linear Ranges established and verified quarterly? Yes ☐ No ☐ *Not Applicable*

If no for any of the above, review problems and resolutions in narrative report. _____

11.2 Reporting Requirements

Were sample results reported down to the PQL? Yes ☒ No ☐

If no, indicate necessary corrections. _____

Were sample results that were analyzed by ICP for Se, Ti, As, or Pb at least 5xIDL? Yes ☒ No ☐

Were sample weights, volumes, and dilutions taken into account when reporting sample results and detection limits? Yes ☒ No ☐

Reviewed By: Kevin A. Lambert Date: 7/16/98

INORGANIC DATA ASSESSMENT SUMMARY FORM
(Data Verification/Validation Level 3—DV3)

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If no for any of the above, sample results may be inaccurate. Note necessary changes and if errors are present, request resubmittal of laboratory package.

Were any sample results higher than the linear range of calibration curve and not subsequently reanalyzed at the appropriate dilution? Yes ☐ No ☐ *Not Applicable*

Samples affected: _____

11.3 Sample Quantitation

Check a minimum of 10% of positive sample results for transcription/calculation errors. Summarize necessary corrections. If errors are large, request resubmittal of laboratory package.

Comments:

OK Look good

Approved By: _____

Date: _____

*Task/Project Leader is responsible for approval of data set.

Reviewed By: *Karin A. Lambert*

Date: *7/16/98*

ANNEX 3-D
Risk Screening Assessment

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SWMU 10: RISK SCREENING ASSESSMENT REPORT**I. Site Description and History**

Solid Waste Management Unit (SWMU) 10 is associated with SWMU 60 and is located near the northeastern corner of Kirtland Air Force Base (KAFB), on federally owned land controlled by KAFB (SNL/NM July 1994a). Access to the general area is by way of Coyote Springs Road to Pendulum Road and then continue approximately 1.5 miles north (Gaither Date [Unk]; Oldewage May 1993). The site lies on approximately 2.9 acres at a mean elevation of 6,175 feet above sea level (SNL/NM April 1995).

SWMU 10, Burial Mounds, inactive since the late 1970s, consists of nine soil/debris mounds, one former soil/debris mound removed in April 1996, and a former vermiculite mound removed in May 1998. The former soil/debris mound was removed in conjunction with a radiological Voluntary Corrective Measure (VCM) (Section 3.4.4). The former vermiculite mound was removed as solid waste in a Voluntary Corrective Action (VCA) (Section 3.4.5). The site boundary is based upon the fragmentation radius of depleted uranium (DU) fragments found in the initial surface gamma radiation survey conducted in October 1993 (RUST Geotech Inc. December 1994).

SWMU 10 lies on Tesajo-Millett stony sandy loams that are underlain by igneous and metamorphic Precambrian rocks (USDA June 1977). Immediate topographic relief around the site is approximately 50 feet. The nearest monitoring wells, the Greystone Manor and TSA-1 wells, are located approximately 2.2 miles southwest and southeast of SWMU 10, respectively. Groundwater conditions at TSA-1 are probably more representative of conditions at SWMU 10, because SWMU 10 and TSA-1 are east of the Coyote Fault on thin alluvium deposits surrounded by Precambrian rocks (IT May 1994). At TSA-1 well, semiconfined to confined groundwater is encountered in fractured Precambrian bedrock at a depth of 180 feet below ground surface (bgs) (IT May 1994). Local groundwater flow in the vicinity of SWMU 10 may be complicated because of abundant fractures and faults in the area.

For a detailed discussion of the local setting and other information pertaining to SWMU 10, refer to the "RCRA [Resource Conservation and Recovery Act] Facility Investigation Work Plan for OU 1333, Canyons Test Area" (SNL/NM September 1995).

II. Comparison of Results to Data Quality Objectives

The confirmatory sampling conducted at SWMU 10 was designed to collect samples adequate to:

- Determine whether hazardous waste or hazardous constituents have been released at the site
- Characterize the nature and extent of any releases

- Verify that radiation anomalies have been removed
- Provide sufficient Level 3 analytical data to support risk screening assessments.

Table 1 summarizes the sample location design for SWMU 10. The source of potential contaminants of concern (COC) at SWMU 10 is high explosives (HE), DU, and metals used in a failed Torch-Activated Burn System (TABS) test conducted on two mock nuclear weapons. Other experiments conducted prior to the TABS test may also have contributed COCs at SWMU 10, but the specific materials used in those tests are unknown. Based upon salvage activities performed immediately after the failed TABS test, the radiological VCM conducted in 1996, and the VCA removal of the vermiculite mound in 1998, only residual COCs remain at the site.

The number and location of the samples collected depended upon the completeness of historical information, results of previous radiological surveys performed at the site, and activities conducted during the VCM. In addition, samples were collected from areas where contamination could potentially migrate as a result of surface-water runoff, such as the nearby arroyos and topographically low areas (e.g., the pit near Mound 9).

Table 2 identifies the analytical methods and data quality requirements necessary to (1) characterize adequately hazardous waste or hazardous constituents associated with the HE, DU, and metals used in TABS test conducted at the site; and (2) support risk screening assessments.

A total of 76 locations were sampled at SWMU 10 and analyzed by Sandia National Laboratories/New Mexico (SNL/NM) on-site laboratories. Twenty percent of the samples were sent off site for verification analyses for both RCRA metals plus beryllium and HE. The method detection limits (MDL) for both on-and off-site analyses were below the quantified background concentration limits for RCRA metals plus beryllium, with only one exception. The MDL used by the off-site laboratory for analysis of some samples for mercury exceeded the 0.055 milligrams per kilogram (mg/kg) background concentration limit. Silver does not have a quantified background concentration, thus comparison of the MDL to a background concentration could not be made.

All gamma spectroscopy data were reviewed by SNL/NM Department 7713 (Radiation Protection Sample Diagnostic Laboratory) according to "Laboratory Data Review Guidelines," Procedure No. RPSD-02-11, Issue No: 02 (SNL/NM July 1996). In addition, all off-site laboratory results were reviewed and verified/validated according to "Data Verification/Validation Level 3—DV-3" in Attachment C of the Technical Operating Procedure 94-03, Rev. 0 (SNL/NM July 1994). The reviews confirmed that the data are acceptable for use in the no further action (NFA) proposal for SWMU 10. The data quality objectives for SWMU 10 have been met.

Table 1
Summary of Sampling Performed to Meet Data Quality Objectives

SWMU 10 Secondary Source Areas	Potential COC	Number of Sampling Locations	Sample Density	Sampling Location Rationale
Soil/debris Mounds	Residual HE, DU, and metals	50	Judgmental based upon Mound 1: 4 samples Mound 2: 6 samples Mound 3: 4 samples Mound 4: 2 samples Mound 5: 2 samples Mound 6: 8 samples Mound 7: 6 samples Mound 8: 2 samples Mound 9: 6 samples Mound 10: 6 samples Soil Berm: 2 samples Pit : 1 sample Vermiculite Mound: 1 sample (Pre-VCA)	Samples collected from middle and bottom of trenches excavated during VCM (Mounds 1, 2, 6, 7, 8, and 10). Samples collected at surface (0 to 12 inches) where mounds completely removed during VCM (e.g., Mounds 3, 4, 5, and part of 6). Samples collected from middle and bottom of three trenches excavated through Mound 9 (not investigated during VCM). Surface samples collected from soil berm and pit near Mound 9, and vermiculite mound.
		2	Vermiculite Mound: 2 samples (Post-VCA)	Confirmation samples collected beneath former vermiculite mound location.
Fragmentation Area (surface soil)	Residual HE, DU, and metals	17	Random based upon eight cardinal direction- based spokes centered on SWMU 60 bunker and concentric circles at distances of 25, 50, 100, and 200 feet	Sample locations distributed on the basis of expected radial distribution from original explosion during failed TABS test. Samples added to grid where mound sample coverage did not exist, and samples eliminated where mound sample coverage overlapped grid.
Arroyo (sediments)	Residual HE, DU, and metals	7	Judgmental based upon 150-foot intervals starting 250 feet upstream from SWMU 10 to 250 feet downstream from SWMU 10.	Sample locations distributed upstream and downstream to investigate possible COC migration from SWMU 10.

COC = Constituents of concern.
 DU = Depleted uranium.
 HE = High explosive.
 SWMU = Solid waste management unit.
 TABS = Torch-Activated Burn System.
 VCA = Voluntary Corrective Action
 VCM = Voluntary Corrective Measure.

Table 2
Summary of Data Quality Requirements

Analytical Requirement	Data Quality Level	ER Chemistry Laboratory Department 6133 SNL/NM	Radiation Protection Sample Diagnostics Laboratory Department 7713 SNL/NM	Lockheed Analytical Services Las Vegas, Nevada	General Engineering Laboratories, Charleston, South Carolina
RCRA metals plus beryllium EPA Method 6010/7000 ^a	Level 3	72 samples 6 samples (internal duplicates)	Not applicable	2 samples 7 samples (off-site duplicates) 7 samples (off-site internal duplicates)	2 samples 1 sample (off-site internal duplicate)
HE compounds EPA Method 8330 ^a	Level 3	72 samples 6 samples (internal duplicates)	Not applicable	2 samples 7 samples (off-site duplicates) 7 samples (off-site internal duplicates)	Not applicable
Gamma Spectroscopy	Level 2	Not applicable	50 samples 4 samples (internal duplicates)	Not applicable	Not applicable

^aEPA November 1986.

EPA = U.S. Environmental Protection Agency.

ER = Environmental Restoration.

HE = High explosive.

RCRA = Resource Conservation and Recovery Act.

SNL/NM = Sandia National Laboratories/New Mexico.

III. Determination of Nature, Rate, and Extent of Contamination

III.1 Introduction

Determining the nature, rate, and extent of contamination at SWMU 10 was based upon an initial conceptual model validated by confirmatory sampling at the site. The initial conceptual model was developed from historical background information including site inspections, interviews, historical photographs, and radiological surveys. The data quality objectives in the Sampling and Analysis Plan (SNL/NM March 1997) and Bullets of Understanding relating to the sampling (NMED DOE OB April 1997), identified the sample locations, sample density, sample depth, and analytical requirements. The sample data were used subsequently to develop the final conceptual model for SWMU 10, which is presented in Section 3.5 of the associated NFA

proposal. The quality of the data specifically used to determine the nature, rate, and extent of contamination are described below.

III.2 Nature of Contamination

The nature of contamination at SWMU 10 was determined with analytical testing of soil media and the potential of relevant COCs to degrade (Section V). The analytical requirements included RCRA metals plus beryllium to characterize nonradiological inorganic constituents released at the site. Gamma spectroscopy was used to characterize residual DU concentrations remaining after the VCM activities were conducted at the site. HE analyses were performed to characterize any potential explosive materials that may have not been consumed during the failed TABS test. These analytes and methods are appropriate to characterize the COCs and potential degradation products associated with the historical activities at SWMU 10.

III.3 Rate of Contaminant Migration

SWMU 10 is an inactive site, and therefore, all primary sources of COCs (test activities involving hazardous and radioactive materials) have been removed. In addition, post-test salvage operations and VCM and VCA activities conducted in 1996 and 1998, respectively, have reduced contamination at SWMU 10 to residual levels. As a result, only secondary sources of COCs in soil remain at the site. The rate of COC migration depends primarily upon site meteorological and surface hydrologic processes as described in Section V. Data available from the Site-Wide Hydrogeologic Characterization Project (published annually); numerous SNL/NM air, surface water, and radiological monitoring programs; biological surveys; and other governmental atmospheric monitoring at the KAFB (i.e., National Oceanographic and Atmospheric Administration) are adequate to characterize the rate of COC migration at SWMU 10.

