Los Alamos
NATIONAL LABORATORY

Environment, Safety And Health Division
Los Alamos, New Mexico 87545
FAX (505) 665-3811

Date: July 14, 1995
In Reply Refer To: ESH-DO:94-430
Mail Stop: K491
Telephone: (505) 667-4218

TA 35

Mr. Joseph C. Vozella
Chief Environment, Safety, and Health Branch
U. S. Department of Energy
Los Alamos Area Office
Los Alamos, New Mexico 87544

Dear Mr. Vozella:

SUBJECT: PROPOSED MODIFICATIONS

Enclosed for your signature is a draft letter to the New Mexico Environment Department (NMED) transmitting the enclosed proposed modifications to the Resource Conservation and Recovery Act (RCRA) Research, Development, and Demonstration (RD&D) Permit for the Packed Bed Reactor/Silent Discharge Plasma (PBR/SDP) Unit located at Technical Area 35 (TA-35), Building 421. These permit modifications are necessary to reflect the relocation of the unit from TA-35, Building 128 to TA-35, Building 421 (refer to letter ESH-19/HSWS-94-0407). In addition, the permit modifications reflect LANL organizational changes that have occurred since the issuance of the RD&D Permit, and modifications that provide editorial and typographical corrections and changes. The LANL organizational restructuring, along with the need to provide an emergency equipment list, also created the need to include a new contingency plan for the permit.

Please prepare, sign, and transmit the enclosed draft letter and RD&D Permit modification package to the NMED as soon as possible. In addition, please transmit the enclosed computer diskette (3-1/2 inch) to the NMED along with the modification package. This diskette includes the modified RD&D permit for use by the NMED.

In addition, please remember that the enclosed Certification Statement must be signed by an authorized representative of DOE/LAAO before submittal to the NMED. If you have any questions or would like to discuss this matter further, please contact Tony Grieggs of my staff at 665-0451.

Sincerely,

7/17

Alexander J. Gancarz, Director
Chemical Science & Technology Division

Dennis J. Erickson, Director
Environment, Safety & Health Division

AG/DJE/JP:es

Enclosures: a/s

Cy: J. Ellvinger, LANL, ESH-19, MS K490, w/o encl.
A. Grieggs, LANL, ESH-19, MS K498, w/o encl.
J. Pieniazek, LANL, ESH-19, MS K498, w/o encl.
J. Coogan, LANL, CST-18, MS E525, w/o encl.
L. Rosocha, LANL, CST-18, MS E525, w/o encl.
(ESH-19:95-324.JP), MS K490
ESH-DO File, MS K491
ESH-19 Reading File
CIC-10, MS A150

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Modifications to the RD&D Permit
for the Packed Bed Reactor/Silent
Discharge Plasma Treatment Unit

Los Alamos National Laboratory
Los Alamos, New Mexico

RD&D Permit No. NM0890010515-RDD1
Permit Modification No. 1.0
July 1995

CERTIFICATION

I certify under penalty of law that these permit modifications and all enclosures and attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Signature — Date: 7/17/95

Alexander J. Gancarz, Director
Chemical Science and Technology Division

Signature — Date: 7/18/95

Dennis J. Erickson, Director
Environment, Safety and Health Division

Signature — Date

Larry D. Kirkman, Acting Area Manager
U.S. Department of Energy
Los Alamos Area Office

(2)

Department of Energy
Albuquerque Operations Office
Los Alamos Area Office
Los Alamos, New Mexico 87544

JUN 8 1994

Ms. Barbara Hoditschek
RCRA Permits Program Manager
Hazardous and Radioactive Materials Bureau
New Mexico Environment Department
P. O. Box 26110
Santa Fe, New Mexico 87502

re: Response to Noted Deficiencies in the Amendment to the Closure Plan for Technical Area 35, TSL-85 Surface Impoundment

Dear Ms. Hoditschek:

Attached is the response to the Notice of Deficiency (NOD) dated May 5, 1994, for the Technical Area (TA) 35, TSL-85 surface impoundment. Items are referenced by item number, document section, page and paragraph if applicable, and consist of the New Mexico Environment Department (NMED) comment, the proposed resolution, and any necessary text changes. Where an extension is requested for an individual item, justification is provided along with an expected submittal date. Once approval is received for all items, a Revised Amendment to the Closure Plan will be submitted which incorporates the deficiency resolutions, as well as minor changes due to internal University of California (UC) and DOE comments.

It is requested that NMED approve the technical responses to the deficiency items included with this letter and grant an extension of the deadline for response to items 2, 3 and 4 so that UC and DOE may proceed with modifications to the amendment of the closure plan.

If you have any questions, please call me or have your staff call Court Fesmire at 665-4718.

Sincerely,

Tom Rusk for
Joseph Vozella, Chief
Environmental, Safety and Health
Branch

Received by ER-RPF
JUN 10 1994

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JUN 8 1994

cc w/attachment:
E. Swanton, NMED-AIP, MS M993
C. Fennie, LAAO, ES&H, MS A316
K. Schenck, Schenck/LAAO, ES&H, MS A316
LAAO/ER Program file [OU 1127] 1.4.2.8.1.17

cc w/o attachment:
L. Taylor, LAAO, ES&H, MS A316
K. Soendsen, AL-ERPO, MS A996
W. Sturgeson, EM-452, HQ
C. Beck, UC-LANL, EMP, MS J591
J. Jansen, EM/ER, MS M992
[redacted]

TA-35, TSL-85, RESPONSE TO NOTICE OF DEFICIENCY (NOD)

ITEM 1

Section and Comment

"Section 2.0, Response to *NMED's Reason for Closure Plan Disapproval*, page 2-2, paragraph 2. **`The action level calculated for selenium in the Closure Certification Report risk assessment (BEC, 1991) is summarized in Table 2-2 of this amendment.'**

a. Table 2-2 - In deriving action levels for a systemic toxicant in soil:

   i. The source of the reference dose (RfD) needs to be cited and dated for the time the reference was published;

   ii. An intake of 0.2 grams per day for a 16 kilogram child per 5 years of exposure must be used.

b. Why was other criteria used in Table 2-2? Use of the provided RfD (assuming that the RfD was the most current at the time the presentation was made and assuming that the RfD was from an acceptable source) versus a screening action level of 250 mg/kg, the calculated screening action level for selenium would have been lower."

Response

Item 1.a.i. The footnotes to the RfD, as well as the slope factors (SF), will be revised to indicate that source of the data was the U.S. Environmental Protection Agency (EPA)'s July 1991 edition of the Integrated Risk Information System (IRIS) database. The following are the revised footnotes:

"c "SF" refers to a carcinogenic slope factor. The data was obtained from the EPA's Integrated Risk Information System (IRIS) database (July 1991 edition). Units are (milligrams per kilogram-day)$^{-1}$.

d "RfD" refers to a reference dose for a systemic toxicant. The data was obtained from the EPA's IRIS database (July 1991 edition). Units are milligrams per kilogram-day."

Item 1.a.ii. Section 4.1 of the amendment to the closure plan details how health-based soil concentration action levels will be calculated for systemic toxicants. The governing equation is listed along with definitions of the parameters. The definitions indicate a child weight of 16 kilograms (kg) and an intake of 0.2 grams per day (g/day).

Item 1.b. The information regarding action level determination contained in Table 2-2 was taken from the "Closure Certification Report, TA-35 TSL-85 Surface Impoundment" (Benchmark Environmental Corporation, 1991). The intent of the table was to present the action levels for selenium and antimony. The intake value listed in Table 2-2 is 0.0002 kg/day which is equal to 0.2 g/day. Enclosure 5 of the Closure Certification Report, entitled "Explanation for Risk Calculation Tables," states that NMED recommended assuming 10 kg for a child's body weight.

Section 4.1 of the amendment to the closure plan stipulates that health-based soil concentration action levels will be calculated for the constituents listed in Tables 3-2 through 3-5. However, based on the NMED statement that using the provided RfD would result in a lower calculated screening level, the following calculations are provided using the data presented in Table 2-2.

$C = (RfD*W)/(I*A*CF)$

RfD = 0.005 mg/kg/day
W = 10 kg
I = 0.0002 kg/day
A = 1 (dimensionless)
CF = 1 (no conversion factor is necessary because the intake is in units of kg/day)

Therefore, $C = (0.005*10)/(0.0002*1*1) = 250$ mg/kg

ITEM 2
Section and Comment
"Section 2.0, Response to *Section and Comment*, page 2-2, paragraph 3.
'However, a comparison of beryllium concentrations detected at sample locations 85PL-1 through 85PL-12 (Table 2-1), with background levels for beryllium (Table 2-3) shows that the beryllium concentrations are all below background levels.'

In order to verify that beryllium concentrations are below background levels, the Table 2-3 reference to background study reports must be provided to NMED for review and approval. Submittal of these documents must be separated from the Closure Plan or an amendment to the Plan. Unless the method and procedure used to make the background determination are acceptable, NMED will not agree with the findings in the above comparison."

Response
It is requested that a deadline extension of 30 days, from the date of receipt of approval for this request, be granted for this item. This request is based on the need to resubmit, under separate cover, relevant documentation on background levels at the

Los Alamos National Laboratory (LANL) facility. In accordance with NMED's request, it is proposed that the report entitled "Sigma Mesa: Background Elemental Concentrations in Soil and Vegetation" (Ferenbaugh et al., 1979) be resubmitted to NMED as well as the draft study "Preliminary Background Elemental Concentrations in Bandelier Tuff and Selected Soil Series" (Longmire et al., November 1993), and additional supporting documentation, including site-specific information, to address the concerns expressed by NMED in Item 3.

ITEM 3
Section and Comment
"Section 2.0, Response to *NMED's Reason of Closure Plan Disapproval*, page 2-2 through 2-3, paragraph 4. `**Background levels for beryllium are documented in the report entitled *Sigma Mesa: Background Elemental Concentrations in Soil and Vegetation* (Ferenbaugh et al., 1979) (Appendix B) and the study *Preliminary Background Elemental Concentrations in Bandelier Tuff and Selected Soil Series* (Longmire et al., November 1993). The study by Longmire et al., (1993) will be completed in November 1993; Attachment 2-1 of this amendment provides a telephone log with summaries of the background concentration data determined by Longmire et al. for antimony, beryllium and selenium.**'

The documentation for Attachment 2-1 and Appendix B, referred to above, must be reviewed and approved by NMED, as a separate document submittal, prior to being acceptable for the support of establishing background values. If it is the desire of LANL to pursue the establishment of background values, provide all materials necessary for NMED to validate the documented hypothesis.

In addition to the report itself, the following information are examples of concerns which may be addressed in the background investigation:

a. Describe the geographical location of the Sigma Mesa relative to the TA-35, TSL-85 surface impoundment.
b. Report the detection limits for the metals that were analyzed, and indicate whether these limits were below the calculated screening action levels.

c. Provided a demonstration to show that sample sites were not previously contaminated. Stratigraphic cross-sections need to be provided to show that samples for background represent the same stratigraphic layer and soil type as the unit being investigated.

   RFI Guidance: Volume II of IV, *Soil, Groundwater, and Subsurface Gas Releases*, EPA 530/SW-89-031, May 1989, OSWER Directive 9502.00-6D, page 9-44 states: `Background soil samples should be taken from areas that

are not near a suspected source of contamination and from the same stratigraphic layer as the study area samples, if possible.'"

Response
As in the response to Item 2, it is requested that a 30-day deadline extension be granted to make a separate submittal of background information to NMED. Collectively, the documentation provided in the additional submittal will allow NMED to evaluate and determine the applicability of the various background values presented in the associated documentation. The submittal will also, at a minimum, address the three samples of concern posed by NMED in the comment portion of this item.