III.4 Extent of Contamination

Soil samples were collected from the existing and former soil/debris mound locations and from surface soils within the fragmentation radius surrounding the SWMU 60 bunker where two mock weapons were detonated during the failed TABS test. In addition, samples were collected from the soil berm adjacent to Mound 9 and from areas where contamination could potentially migrate as a result of surface-water runoff, including nearby arroyos and topographically low areas (e.g., the pit near Mound 9). These sample locations are deemed appropriate to determine the lateral extent of COC migration.

The sample density for soil/debris mounds was based upon the size of the mounds and the number of trenches excavated through the mounds during VCM activities. The sample density for surface soil was based upon the expected radial distribution of materials resulting from the original explosion at the SWMU 60 bunker and the expected uniformity of COCs at specific radii from the bunker. The sample density for the arroyos was based upon the extent of potential migration from surface water runoff in the vicinity of the site. The number of samples was

deemed sufficient to establish the presence of residual COCs at the site or in potential migration pathways near the site.

Because of the relatively low solubility of most metals and organic compounds, limited precipitation, and high evapotranspiration, the vertical rate of contamination migration is expected to be extremely low. Because the soil/debris mounds were constructed above grade, samples were collected from the middle of the trenches approximately 1-foot below ground surface (bgs) and from the bottom of the trenches approximately 2 to 3 feet bgs. Samples from the bottoms of the trenches were collected approximately 0.5 feet below the actual trench bottom to ensure undisturbed material was collected from below grade. Surface soil and arroyo sediment samples were collected within 0 to 12 inches of the ground surface, including samples collected from mounds that were removed completely during the VCM. There is no historical information to indicate that any subsurface disturbance, testing, or disposal ever occurred at the site that could mix surface soils beneath the 12-inch depth, with the exception of the former vermiculite mound, which was excavated and removed from the site. Therefore, the sample collection protocol used at SWMU 10 is representative of the media potentially impacted by site activities and is sufficient to determine the vertical extent of COC migration.

In summary, the design of the confirmatory sampling was appropriate and adequate to determine the nature, rate, and extent of contamination.

IV. Comparison of COCs to Background Screening Levels

Site history and characterization activities are used to identify potential COCs. The identification of COCs and the sampling to determine the concentration levels of those COCs across the site are described in the SWMU 10 NFA proposal. Generally, COCs evaluated in this risk assessment include all detected organics and radiological contaminants and all inorganic COCs that were analyzed for. If the detection limit of an organic compound was too high (could possibly cause an adverse effect to human health or the environment), the compound was retained. Nondetect organics that were not included in this assessment were determined to have sufficiently low detection limits to ensure protection of human health and the environment. In order to provide conservatism in this risk assessment, the calculation uses only the maximum concentration value of each COC determined for the entire site. The SNL/NM maximum background concentration (Dinwiddie September 1997; Zamorski December 1997) was selected to provide the background screen in Tables 3 and 4. Human health nonradiological COCs were also compared to SNL/NM proposed Subpart S action levels (Table 1) (IT July 1994).

Nonradiological inorganics such as iron, magnesium, calcium, potassium, and sodium that are essential nutrients were not included in this risk assessment (EPA 1989). Both radiological and nonradiological COCs are evaluated. The nonradiological COCs evaluated in this risk assessment includes only inorganics because all HE were reported as nondetect.

Nonradiological COCs for Human Health and Ecological Risk Assessment at SWMU 10 are listed in Table 3. Radiological COCs are listed in Table 4. All tables show the associated approved SNL/NM background concentration values (Dinwiddie September 1997, Zamorski December 1997). Discussion of Tables 3 and 4 is provided in Sections VI.4, VII.2, and VII.3.

Table 3
Nonradiological COCs for Human Health and Ecological Risk Assessment at SWMU 10 with Comparison to the Associated SNL/NM Background Screening Value, BCF, Log K_{ow}, and Subpart S Screening Value

COC Name	Maximum Concentration (mg/kg)	SNL/NM Background Concentration (mg/kg) ^a	Is Maximum COC Concentration Less Than or Equal to the Applicable SNL/NM Background Screening Value?	BCF (maximum aquatic)	Log K _{ow}	Bioaccumulator ^g (BCF>40, Log K _{ow} >4)	Subpart S Screening Value ^b	Is Individual COC less than 1/10 of the Action Level?
Arsenic	8.7	9.8	Yes	44 ^c	NA	Yes	0.5	No
Barium	250	246	No	170 ^d	NA	Yes	6000	Yes
Beryllium	3.4 B	0.75	No	19 ^e	NA	No	0.2	No
Cadmium	0.65	0.64	No	64 ^e	NA	Yes	80	Yes
Chromium, total ^f	46	18.8	No	16 ^e	NA	No	400	No
Lead	30	18.9	No	49 ^e	NA	Yes	--	--
Mercury	0.075 J	0.055	No	5500 ^e	NA	Yes	20	Yes
Selenium	3.1	3.0	No	800 ^f	NA	Yes	400	Yes
Silver	0.61	<0.5	No	0.5 ^e	NA	No	400	Yes

^aFrom Zamorski (December 1997) Canyon Areas.

^bIT (July 1994).

^cBCF and/or Log K_{ow} from Yanicak (March 1997).

^dBCF from Neumann (1976).

^eAssumed to be chromium VI for Subpart S screening procedure.

^fBCF from Callahan et al. (1979).

^gFrom NMED (March 1998).

B = Constituent found in blank.

BCF = Bioconcentration factor.

COC = Constituent of concern.

J = Estimated concentration.

K_{ow} = Octanol-water partition coefficient.

Log = Logarithm (base 10).

mg/kg = Milligram(s) per kilogram.

NA = Not applicable.

NMED = New Mexico Environment Department.

SNL/NM = Sandia National Laboratories/New Mexico.

SWMU = Solid waste management unit.

-- = Information not available.

Table 4
Radiological COCs for Human Health and Ecological Risk Assessment at SWMU 10 with Comparison to the Associated SNL/NM Background Screening Value, BCF, and Log K_{ow}

COC Name	Maximum Concentration (pCi/g)	SNL/NM Background Concentration (pCi/g)^a	Is Maximum COC Concentration Less Than or Equal to the Applicable SNL/NM Background^a Screening Value?	BCF (maximum aquatic)	Bioaccumulator^e (BCF>40, log K_{ow}>4)
Cs-137	0.54	1.55	Yes	3,000 ^c	Yes
Th-232	2.29	1.03	No	3,000 ^d	No
U-234 ^b	1.05	2.31	Yes	900 ^d	Yes
U-235	0.30	0.16	No	900 ^d	Yes
U-238	8.41	2.31	No	900 ^d	Yes

^aFrom Dinwiddie (September 1997) Lower Canyons Area.

^bU-234 values were calculated using the U-238 concentration and assuming that the U-238 to U-234 ratio was equal to that detected during waste characterization of depleted uranium-contaminated soils generated during the radiological voluntary corrective measures project, where U-234=U-238/8 (Miller June 1998).

^cBCF from Yanicak (March 1997).

^dFrom Baker and Soldat (1992).

^eBioaccumulation designation from Yanicak (March 1997).

BCF = Bioconcentration factor.

COC = Constituent of concern.

DU = Depleted uranium.

K_{ow} = Octanol-water partition coefficient.

Log = Logarithm (base 10).

pCi/g = Picocuries per gram.

SNL/NM = Sandia National Laboratories/New Mexico.

SWMU = Solid waste management unit.

V. Fate and Transport

The primary release of COCs at SWMU 10 was to the surface soil. Wind, water, and biota are natural mechanisms of COC transport from the primary release point. Excavation and removal of the soil is a potential human-caused mechanism of transport. At the surface, the soil may be transported by wind and surface runoff. Because the site is situated between the Manzanita Mountains to the east and the mountains of Manzano Base to the west and is within woodland vegetation, it is protected from strong winds at the ground surface. Therefore, wind is probably not a significant transport mechanism for surface soils.

Water at SWMU 10 is received as precipitation (rain or occasionally snow). Precipitation will either infiltrate or form runoff. Infiltration at the site is enhanced by the coarse textures of the canyon soils (Tesajo-Millelt stony sandy loam [USDA June 1977]), but the slopes at this site will produce runoff during intense rainfall events and during extended rainfall periods when soils are near saturation from previous rainfall. Surface runoff is to the ephemeral drainage adjacent to the west side of the site, which is a tributary to the Arroyo del Coyote. Runoff may carry soil particles with adsorbed COCs. The distance of transport will depend upon the size of the particle and the velocity of the water.

Water that infiltrates into the soil will continue to percolate through the soil until field capacity is reached. COCs desorbed from the soil particles into the soil solution may be leached farther into the subsurface soil with this percolation. Runoff from the overlying slopes and evapotranspiration from the soil will limit infiltration potential, making it unlikely to percolate to groundwater. Because none of the COCs at this site have a high potential for leaching in soil, they are highly unlikely to reach groundwater.

Plant roots can take up COCs that are in the soil solution. These COCs may be transported to the above-ground tissues with the xylem stream and may then be consumed by herbivores or returned to the soil as litter. Above-ground litter is capable of transport by wind until consumed by decomposer organisms in the soil. Constituents in plant tissues that are consumed by herbivores may pass through the gut and returned to the soil (at the site or transported from the site in the herbivore) in feces, or may be absorbed and held in tissues, metabolized, or excreted. The herbivore may be eaten by a primary carnivore or scavenger and the constituent still held in the consumed tissues will repeat the sequence of absorption, metabolism, excretion, and consumption by higher predators, scavengers, and decomposers. The potential for transport of the constituents within the food chain is dependent upon the mobility of the species that comprise the food chain and the potential for the constituent to be transferred across the links in the food chain. Because the COCs at SWMU 10 are inorganics, degradation is negligible. Radiological decay will occur in the radionuclides; however, radiological COCs with long half-lives will persist in the environment.

Table 5 summarizes the fate and transport processes that may occur at SWMU 10. COCs at this site are inorganics (metals and radionuclides) in surface and subsurface soil. Wind is not expected to be a significant factor because of the topography and vegetation of the site. Surface runoff may be of moderate significance because of the moderate slopes on the site leading to a nearby ephemeral drainage. Because the COCs are primarily metals, significant leaching deeper into the subsurface soil is also unlikely, and leaching to the groundwater at this site is highly unlikely. Significant food chain transport is unlikely and degradation of the

nonradiological COCs will be insignificant. Decay of the radiological COCs will be slow because of the long half-lives of these isotopes.

Table 5
Summary of Fate and Transport at SWMU 10

Transport and Fate Mechanism	Existence at Site	Significance
Wind	Yes	Low
Surface runoff	Yes	Moderate
Migration to groundwater	Unlikely	Very low
Food chain uptake	Yes	Low
Transformation/degradation	Yes	Low

SWMU = Solid waste management unit.

VI. Human Health Risk Screening Assessment

VI.1 Introduction

Human health risk screening assessment of this site includes a number of steps that culminate in a quantitative evaluation of the potential adverse human health effects caused by constituents located at the site. The steps to be discussed include the following:

Step 1.	Site data are described that provide information on the potential COC, as well as the relevant physical characteristics and properties of the site.
Step 2.	Potential pathways are identified by which a representative population might be exposed to the COCs.
Step 3.	The potential intake of these COCs by the representative population is calculated using a tiered approach. The first component of the tiered approach includes two screening procedures. One screening procedure compares the maximum concentration of the COC to an SNL/NM maximum background screening value. COCs that are not eliminated during the first screening procedure are subjected to a second screening procedure that compares the maximum concentration of the COC to the SNL/NM proposed Subpart S action level.
Step 4.	Toxicological parameters are identified and referenced for COCs that were not eliminated during the screening steps.
Step 5.	Potential toxicity effects (specified as a hazard index [HI]) and excess cancer risks are calculated for nonradiological COCs and background. For radiological COCs, the incremental total effective dose equivalent (TEDE) and incremental estimated cancer risk are calculated by subtracting applicable background concentrations directly from maximum on-site contaminant values. This background subtraction only occurs when a radiological COC occurs as contamination and exists as a natural background radionuclide.

Step 6. These values are compared with guidelines established by the U.S. Environmental Protection Agency (EPA) and U.S. Department of Energy (DOE) to determine if further evaluation, and potential site clean-up, is required. Nonradiological COC risk values are also compared to background risk so that an incremental risk may be calculated.

Step 7. Uncertainties in each of the previous steps are discussed.

VI.2 Step 1. Site Data

The description and history for SWMU 10 is provided in Section I. Comparison of results to data quality objective (DQO) is presented in Section II. The determination of the nature, rate and extent of contamination is described in Section III.

VI.3 Step 2. Pathway Identification

SWMU 10 has been designated a future land-use scenario of industrial although the Citizen's Advisory Board recommends using residential risk-based cleanup levels (DOE and USAF March 1996) (see Appendix 1 for default exposure pathways and parameters). Because of the location and the characteristics of the potential contaminants, the primary pathway for human exposure is considered to be soil ingestion for the nonradiological COCs and direct gamma exposure for the radiological COCs. The inhalation pathway for both nonradiological and radiological COCs is included because of the potential to inhale dust. Soil ingestion is included for the radiological COCs as well. No contamination at depth was determined, and therefore no water pathways to the groundwater are considered. Depth to groundwater at SWMU 10 is approximately 180 feet bgs. Because of the lack of perennial surface water or other significant mechanisms for dermal contact, the dermal exposure pathway is considered not to be significant. No intake routes through plant, meat, or milk ingestion are considered appropriate for the industrial land-use scenario. However, plant uptake is considered for the residential land-use scenario.

Pathway Identification

Chemical Constituents	Radiological Constituents
Soil ingestion	Soil ingestion
Inhalation (dust)	Inhalation (dust)
Plant uptake (residential only)	Plant uptake (residential only)
	Direct gamma

VI.4 Step 3. COC Screening Procedures

Step 3 is discussed in this section. This step includes the discussion of two screening procedures. The first screening procedure is a comparison of the maximum COC concentration to the approved background screening level. The second screening procedure compares maximum COC concentrations to SNL/NM proposed Subpart S action levels. This second procedure is only applied to COCs that are not eliminated during the first screening procedure.

VI.4.1 Background Screening Procedure

VI.4.1.1 Methodology

Maximum concentrations of nonradiological COCs are compared to the SNL/NM maximum screening level for this area. SNL/NM has been verbally informed by the New Mexico Environment Department (NMED) that all the metals background values from the Canyons Study (Zamorski December 3, 1997), with the exception of selenium, will be approved (NMED May 1998). Samples have been collected to resolve the selenium background concentration. The SNL/NM maximum background concentration is selected to provide the background screen in Table 3 and used to calculate risk attributable to background in Table 9. Only the COCs that are above their respective SNL/NM background screening level or do not have a quantifiable background screening level are considered in further risk assessment analyses.

For radiological COCs that exceed the SNL/NM background screening levels, background values are subtracted from the individual maximum radionuclide concentrations. Those that do not exceed these background levels are carried no further in the risk assessment. This approach is consistent with DOE Order 5400.5, "Radiation Protection of the Public and the Environment" (DOE 1993). Radiological COCs that do not have a background value and are detected above the analytical minimum detectable activity are carried through the risk assessment at their maximum levels. The resultant radiological COCs remaining after this step are referred to as background-adjusted radiological COCs.

VI.4.1.2 Background Screening Procedure Results

A comparison of SWMU 10 data to SNL/NM maximum background values (Dinwiddie September 1997; Zamorski December 1997) for Human Health risk assessment is presented in Tables 3 and 4. For the nonradiological COCs, eight constituents have maximum measured values greater than their respective background screening levels.

The maximum concentration value for lead is 30 mg/kg. The EPA intentionally provides no human health toxicological data on lead, and therefore, no risk parameter values can be calculated. However, EPA Region 6 guidance for the screening value for lead for an industrial land-use scenario is 2,000 mg/kg (EPA 1996a); for a residential land-use scenario, the EPA screening guidance value is 400 mg/kg (EPA July 1994). The maximum concentration value for lead at this site is less than both screening values, and therefore, lead is eliminated from further consideration in the human health risk assessment.

For the radiological COCs, three constituents had maximum measured activities greater than their respective background (U-238, U-235, and Th-232). The constituents are attributable to the DU used at the site and the natural Th-232 decay series.

VI.4.2 Subpart S Screening Procedure

VI.4.2.1 Methodology

The maximum concentrations of nonradiological COCs not eliminated during the background screening process were compared with action levels (IT July 1994) calculated using methods and equations promulgated in the proposed RCRA Subpart S (EPA July 1990) and Risk Assessment Guidance for Superfund (RAGS) (EPA 1989). Accordingly, all calculations were based upon the assumption that receptor doses from both toxic and potentially carcinogenic compounds result most significantly from ingestion of contaminated soil. Because the samples were all taken from the surface, this assumption is considered valid. If there were ten or fewer COCs and each had a maximum concentration less than 1/10 of the action level, then the site would be judged to pose no significant health hazard to humans. If there were more than ten COCs, the Subpart S screening procedure is not performed.

VI.4.2.2 Results

Table 3 shows the COCs and the associated proposed Subpart S action level. The table compares the maximum concentration values to 1/10 of the proposed Subpart S action level. This methodology was guidance given to SNL/NM from the EPA (EPA 1996b). Two COCs that failed the background screen had concentrations that exceeded 1/10 of the proposed Subpart S action level. Because of these COCs, the site fails the Subpart S screening criteria, and a hazard quotient (HQ) and excess cancer risk value must be calculated for all the COCs.

Radiological COCs have no predetermined action levels analogous to proposed Subpart S levels, and therefore this step in the screening process is not performed for radiological COCs.

VI.5 Step 4. Identification of Toxicological Parameters

Tables 6 (nonradiological) and 7 (radiological) show the COCs retained in the risk assessment and the values for the available toxicological information. The toxicological values used in Table 6 are from the Integrated Risk Information System (IRIS) (EPA 1998), Health Effects Assessment Summary Tables (HEAST) (EPA 1997a), and EPA Region 9 (EPA 1996c) and Region 3 (EPA 1997b) databases. Dose conversion factors (DCF) used in determining the excess TEDE values for the individual pathways were the default values provided in the RESRAD computer code (Yu et al. 1993a) as developed in the following documents:

- DCFs for ingestion and inhalation are taken from "Federal Guidance Report No. 11, Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion" (EPA 1988).
- DCFs for surface contamination (contamination on the surface of the site) were taken from DOE/EH-0070, "External Dose-Rate Conversion Factors for Calculation of Dose to the Public" (DOE 1988).

Table 6
Toxicological Parameter Values for SWMU 10 Nonradiological COCs

COC Name	RfD _o (mg/kg-d)	Confidence ^a	RfD _{inh} (mg/kg-d)	Confidence ^a	SF _o (mg/kg-day) ⁻¹	SF _{inh} (mg/kg-day) ⁻¹	Cancer Class ^b
Barium	7E-2 ^c	M	1.4E-4 ^d	--	--	--	--
Beryllium	2E-3 ^c	L to M	5.7E-6 ^c	M	--	8.4E+0 ^c	B1
Cadmium	5E-4 ^c	H	5.7E-5 ^d	--	--	6.3E+0 ^c	B1
Chromium III	1E+0 ^c	L	5.7E-7 ^e	--	--	--	--
Chromium VI	5E-3 ^c	L	--	--	--	4.2E+1	A
Mercury	3E-4 ^f	--	8.6E-5 ^c	M	--	--	D
Selenium	5E-3 ^c	H	--	--	--	--	D
Silver	5E-3 ^c	L	--	--	--	--	D

^aConfidence associated with IRIS (EPA 1998a) database values. Confidence: L = low, M = medium, H = high.

^bEPA weight-of-evidence classification system for carcinogenicity (EPA 1989) taken from IRIS (EPA 1998a):

A – Human carcinogen.

B1 - Probable human carcinogen. Limited human data are available.

D - Not classifiable as to human carcinogenicity.

^cToxicological parameter values from IRIS electronic database (EPA 1998a).

^dToxicological parameter values from EPA Region 9 electronic database (EPA 1996c).

^eToxicological parameter values from EPA Region 3 electronic database (EPA 1997b).

^fToxicological parameter values from HEAST database (EPA 1997a).

COC = Constituent of concern.

EPA = U.S. Environmental Protection Agency.

HEAST = Health Effects Assessment Summary Tables.

IRIS = Integrated Risk Information System.

mg/kg-day = Milligram(s) per kilogram day.

(mg/kg-day)⁻¹ = Per milligram per kilogram day.

RfD_o = Oral chronic reference dose.

RfD_{inh} = Inhalation chronic reference dose.

SF_{inh} = Inhalation slope factor.

SF_o = Oral slope factor.

SWMU = Solid waste management unit.

-- = Information not available.

Table 7
Radiological Toxicological Parameter Values for SWMU 10 COCs Obtained from
RESRAD Risk Coefficients^a

COC Name	SF _o (1/pCi)	SF _{inh} (1/pCi)	SF _{ev} (g/pCi-yr)	Cancer Class ^b
U-238	6.20E-11	1.20E-08	6.60E-08	A
U-235	4.70E-11	1.30E-08	2.70E-07	A
Th-232	3.30E-11	1.90E-08	2.00E-11	A

^aFrom Yu et al. (1993a).

^bEPA weight-of-evidence classification system for carcinogenicity (EPA 1989): A - human carcinogen.

1/pCi = One per picocurie.

COC = Constituent of concern.

EPA = U.S. Environmental Protection Agency.

g/pCi-yr = Gram(s) per picocurie-year.

SF_{ev} = External volume exposure slope factor.

SF_{inh} = Inhalation slope factor.

SF_o = Oral (ingestion) slope factor

SWMU = Solid waste management unit.

- DCFs for volume contamination (exposure to contamination deeper than the immediate surface of the site) were calculated using the methods discussed in "Dose-Rate Conversion Factors for External Exposure to Photon Emitters in Soil" (Kocher 1983), and ANL/EAIS-8, "Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil" (Yu et al. 1993b).

VI.6 Step 5. Exposure Assessment and Risk Characterization

Section VI.6.1 describes the exposure assessment for this risk assessment. Section VI.6.2 provides the risk characterization, including the HI value and the excess cancer risk for both the potential nonradiological COCs and associated background for industrial and residential land uses. The incremental TEDE and incremental estimated cancer risk are provided for the background-adjusted radiological COCs for both industrial and residential land uses.