ITEM 4
Section and Comment
"Section 2.0, Response to *NMED's Reason of Closure Plan Disapproval*, page 2-3, paragraph 3. **`The presence of nonhazardous dielectric waste oil in the soils appears to have interfered with the SVOC analyses for the soils, resulting in samples with elevated LOQs.'**

Remediation of the dielectric oil is necessary for the following reasons:

- Inability to accurately determine the presence of semivolatiles as a result of the masking affect from the dielectric waste oil;
- The presence of waste oil in the soil indicates that a leak occurred under the surface impoundment; and
- Hazardous waste constituents were part of the overall waste stream generated at the surface impoundment."

Response
It is agreed that the presence of nonhazardous dielectric waste oil in the soils, in the area of the former surface impoundment (TSL-85), is interfering with the semivolatile organic compound (SVOC) analyses for those soils. It is requested that a 60-day deadline extension, from the date of receipt of approval of this request, be granted to address this item. This request is based on the need for an evaluation of remedial options as well as other applicable alternatives. At the end of the 60-day extension, a written plan will be submitted to NMED that presents all relevant and applicable information regarding the proposed resolution to this item. At a minimum, this plan will address NMED's three reasons for remediation that are listed in NMED's comment for this item.

ITEM 5
Section and Comment
"Section 2.0, Response to *NMED's Reason of Closure Plan Disapproval*, page 2-4, paragraph 4. '**For the proposed additional sampling presented in Section 3.0 of this amendment, LANL's Environmental Chemistry Group (EM-9) will conduct analyses for all Appendix VIII analytes that their in-house laboratories have the analytical capability to perform.**'

This statement seems to imply that not all Appendix VIII constituents can be analyzed through in-house capabilities, and that any constituents that cannot be analyzed through in-house capabilities may not be analyzed at all. Provide clarification for the above sentence that may include how outside laboratories may be called upon to conduct analysis that will not be conducted at LANL."

Response
Based on a review of relevant documentation for other Resource Conservation and Recovery Act (RCRA)-regulated sites at the LANL facility, as well as, research on the analytical capabilities of an analytical laboratory that performs contract work under EPA's Contract Laboratory Program (CLP), it is proposed that all additional samples associated with the TSL-85 surface impoundment be analyzed for the standard suite of analytes for volatile organic compounds (VOCs) by Method 8260, SVOCs by Method 8270, polychlorinated biphenyls (PCBs) by Method 8080, total metals by Method 6010, and toxicity characteristic leaching procedure (TCLP) metals by Method 1311 as specified in "Test Methods for Evaluating Solid Waste" (SW-846) (U.S. EPA, 1992). It is strongly believed that this approach will adequately reflect site conditions and will result in identifying all constituents present at the TSL-85 site that may be of concern. In addition, it is proposed that gel permeation chromatography (GPC), SW-846 Method 3640, be performed for all samples prior to analyses for individual analytes. GPC, a size exclusion procedure, will be used to separate hydrocarbon oils, if present, from SVOCs. All resulting tentatively identified compounds (TICs) and J-flags, if any, will be addressed in accordance with SW-846 protocol.

This proposal is based, in part, on the knowledge that accepted analytical techniques and methods are not available for a large number of Appendix VIII constituents. Attachment 1 includes a record of telephone conversation with Joan Fisk of EPA, as well as, a copy of a letter from Craig Leasure of LANL's Environmental Chemistry Group (CST-9) to Robert Vocke of LANL's Environmental Restoration and Waste Management (ERWM) Program dated June 4, 1993 regarding this issue.

In addition, this proposal is based on the fact that this proposed approach is consistent with the approaches accepted by NMED or EPA, Region VI for other RCRA units at the LANL facility. Most recently, approval of clean closure demonstration was granted by NMED for the TSL-125 surface impoundment at TA-35 (refer to Attachment 2). Samples associated with this clean closure demonstration were analyzed for VOCs by Method 8240, SVOCs by Method 8250 or Method 8270, PCBs by modified Method

8080, total metals by Method 6010, and metals by the extraction procedure (EP) toxicity test (Method 1310) using SW-846 standard analytical methods and protocol. LANL's operable unit (OU) 1148 workplan was approved by EPA, Region VI in December 1993. This workplan specified use of the EPA's CLP target analyte lists for VOCs and SVOCs as well as analyzing for metals, pesticides, and PCBs according to SW-846 protocol. Copies of the approval letter and the relevant text in the response to EPA's NOD are included as Attachment 3.

If this proposal is approved, Tables 3-2 through 3-5 of the Amendment to the Closure Plan for TSL-85 will be revised to reflect the standard suite of analytes, as represented in SW-846, for each category of analyses (e.g., VOCs, SVOCs) and will be included in the revised Amendment to the Closure Plan for TSL-85 to be submitted to NMED.

ITEM 6
Section and Comment
"Section 2.0, Response to *NMED's Reason of Closure Plan Disapproval*, page 2-7, paragraph 2. `**Acetone and 4-isopropyltoluene are not listed in Appendix VIII; therefore, they were not included in the Closure Certification Report risk assessment (BEC, 1991).**'

The New Mexico Hazardous Waste Regulations dealing with closure activity (HWMR-7, Part V, §264.111) states that the owner or operator must close a facility in a manner that minimizes the need for further maintenance and controls, minimizes or eliminates to the extent necessary, to protect human health and the environment, post-closure escape of hazardous waste, hazardous waste constituents, leachate, contaminated run-off, or hazardous waste decomposition products to the ground or surface waters or to the atmosphere.

Therefore, acetone and 4-isopropyltoluene must be included in the Closure Certification Report risk assessment."

Response
It is agreed that acetone and 4-isopropyltoluene should be included in the risk assessment. Therefore, these constituents will be added to Table 3-2 for VOC analysis and inclusion in the risk assessment.

ITEM 7
Section and Comment
"Section 2.0, Response to *NMED's Reason of Closure Plan Disapproval*, page 2-8, paragraph 1. `**Pure 1,1,1-trichloroethane was the primary degreasing solvent used in Building 85 and 118... Current analytical methods are unable to measure concentrations of hazardous constituents down to a concentration of 0.**'

The phrase `primary degreasing solvents' implies that other solvents were used. Provide a complete list of those solvents used for degreasing operations in Building 85 and 118 prior to the closure of the TA-35, TSL-85 surface impoundment.

Measuring the concentrations of constituents is typically done to the estimated quantitation limit. J-flag or TIC reporting is also necessary and must be included in any acceptable baseline risk assessment."

Response
Based on the research conducted regarding knowledge of process, 1,1,1-trichloroethane, acetone, freon, and methanol were the only known solvents used in Buildings 85 and 118. Therefore, it is proposed to revise the subject sentence as follows:

> "The only known degreasing solvents used in Buildings 85 and 118 were 1,1,1-trichloroethane, acetone, freon, and methanol."

EPA guidance entitled "Guidance for Data Useability in Risk Assessment" (EPA/540/G-90/008, October 1990) allows for the use of J-flag data and TIC's in risk assessment. Therefore, J-flag and TIC data will be utilized in accordance with EPA guidance.

ITEM 8
Section and Comment
"Section 2.0, Response to *NMED's Reason of Closure Plan Disapproval*, page 2-9, paragraph 2. **`PCBs were detected in Phase I, III and IV at concentrations listed in Enclosure 4 of the Closure Certification Report (BEC, 1991) that exceeded calculated action levels. However, all detected concentrations of PCBs were below the NMED clean closure required cleanup level of 10 mg/kg (ppm) as specified in the Closure Certification Report risk assessment. Therefore, PCB concentrations are not considered a concern at the site and unless determined otherwise do not require any remedial action.'**

Due to the fact that there is an occurrence of multiple hazardous waste constituents present in the soil at the closure, PCB values must be included in the calculation during risk assessment for aggregate risk or for the hazard index."

Response
The maximum concentration of PCBs detected in the soils was 1.1 parts per million (ppm). This is well below the NMED clean closure required cleanup level of 10 mg/kg (ppm). Therefore, PCBs have been discounted from further consideration and should not be considered in the risk assessment. Furthermore, the slope factor for PCBs is such that a concentration of 0.08 ppm results in a risk of $1X10^{-6}$. Therefore, a

concentration of 1.1 ppm would indicate a risk much greater than $1X10^{-6}$ (in the range of $1X10^{-4}$ to $1X10^{-5}$). If this risk is included in the aggregate risk calculation, the aggregate risk will appear much greater. This would, in essence, force the cleanup level for PCBs down to a level of 0.08 ppm. At the TA-35 TSL-125 surface impoundment, a sister unit to the TA-35 TSL-85 surface impoundment, clean closure has been granted by NMED. PCBs were detected in five samples at TA-35 TSL-125, ranging from 0.11 to 0.58 ppm. NMED agreed that cleanup of PCBs was not needed as long as the concentrations were below the TSCA cleanup level of 10 ppm. Based on the above, it is not appropriate to include PCBs in the risk assessment unless resampling detects PCBs equal to or greater than the 10 ppm cleanup level.

ITEM 9
Section and Comment
"Section 2.0, Response to *NMED's Reason of Closure Plan Disapproval*, page 2-9, paragraph 4. `**A summary of the most current IRIS values used for the proposed risk evaluation will be included with the submittal of the Revised Closure Plan Certification Report as part of the risk evaluation.**'

In the case that toxicological data is not found in IRIS, LANL must look for HEAST data or other available, EPA approved sources. Sources must be referenced in the report along with a date for the reference."

Response
It is agreed that if toxicological data are not found in the current IRIS database, current Health Effects Assessment Summary Tables (HEAST) data or data from other EPA approved sources will be used. Therefore, it is proposed that the subject text be revised as follows:

> "A summary of the most current IRIS, Health Effects Assessment Summary Tables (HEAST), or other EPA approved toxicity values used for the proposed risk evaluation will be included with the submittal of the Revised Closure Certification Report as part of the risk evaluation."

It is also proposed that the same type of change be made to the first sentence of Section 4.1, Calculation of Action Levels. The sentence will be revised as follows:

> "Screening action levels will be calculated for the constituents listed in Tables 3-2 through 3-5 only if toxicological data (i.e., slope factors or reference dose) are available in the most current IRIS database, the most current HEAST, or other EPA approved sources."

ITEM 10
Section and Comment
"Section 3.0, Proposed Sampling and Analysis Plan, page 3-1, paragraph 3. `**All analyses, QA and QC will follow guidance specified in "Test Methods for Evaluating Solid Waste" (SW-846) (U.S. EPA, 1992). If hazardous constituents are detected in any of the samples, a risk evaluation will be performed as outlined in Section 4.0 of this amendment.**'

Quality assurance results must be supplied with all analytical results. The analytical report must include any J-flag data and TICs, which in turn must be used in risk assessment or when multiple constituents have been detected."

Response
Quality assurance results, as well as J-flag data and TICs, will be supplied with all analytical results. J-flag data and TICs will be utilized in the risk assessment in accordance with EPA guidance.

ITEM 11
Section and Comment
"Section 3.0, Proposed Sampling and Analysis Plan, page 3-1, paragraph 3. `**The analyses performed for Phase I soil samples generated analytical data for VOCs and SVOCs that are suspected due to surrogate recovery results outside EPA limits and missed EPA-allowable holding times. In addition, the SVOC data were compromised due to the interference from dielectric waste oil resulting in elevated LOQs. Therefore, Phase VI soil samples will be collected in the area of the former surface impoundment at locations representative of the locations sampled during Phase I.**'

The comment for item 4 provides reasons for the need to remediate the dielectric waste oil. One of the given reasons was the interference from the dielectric oil, effecting the LOQ.

No response is needed for this comment. Attention is being focused on this part of the reviewed document for the same concern that is brought out in item 4 of this paper."

Response
No response is necessary for this comment.