VI.6.1 Exposure Assessment

Appendix 1 shows the equations and parameter input values used in the calculation of intake values and the subsequent HI and excess cancer risk values for the individual exposure pathways. The appendix shows the parameters for both industrial and residential land-use scenarios. The equations for nonradiological COCs are based upon RAGS (EPA 1989). The parameters are based upon information from RAGS (EPA 1989) as well as other EPA guidance documents and reflect the reasonable maximum exposure (RME) approach advocated by RAGS (EPA 1989). For radiological COCs, the coded equations provided in the RESRAD computer code were used to estimate the incremental TEDE and cancer risk for the individual exposure pathways. Further discussion of this process is provided in *Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD*, Version 5.0 (Yu et al. 1993a).

Although the land-use scenario is industrial for this site, the risk and TEDE values for a residential land-use scenario are presented as recommended by the Citizen's Advisory Board.

VI.6.2 Risk Characterization

Table 8 shows that for the SWMU 10 nonradiological COCs, the HI value is 0.01, and the excess cancer risk is $1\text{E-}7$ for the industrial land-use scenario. The numbers presented included exposure from soil ingestion and dust inhalation for the nonradiological COCs. Table 9 shows that assuming the maximum background concentrations of the SWMU 10 associated background constituents, the HI is 0.00, and the excess cancer risk is $5\text{E-}10$ for the industrial land-use scenario.

For the radiological COCs, contribution from the direct gamma exposure pathway is included. For the industrial land-use scenario, the most limiting case TEDE was calculated for an individual who spends his workday on the site 50/50 indoors/outdoors on the site. This resulted in an incremental TEDE of 3.8 millirem per year (mrem/yr). In accordance with EPA guidance found in OSWER Directive No. 9200.4-18 (EPA 1997c), an incremental TEDE of 15 mrem/yr is used for the probable land-use scenario (industrial in this case); the calculated dose value for SWMU 10 for the industrial land use is well below this guideline. The estimated excess cancer risk is $5.5\text{E-}5$.

For the residential land-use scenario nonradiological COC the HI value increases to 2, and the excess cancer risk is $2\text{E-}7$ (Table 8). The numbers presented included exposure from soil ingestion, dust inhalation, and plant uptake. Although the EPA (1991) generally recommends that inhalation not be included in a residential land-use scenario, this pathway is included because of the potential for soil in Albuquerque, New Mexico, to be eroded and, subsequently, for dust to be present in predominantly residential areas. Because of the nature of the local soil, other exposure pathways are not considered (see Appendix 1). Table 9 shows that for the SWMU 10 associated background constituents, the HI is 2, and the excess cancer risk is $1\text{E-}9$.

For the radiological COCs the incremental TEDE for the residential land-use scenario is 6.8 mrem/yr. The guideline being used is an excess TEDE of 75 mrem/yr (SNL/NM February 1998) for a complete loss of institutional controls (residential land use in this case); the calculated dose value for SWMU 10 for the residential land-use is well below this guideline. Consequently, SWMU 10 is eligible for unrestricted radiological release as the residential land-use scenario resulted in an incremental TEDE to the on-site receptor of less than 75 mrem/yr. The estimated excess cancer risk is $1.1\text{E-}4$. The excess cancer risk from the nonradiological COCs and the radiological COCs is not additive, as noted in RAGS (EPA 1989).

VI.7 Step 6. Comparison of Risk Values to Numerical Guidelines.

The human health risk assessment analysis evaluated the potential for adverse health effects for both an industrial land-use scenario and a residential land-use scenario.

For the industrial land-use scenario nonradiological COCs, the HI calculated is 0.01 (much less than the numerical guideline of 1 suggested in RAGS [EPA 1989]). Excess cancer risk is estimated at $1\text{E-}7$. Guidance from the New Mexico Environment Department (NMED) indicates

Table 8
Risk Assessment Values for SWMU 10 Nonradiological COCs

COC Name	Maximum Concentration (mg/kg)	Industrial Land-Use Scenario ^a		Residential Land-Use Scenario ^a	
		HI	Cancer Risk	HI	Cancer Risk
Barium	250	0.00	--	0.04	--
Beryllium	3.4 B	0.00	2E-9	0.01	3E-9
Cadmium	0.65	0.00	2E-10	0.53	4E-10
Chromium, total ^b	46	0.01	1E-7	0.04	2E-7
Mercury	0.075 J	0.00	--	0.13	--
Selenium	3.1	0.00	--	1.09	--
Silver	0.61	0.00	--	0.03	--
TOTAL		0.01	1E-7	2	2E-7

^aEPA (1989).

^bChromium, total assumed to be chromium VI (most conservative).

B = Constituent found in blank.

COC = Constituents of concern.

EPA = U.S. Environmental Protection Agency.

HI = Hazard index.

J = Estimated concentration.

mg/kg = Milligram(s) per kilogram.

SWMU = Solid waste management unit.

-- = Information not available.

Table 9
Risk Assessment Values for SWMU 10 Nonradiological Background Constituents

COC Name	Background Concentration ^a (mg/kg)	Industrial Land- Use Scenario ^b		Residential Land- Use Scenario ^b	
		HI	Cancer Risk	HI	Cancer Risk
Barium	246	0.00	--	0.04	--
Beryllium	0.75	0.00	3E-10	0.00	6E-10
Cadmium	0.64	0.00	2E-10	0.52	4E-10
Chromium, total ^c	18.8	0.00	--	0.01	--
Mercury	0.055	0.00	--	0.09	--
Selenium	3.0	0.00	--	1.06	--
Silver	<0.5	--	--	--	--
TOTAL		0.00	5E-10	2	1E-9

^aFrom Zamorski (December 1997, Lower Canyons Area).

^bEPA (1989).

^cChromium, total assumed to be chromium III

COC = Constituents of concern.

EPA = U.S. Environmental Protection Agency.

HI = Hazard index.

SWMU = Solid waste management unit.

mg/kg = Milligram(s) per kilogram.

-- = Information not available.

that excess lifetime risk of developing cancer by an individual must be less than 1E-6 for Class A and B carcinogens and less than 1E-5 for Class C carcinogens (NMED March 1998). The excess cancer risk is driven by chromium, total. Chromium, total is assumed to be chromium VI (most conservative) which is a Class A carcinogen. Thus, the total excess cancer risk for this site is below the suggested acceptable risk value of 1E-6. This assessment also determined risks considering background concentrations of the potential nonradiological COCs for both the industrial and residential land-use scenarios. For nonradiological COCs, assuming the industrial land-use scenario, the HI is 0.00. The excess cancer risk is 5E-10. Incremental risk is determined from subtracting risk associated with background from potential COC risk. These numbers are not rounded before the difference is determined and therefore may appear to be inconsistent with numbers presented in tables and within the text. The incremental HI is 0.01, and the incremental cancer risk is 1E-7 for the industrial land-use scenario. These incremental risk calculations indicate risk below the proposed NMED guidelines considering an industrial land-use scenario.

For radiological COCs of the industrial land-use scenario, incremental TEDE is 3.8 mrem/yr, which is significantly less than the EPA's numerical guideline of 15 mrem/yr. Incremental estimated excess cancer risk is 5.5E-5.

For the residential land-use scenario nonradiological COCs, the calculated HI is 2, which is above the numerical guidance. The excess cancer risk is estimated at 2E-7. The excess cancer risk is again driven by chromium, total (assumed to be chromium VI) which is a Class A

carcinogen. Therefore, the total excess cancer risk for this site is below the suggested acceptable risk value of $1\text{E-}6$. The HI for associated background for the residential land-use scenario is 2. The excess cancer risk is $1\text{E-}9$. The incremental HI is 0.15, and the incremental cancer risk is $2\text{E-}7$ for the residential land-use scenario. These incremental risk calculations indicate insignificant risk considering a residential land-use scenario.

The incremental TEDE for a residential land-use scenario from the radiological components is 6.8 mrem/yr, which is significantly less than the numerical guideline of 75 mrem/yr suggested in SNL/NM RESRAD Input Parameter Assumptions and Justification (SNL/NM February 1998). The estimated excess cancer risk is $1.1\text{E-}4$.

VI.8 Step 7. Uncertainty Discussion

The determination of the nature, rate, and extent of contamination at SWMU 10 was based upon an initial conceptual model validated with confirmatory sampling conducted at the site. The confirmatory sampling was implemented in accordance with the Sampling and Analysis Plan (SNL/NM March 1997) and Bullets of Understanding relating to the sampling (NMED DOE OB April 1997). The DQOs contained in the Sampling and Analysis Plan (SNL/NM March 1997) are appropriate for use in screening risk assessments. The data collected, based upon sample location, density, and depth, are representative of the site. The analytical requirements and results satisfy the DQOs. Data quality were validated in accordance with SNL/NM procedures (SNL/NM July 1994). Therefore, there is no uncertainty associated with the data quality used to perform the screening risk assessment at SWMU 10. HE was not detected in any of the soil, sediment, and quality assurance and quality control samples analyzed.

Because of the location, history of the site, future and recommended land-use scenarios (DOE and USAF March 1996), there is low uncertainty in the land-use scenario and the potentially affected populations that were considered in making the risk assessment analysis. Because the COCs are found in surface and near-surface soils and because of the location and physical characteristics of the site, there is little uncertainty in the exposure pathways relevant to the analysis.

An RME approach was used to calculate the risk assessment values. This means that parameter values used in calculations were conservative and that the calculated intakes are likely overestimates. Maximum measured values of the concentrations of the COCs were used to provide conservative results.

Table 4 shows the uncertainties (confidence) in nonradiological toxicological parameter values. There is a mixture of estimated values and values from IRIS (EPA 1998), HEAST (EPA 1997a), EPA Region 9 (EPA 1996c) and EPA Region 3 (EPA 1997b) databases. Where values are not provided, information is not available from the HEAST (1997a), IRIS (EPA 1998), or the EPA regions (EPA 1996c, 1997b). Because of the conservative nature of the RME approach, uncertainties in toxicological values are not expected to be of high enough concern to change the conclusion from the risk assessment analysis.

The risk assessment values for the nonradiological COCs are within the human health acceptable range for the industrial land-use scenario compared to the established numerical

guidance. The incremental risk assessment values for the residential land-use scenario are also below the NMED numerical guidance.

For the radiological COCs, the conclusion of the risk assessment is that potential effects on human health, for both industrial and residential land-use scenarios are within guidelines and are a small fraction of the estimated 360 mrem/yr received by the average U.S. population (NCRP 1987).

The overall uncertainty in all of the steps in the risk assessment process is considered not significant with respect to the conclusion reached.

VI.9 Summary

SWMU 10 has identified COCs consisting of some inorganic and radiological compounds. Because of the location of the site, the use of both industrial and residential land-use scenarios, and the nature of contamination, potential exposure pathways identified for this site included soil ingestion and dust inhalation for nonradiological inorganic constituents and soil ingestion, dust inhalation, and direct gamma exposure for radiological exposure. Plant uptake was included as an exposure pathway for the residential land-use scenario.