ITEM 12
Section and Comment
"Section 3.0, Proposed Sampling and Analysis Plan, page 3-2, paragraph 3.
`**Twelve soil samples will be collected, following the procedures**

described in Section 3.4.1.2, at a depth of 3.5 to 4.5 feet at approximately the same sampling locations as the Phase III samples.'

a. Indicate sampling locations for all Phase III samples collected on a site map.

b. A minimum of five samples must be collected below the fill soil of where the underground storage tank had been positioned.

c. Provide the basis for deciding upon twelve soil samples to characterize the horizontal and vertical extent of contamination.

Be advised that composite sampling is not acceptable for characterizing VOCs in contaminated soils."

Response
Item 12.a. Figure 2-2 is a site map presenting the Phase III sample locations. Figure 3-2 is a site map presenting the proposed Phase VI sample locations.

Item 12.b. It is agreed that five samples will be collected below the fill soil of where the underground storage tank (UST) had been positioned. Figure 3-2 will be revised to indicate that the five samples will be taken from the center and corners of the tank excavation. The following text will be inserted into the subject paragraph after the sentence ending "...surface impoundment (Figure 3-2).":

"Five additional samples will be collected from below the fill soil of where the UST had been positioned. Sampling personnel will collect these samples from the approximate center and four corners of the tank excavation".

Item 12.c. The twelve sample locations are based on the locations of the joints in the pipe from the abandoned UST to the surface impoundment. These are the most likely locations for contamination due to leaks in the pipe. The Phase III sample locations are being resampled due to missed EPA allowable holding times on the SVOCs and mercury (Hg) analyses and surrogate results outside EPA limits for the majority of the VOCs. Therefore, the samples are not intended to characterize the horizontal and vertical extent of contamination. They were selected to indicate if there has been a release to the soil.

ITEM 13
Section and Comment
"Section 3.0, Proposed Sampling and Analysis Plan, page 3-3, paragraph 4. `**Take small, equal portions of sample from the surface or near the surface of the material to be sampled. Composite the samples in a glass container.'**

It is not acceptable to composite samples being analyzed for VOCs as noted in item 14 above. Make the appropriate changes in the text of the Sampling and Analysis Plan."

Response
It is agreed that it is not acceptable to composite samples being analyzed for VOCs. It was never the intent to composite samples, only to describe the progress by which the sample jar would be filled. Therefore, it is proposed to revise the text and combine the two subject bullets as follows:

"• Take small, equal portions of the material to be sampled from the surface or near surface to fill the sample jar."

ITEM 14
Section and Comment
"Section 3.0, Proposed Sampling and Analysis Plan, page 3-5, paragraph 4. `**The analytical methods expected to be employed for analysis of samples collected during closure activities are denoted in Table 3-6.**'

a. Include the following hazardous waste constituents to the appropriate analytical methods list in Table 3-6: Cobalt, copper, acetone, isopropyltoluene, and PCBs.

b. The Table must also include columns that indicate the method detection limits, the estimated quantitation limits, and the screening action levels for each constituent being analyzed.

c. Since not all Appendix VIII constituents can be analyzed at LANL, provide a comparative list of analytical methods and associated constituents from a U.S. EPA Contract Laboratory Procedure (CLP) approved laboratory. The CLP laboratory selected must be capable of using unmodified methods for the Appendix VIII list of hazardous constituents."

Response
Item 14.a. Based on a telephone conversation with Ms. Lee Winn at NMED on May 25, 1994 (Attachment 4), cobalt does not need to be included. Based on the same conversation, copper cyanide was to be included (already in Appendix VIII) as opposed to copper. However, there is no current analytical method to analyze for copper cyanide (refer to Item 5 for a discussion of difficulties associated with analyzing for all Appendix VIII constituents). Furthermore, copper cyanide is used for electroplating copper on iron. Based on the knowledge of process, this activity never took place in TA-35 Buildings 85 or 118. Therefore, it is proposed that copper cyanide not be included in further analysis. Acetone, 4-isopropyltoluene will be added to Table 3-2, Method 8260 (VOC analysis), and PCBs (in the form of individual and mixed

aroclors) will be added to Table 3-4, Method 8080 (pesticide analysis). These constituents will not be added to Table 3-6 as they are not Appendix VIII constituents.

Item 14.b. The purpose of Table 3-6 was to present a comparison of the Appendix VIII constituents to the CST-9 analytical capabilities. It is not possible to analyze for all of the constituents listed in Appendix VIII (see Item 5). It is also very unlikely that all of the constituents analyzed for will be detected. Common industry practice is to calculate screening action levels (SALs) for only those constituents expected to be present or actually detected. Calculating SALs for all constituents in Appendix VIII would be premature, time consuming, and expensive. It is therefore proposed that revision of this table to include SALs for suspected and detected constituents be postponed until the Phase VI analytical results are available. The analytical results will include the limit of quantification (LOQ or method detection limit) for each of the constituents detected which will then be added to the table. The estimated quantitation limits (EQLs) from SW-846 will also be added to the revised table at that time.

Item 14.c. See Item 5 for the resolution to this item.

ITEM 15
Section and Comment
"Section 4.0, Proposed Risk Evaluation, page 4-1, paragraph 3.

The provided equation fails to include the absorption factor equal to one. Make the appropriate changes in the text of the Proposed Risk Evaluation."

Response
It is agreed that the governing equation for calculation of health-based action levels, as presented, does not include the absorption factor. Therefore, it is proposed to revise the equation and add a definition for the absorption factor as follows:

$$C=(RfD*W)/(I*A*CF)$$

where:

A = absorption factor (dimensionless and assumed equal to 1).

ITEM 16
Section and Comment
"Section 4.0, Proposed Risk Evaluation, page 4-2, paragraph 2. '**Aggregate hazard and risk indices are normally calculated for a site by summing these individual hazard quotients and risks, respectively, over the major constituents that are observed at a given site.**'

Explain what is meant by the term `major constituents' as used in the above statement."

Response
The term "major constituents" was meant to refer to suspected or detected constituents which were identified as contaminants of concern. The text will be modified to indicate that the risk assessment will include constituents detected in the sample analysis, including J-flags and tentatively identified components (TICs), and those constituents suspected of being present. PCBs will not be included in the risk assessment unless resampling detects PCBs at equal to or greater than the 10 ppm cleanup level (see response to Item 8, above).

ITEM 17
Section and Comment
"Section 4.0, Proposed Risk Evaluation, page 4-3, number 1. `**If a constituent is detected above the LOQ in all samples, the 95 percent upper confidence limit of the arithmetic average will be used (per RAGS).**'

Explain what is meant by the phrase `all samples' from the above statement. In order to be appropriate, a risk assessment must be performed when any constituent is detected either by J-flag, TIC or quantity."

Response
The subject sentence is part of a discussion relating to how and when calculation of hazard and/or risk for a given constituent will be performed. Three situations are given which would result in this calculation for a given constituent. The first situation involves the detection of the constituent above the LOQ in all of the samples collected. The second situation involves detection of the constituent above the LOQ in only some of the samples, and the third situation involves additional considerations for the remaining constituents if any sample-specific LOQs exceed the calculated health-based action level. It is proposed that the last sentence in the paragraph above the subject sentence be revised as follows:

> "Three situations which will result in calculation of hazard and/or risk for a given constituent are possible:"

ITEM 18
Section and Comment
"Section 4.0, Proposed Risk Evaluation, page 4-5, paragraph 1. `**If the aggregate hazard index is greater than or equal to 1, or the aggregate risk exceeds 1X10E-6, risk assessment using a site-specific, realistic exposure assessment will be performed.**'

Los Alamos

Los Alamos National Laboratory
Los Alamos, New Mexico 87545

DATE: July 8, 1994
IN REPLY REFER TO: EM/ER:94-J266
MAIL STOP: M992
TELEPHONE: (505) 667-0819

Ms. Barbara Hoditschek, Program Manager
Hazardous Waste Bureau
State of New Mexico Environment Department
525 Camino de los Marquez
Santa Fe, NM 87502

SUBJECT: REQUESTED DOCUMENT REPORTS

Dear Ms. Hoditschek:

Enclosed please find the two reports requested in your June 24, 1994, letter. This information is being supplied to your office as part of the Los Alamos National Laboratory's (LANL's) response to a notice of deficiency (NOD) received on the Closure Plan for surface impoundment TA-35 TSL 85. Additional supporting documentation will be presented to your department by Mr. Patrick Longmire of LANL'S Environmental Restoration Program. It is my understanding that Mr. Longmire is coordinating this effort with you.

If you have any questions, please feel free to call me at 667-0819. Thank you.

Sincerely,

David J. McInroy
Technical Staff Member
Environmental Restoration Program

DM/tm

Enclosures a/s

Cy: J. Jansen, EM/ER, MS M992
T. Tatkin, NMED
RPF, M707

The above statement being the case, LANL must consider all exposure pathways."

Response
It is agreed that all exposure pathways must be considered. It is proposed to revise the subject sentence as follows:

> "If the aggregate hazard index is greater than or equal to 1, or the aggregate risk exceeds $1X10^{-6}$, risk assessment using a site-specific, realistic exposure assessment will be performed including a qualitative consideration of all exposure pathways, and a quantitative evaluation of those pathways deemed appropriate".

ATTACHMENT 1

INTERNATIONAL TECHNOLOGY CORPORATION

RECORD OF

☑ TELECON
☐ MEETING

Project Name	Number	Phase	Task	Subtask
TA-35TSL-85	301625	03		

Date 5-19-94 | Time 8:35 am

CALL FROM ☑ CALL TO ☐ NAME: Wendi Knutsen

CALL FROM ☐ CALL TO ☑ NAME: Joan Fisk

Telephone Number: 667-0118

Company Name: EPA

Address:

City

State | Zip Code

Other Participants — Name/Location/Representing:

Topic EPA's Standing on Analysis of all App. VIII Constituents

Summary (Decisions & Specific Actions Required by Named Persons):

8:35am — talked w/ Joan:

- she said it is not possible to analyze for all of App. VIII and that was not its intent; it was created as a list of toxic substances.

- App. IX was created to address GW concerns and is a list of toxic substances that could reasonably be analyzed for in GW samples.

- Joan referred to a letter that she wrote regarding this issue for Craig Leasure of CSTL-9 on 6-4-93 to Robert Vocke of ERWM. Joan, while drafting this letter, had talked with Barbara Driscoll (EPA Regional regulator) and Barbara had thought that the approach proposed in the letter was the best response to this issue.

Required Actions

- Joan will fax me a copy of the letter today for our review and reference.

Prepared by (Signature): Wendi D. Knutsen

Distribution:
Original to Project File
Copy to Project Manager
Copy to Preparer

☑ Other Distribution (By Preparer)
Jeff Tucker

Los Alamos

Los Alamos National Laboratory
Los Alamos New Mexico 87545

memorandum

TO: Robert Vocke, EM-13, MS M992 DATE: June 4, 1993

FROM: Craig S. Leasure, EM-9 Group Leader CSL MAIL STOP/TELEPHONE: K484/7-3269

SYMBOL: EM-9:93-858

SUBJECT: RESPONSE ON REQUEST FOR APPENDIX VIII ANALYSIS

We have reviewed the list of deficiencies associated with the OU 1148 workplan. On page 6, response 16. a and b., the list of deficiencies indicates that samples for the 14 high priority pits be analyzed for the Appendix VIII constituents. Because methods are not available for a large number of these Appendix VIII analytes, we are proposing to focus on the Appendix IX list developed by EPA to provide a list of analytes for which methods and standards are available. Appendix IX started with Appendix VIII as the parent list and was reduced to approximately 224 organic compounds, 17 inorganic metals, and 2 miscellaneous tests for which methods and standards were available or which were similar in chemical structure and existing methods were expected to be applicable. Some additional analytes not on Appendix VIII were added to the Appendix IX list because the original intent of Appendix IX was associated with groundwater.

Since there are still difficulties associated with analyses for some of the Appendix IX analytes, and lack of availability of some standards, we propose to use the EPA Superfund's Contract Laboratory Program target analyte lists for organics and inorganics as our required list of target analytes (volatiles and semivolatiles lists attached).