Using conservative assumptions and employing an RME approach to risk assessment, calculations for nonradiological COCs show that for the industrial land-use scenario the HI of 0.01 is significantly less than the accepted numerical guidance from the EPA. The excess cancer risk of $1\text{E-}7$ is also below the acceptable risk value provided by the NMED for an industrial land-use (NMED March 1998). The incremental HI is 0.01, and the incremental cancer risk is $1\text{E-}7$ for the industrial land-use scenario. Risk calculations indicate insignificant risk to human health considering an industrial land-use scenario.

Incremental TEDE and corresponding estimated cancer risk from radiological COCs are much less than EPA guidance values; the estimated TEDE is 3.8 mrem/yr for the industrial land-use scenario. This value is much less than the numerical guidance of 15 mrem/yr in EPA guidance (EPA 1997c). The corresponding incremental estimated cancer risk value is $5.5\text{E-}5$ for the industrial land-use scenario.

Using conservative assumptions and employing an RME approach to the risk assessment, the calculations for the nonradiological COCs show that for the residential land-use scenario the HI of 2 is greater than the accepted numerical guidance from the EPA. The excess cancer risk of $2\text{E-}7$ is below the acceptable risk value provided by the NMED for a residential land-use (NMED March 1998). The incremental HI is 0.15, and the incremental cancer risk is $2\text{E-}7$ for the residential land-use scenario. Incremental risk calculations indicate insignificant risk to human health for a residential land-use scenario.

The incremental TEDE and corresponding estimated cancer risk from the radiological COCs are much less than EPA guidance values; the estimated TEDE is 6.8 mrem/yr for the residential land-use scenario. This value is much less than the numerical guidance of 75 mrem/yr in SNL/NM RESRAD Input Parameter Assumptions and Justification (SNL/NM February 1998). The corresponding incremental estimated cancer risk value is $1.1\text{E-}4$ for the residential land-use scenario. Therefore, SWMU 10 is eligible for unrestricted radiological release.

The uncertainties associated with the calculations are considered small relative to the conservativeness of the risk assessment analysis. It is, therefore, concluded that this site does not have potential to affect human health under an industrial land-use scenario.

VII. Ecological Risk Screening Assessment

VII.1 Introduction

This section addresses the ecological risks associated with exposure to constituents of potential ecological concern (COPEC) in soils at SWMU 10, (Burial Mounds). A component of the NMED Risk-Based Decision Tree is to conduct an ecological screening assessment that corresponds with that presented in the EPA's Ecological Risk Assessment Guidance for Superfund (EPA 1997d). The current methodology is tiered and contains an initial scoping assessment followed by a more detailed screening assessment. Initial components of NMED's decision tree (a discussion of DQOs, a data assessment, and evaluations of bioaccumulation and fate-and-transport potential) are addressed in the scoping assessment (Section VII.2 of this report), with the exception of DQOs which are reviewed in Section II of this report. Following the completion of the scoping assessment, a determination is made as to whether a more detailed examination of potential ecological risk is necessary. If deemed necessary, the scoping assessment proceeds to a screening assessment whereby a more quantitative estimate of ecological risk is conducted. Although this assessment incorporates conservatism in the estimation of ecological risks, ecological relevance and professional judgment are also used as recommended by the EPA (1998b) to ensure that predicted exposures of selected ecological receptors reflect those reasonably expected to occur at the site.

VII.2 Scoping Assessment

The scoping assessment focuses primarily on the likelihood of exposure of biota at or adjacent to the site to be exposed to constituents associated with site activities. Included in this section are an evaluation of existing data and a comparison of maximum detected concentrations to background concentrations, examination of bioaccumulation potential, and fate and transport potential. A Scoping Risk Management Decision will involve a summary of the scoping results and a determination as to whether further examination of potential ecological impacts is necessary.

VII.2.1 Data Assessment

As indicated in Section IV (Tables 3 and 4), constituents in soil within the 0- to 5-foot-depth interval that exceeded background concentrations were as follows:

- Barium
- Beryllium
- Cadmium
- Chromium (total)

- Lead
- Mercury
- Selenium
- Silver
- Th-232
- U-235
- U-238.

No organic analytes were detected in soil.

VII.2.2 Bioaccumulation

Among the COPECs listed in Section VII.2.1, the following were considered to have bioaccumulation potential in aquatic environments (Section IV, Tables 3 and 4):

- Barium
- Cadmium
- Lead
- Mercury
- Selenium
- U-235
- U-238.

It should be noted, however, that as directed by the NMED (NMED March 1998), bioaccumulation for inorganics is assessed exclusively based upon maximum reported bioconcentration factors (BCF) for aquatic species. Because only aquatic BCFs are used to evaluate the bioaccumulation potential for metals, bioaccumulation in terrestrial species is likely to be overpredicted.

VII.2.3 Fate and Transport Potential

The potential for the COPECs to move from the source of contamination to other media or biota is discussed in Section V. As noted in Table 3 (Section V), surface-water runoff is expected to be of moderate significance, while significant wind dispersion, transformation, and degradation are expected to be low. Food-chain uptake is expected to be of moderate to low significance. Migration to groundwater is not anticipated.

VII.2.4 Scoping Risk Management Decision

Based upon information gathered through the scoping assessment, it was concluded that complete ecological pathways may be associated with this SWMU and that COPECs also exist at the site. As a consequence, a screening assessment was deemed necessary to predict the potential level of ecological risk associated with the site.

VII.3 Screening Assessment

As concluded in Section VII.2.4, complete ecological pathways and COPECs are associated with this SWMU. The screening assessment performed for the site involves a quantitative estimate of current ecological risks using exposure models in association with exposure parameters and toxicity information obtained from the literature. The estimation of potential ecological risks is conservative to ensure ecological risks are not underpredicted.

Components within the screening assessment include the following:

- Problem Formulation—sets the stage for the evaluation of potential exposure and risk.
- Exposure Estimation—provides a quantitative estimate of potential exposure.
- Ecological Effects Evaluation—presents benchmarks used to gauge the toxicity of COPECs to specific receptors.
- Risk Characterization—characterizes the ecological risk associated with exposure of the receptors to environmental media at the site.
- Uncertainty Assessment—discusses uncertainties associated with the estimation of exposure and risk.
- Risk Interpretation—evaluates ecological risk in terms of HQs and ecological significance.
- Screening Assessment Scientific/Management Decision Point—presents the decision to risk managers based upon the results of the screening assessment.

VII.3.1 Problem Formulation

Problem Formulation is the initial stage of the screening assessment that provides the introduction to the risk evaluation process. Components that are addressed in this section include a discussion of ecological pathways and the ecological setting, identification of COPECs, and selection of ecological receptors. The conceptual model, ecological food webs, and ecological endpoints (other components commonly addressed in a screening assessment) are presented in the "Predictive Ecological Risk Assessment Methodology for SNL/NM ER [Environmental Restoration] Program" (IT July 1998) and are not duplicated here.

VII.3.1.1 Ecological Pathways and Setting

SWMU 10 is located about 1.8 miles north of the Coyote Springs between the Manzanita Mountains and the Four Hills (Manzano Base). The site occupies an area approximately 400 feet in diameter and contains SWMU 60 within its boundary. The site was formerly comprised of soil mounds containing testing debris from the TABS test. Subsequent VCM activity at the site have removed all primary sources of COPECs. The site is located within

piñon-juniper woodland vegetation, with an understory dominated by blue grama (*Bouteloua gracilis*). The terrain is rolling, and the soil is coarse to rocky. The shallow subsurface geology is comprised of a thin layer of alluvial sediments overlying granitic bedrock. This area of SNL/NM is characterized by considerable structural complexity in the subsurface. Several major fault systems intersect the general area. Site-specific depth to groundwater is unknown, but is considered to be approximately 180 feet bgs. The water table may occur in unconsolidated material but most likely occurs in fractured bedrock. The site is immediately adjacent to an arroyo that flows south, entering the Arroyo del Coyote below the Coyote Springs. There is no wetland or aquatic habitat on the site or along this arroyo. SWMU 10 was surveyed for sensitive species on April 26 and May 24, 1994 (IT February 1995). No sensitive species were found within the current boundaries of the site.

Complete ecological pathways may exist at this site through the exposure of plants and wildlife to COPECs in surface and subsurface soil. Direct uptake of COPECs from soil was assumed to be the major route of exposure for plants, with exposure of plants to wind-blown soil assumed to be minor. Exposure modeling for the wildlife receptors was limited to the food and soil ingestion pathways. Because of the lack of surface water at this site, exposure to COPECs through the ingestion of surface water was considered insignificant. Inhalation and dermal contact were also considered insignificant pathways with respect to ingestion (Sample and Suter 1994). Groundwater is not expected to be affected by COPECs at this site.

VII.3.1.2 COPECs

Historically, activities at SWMU 10 included tests involving DU, beryllium, HE, and radioactive tracers (osmium and others). Based upon confirmatory sampling following the VCM activities, the COPECs at SWMU 10 include metals and DU.

In order to provide conservatism in this ecological risk assessment, the assessment is based upon the maximum soil concentrations of the COPECs as measured in soil samples within the first 5 feet of soil. Both radiological and nonradiological COPECs are evaluated. The nonradiological COCs consist of inorganic analytes (i.e., metals). No organic analytes were detected in these soil samples. Inorganic analytes and radionuclides were screened against background concentrations, and those that exceeded the approved SNL/NM background screening levels (Dinwiddie September 1997; Zamorski December 1998) for the area were considered to be COPECs. Maximum COPEC concentrations are reported in Tables 3 and 4. Nonradiological inorganics that are essential nutrients such as iron, magnesium, calcium, potassium, and sodium were not included in this risk assessment as set forth by the EPA (1989).

VII.3.1.3 Ecological Receptors

A nonspecific perennial plant was selected as the receptor to represent plant species at the site (IT July 1998). Vascular plants are the principal primary producers at the site and are key to the diversity and productivity of the wildlife community associate with the site. A deer mouse (*Peromyscus maniculatus*) and burrowing owl (*Speotyto cunicularia*) were used to represent wildlife use. Because of its opportunistic food habits, the deer mouse was used to represent a mammalian herbivore, omnivore, and insectivore. The burrowing owl was selected as the top predator. The burrowing owl is present at SNL/NM and is designated a species of management concern by the U.S. Fish and Wildlife Service in Region 2, which includes the state of New Mexico (USFWS September 1995).

VII.3.2 Exposure Estimation

Direct uptake of COPECs from the soil was considered the only significant route of exposure for terrestrial plants. Exposure modeling for the wildlife receptors exposed to nonradioactive and radioactive COPECs was limited to food and soil ingestion pathways with external dose included for radiation exposure only (IT July 1998). Inhalation and dermal contact were considered insignificant pathways with respect to ingestion (Sample and Suter 1994). Drinking water was also considered an insignificant pathway because of the lack of surface water at this site. The deer mouse was modeled under three dietary regimes: as an herbivore (100 percent of its diet as plant material), as an omnivore (50 percent of its diet as plants and 50 percent as soil invertebrates), and as an insectivore (100 percent of its diet as soil invertebrates). The burrowing owl was modeled as a strict predator on small mammals (100 percent of its diet as deer mice). Because the exposure in the burrowing owl from a diet consisting of equal parts of herbivorous, omnivorous, and insectivorous mice would be equivalent to the exposure consisting of only omnivorous mice, the diet of the burrowing owl was modeled with intake of omnivorous mice only. Both species were modeled with soil ingestion comprising 2 percent of the total dietary intake. Table 10 presents the species-specific factors used in modeling exposures in the wildlife receptors. Justification for use of the factors presented in this table is described in the ecological risk assessment methodology document (IT July 1998).

Although home range is also included in this table, exposures for this risk assessment were modeled using an area use factor of 1, implying that all food items and soil ingested are from the site being investigated. The maximum measured COPEC concentrations from surface soil samples were used to conservatively estimate potential exposures and risks to plants and wildlife at this site.

For the radiological dose rate calculations, the deer mouse was modeled as an herbivore (100 percent of its diet as plants), and the burrowing owl was modeled as a strict predator on small mammals (100 percent of its diet as deer mice). Both were modeled with soil ingestion comprising 2 percent of the total dietary intake. Receptors are exposed to radiation both internally and externally from U-235, U-238, and Th-232. Internal and external dose rates to the deer mouse and burrowing owl are approximated using modified dose rate models from the *Hanford Site Risk Assessment Methodology* (DOE 1995) as presented in the ecological risk assessment methodology document for the SNL/NM ER Program (IT July 1998). Radionuclide-dependent data for the dose rate calculations were obtained from Baker and Soldat (1992). The external dose rate model examines the total-body dose rate to a receptor residing in soil exposed to radionuclides. The soil surrounding the receptor is assumed to be an infinite medium uniformly contaminated with gamma-emitting radionuclides. The external dose rate model is the same for both the deer mouse and the burrowing owl. The internal total-body dose rate model assumes that a fraction of the radionuclide concentration ingested by a receptor is absorbed by the body and concentrated at the center of a spherical body shape. This provides for a conservative estimate for absorbed dose. This concentrated radiation source at the center of the body of the receptor is assumed to be a "point" source. Radiation emitted from this point source is absorbed by the body tissues to contribute to the absorbed dose. Alpha and beta emitters are assumed to transfer 100 percent of their energy to the receptor as they pass through tissues. Gamma-emitting radionuclides only transfer a fraction of their energy to the tissues because gamma rays interact less with matter than do beta or alpha emitters. The

Table 10
Exposure Factors for Ecological Receptors at SWMU 10

Receptor Species	Class/Order	Trophic Level	Body Weight (kg) ^a	Food Intake Rate (kg/day) ^b	Dietary Composition ^c	Home Range (acres)
Deer Mouse (<i>Peromyscus maniculatus</i>)	Mammalia/ Rodentia	Herbivore	2.39E-2 ^d	3.72E-3	Plants: 100% (+ Soil at 2% of intake)	2.7E-1 ^e
Deer Mouse (<i>Peromyscus maniculatus</i>)	Mammalia/ Rodentia	Omnivore	2.39E-2 ^d	3.72E-3	Plants: 50% Invertebrates: 50% (+ Soil at 2% of intake)	2.7E-1 ^e
Deer Mouse (<i>Peromyscus maniculatus</i>)	Mammalia/ Rodentia	Insectivore	2.39E-2 ^d	3.72E-3	Invertebrates: 100% (+ Soil at 2% of intake)	2.7E-1 ^e
Burrowing owl (<i>Speotyto cunicularia</i>)	Aves/ Strigiformes	Carnivore	1.55E-1 ^f	1.73E-2	Rodents: 100% (+ Soil at 2% of intake)	3.5E+1 ^g

^aBody weights are in kilograms wet weight.

^bFood intake rates are estimated from the allometric equations presented in Nagy (1987). Units are kilograms dry weight per day.

^cDietary compositions are generalized for modeling purposes. Default soil intake value of 2% of food intake.

^dFrom Silva and Downing (1995).

^eEPA (1993), based upon the average home range measured in semiarid shrubland in Idaho.

^fFrom Dunning (1993).

^gFrom Haug et al. (1993).

EPA = U.S. Environmental Protection Agency.

kg = Kilogram(s).

kg/day = Kilogram(s) per day.

SWMU = Solid waste management unit.

external and internal dose rate results are summed to calculate a total dose rate caused by exposure to radionuclides in soil.

Table 11 presents the transfer factors used in modeling the concentrations of COPECs through the food chain. Table 12 presents maximum concentrations in soil and derived concentrations in tissues of the various food-chain elements that are used to model dietary exposures for each of the wildlife receptors.

VII.3.3 Ecological Effects Evaluation

Benchmark toxicity values for the plant and wildlife receptors are presented in Table 13. For plants, the benchmark soil concentrations are based upon the lowest-observed-adverse-effect level (LOAEL). For wildlife, the toxicity benchmarks are based upon the no-observed-adverse-effect level (NOAEL) for chronic oral exposure in a taxonomically similar test species. Insufficient toxicity information was found to estimate the LOAELs or NOAELs for some COPECs for terrestrial plant life and wildlife receptors, respectively.

The benchmark used for exposure of terrestrial receptors to radiation was 0.1 rad/day. This value has been recommended by the International Atomic Energy Agency (IAEA 1992) for the protection of terrestrial populations. Because plants and insects are less sensitive to radiation than vertebrates (Whicker and Schultz 1982), the dose of 0.1 rad per day should also offer sufficient protection to other components within the terrestrial habitat of SWMU 10.

VII.3.4 Risk Characterization

Maximum concentrations in soil and estimated dietary exposures were compared to plant and wildlife benchmark values, respectively. Results of these comparisons are presented in Table 14. HQs are used to quantify the comparison with benchmarks for plants and wildlife exposure.

Analytes with HQs exceeding unity for plants were chromium (total) and selenium. Barium resulted in an HQ in excess of unity for the omnivorous and insectivorous deer mouse. Selenium resulted in an HQ greater than 1.0 for the insectivorous deer mouse. One analyte, mercury (organic), resulted in an HQ greater than 1.0 for the burrowing owl, although HQs for the burrowing owl could not be determined for beryllium and silver. As directed by the NMED, HIs were calculated for each of the receptors (the HI is the sum of chemical-specific HQs for all pathways for a given receptor). All receptors had HIs greater than unity, with a maximum HI of 45 for plants.

Tables 15 and 16 summarize the internal and external dose rate model results for the six radionuclides. The total radiation dose rate to the deer mouse was predicted to be $5.4\text{E-}4$ rad/day. Total dose rate to the burrowing owl was predicted to be $4.9\text{E-}4$ rad/day. The external dose rate from exposure to these radionuclides for both receptors is the primary contributor to the total dose rate. The dose rates for the deer mouse and the burrowing owl are considerably less than the benchmark of 0.1 rad/day.

Table 11
Transfer Factors Used in Exposure Models for
Constituents of Potential Ecological Concern at SWMU 10

Constituent of Potential Ecological Concern	Soil-to-Plant Transfer Factor	Soil-to-Invertebrate Transfer Factor	Food-to-Muscle—Transfer Factor
Inorganic			
Barium	1.5E-1 ^a	1.0E+0 ^b	2.0E-4 ^c
Beryllium	1.0E-2 ^a	1.0E+0 ^b	1.0E-3 ^a
Cadmium	5.5E-1 ^a	6.0E-1 ^d	5.5E-4 ^a
Chromium (total)	4.0E-2 ^c	1.3E-1 ^e	3.0E-2 ^c
Lead	9.0E-2 ^c	4.0E-2 ^d	8.0E-4 ^c
Mercury	1.0E+0 ^c	1.0E+0 ^b	2.5E-1 ^a
Selenium	5.0E-1 ^c	1.0E+0 ^b	1.0E-1 ^c
Silver	1.0E+0 ^c	2.5E-1 ^d	5.0E-3 ^c

^aFrom Baes et al. (1984).^bDefault value.^cNCRP (January 1989).^dFrom Stafford et al. (1991).^eFrom Ma (1982).

SWMU = Solid waste management unit.

Table 12
Media Concentrations^a for Constituents of
Potential Ecological Concern at SWMU 10

Constituent of Potential Ecological Concern	Soil (maximum)	Plant Foliage ^b	Soil Invertebrate ^b	Deer Mouse Tissues ^c
Inorganic				
Barium	2.5E+2	3.8E+1	2.5E+2	9.3E-2
Beryllium	3.4E+0	3.4E-2	3.4E+0	5.6E-3
Cadmium	6.5E-1	3.6E-1	3.9E-1	6.7E-4
Chromium (total)	4.6E+1	1.8E+0	6.0E+0	4.5E-1
Lead	3.0E+1	2.7E+0	1.2E+0	6.0E-2
Mercury	0.075 J	7.5E-2	7.5E-2	6.0E-2
Selenium	3.1E+0	1.6E+0	3.1E+0	7.5E-1
Silver	6.1E+1	6.1E-1	1.5E-1	6.2E-3

^aIn milligrams per kilogram. All are based upon dry weight of the media.^bProduct of the soil concentration and the corresponding transfer factor.^cBased upon the deer mouse with an omnivorous diet. Product of the average concentration in food times the food-to-muscle transfer factor times the wet weight-dry weight conversion factor of 3.125 (from EPA 1993).

SWMU = Solid waste management unit.

Table 13
Toxicity Benchmarks for Ecological Receptors at SWMU 10

		Mammalian NOAELs			Avian NOAELs		
Constituent of Potential Ecological Concern	Plant Benchmark ^{a,b}	Mammalian Test Species ^{c,d}	Test Species NOAEL ^{d,e}	Deer Mouse NOAEL ^{e,f}	Avian Test Species ^d	Test Species NOAEL ^{d,e}	Burrowing Owl NOAEL ^{e,g}
Inorganic							
Barium	500	Rat ^h	5.1	10.5	Chicks	20.8	20.8
Beryllium	10	Rat	0.66	1.29	---	---	---
Cadmium	3	Rat ^j	1.0	1.9	Mallard	1.45	1.45
Chromium (total)	1	Rat	2,737	5,354	Black duck	1.0	1.0
Lead	50	Rat	8.0	15.6	American kestrel	3.85	3.85
Mercury (inorganic)	0.3	Mouse	13.2	14.0	Japanese quail	0.45	0.45
Mercury (organic)	0.3	Rat	0.032	0.063	Mallard	0.0064	0.0064
Selenium	1	Rat	0.20	0.39	Screech owl	0.44	0.44
Silver	2	Rat	17.8	34.8	---	---	---

^aIn milligrams per kilogram soil.

^bFrom Will and Suter (1995).

^cBody weights (in kilograms) for the no-observed-adverse-effect level (NOAEL) conversion are as follows: lab mouse, 0.030; lab rat, 0.350 (except where noted).

^dFrom Sample et al. (1996), except where noted.

^eIn milligrams per kilogram body weight per day.

^fBased upon NOAEL conversion methodology presented in Sample et al. (1996), using a deer mouse body weight of 0.0239 kilogram and a mammalian scaling factor of 0.25.

^gBased upon NOAEL conversion methodology presented in Sample et al. (1996). The avian scaling factor of 0.0 was used, making the NOAEL independent of body weight.

^hBody weight: 0.435 kilogram.

ⁱ--- designates insufficient toxicity data.

^jBody weight: 0.303 kilogram.

SWMU = Solid waste management unit.

NOAELs = No-observed-adverse-effect levels.