For inorganics, the CLP list contains all Appendix IX analytes except tin. If Region VI needs information on tin, we can supply analyses for tin in addition to the CLP suite of metals, plus cyanide.

For organics, in addition to the CLP target compound list of approximately 140 compounds, we propose to follow CLP procedures for searching the NIST/EPA/MSDC Mass Spectral Library of approximately 53,000 organic compounds. Any additional organic compounds identified this way will be indicated as a Tentatively Identified Compound (TIC). Of the 87 compounds not included in our standard volatiles and semivolatiles analyses, almost all are either chlorinated pesticides, PCBs, herbicides, or polychlorinated dibenzo dioxins and furans. We will use the services of a highly skilled mass spectrometrist to interpret the data from the mass spectral search and determine if there is any indication of the presence of any organic constituents from the Appendix IX list. If this occurs, we will confirm the presence and concentration of any of these possible Appendix IX compounds for which standards are available.

In addition, if any Appendix IX compounds are discovered that are not on the CLP list, we will add them as target compounds for the future, if standards are available.

Please contact us if you need additional information.

Attachment: a/s

Cy:

Don Neeper, MEE-13, MS J576
Larry Maassen, EM-13, MS M992
Joan Fisk, EM-9, MS K484
Chris Leibman, EM-9, MS K484
EM-9 Files

ATTACHMENT 2

State of New Mexico

ENVIRONMENT DEPARTMENT

Post-it™ brand fax transmittal memo 7671	# of pages ▸ 2
To D McInroy	From S. Stoddard
Co.	Co.
Dept.	Phone #
Fax # 665-4747	Fax #

BRUCE KING
GOVERNOR

JUDITH M. ESPINOSA
SECRETARY

RON CURRY
DEPUTY SECRETARY

662-1222

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

September 27, 1993

Mr. Jerry L. Bellows, Area Manager
Department of Energy
Los Alamos Area Office
528 35th Street
Los Alamos, New Mexico 87544-5000

Dear Mr. Bellows:

On July 7, 1992, the New Mexico Environment Department (NMED) denied Los Alamos National Laboratory's (LANL) clean closure equivalency demonstration for the TA-35 TSL 125 Surface Impoundment on the basis that LANL had failed to establish that releases from the unit impacting surrounding soils or surface water (Ten Site Canyon) were below NMED-Approved Health Based Action Levels. On September 29, 1992, NMED approved LANL's closure plan for this unit when the closure plan was amended to include a sampling and analysis plan to characterize releases from the impoundment into Ten Site Canyon. At that time, NMED stated that LANL had satisfactorily completed partial closure of the surface impoundment and instructed LANL to complete final closure activities by implementing the approved sampling and anlaysis plan, removing any soil contaminated with hazardous constituents, and confirming that clean closure had been accomplished. The supplemental sampling and closure effort resulted in two documents: Closure Certification Report, Amended April 22, 1992 and Response to Concerns Regarding Closure of the TA-35 TSL-125 Surface Impoundment, September 17, 1993.

After review of the closure work LANL documented in the approved closure plan and in the reports mentioned above, HRMB finds that the sampling and analysis results indicate that no hazardous constituents remain at the site above NMED-Approved Health Based Action Levels. NMED agrees that the investigations were conducted in accordance with the approved closure plan and has determined that LANL has met the requirements for closure by removal for this haardous waste management unit.

However, sampling and analysis results conducted per the approved closure plan show total petroleum hydrocarbons (TPH) contamination ranging from 7.8 ppm to 30888 ppm downgradient from the unit in Ten Site Canyon. TPH is not regulated under the Resource Conservation and Recovery Act. These sample locations are in a watercourse and may be regulated under the Water Quality Control Commission Regulations. The Hazardous and Radioactive Materials Bureau is hereby referring this matter to NMED's Surface Water Quality Bureau for further investigation.

If there are any questions regarding this matter, please contact Ms. Stephanie Stoddard of my staff at 827-4308.

Sincerely,

Kathleen M. Sisneros

Kathleen M. Sisneros
Director, Water and Waste Management Division
New Mexico Environment Department

xc: Mr. Jim Piatt, NMED/SWQB

ATTACHMENT 3

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

DEC 14 1993

Mr. Joseph C. Vozella, Chief
Environment, Safety and Health Branch
Department of Energy
Los Alamos Area Office
Los Alamos, New Mexico 87544

Re: RFI Work Plan for OU 1148, Approval
Los Alamos National Laboratory
NM0890010515

Dear Mr. Vozella:

The Environmental Protection Agency (EPA) hereby approves your Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Work Plan for Operable Unit (OU) 1148 with the enclosed modification. The approved work plan consists of the RFI work plan dated May 23, 1993, the Revised Notice of Deficiency (NOD) Response dated November 23, 1993, and the enclosed modification. You shall immediately initiate the implementation of this approved RFI work plan.

If you have any questions, please contact Barbara Driscoll of my staff at (214) 655-7441.

Sincerely yours,

Allyn M. Davis

Allyn M. Davis, Director
Hazardous Waste Management Division (6H)

Enclosure

cc: Kathleen Sisneros, NMED
Robert Vocke, EM-13, LANL

Printed on Recycled Paper

MODIFICATION

EPA interprets that a release from any unit, whether inside or outside a fenced area, constitutes migration "beyond institutional control" and such a release should be characterized. LANL cannot consider the security fence as the boundary for any unit.

15. *5.4.4.2.4 Rationale for Sampling Activity, p. 5-231 - Are there any additional surface water runoff channels on the north side of Area G which could also be sampled?*

Response: A recently completed study of the north facing slope of Canada del Buey identified a total of 5 surface water runoff channels on the north side of MDA G. The work plan is revised to include samples from these channels (see attached text and figure from the revised work plan).

16. ***EPA comments on 4/23/93***
5.4.4.3.5.1 Boreholes at MDA G, p. 5-142 - Five sample boreholes in an area this large is insufficient to determine if a release has occurred. Additional borings are necessary.

a. *At a minimum the 14 high priority pits should have a boring on each side. Samples should be collected on five-foot intervals down to a depth of ten feet below the bottom of the cells. Below that depth they may be collected on ten-foot intervals. Samples should be analyzed for Appendix VIII constituents. (See response following EPA comments on 9/2/93).*

b. *Additional boreholes shall be located in the shaft fields. Two additional boreholes should be located on the west side of the shaft field containing shafts 1-135. Two boreholes should also be placed next to shafts C1-C13. Samples should be collected on ten-foot intervals down to a depth of ten feet below the bottom of the shafts. Below that depth samples may be collected on twenty-foot intervals. Samples should be analyzed for Appendix VIII constituents. (See response following EPA comments on 9/2/93).*

c. *A better map(s) should be provided showing the numbers for each disposal shaft.*

Response: The work plan is revised to include a map that shows the location and identification number for each disposal shaft at MDA G (see attached maps from the revised work plan).

EPA comments on 9/2/93

MDA G: The additional boreholes which are added should be drilled to approximately 20 feet below the depth of the adjacent pits, shafts or trenches. LANL should determine if releases are occurring from these units and based on this information later determine the extent of any release by drilling deeper holes. This applies to the proposed perimeter boreholes and interior boreholes. Additional boreholes should be added as follows:

a borehole between pits 2 and 4
a borehole between pits 4 and 5
a borehole south of 5 and located near the north end of pit 1
a perimeter borehole located close to pit 27's southern end
a borehole east of pit 37

5.4.4.2.7 **Phase II SAP**

Phase II sampling of surface sediment will be conducted at MDA G to determine the vertical and lateral extent of any COCs detected during the Phase I sampling that exceeded health risk-based criteria. Samples will be collected from 6 to 12 inches below the 27 locations that had the highest concentrations of COCs during Phase I sampling. The Phase II sampling will provide data for health risk assessments. Table 5.4-23 summarizes the number of samples and the analytical requirements for the Phase II sampling activities. The Phase II plan outline in this table may be modified, as appropriate, after results of Phase I sampling are reviewed.

5.4.4.2.8 **Health and Safety**

This SAP will follow the procedures outlined in the Laboratory's Environment, Safety and Health Manual (LANL 1990, 0335) and Annex III of this RFI Work Plan.

5.4.4.2.9 **Schedule**

See Annex I.

5.4.4.3 **Vertical Borehole Sampling at MDA G**

5.4.4.3.1 **Sampling and Analysis Components**

The purpose of collecting and analyzing samples from twenty eight vertical boreholes at MDA G is to provide technically accurate and legally defensible data which can be used to characterize the nature of any contaminant releases at MDA G. The sampling component of the Phase I characterization consists of drilling vertical boreholes to collect continuous rock core samples for chemical and radiological analyses. The analytical component consists of field and laboratory analysis of rock core samples. Rock core samples will be screened in the field for VOCs, tritium, gross alpha, gross beta, and gross gamma ionizing radiation. Analysis at a LANL-contracted analytical laboratory will be conducted on core samples for VOCs, SVOCs, metals, pesticides, PCBs, cyanide, and ROCs (see Table 5.4-24). The data will be validated according to EPA functional guidelines for organic analysis (EPA 1988, 0293) and inorganic analysis (EPA 1988, 0296). Currently, there are no published EPA methods for validating all radionuclide analyses.

TABLE 5.4-24
SAMPLING SUMMARY FOR VERTICAL BOREHOLES AT MDA G[a]

Analytical Level	Sampling[a] Interval	Analysis	Medium
Laboratory Analysis[b]			
Level [illegible]	10ft	VOCs	Rock Core
Level [illegible]	10ft	SVOCs	Rock Core
Level [illegible]	10ft	Metals	Rock Core
Level [illegible]	10ft	Pesticides, PCBs, Cyanide	Rock Core
Level [illegible]	10ft	ROCs	Rock Core
Field Instrument Screening[c]			
Level [illegible]	all core	Organic Vapors (PID/FID)	Rock Core
Level [illegible]	all core	Alpha, Beta, & Gamma Emissions	Rock core
Field Laboratory Analysis			
Level [illegible]	5 ft	Alpha, Beta, & Gamma Emissions	Rock Core
Level [illegible]	5 ft	Tritium	Rock Core
Level [illegible]	5 ft	Gravimetric moisture	Rock Core

[a] The total depth for each borehole is as follows:

Borehole #	Depth (feet)	Borehole #	Depth (feet)	Borehole #	Depth (feet)
1	80	11	90	21	60
2	80	12	60	22	60
3	70	13	60	23	60
4	70	14	60	24	60
5	70	15	60	25	60
6	60	16	90	26	60
7	90	17	90	27	60
8	90	18	90	28	60
9	90	19	90		
10	90	20	60		

[b] A sample will be collected a minim7um spacing of 10 ft for analysis for confirm the absence or presence of COCs above the health risk-based criteria. The actual depth of the sample will be determined from field screening and observation.

[c] Hand held field instruments are described in Section 5.4.4.3.3.2.

5.4.4.3.2 **Sampling Analysis Approach**

A phased drilling approach will be used to characterize subsurface contamination at MDA G. Continuous rock core will be collected from the proposed Phase I boreholes. Rock core samples will be shipped to a Laboratory-contracted environmental laboratory for analysis. All analyses for hazardous constituents will be performed according to EPA SW-846 (third edition) protocol. Analyses with Tentatively Identified Compounds (TICs) will be reported in Level III SW-846 packages for subsequent data validation. Analysis for radionuclides will be reported in data packages formatted to LANL requirements for the off-site laboratory statement of work.

5.4.4.3.3 **Primary Data Quality Factors**

- Site characterization- There is a data base for VOCs from four existing wells at MDA G. However, the data do no include all of the regulated volatile organic compounds. Existing data have not been validated in accordance with the EPA functional guidelines. The data base does not include data for SVOCs, metals, pesticides, PCBs, cyanide, or ROCs. Data will be collected to fill existing data gaps and to support the validity and use of the existing data base.

- Risk Assessment - the source term is not fully understood because the exact chemical constituents and quantities that were disposed of in MDA G are unknown. The locations of potential sources of contamination, the rate of organic vapor generation, and the flux emanating from the site are also unknown. Data will be collected to help determine the nature and extent of any residual rock contamination at MDA G, and the potential contribution to environmental transport and exposure pathways.

5.4.4.3.3.2 **Appropriate Analytical Levels**

Samples collected will be screened in the field and analyzed in a laboratory using SW-846 (third edition) protocol. A PID will be used in the field to screen for organic vapors immediately after samples have been collected.

Radiological screening of samples will be conducted for tritium, gross beta and gamma radioactivity, and gross alpha contamination. Screening for gross beta and gamma radioactivity will be conducted with a hand-held sodium iodide detector (NaID) probe and rate meter, or equivalent system. Screening for gross alpha contamination will be conducted with a hand-held alpha scintillation detector (ASD) and rate meter, or equivalent system. A windowless gas flow proportional (GFP) counter and a liquid scintillation counter in a mobile laboratory will be used to detect for the presence of radionuclides, in addition to screening with the hand-held detectors. The analytical levels include:

Level I	Field Screen: PID Instrument; NaID/ASD Instruments,
Level II	Field Analysis: Windowless GFP Counter; Liquid Scintillation Counter,
Level III	SW-846 Laboratory Methods, and
Level V	Radiological Analysis Laboratory Methods.

5.4.4.3.3.3 Primary Contaminants of Concern

The primary contaminants of concern at MDA G are VOCs, SVOCs, metals, pesticides, PCBs, cyanide, and ROCs (see Table 5.4-18 for a list of the ROCs). Core samples will be analyzed for analytes on the EPA Superfund's Contract Laboratory Program (CLP) target lists for organics and inorganics. The required inorganic analytes and contract required detection limits are as follows:

INORGANIC TARGET ANALYTE LIST (TAL)

Analyte	Contract Required Detection Limit [1,2] (ug/L)
Aluminum	200
Antimony	60
Arsenic	10
Barium	200
Beryllium	5
Cadmium	5
Calcium	5000
Chromium	10
Cobalt	50
Copper	25
Iron	100
Lead	3
Magnesium	5000
Manganese	15
Mercury	0.2
Nickel	40
Potassium	5000
Selenium	5
Silver	10
Sodium	5000
Thallium	10
Vanadium	50
Zinc	20
Cyanide	10

(1) Subject to the restrictions specified in the first page of Part G, Section IV of Exhibit D (Alternate Methods - Catastrophic Failure) any analytical method specified in SOW Exhibit D may be utilized as long as the documented instrument or method detection limits meet the Contract Required Detection Limit (CRDL) requirements. Higher detection limits may only be used in the following circumstance:

If the sample concentration exceeds five times the detection limit of the instrument or method in use, the value may be reported even though the instrument or method detection limit may not equal the Contract Required Detection Limit. This is illustrated in the example below:

For lead:

Method in use - ICP
Instrument Detection Limit (IDL) - 40
Sample concentration = 220
Contract Required Detection Limit (CRDL) = 3

The value of 220 may be reported even though the instrument detection limit is greater than CRDL. The instrument or method detection limit must be documented as described in Exhibits B and E.

(2) The CRDLs are the instrument detection limits obtained in pure water that must be met using the procedure in Exhibit E. The detection limits for samples may be considerably higher depending on the sample matrix.

For organics, in addition to the CLP target compound list, CLP procedures will be followed for searching the NIST/EPA/MSDC mass spectral library of approximately 53,000 organic compounds ("Tentatively Identified Compounds") to provide information about additional organic analytes that may be present. A highly skilled mass spectrometrist will interpret the data from the mass spectral search and determine if there is any indication of the presence of organic constituents from the Appendix IX list. The presence and concentration of any of these possible Appendix IX compounds will be confirmed if standards are available.

The required organic analytes and contract required quantitation limits are as follows:

TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL)

		Quantitation Limits*			
Volatiles	CAS Number	Water ug/L	Low Soil ug/kg	Med. Soil ug/kg	on Column (ng)
1. Chloromethane	74-87-3	10	10	1200	(50)
2. Bromomethane	74-83-9	10	10	1200	(50)
3. Vinyl Chloride	75-01-4	10	10	1200	(50)
4. Chloroethane	75-00-3	10	10	1200	(50)
5. Methylene Chloride	75-09-2	10	10	1200	(50)
6. Acetone	67-64-1	10	10	1200	(50)
7. Carbon Disulfide	75-15-0	10	10	1200	(50)
8. 1,1-Dichloroethene	75-35-4	10	10	1200	(50)
9. 1,1-Dichloroethane	75-34-3	10	10	1200	(50)
10. 1,2-Dichloroethene (total)	540-59-0	10	10	1200	(50)
11. Chloroform	67-66-3	10	10	1200	(50)
12. 1,2-Dichloroethane	107-06-2	10	10	1200	(50)
13. 2-Butanone	78-93-3	10	10	1200	(50)
14. 1,1,1-Trichloroethane	71-55-6	10	10	1200	(50)
15. Carbon Tetrachloride	56-23-5	10	10	1200	(50)
16. Bromodichloromethane	75-27-4	10	10	1200	(50)
17. 1,2-dichloropropane	78-87-5	10	10	1200	(50)
18. cis-1,3-Dichloropropene	10061-01-5 79-	10	10	1200	(50)
19. Trichloroethene	01-6	10	10	1200	(50)
20. Dibromochloromethane	124-48-1	10	10	1200	(50)
21. 1,1,2-Trichloroethane	79-00-5	10	10	1200	(50)
22. Benzene	71-43-2	10	10	1200	(50)
23. Trans-1,3-Dichloropropene	10061-02-6 75-	10	10	1200	(50)
24. Bromoform	25-2	10	10	1200	(50)
25. 4-Methyl-2-pentanone	108-10-1	10	10	1200	(50)
26. 2-Hexanone	591-78-6	10	10	1200	(50)
27. Tetrachloroethene	127-18-4	10	10	1200	(50)
28. Toluene	108-88-3	10	10	1200	(50)
29. 1,1,2,2-Tetrachloroethane	79-34-5	10	10	1200	(50)
30. Chlorobenzene	108-90-7	10	10	1200	(50)
31. Ethyl Benzene	100-41-4	10	10	1200	(50)
32. Styrene	100-42-5	10	10	1200	(50)
33. Xylenes (Total)	1330-20-7	10	10	1200	(50)

*Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis as required by the contract, will be higher.

TARGET COMPOUND LIST, (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL)

		Quantitation Limits*			
Semivolatiles	CAS Number	Water ug/L	Low Soil ug/kg	Med. Soil ug/kg	on Column (ng)
34. Phenol	108-95-2	10	330	10000	(20)
35. bis(2-Chloroethyl) ether	111-44-4	10	330	10000	(20)
36. 2-Chlorophenol	95-57-8	10	330	10000	(20)
37. 1,3-Dichlorobenzene	541-73-1	10	330	10000	(20)
38. 1,4-Dichlorobenzene	106-46-7	10	330	10000	(20)
39. 1,2-Dichlorobenzene	95-50-1	10	330	10000	(20)
40. 2-Methylphenol	95-48-7	10	330	10000	(20)
41. 2,2'-oxybis (1-Chloropropane)#	108-60-1	10	330	10000	(20)
42. 4-Methylphenol	106-44-5	10	330	10000	(20)
43. N-Nitroso-di-n-propylamine	621-64-7	10	330	10000	(20)
44. Hexachloroethane	67-72-1	10	330	10000	(20)
45. Nitrobenzene	98-95-3	10	330	10000	(20)
46. Isophorone	78-59-1	10	330	10000	(20)
47. 2-Nitrophenol	88-75-5	10	330	10000	(20)
48. 2,4-dimethylphenol	105-67-9	10	330	10000	(20)
49. bis(2-Chloroethoxy) methane	111-91-1	10	330	10000	(20)
50. 2,4-Dichlorophenol	120-83-2	10	330	10000	(20)
51. 1,2,4-Trichlorobenzene	120-82-1	10	330	10000	(20)
52. Naphthalene	91-20-3	10	330	10000	(20)
53. 4-Chloroaniline	106-47-8	10	330	10000	(20)
54. Hexachlorobutadiene	87-68-3	10	330	10000	(20)
55. 4-Chloro-3-methylphenol	59-50-7	10	330	10000	(20)
56. 2-Methylnaphthalene	91-57-6	10	330	10000	(20)
57. Hexachlorocyclopentadiene	77-47-4	10	330	10000	(20)
58. 2,4,6-Trichlorophenol	88-06-2	10	330	10000	(20)
59. 2,4,5-Trichlorophenol	95-95-4	25	800	25000	(50)
60. 2-Chloronaphthalene	91-58-7	10	330	10000	(20)
61. 2-Nitroaniline	88-74-7	25	800	25000	(50)
62. Dimethylphthalate	131-11-3	10	330	10000	(20)
63. Acenaphthylene	208-96-8	10	330	10000	(20)
64. 2,6-Dinitrotoluene	606-20-2	10	330	10000	(20)
65. 3-Nitroaniline	99-09-2	25	800	25000	(50)
66. Acenaphthene	83-32-9	10	330	10000	(20)
67. 2,4-Dinitrophenol	51-28-5	25	800	25000	(50)
68. 4-Nitrophenol	100-02-7	25	800	25000	(50)

* Previously known by the name bis(2-Chloroisopropyl) ether

		Quantitation Limits*			
[illegible]	CAS Number	Water ug/L	Low Soil ug/kg	Med. Soil ug/kg	on Column (ng)
[illegible]	132-64-9	10	330	10000	(20)
[illegible]	121-14-2	10	330	10000	(20)
[illegible]	84-66-2	10	330	10000	(20)
[illegible]-chlorophenyl ether	005-72-3	10	330	10000	(20)
[illegible]	86-73-7	10	330	10000	(20)
[illegible]	100-01-6	25	800	25000	(50)
[illegible]-chlorophenol	534-52-1	25	800	25000	(50)
[illegible]amine	86-30-6	10	330	10000	(20)
[illegible]-phenylether	101-55-3	10	330	10000	(20)
[illegible]	118-74-1	10	330	10000	(20)
[illegible]	87-86-5	25	800	25000	(50)
[illegible]	85-01-8	10	330	10000	(20)
[illegible]	120-12-7	10	330	10000	(20)
[illegible]	86-74-8	10	330	10000	(20)
[illegible]	84-74-2	10	330	10000	(20)
[illegible]	206-44-0	10	330	10000	(20)
[illegible]	129-00-0	10	330	10000	(20)
[illegible]	85-68-7	10	330	10000	(20)
[illegible]benzidine	91-94-1	10	330	10000	(20)
[illegible]	56-55-3	10	330	10000	(20)
[illegible]	218-01-9	10	330	10000	(20)
[illegible]phthalate	117-81-7	10	330	10000	(20)
[illegible]	117-84-0	10	330	10000	(20)
[illegible]fluoranthene	205-99-2	10	330	10000	(20)
[illegible]fluoranthene	207-08-9	10	330	10000	(20)
[illegible]	50-32-8	10	330	10000	(20)
[illegible]pyrene	193-39-5	10	330	10000	(20)
[illegible]anthracene	53-70-3	10	330	10000	(20)
[illegible]	191-24-2	10	330	10000	(20)

* [illegible] for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for [illegible] on dry weight basis as required by the contract, will be higher.

TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL)

Pesticides/Aroclors	CAS Number	Quantitation Limits* Water ug/L	Soil ug/kg	on Column (pg)
98. alpha-BHC	319-84-9	0.05	1.7	5
99. beta-BHC	319-85-7	0.05	1.7	5
100. delta-BHC	319-86-8	0.05	1.7	5
101. gamma-BHC (Lindane)	58-89-9	0.05	1.7	5
102. Heptachlor	76-44-8	0.05	1.7	5
103. Aldrin	309-00-2	0.05	1.7	5
104. Heptachlor epoxide	1024-57-3	0.05	1.7	5
105. Endosulfan I	959-98-8	0.05	1.7	5
106. Dieldrin	60-57-1	0.10	3.3	10
107. 4,4'DDE	72-55-9	0.10	3.3	10
108. Endrin	72-20-8	0.10	3.3	10
109. Endosulfan II	33213-65-9	0.10	3.3	10
110. 4,4'DDD	72-54-8	0.10	3.3	10
111. Endosulfan Sulfate	1031-07-8	0.10	3.3	10
112. 4,4'-DDT	50-29-3	0.10	3.3	10
113. Methoxychlor	72-43-5	0.50	17.0	50
114. Endrin Ketone	53494-70-5	0.10	3.3	10
115. Endrin aldehyde	7421-36-3	0.10	3.3	10
116. alpha-Chlordane	5103-71-9	0.05	1.7	5
117. gamma-Chlordane	5103-74-2	0.05	1.7	5
118. Toxaphene	8001-35-2	5.0	170.0	500
119. Aroclor-1016	12674-11-2	1.0	33.0	100
120. Aroclor-1221	11104-28-2	2.0	67.0	200
121. Aroclor-1232	11141-16-5	1.0	33.0	100
122. Aroclor-1242	53469-21-9	1.0	33.0	100
123. Aroclor-1248	12672-29-6	1.0	33.0	100
124. Aroclor-1254	11097-69-1	1.0	33.0	100
125. Aroclor-1260	11096-82-5	1.0	33.0	100

* Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis as required by the contract, will be higher.

There is no differentiation between the preparation of low and medium soil samples in this method for the analysis of Pesticides/Aroclors.

5.4.4.3.3.4 **Levels of Concern**

Appendix F of the IWP (LANL 1991, 0553) and 40 CFR 264, Proposed Subpart S, contain information on constituent levels of concern. Health risk-based determination of levels of concern will be developed for constituents not listed in Appendix F. The ER Program is currently developing baseline risk assessment scenarios and criteria that will be presented in the 1992 IWP. This approach will be developed in adequate time for data analysis.

5.4.4.3.3.5 **Required Quantitation Limits**

Quantitation limits for laboratory analysis of hazardous substances and radionuclides are presented in Tables V.3 through V.9 of the Laboratory's Generic QAPjP (LANL 1991,0412).

5.4.4.3.3.6 **Critical Samples**

The locations of the 28 proposed vertical boreholes are shown on Figure 5.4-9. Samples collected from the vertical boreholes located at the perimeter of the MDA are important in determining the nature and extent of contamination. Samples collected from boreholes placed in areas of potential or known contamination are important in detecting and characterizing contaminant releases. Samples from the boreholes are critical in the design of Phase II subsurface characterization and future corrective actions.

5.4.4.3.4 **Rationale for Sampling Activity**

The rationale for installing boreholes is to:

- determine the nature and extent of any residual soil or rock contamination;
- determine the source term for any residual soil or rock contamination; and
- collect data that can be validated according to EPA functional guidelines for data validation and that can be used to support the use of existing data.

Data obtained through implementation of the Phase I SAP will be used for the initial characterization of the nature, extent, and source of any residual soil or rock contamination at MDA G. This information will be obtained through the following sampling tasks:

- Twenty eight boreholes will be installed to determine the nature and extent of any residual soil or rock contamination (see Figure 5.4-9 for the proposed borehole locations).
- Core samples will be collected and analyzed for VOCs, SVOCs, metals, pesticides, PCBs, cyanide, and ROCs by a contract analytical laboratory that is certified to perform SW-846 analyses.

ATTACHMENT 4

INTERNATIONAL TECHNOLOGY CORPORATION

RECORD OF MEETING

Project Name: Closure Cert TSL-85 **Project Number:** 301625.03.01

Date and Time: 5/25/94 - 1020

Call From: Lee Winn, NMED **Call To:** J. Tucker

Subject: NOD Responses for Items 12b and 14a (cobalt & copper)

Summary of Discussion:

Item 12b - This is a RCRA tank and doesn't fall under State Regs. Refer to Subpart J of RCRA Regs. 5 sample locations is Lee's recommendation but has no regulatory basis. We must convince NMED that less than 5 samples are needed using statistical reassuring.

Item 14a - Replace copper w/copper cyanide which is already on App. VIII. Don't need to do cobalt. She thought these may have been in the waste stream.

- Some of the listed methods do not include all constituents that could be analyzed with the method. *Check.

- Can get rid of some App. VIII constituents based on KOP, no method, etc.

- They ask how will we clean up the dielectric oil. Told them it would be remediated or treated to a level which would not cause the interference, but this is our proposed response and requires LANL approval.

- Oil in the soil makes it a solid waste. ⇒ acetone mixes w/soil ⇒ mixture role makes it all haz. 261.3(a)(2)(iii) & (iv). Acetone is a listed waste. Must include acetone in resampling.

* Check on mixture role.

- Extensions are possible on individual items as long as their not too long.

Prepared by (Signature)

Los Alamos

Los Alamos National Laboratory
Los Alamos, New Mexico 87545

Date: March 21, 1994

Mail Stop: J534
Telephone: 665-6493, 665-1264
Fax: 665-9118

memorandum

To: Distribution

From: Patrick Longmire, CST-10, Earth Sciences Technical Team

Subject: **BACKGROUND SOIL CHEMICAL DATA USING EPA SW846 PROCEDURES**

Attached are more recent background chemical data for soils collected at Los Alamos (Tables I and II). These data are collected from "true soils", which may have application for fill or reworked unconsolidated material found at the townsites and other disturbed areas of the Laboratory. Table I contains chemical data for all soils and fracture fill material sampled at the Laboratory. Table II contain chemical data from A horizons, which typically are the uppermost soil horizons found on the Pajarito Plateau. These A horizons are probably comparable to surface soil samples, excluding fill material, collected at operable units (OUs). Clearly, more Laboratory-wide background soil samples need to be collected from A horizons.

Nitric acid (HNO_3) was used to partly dissolve the soil samples. Atomic absorption (AA) and inductively coupled plasma spectroscopy (ICP) were the analytical methods used. Analytes of most concem include arsenic (As) and beryllium (Be) because background soil concentrations exceed screening action levels (SALs) for these two elements (Be, 0.16 ppm; As, 0.40 ppm). A seminar will be given in early May discussing details of these background data. Thank you for your interest in these background soil data.

TABLE I. Background Elemental Concentrations in Soils at Los Alamos, New Mexico

	Nitric Acid Dissolution (SW846)			INAA or DNAA (Uranium Only)		
Element[a]	Number of Samples	Mean	Range	Number of Samples	Mean	Range
As	72	4.9	0.5 - 13.6	67	5.04	1.20 - 10.81
Ba	72	176	24 - 730	75	459	125 - 829
Be	72	1.23	0.18 - 4.00		-	-
	75	[b]2.37	1.00 - 4.40			
Co	72	15.2	5.5 - 34	75	7.14	0.44 - 23.35
Cr	72	12.2	1.9 - 37.0	74	34.74	2.03 - 71.07
Cu	67	6.6	0.6 - 16.0		-	-
Fe (wt.%)	72	1.51	0.33 - 3.60	75	2.37	1.09 - 4.86
Ni	70	10.3	2.0 - 28.0		-	-
Pb	69	16.7	4.0 - 37.0		-	-
		[b]28.36	18.00 - 56.00			
Se	41	0.75	0.30 - 2.40		-	-
Th	72	7.1	0.6 - 15.0	75	16.06	10.09 - 27.30
Tl	40	0.42	0.20 - 0.90		-	-
U	72	0.94	0.20 - 2.40	75	3.41	1.54 - 6.73
V	72	26.6	4.0 - 56.0	72	48.95	11.54 - 113.10

[a]Data are reported in parts per million (ppm) unless otherwise noted.
[b]Hydrofluoric acid used in sample dissolution.

TABLE II. Background Elemental Concentrations in A Horizons of Soils at Los Alamos, New Mexico

	Nitric Acid Dissolution (SW846)		
Element[a]	Number of Samples	Mean	Range
As	9	3.1	0.8 - 5.4
Ba	9	123	27 - 220
Be	9	0.71	0.31 - 1.00
Co	9	16.7	10.0 - 29.0
Cr	9	8.1	1.9 - 16.0
Cu	7	6.5	3.3 - 9.5
Fe (wt.%)	9	1.21	0.33 - 2.80
Ni	9	6.7	2.0 - 12.0
Pb	9	15.8	4.0 - 38.0
Se	2	0.58	0.50 - 0.65
Th	9	5.8	2.0 - 8.0
Ti	2	0.2	0.2 - 0.2
U	9	0.9	0.5 - 2.4
V	9	19.8	4.6 - 37.0

[a]Data are reported in parts per million (ppm) unless otherwise noted.

Note: A horizon is uppermost soil horizon characterized during background investigation.

PRELIMINARY BACKGROUND ELEMENTAL CONCENTRATIONS IN BANDELIER TUFF AND SELECTED SOIL SERIES, 1993

DRAFT

by

Patrick Longmire, Clarence Duffy, and Steven Reneau

ABSTRACT

During spring and summer of 1992, the Bandelier Tuff and several soil series were sampled to determine background elemental concentrations. Thirty-eight samples of the Bandelier Tuff and seventy-five soil samples were submitted for chemical analyses. Rock and soil samples were analyzed for antimony (Sb), arsenic (As), barium (Ba), beryllium (Be), cadmium (Cd), chromium (Cr), lead (Pb), mercury (Hg), silver (Ag), thorium (Th), uranium (U), and other elements. The soil samples contain higher concentrations of aluminum (Al), As, Ba, calcium (Ca), cesium (Cs), cobalt (Co), Cr, and iron (Fe) relative to the Bandelier Tuff samples. The Bandelier Tuff samples, however, contain higher concentrations of Be, Pb, sodium (Na), potassium (K), Th, and U relative to soils. Variations in soil elemental concentrations are related to chemical characteristics of a particular soil horizon and to the parent material, which consists of alluvial fans, sheet wash material, colluvium, air-fall pumice (El Cajete), loess, and the Bandelier Tuff. Because of the limited number of Bandelier Tuff and soil samples collected, this data set should not be considered statistically representative of the full suite of soils and tuff present at the Laboratory, and may not include the full range of natural concentrations for all elements. Generally, these data agree well with soil data reported by Ferenbaugh et al. (1990) and Schacklette and Boerngen (1984).