Table 14
Hazard Quotients for Ecological Receptors at SWMU 10

Constituent of Potential Ecological Concern	Plant HQ ^a	Deer Mouse HQ (Herbivorous) ^a	Deer Mouse HQ (Omnivorous) ^a	Deer Mouse HQ (Insectivorous) ^a	Burrowing Owl HQ ^a
Inorganic					
Barium	5.0E-1	6.3E-1	2.2E+0	3.8E+0	2.7E-2
Beryllium	3.4E-1	1.2E-2	2.2E-1	4.2E-1	---
Cadmium	2.2E-1	3.1E-2	3.2E-2	3.3E-2	1.1E-3
Chromium (total)	4.6E+1	8.0E-5	1.4E-4	2.0E-4	1.5E-1
Lead	6.0E-1	3.3E-2	2.5E-2	1.8E-2	1.8E-2
Mercury (inorganic)	2.5E-1	8.5E-4	8.5E-4	8.5E-4	1.5E-2
Mercury (organic)	2.5E-1	1.9E-1	1.9E-1	1.9E-1	1.1E+0
Selenium	3.1E+0	6.4E-1	9.5E-1	1.3E+0	2.1E-1
Silver	3.1E-1	2.8E-3	1.8E-3	7.4E-4	---
HI^c	5.1E+1	1.5E+0	3.6E+0	5.8E+0	1.5E+0

^a**Bold** text indicates HQ or HI exceeds unity.

^cThe HI is the sum of individual HQs using the value for organic mercury as a conservative estimate of the HI.

HI = Hazard index.

HQ = Hazard quotient.

SWMU = Solid waste management unit.

--- designates insufficient toxicity data available for risk estimation purposes.

Table 15
Internal and External Dose Rates for
Deer Mice Exposed to Radionuclides at SWMU 10

Radionuclide	Maximum Concentration (pCi/g)	Internal Dose (rad/day)	External Dose (rad/day)	Total Dose (rad/day)
U-235 ^a	3.0E-1	3.3E-6	4.9E-6	8.2E-6
U-238	8.4E+0	8.5E-5	1.7E-5	1.0E-4
Th-232	2.3E+0	9.2E-7	4.3E-4	4.3E-4
Total		8.9E-5	4.5E-4	5.4E-4

^aThe U-235 value was calculated using the U-238 concentration and assuming that the U-238 to U-235 ratio was equal to that detected during waste characterization of depleted uranium-contaminated soils generated during the radiological voluntary corrective measures project, where $U-235 = U-238/73$ (Miller June 1998).

pCi/g = Picocurie(s) per gram.

SWMU = Solid waste management unit.

Table 16
Internal and External Dose Rates for
Burrowing Owls Exposed to Radionuclides at SWMU 10

Radionuclide	Maximum Concentration (pCi/g)	Internal Dose (rad/day)	External Dose (rad/day)	Total Dose (rad/day)
U-235 ^a	3.0E-1	1.3E-6	4.9E-6	6.2E-6
U-238	8.4E+0	3.4E-5	1.7E-5	5.1E-5
Th-232	2.3E+0	1.3E-6	4.3E-4	4.3E-4
Total		3.7E-5	4.5E-4	4.9E-4

^aThe U-235 value was calculated using the U-238 concentration and assuming that the U-238 to U-235 ratio was equal to that detected during waste characterization of depleted uranium-contaminated soils generated during the radiological voluntary corrective measures project, where $U-235 = U-238/73$ (Miller June 1998).

VII.3.5 Uncertainty Assessment

Many uncertainties are associated with the characterization of ecological risks at SWMU 10. These uncertainties result from assumptions used in calculating risk that may overestimate or underestimate true risk presented at a site. For this risk assessment, assumptions are made that are more likely to overestimate exposures and risk rather than to underestimate them. These conservative assumptions are used to be more protective of the ecological resources potentially affected by the site. Conservatism incorporated into this risk assessment include the use of maximum measured analyte concentrations in soil to evaluate risk, the use of wildlife toxicity benchmarks based upon NOAEL values, the incorporation of strict herbivorous and strict insectivorous diets for predicting the extreme HQ values for the deer mouse, and the use of 1.0 as the area use factor for wildlife receptors regardless of seasonal use or home range size. Each of these uncertainties, which are consistent among each of the SWMU-specific ecological risk assessments, is discussed in greater detail in the uncertainty section of the ecological risk assessment methodology document for the SNL/NM ER Program (17 July 1998).

Uncertainties associated with the estimation of risk to ecological receptors following exposure to U-235, U-238, and Th-232 are primarily related to those inherent in the radionuclide-specific data. Radionuclide-dependent data are measured values that have their associated errors, which are typically negligible. The dose rate models used for these calculations are based upon conservative estimates on receptor shape, radiation absorption by body tissues, and intake parameters. The goal is to provide a realistic but conservative estimate of a receptor's exposure to radionuclides in soil, both internally and externally.

One large uncertainty associated with the prediction of ecological risks at this site is the use of the maximum measured concentrations in soil to evaluate risk. This results in a conservative exposure scenario that does not necessarily reflect actual site conditions. This is also true with regard to the use of detection limits in the estimation of risk. The assumption of an area use factor of 1.0 is a source of uncertainty for the burrowing owl. Because SWMU 10 is less than 3 acres in size, an area use factor of less than 0.1 would be justified for this receptor. This is sufficient to reduce the HQ for mercury well below unity.

Analytical data were examined more closely to assess variability within the data. Exclusion of these data results in maximum chromium and barium concentrations of 40 and 250 mg/kg, respectively. Utilization of 40 mg/kg chromium concentration in the estimation of risks to plants results in an HQ of 40. The average chromium within this data set, however, is only 12.0 mg/kg, which is less than background. Consequently, risks to plant communities on site from exposure to chromium are not expected to be significant. Risk was also predicted for deer mice exposed to barium. Utilization of the average barium concentration of 109 mg/kg results in an HQ of greater than (1.6) for the insectivorous mouse alone. Risks to ecological receptors from exposure to chromium and barium on-site are, therefore, expected to be low. Selenium was also predicted to be potentially hazardous to plants and the insectivorous mice at the site. Exposure of plants at this site to the average detected concentration would result in an HQ of 1.1 for the plant and less than unity for the deer mouse. Mercury resulted in an HQ of greater than 1.0; however, it was detected in less than 7 percent of the samples. This only occurs if mercury is assumed to be entirely in the organic form. Consideration of the nondetected values would lower the HQ to below 1 for plants at the site. Based upon this analysis, chromium, barium, selenium, and mercury are not expected to pose a significant risk to biota associated with the site.

In the estimation of ecological risk, background concentrations are included as a component of maximum on-site concentrations. Table 17 illustrates risk estimates associated with exposure of each of the receptors to background concentrations of the metal COPECs. With respect to the plant, an HQ greater than 1.0 was obtained for chromium (total) and selenium. HQs greater than unity were also obtained for the omnivorous and insectivorous deer mouse exposed to barium. Selenium also resulted in an HQ greater than 1.0 for the insectivorous deer mouse. No HQs greater than 1.0 were reported for the burrowing owl from background exposure. Although less than 50 percent of the maximum on-site total chromium soil concentration was associated with background, 97 percent of the maximum on-site total selenium concentration was associated with background. Likewise, 98 percent of the maximum on-site barium concentration and 73 of the maximum on-site mercury concentration were associated with background. Average on-site concentrations of barium, chromium, and selenium are within the range of background concentrations. Because of the uncertainties associated with exposure and toxicity, it is unlikely that selenium, chromium, and barium, with exposure concentrations largely attributable to background, present significant ecological risk.

Based upon this uncertainty analysis, ecological risks at SWMU 10 are expected to be very low. HQs greater than unity were initially predicted; however, closer examination of the exposure assumptions revealed an overestimation of risk primarily attributed to exposure concentration, background risk, quality of analytical data, and the assumption of mercury as entirely in the organic form.

VII.3.6 Risk Interpretation

Ecological risks associated with SWMU 10 were estimated through a screening assessment that incorporated site-specific information when available. Overall, ecological risks to plants are expected to be low because of the fact that predicted risks associated with exposure to barium, chromium (total), selenium, and mercury are based upon calculations using maximum detected values. With respect to the deer mouse, risk is also expected to be low. In addition, average barium, chromium, and selenium concentrations at the site were within the range of background concentrations. Mercury was predicted to be hazardous to the burrowing owl. Potential risks associated with mercury for the burrowing owl were evaluated using maximum detected values, an assumption that the concentration was entirely in an organic form, and an area use factor of 1.0, all of which can account for the HQ exceeding unit. Based upon this final analysis, ecological risks associated with SWMU 10 are expected to be very low.

VII.3.7 Screening Assessment Scientific/Management Decision Point

Once potential ecological risks associated with the site have been assessed, a decision is made as whether the site should be recommended for NFA or additional data should be collected to more thoroughly assess actual ecological risk at the site. With respect to this site, ecological risks were predicted to be very low. The scientific/management decision is to recommend this site for NFA.

Table 17
HQs for Ecological Receptors Exposed to Background Concentrations for SWMU 10

Constituent of Potential Ecological Concern	Plant HQ ^a	Deer Mouse HQ (Herbivorous) ^a	Deer Mouse HQ (Omnivorous) ^a	Deer Mouse HQ (Insectivorous) ^a	Burrowing Owl HQ ^a
Inorganic					
Barium	4.9E-1	6.2E-1	2.2E+0	3.7E+0	2.7E-2
Beryllium	7.5E-2	2.7E-3	4.8E-2	9.2E-2	--- ^b
Cadmium	2.1E-1	3.0E-2	3.1E-2	3.3E-2	1.0E-3
Chromium (total)	1.9E+1	3.3E-5	5.7E-5	8.2E-5	6.3E-2
Lead	3.8E-1	2.1E-2	1.6E-2	1.1E-2	1.1E-2
Mercury (inorganic)	1.8E-1	6.3E-4	6.3E-4	6.3E-4	1.1E-2
Mercury (organic)	1.8E-1	1.4E-1	1.4E-1	1.4E-1	7.8E-1
Selenium	3.0E+0	6.2E-1	9.2E-1	1.2E+0	2.0E-1
Silver	1.3E-1	1.1E-3	7.2E-4	3.0E-4	---
HI ^c	2.3E+1	1.4E+0	3.4E+0	5.2E+0	1.1E+0

^a**Bold** text indicates HQ or HI exceeds unity.

^b--- designates insufficient toxicity data available for risk estimation purposes.

^cThe HI is the sum of individual HQs using the value for organic mercury as a conservative estimate of the HI.

HI = Hazard index.

HQ = Hazard quotients.

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APPENDIX 1 EXPOSURE PATHWAY DISCUSSION FOR CHEMICAL AND RADIONUCLIDE CONTAMINATION

Sandia National Laboratories (SNL/NM) proposes that a default set of exposure routes and associated default parameter values be developed for each future land-use designation being considered for SNL/NM Environmental Restoration (ER) project sites. This default set of exposure scenarios and parameter values would be invoked for risk assessments unless site-specific information suggested other parameter values. Because many SNL/NM solid waste management units (SWMU) have similar types of contamination and physical settings, SNL/NM believes that the risk assessment analyses at these sites can be similar. A default set of exposure scenarios and parameter values will facilitate the risk assessments and subsequent review.

The default exposure routes and parameter values suggested are those that SNL/NM views as resulting in a Reasonable Maximum Exposure (RME) value. Subject to comments and recommendations by the U.S. Environmental Protection Agency (EPA) Region VI and New Mexico Environment Department (NMED), SNL/NM proposes that these default exposure routes and parameter values be used in future risk assessments.

At SNL/NM, all SWMUs exist within the boundaries of the Kirtland Air Force Base (KAFB). Approximately 157 potential waste and release sites have been identified where hazardous, radiological, or mixed materials may have been released to the environment. Evaluation and characterization activities have occurred at all of these sites to varying degrees. Among other documents, the SNL/NM ER draft Environmental Assessment (DOE 1996) presents a summary of the hydrogeology of the sites, the biological resources present and proposed land-use scenarios for the SNL/NM SWMUs. At this time, all SNL/NM SWMUs have been tentatively designated for either industrial or recreational future land use. The NMED has also requested that risk calculations be performed based upon a residential land-use scenario. All three land-use scenarios will be addressed in this document.

The SNL/NM ER project has screened the potential exposure routes and identified default parameter values to be used for calculating potential intake and subsequent Hazard index (HI), risk and dose values. The EPA (EPA 1989a) provides a summary of exposure routes that could potentially be of significance at a specific waste site. These potential exposure routes consist of:

- Ingestion of contaminated drinking water
- Ingestion of contaminated soil
- Ingestion of contaminated fish and shell fish
- Ingestion of contaminated fruits and vegetables
- Ingestion of contaminated meat, eggs, and dairy products
- Ingestion of contaminated surface water while swimming
- Dermal contact with chemicals in water
- Dermal contact with chemicals in soil
- Inhalation of airborne compounds (vapor phase or particulate)

- External exposure to penetrating radiation (immersion in contaminated air; immersion in contaminated water and exposure from ground surfaces with photon-emitting radionuclides).

Based upon the location of the SNL/NM SWMUs and the characteristics of the surface and subsurface at the sites, we have evaluated these potential exposure routes for different land-use scenarios to determine which should be considered in risk assessment analyses (the last exposure route is pertinent to radionuclides only). At SNL/NM SWMUs, there does not currently occur any consumption of fish, shell fish, fruits, vegetables, meat, eggs, or dairy products that originate on site. Additionally, no potential for swimming in surface water is present due to the high-desert environmental conditions. As documented in the RESRAD computer code manual (ANL 1993), risks resulting from immersion in contaminated air or water are not significant compared to risks from other radiation exposure routes.

For the industrial and recreational land-use scenarios, SNL/NM ER has, therefore, excluded the following four potential exposure routes from further risk assessment evaluations at any SNL/NM SWMU:

- Ingestion of contaminated fish and shell fish
- Ingestion of contaminated fruits and vegetables
- Ingestion of contaminated meat, eggs, and dairy products
- Ingestion of contaminated surface water while swimming.

That part of the exposure pathway for radionuclides related to immersion in contaminated air or water is also eliminated.

For the residential land-use scenario, we will include ingestion of contaminated fruits and vegetables because of the potential for residential gardening.

Based upon this evaluation, for future risk assessments, the exposure routes that will be considered are shown in Table 1. Dermal contact is included as a potential exposure pathway in all land use scenarios. However, the potential for dermal exposure to inorganics is not considered significant and will not be included. In general, the dermal exposure pathway is generally considered to not be significant relative to water ingestion and soil ingestion pathways but will be considered for organic components. Because of the lack of toxicological parameter values for this pathway, the inclusion of this exposure pathway into risk assessment calculations may not be possible and may be part of the uncertainty analysis for a site where dermal contact is potentially applicable.

Equations and Default Parameter Values for Identified Exposure Routes

In general, SNL/NM expects that ingestion of compounds in drinking water and soil will be the more significant exposure routes for chemicals; external exposure to radiation may also be significant for radionuclides. All of the above routes will, however, be considered for their appropriate land use scenarios. The general equations for calculating potential intakes via these routes are shown below. The equations are from the Risk Assessment Guidance for Superfund (RAGS): Volume 1 (EPA 1989a, 1991). These general equations also apply to calculating potential intakes for radionuclides. A more in-depth discussion of the equations

Table 1
Exposure Pathways Considered for Various Land Use Scenarios

Industrial	Recreational	Residential
Ingestion of contaminated drinking water	Ingestion of contaminated drinking water	Ingestion of contaminated drinking water
Ingestion of contaminated soil	Ingestion of contaminated soil	Ingestion of contaminated soil
Inhalation of airborne compounds (vapor phase or particulate)	Inhalation of airborne compounds (vapor phase or particulate)	Inhalation of airborne compounds (vapor phase or particulate)
Dermal contact	Dermal contact	Dermal contact
External exposure to penetrating radiation from ground surfaces	External exposure to penetrating radiation from ground surfaces	Ingestion of fruits and vegetables
		External exposure to penetrating radiation from ground surfaces

used in performing radiological pathway analyses with the RESRAD code may be found in the RESRAD Manual (ANL 1993). Also shown are the default values SNL/NM ER suggests for use in RME risk assessment calculations for industrial, recreational, and residential scenarios, based upon EPA and other governmental agency guidance. The pathways and values for chemical contaminants are discussed first, followed by those for radionuclide contaminants. RESRAD input parameters that are left as the default values provided with the code are not discussed. Further information relating to these parameters may be found in the RESRAD Manual (ANL 1993).

Generic Equation for Calculation of Risk Parameter Values

The equation used to calculate the risk parameter values (i.e., hazard quotients/hazard index [HI], excess cancer risk, or radiation total effective dose equivalent [dose]) is similar for all exposure pathways and is given by:

$$\text{Risk (or Dose)} = \text{Intake} \times \text{Toxicity Effect (either carcinogenic, noncarcinogenic, or radiological)}$$

$$= C \times (CR \times EFD/BW/AT) \times \text{Toxicity Effect} \quad (1)$$

where

C = contaminant concentration (site specific)
 CR = contact rate for the exposure pathway
 EFD = exposure frequency and duration
 BW = body weight of average exposure individual
 AT = time over which exposure is averaged.

The total risk/dose (either cancer risk or HI) is the sum of the risks/doses for all of the site-specific exposure pathways and contaminants.

The evaluation of the carcinogenic health hazard produces a quantitative estimate for excess cancer risk resulting from the constituents of concern (COC) present at the site. This estimate

is evaluated for determination of further action by comparison of the quantitative estimate with the potentially acceptable risk range of 10^{-4} to 10^{-6} . The evaluation of the noncarcinogenic health hazard produces a quantitative estimate (i.e., the HI) for the toxicity resulting from the COCs present at the site. This estimate is evaluated for determination of further action by comparison of this quantitative estimate with the EPA standard HI of unity (1). The evaluation of the health hazard due to radioactive compounds produces a quantitative estimate of doses resulting from the COCs present at the site.

The specific equations used for the individual exposure pathways can be found in RAGS (EPA 1989a) and the RESRAD Manual (ANL 1993). Table 2 shows the default parameter values suggested for use by SNL/NM at SWMUs, based upon the selected land use scenario. References are given at the end of the table indicating the source for the chosen parameter values. The intention of SNL/NM is to use default values that are consistent with regulatory guidance and consistent with the RME approach. Therefore, the values chosen will, in general, provide a conservative estimate of the actual risk parameter. These parameter values are suggested for use for the various exposure pathways based upon the assumption that a particular site has no unusual characteristics that contradict the default assumptions. For sites for which the assumptions are not valid, the parameter values will be modified and documented.

Summary

SNL/NM proposes the described default exposure routes and parameter values for use in risk assessments at sites that have an industrial, recreational or residential future land-use scenario. There are no current residential land-use designations at SNL/NM ER sites, but this scenario has been requested to be considered by the NMED. For sites designated as industrial or recreational land-use, SNL/NM will provide risk parameter values based upon a residential land-use scenario to indicate the effects of data uncertainty on risk value calculations or in order to potentially mitigate the need for institutional controls or restrictions on SNL/NM ER sites. The parameter values are based upon EPA guidance and supplemented by information from other government sources. The values are generally consistent with those proposed by Los Alamos National Laboratory, with a few minor variations. If these exposure routes and parameters are acceptable, SNL/NM will use them in risk assessments for all sites where the assumptions are consistent with site-specific conditions. All deviations will be documented.

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DOE, see U.S. Department of Energy.

EPA, see U.S. Environmental Protection Agency.

Table 2
Default Parameter Values for Various Land Use Scenarios

Parameter	Industrial	Recreational	Residential
General Exposure Parameters			
Exposure frequency (day/yr)	***	***	***
Exposure duration (yr)	30 ^{a,b}	30 ^{a,b}	30 ^{a,b}
Body weight (kg)	70 ^{a,b}	56 ^{a,b}	70 adult ^{a,b} 15 child
Averaging Time (days) for carcinogenic compounds (= 70 y x 365 day/yr) for noncarcinogenic compounds (= ED x 365 day/yr)	25550 ^a 10950	25550 ^a 10950	25550 ^a 10950
Soil Ingestion Pathway			
Ingestion rate	100 mg/day ^c	6.24 g/yr ^d	114 mg-yr/kg-day ^a
Inhalation Pathway			
Inhalation rate (m ³ /yr)	5000 ^{a,b}	146 ^d	5475 ^{a,b,d}
Volatilization factor (m ³ /kg)	chemical specific	chemical specific	chemical specific
Particulate emission factor (m ³ /kg)	1.32E9 ^a	1.32E9 ^a	1.32E9 ^a
Water Ingestion Pathway			
Ingestion rate (L/day)	2 ^{a,b}	2 ^{a,b}	2 ^{a,b}
Food Ingestion Pathway			
Ingestion rate (kg/yr)	NA	NA	138 ^{b,d}
Fraction ingested	NA	NA	0.25 ^{b,d}
Dermal Pathway			
Surface area in water (m ²)	2 ^{b,e}	2 ^{b,e}	2 ^{b,e}
Surface area in soil (m ²)	0.53 ^{b,e}	0.53 ^{b,e}	0.53 ^{b,e}
Permeability coefficient	chemical specific	chemical specific	chemical specific

***The exposure frequencies for the land use scenarios are often integrated into the overall contact rate for specific exposure pathways. When not included, the exposure frequency for the industrial land use scenario is 8 hr/day for 250 day/yr; for the recreational land use, a value of 2 hr/wk for 52 wk/yr is used (EPA 1989b); for a residential land use, all contact rates are given per day for 350 day/yr.

^aRAGS, Vol 1, Part B (EPA 1991).

^bExposure Factors Handbook (EPA 1989b)

^cEPA Region VI guidance.

^dFor radionuclides, RESRAD (ANL 1993) is used for human health risk calculations; default parameters are consistent with RESRAD guidance.

^eDermal Exposure Assessment (EPA 1992).

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**Statement of Basis
Approval of No Further Action**

January 2000

**Solid Waste Management Unit 10
Operable Unit 1333
Round 11**

RSI Originally Submitted September 1999

Site-Specific Comments

OU 1333

ER Site 10, Burial Mounds

ER Site 10 is appropriate for NFA, pending submittal of the below requested information.

1. **Page 3-7, Figure 3.2.2-1 -- The site map showing the burial mounds at ER Site 10 is labeled "draft". Please submit a final version of this map.**

Response: The draft label has been removed. See Attachment A.

2. **Page 3-33, Figure 3.4.4-2 -- The site map showing confirmatory sampling locations at ER Site 10 is labeled "draft". Please submit a final version of this map.**

Response: The draft label has been removed. See Attachment A.

3. **Annex 3-A, Figure 1 -- The site map showing the burial mounds at ER Site 10 is labeled "draft". Please submit a final version of this map.**

Response: The draft label has been removed. See Attachment A.

Attachment A

ATTACHMENT A
ER SITE 10
REVISED FIGURES