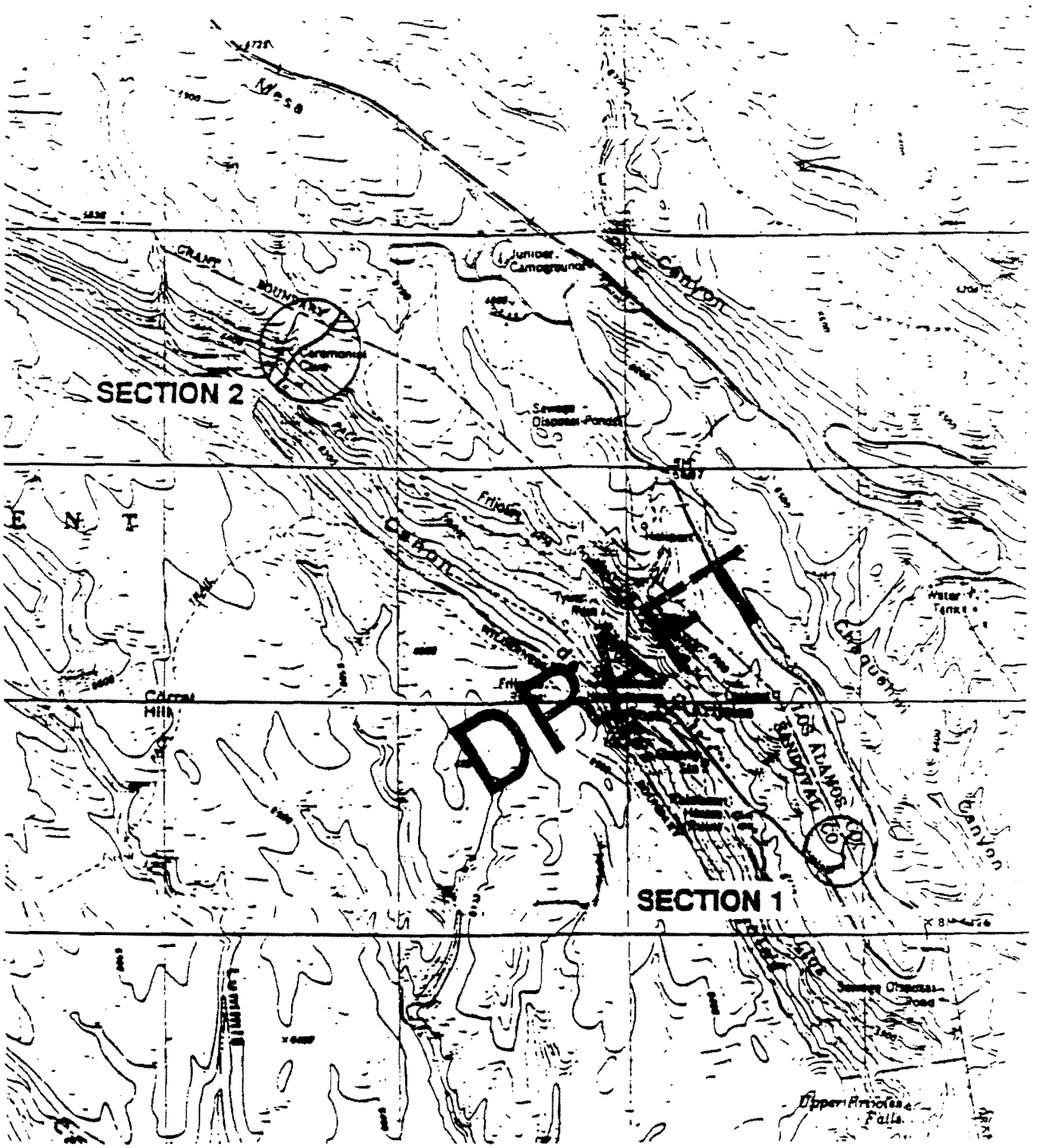

FIGURE 1. LOCATION MAP OF BANDELIER TUFF SECTIONS

the full suite of soils present at the Laboratory, and may not include the full range of natural concentrations for all elements.

Rock and soil samples were analyzed for antimony (Sb), arsenic (As), barium (Ba), beryllium (Be), cadmium (Cd), chromium (Cr), lead (Pb), mercury (Hg), silver (Ag), thorium (Th), and uranium (U). These elements are of primary concern to the ER program, because numerous solid waste management units (SWMUs) at Los Alamos National Laboratory (Laboratory) potentially contain elevated concentrations of these elements. Other elements of secondary importance to the ER Program include aluminum (Al), bromine (Br), calcium (Ca), cesium (Cs), chlorine (Cl), cobalt (Co), copper (Cu), gallium (Ga), gold (Au), hafnium (Hf), indium (In), iodine (I), iron (Fe), magnesium (Mg), manganese (Mn), potassium (K), rare earth elements (REE), rubidium (Rb), scandium (Sc), selenium (Se), sodium (Na), strontium (Sr), tantalum (Ta), titanium (Ti), tungsten (W), vanadium (V), zinc (Zn), and zirconium (Zr).

This report summarizes elemental background concentrations compiled on the Bandelier Tuff and soils collected within and adjacent to the Laboratory boundaries. An additional report will be made available in late spring of 1993, which will consist of statistical evaluation and interpretation of chemical, physical, and mineralogical data collected during this investigation.

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METHODS

Non-contaminated samples of the Bandelier Tuff were collected at two localities within Bandelier National Monument (BNM). Locations of the sections where the samples were taken are shown in Figure 1. Locations of the samples within the sections are shown in Figures 3 and 4. Samples were taken from surface exposure, but material from obvious weathering rinds was excluded.

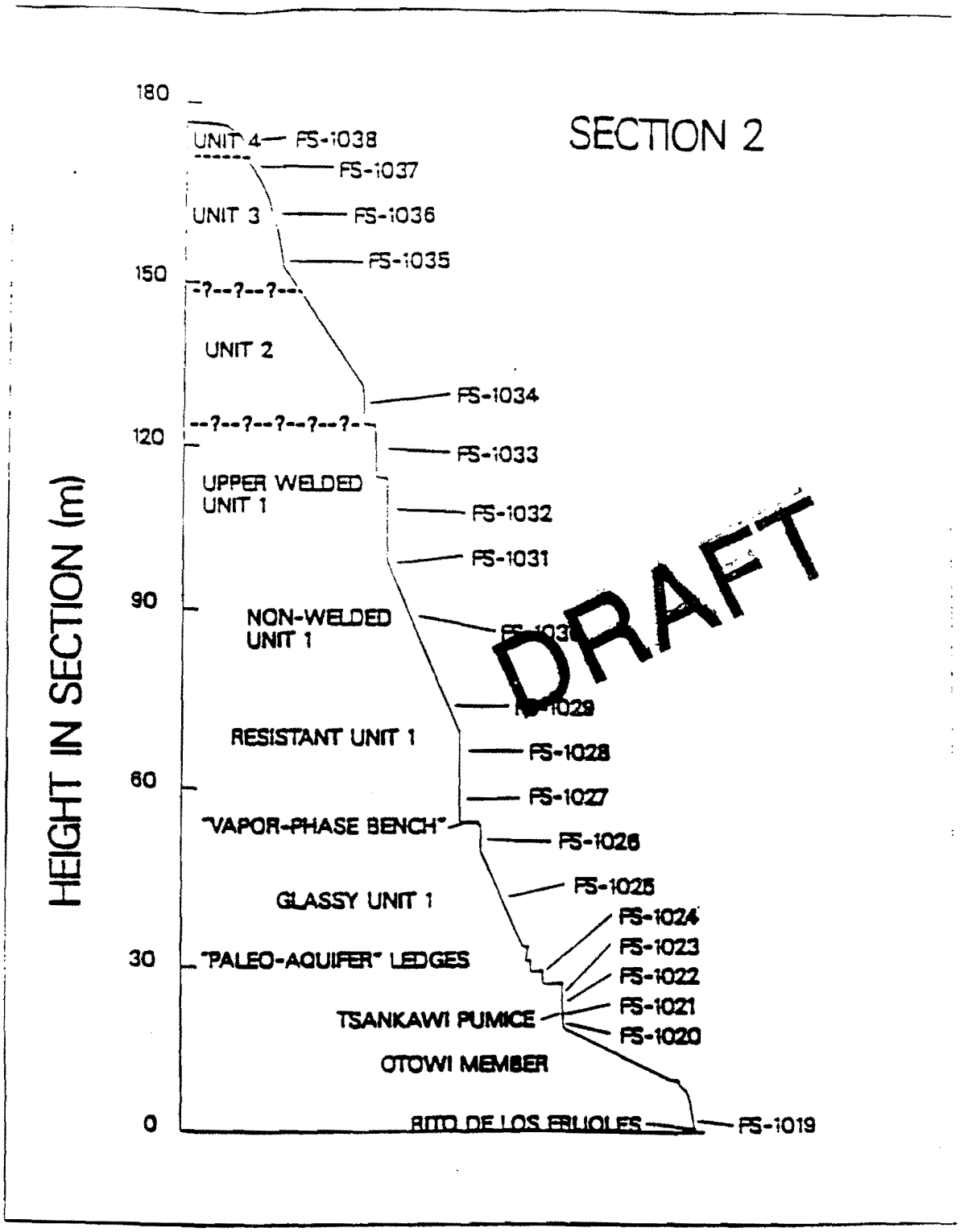

Figure 4 Locations of Bandelier Tuff samples within section 2.

procedures used for these analyses are described in detail in Gautier and Gladney (1986), Gladney et al. (1981), and Garcia (1990). Quality assurance was provided by concurrent analysis of different National Institute of Standards and Technology (NIST), United States Environmental Protection Agency (USEPA), and United States Geological Survey (USGS) reference materials described by Gladney et al. (1981) and Garcia (1991).

RESULTS

Table I summarizes the means and ranges of elements in the Bandelier Tuff and soil series. The soil samples are enriched in Al, As, Ba, Ca, Cs, Co, Cr, and Fe relative to the Bandelier Tuff samples. The Bandelier Tuff samples, however, are enriched in Be, Pb, Na, K, Mn, and U relative to soils. Variations in soil elemental concentrations are related to chemical characteristics of a particular soil horizon and to the parent material, which consists of alluvial fans, sheet wash material, colluvium, and the Bandelier Tuff. Generally, these data agree well with soil data reported from other sources summarized in Table II, including Ferenbaugh et al. (1990) and Schacklette and Boerngen (1984).

The results of individual analyses are tabulated in Appendix A, Tables A-I and A-II.

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TABLE I (continued)

SUMMARY OF TUFF AND SOIL ANALYSES (VALUES IN PPM)

ELEMENT		SAMPLES ABOVE DETECTION LIMIT				SAMPLES BELOW DETECTION		
		NUMBER OF SAMPLES	MINIMUM	MAXIMUM	AVERAGE	NUMBER OF SAMPLES	MINIMUM DETECTION LIMIT	MAXIMUM DETECTION LIMIT
Fe								
	TUFF	38	8818.00	22850.00	11529.60	0		
	SOIL	75	10860.00	48640.00	23704.27	0		
Co								
	TUFF	35	0.49	8.88	1.30	3	0.29	0.35
	SOIL	75	0.44	23.35	7.14	0		
Cu								
	TUFF	0				38	260.80	444.40
	SOIL	0				75	158.90	456.60
Zn								
	TUFF	35	39.85	131.30	81.85	3	6.42	46.20
	SOIL	36	19.97	146.20	64.58	39	5.32	71.93
Ga								
	TUFF	10	14.53	34.21	26.[illegible]	2[illegible]	23.63	62.06
	SOIL	10	7.81	37.39	[illegible]	65	16.54	99.75
As								
	TUFF	16	0.94	3.15	1.89	22	2.29	4.55
	SOIL	67	1.20	10.[illegible]	5.04	8	2.58	5.21
Se								
	TUFF	0				38	1.14	4.92
	SOIL	0				75	1.71	7.72
Br								
	TUFF	9	1.70	6.73	2.79	29	2.55	5.42
	SOIL	64	1.38	46.88	6.48	11	1.77	4.67
Rb								
	TUFF	38	79.13	488.40	187.15	0		
	SOIL	75	43.95	159.00	108.69	0		
Sr								
	TUFF	1	653.90	653.90	653.90	37	236.90	483.80
	SOIL	2	170.40	242.20	206.30	73	164.90	746.10
Zr								
	TUFF	38	144.10	368.82	228.82	0		
	SOIL	70	148.00	704.30	350.64	5	128.40	316.30
Ag								
	TUFF	0				38	1.71	2.95
	SOIL	1	1.61	1.61	1.61	74	1.59	[illegible] 32

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TABLE I (continued)

SUMMARY OF TUFF AND SOIL ANALYSES (VALUES IN PPM)

ELEMENT		SAMPLES ABOVE DETECTION LIMIT				SAMPLES BELOW DETECTION		
		NUMBER OF SAMPLES	MINIMUM	MAXIMUM	AVERAGE	NUMBER OF SAMPLES	MINIMUM DETECTION LIMIT	MAXIMUM DETECTION LIMIT
Dy								
	TUFF	38	4.61	15.57	11.09	0		
	SOIL	75	2.68	10.38	4.88	0		
Yb								
	TUFF	38	2.96	10.63	6.87	0		
	SOIL	75	1.33	5.87	3.50	0		
Lu								
	TUFF	38	0.51	1.40	0.95	0		
	SOIL	75	0.22	0.75	0.48	0		
Hf								
	TUFF	38	6.34	12.13	8.96	0		
	SOIL	75	4.16	18.56	9.76	0		
Ta								
	TUFF	38	2.66	9.70	6.03	0		
	SOIL	75	1.27	5.67	2.44	0		
W								
	TUFF	23	2.04	20.0	6.01	15	3.10	9.62
	SOIL	22	1.62	17.07	5.96	53	1.47	13.21
Au								
	TUFF	0				38	0.01	0.02
	SOIL	4	0.02	0.04	0.03	71	0.01	0.02
Hg								
	TUFF	0				38	0.35	0.69
	SOIL	0				75	0.34	1.37
Pb								
	TUFF	34	18.00	57.00	35.79	4	14.00	14.00
	SOIL	73	18.00	56.00	28.36	2	14.00	14.00
Th								
	TUFF	38	12.90	37.06	23.71	0		
	SOIL	75	10.09	27.30	16.06	0		
U								
	TUFF	38	2.88	10.13	6.27	0		
	SOIL	75	1.54	6.73	3.41	0		

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Table A-1
Bandelier Tuff Analyses

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	Sc	Standard Deviation	Ti	Standard Deviation	V	Standard Deviation	Cr	Standard Deviation	Mn	Standard Deviation	Fe	Standard Deviation
FS-1001	1.06	0.06	<3883.00		<6.74		2.39	0.59	552.60	24.31	11100.00	599.40
FS-1002	1.15	0.07	<4673.00		<7.67		<1.82		598.00	23.92	11550.00	716.10
FS-1003	0.98	0.05	<5160.00		<7.84		4.52	0.62	444.50	18.22	8818.00	458.54
FS-1004	1.21	0.07	<4166.00		<7.00		<1.54		667.60	33.38	11170.00	659.03
FS-1005	1.19	0.08	<4533.00		<7.27		4.99	0.65	541.00	21.64	10600.00	540.60
FS-1006	1.05	0.06	<6364.00		<9.60		3.85	0.56	554.80	22.19	10116.50	531.47
FS-1007	1.16	0.06	432.50	155.70	<6.34		3.13	0.60	531.50	25.51	11040.00	640.32
FS-1008	1.11	0.06	<4385.00		<7.25		4.35	0.53	553.30	24.35	10690.00	641.40
FS-1009	1.07	0.06	<6867.00		<10.37		4.27	0.68	581.70	22.69	10680.00	544.68
FS-1010	1.56	0.08	<4011.00		<6.96		5.90	0.75	683.70	36.92	12440.00	684.20
FS-1011	1.17	0.07	<4355.00		<7.21		4.76	0.57	539.80	22.67	10250.00	533.00
FS-1012	1.17	0.06	<5281.00		<8.24		4.54	0.60	637.95	25.98	11645.00	624.48
FS-1013	1.10	0.06	<3661.00		<6.23		1.97	0.51	525.80	30.50	10710.00	610.47
FS-1014	1.36	0.08	<4131.00		<6.66		4.80	0.55	518.10	21.76	10650.00	660.30
FS-1015	1.34	0.07	<6055.00		<9.05		2.38	0.48	574.90	24.72	11080.00	565.08
FS-1016	1.63	0.09	<3466.00		<5.90		<1.31		459.70	20.69	11080.00	709.12
FS-1017	1.45	0.08	<4103.00		<6.53		3.61	0.51	428.90	16.73	10490.00	597.93
FS-1018	1.57	0.08	<6076.00		<9.19		2.84	0.52	465.70	18.63	10110.00	525.81
FS-1019	5.59	0.30	1943.00	318.65	42.25	2.75	49.85	3.14	834.50	37.55	22850.00	1462.40
FS-1020	4.08	0.22	1505.00	290.46	21.50	2.17	12.00	0.89	465.80	19.56	17080.00	888.16
FS-1021	1.01	0.05	<6524.00		<9.58		2.86	1.33	558.70	21.79	9777.00	518.18
FS-1022	0.91	0.05	<4051.00		<7.10		<0.91		626.90	29.46	11470.00	699.67
FS-1023	0.88	0.06	<4304.00		<7.01		2.70	0.52	574.40	22.40	10020.00	591.18
FS-1024	0.93	0.05	<6017.00		<8.62		<2.66		639.70	24.95	10560.00	538.56
FS-1025	1.19	0.06	<4020.00		<6.93		<1.68		589.80	28.90	11480.00	619.92
FS-1026	1.18	0.08	<4507.50		<7.42		3.94	0.63	581.30	23.87	11475.00	618.80
FS-1027	1.17	0.06	<7024.00		<10.49		3.72	0.61	663.10	25.86	11490.00	620.46
FS-1028	1.17	0.06	721.00	186.02	<6.60		1.79	0.48	663.40	33.17	11260.00	641.82
FS-1029	1.36	0.07	<4138.00		<6.92		3.12	0.59	514.60	22.13	10750.00	612.75
FS-1030	1.14	0.06	<6129.00		<9.28		3.84	0.51	558.20	22.33	10750.00	806.25
FS-1031	1.36	0.07	<3610.00		<6.24		5.94	0.65	590.00	26.55	11390.00	580.89
FS-1032	1.69	0.09	<3831.00		<6.43		5.08	0.63	510.10	20.91	11300.00	745.80
FS-1033	1.25	0.07	<5561.00		<8.45		1.63	0.37	502.10	19.58	10770.00	710.82
FS-1034	1.31	0.07	<3365.00		<5.79		<2.08		482.00	25.06	10220.00	541.66
FS-1035	1.63	0.09	<3873.00		<6.26		1.17	0.46	360.40	14.42	10740.00	579.96
FS-1036	1.92	0.11	1068.00	243.50	<8.40		2.07	0.41	382.75	15.49	10890.00	796.05
FS-1037	1.86	0.10	<3622.00		<6.17		5.80	0.67	449.20	21.56	11570.00	590.07
FS-1036	3.81	0.21	1528.33	285.13	9.63	[illegible]	9.90	0.93	558.48	24.02	17843.33	1015.54

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	Br	Standard Deviation	Rb	Standard Deviation	Sr	Standard Deviation	Zr	Standard Deviation	Ag	Standard Deviation	In	Standard Deviation
FS-1001	1.70	0.50	234.60	11.26	<276.80		227.70	33.02	<1.95		<0.25	
FS-1002	2.39	0.59	234.00	11.23	<325.10		310.20	75.38	<2.47		<0.31	
FS-1003	2.57	0.80	168.80	8.10	<351.60		204.00	28.15	<2.16		<0.30	
FS-1004	<3.07		217.40	10.44	<285.30		220.30	33.27	<2.00		<0.25	
FS-1005	2.56	0.51	200.30	9.61	<312.40		235.40	35.78	<2.40		<0.31	
FS-1006	<4.80		206.40	9.80	<438.55		254.80	47.33	<2.38		<0.37	
FS-1007	6.73	0.81	210.70	10.11	<262.60		206.30	31.98	<1.90		<0.24	
FS-1008	<3.64		205.40	9.86	<309.70		265.00	38.16	<2.31		<0.40	
FS-1009	<5.42		217.00	10.42	<474.60		219.90	33.20	<2.72		<0.40	
FS-1010	<3.01		195.00	9.36	<283.00		225.30	33.79	<1.94		<0.25	
FS-1011	<3.64		193.10	9.27	<308.70		234.60	35.66	<2.25		<0.30	
FS-1012	<3.90		207.75	9.87	<370.25		235.25	32.33	<2.51		<0.32	
FS-1013	<2.93		190.90	9.35	<255.50		184.10	27.61	<1.71		<0.23	
FS-1014	<3.36		147.80	7.24	<286.30		227.80	31.21	<2.09		<0.28	
FS-1015	<4.67		144.30	7.07	<409.60		205.60	28.37	<2.28		<0.35	
FS-1016	<2.81		124.20	6.33	<236.90		144.10	34.30	<1.77		<0.22	
FS-1017	<3.50		124.20	6.21	<281.40		223.90	32.24	<2.16		<0.28	
FS-1018	<4.89		110.30	5.63	<418.30		231.10	37.67	<2.50		<0.36	
FS-1019	<2.56		162.00	8.42	<290.80		165.80	53.39	<2.90		<0.23	
FS-1020	<3.17		157.40	7.71	<275.50		229.90	35.63	<2.95		<0.27	
FS-1021	1.89	0.48	242.90	11.66	<441.40		247.30	35.86	<2.66		<0.36	
FS-1022	2.82	0.70	272.90	13.10	<288.30		217.30	34.77	<2.07		<0.25	
FS-1023	2.34	0.78	259.50	12.20	<305.70		249.10	36.37	<2.21		<0.29	
FS-1024	<3.43		488.40	22.47	653.90	120.32	243.70	33.87	<2.63		<0.30	
FS-1025	2.07	0.52	211.80	10.38	<286.60		196.80	33.85	<2.12		<0.25	
FS-1026	<3.38		194.90	9.55	<312.65		264.05	42.57	<2.21		<0.30	
FS-1027	<5.14		178.60	8.75	<483.80		259.40	43.84	<2.74		<0.40	
FS-1028	<2.75		198.10	9.71	<276.00		173.20	27.89	<1.86		<0.24	
FS-1029	<3.17		188.70	9.06	<287.90		227.10	32.48	<1.77		<0.28	
FS-1030	<4.44		198.30	9.52	<421.00		270.10	37.54	<2.17		<0.36	
FS-1031	<2.59		202.30	9.51	<254.60		216.30	30.93	<2.47		<0.23	
FS-1032	<3.10		145.90	7.15	<270.60		183.60	25.70	<1.71		<0.26	
FS-1033	<4.08		145.90	7.00	<381.60		246.70	32.81	<1.95		<0.33	
FS-1034	<2.55		145.80	7.00	<238.40		195.40	27.36	<2.30		<0.21	
FS-1035	<3.21		100.60	5.23	<266.40		200.20	28.43	<1.76		<0.27	
FS-1036	<4.30		100.85	5.14	<375.55		258.80	34.14	<2.21		<0.34	
FS-1037	<2.66		105.60	5.39	<242.30		226.30	30.55	<2.62		<0.22	
FS-1036	<3.55		79.13	4.57	<327.17		368.82	50.10	<2.95		<0.30	

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	Ba	Standard Deviation	Sm	Standard Deviation	Eu	Standard Deviation	Tb	Standard Deviation	Dy	Standard Deviation	Yb	Standard Deviation
FS-1001	16.28	1.56	11.42	0.51	<0.16		2.34	0.21	14.96	1.12	8.46	0.48
FS-1002	63.07	5.30	10.29	0.47	0.09	0.01	2.44	0.21	15.57	1.23	7.75	0.85
FS-1003	40.03	3.40	10.30	0.48	0.11	0.01	1.94	0.17	10.41	0.92	7.84	0.45
FS-1004	43.87	4.56	10.05	0.47	0.18	0.09	2.12	0.20	12.21	0.96	7.30	0.43
FS-1005	56.27	4.78	9.64	0.44	<0.18		2.35	0.23	14.13	1.13	7.90	0.99
FS-1006	51.96	4.39	12.26	0.58	0.12	0.01	2.11	0.19	12.52	1.00	9.21	0.51
FS-1007	44.56	4.50	10.02	0.47	<0.17		2.10	0.19	11.76	0.99	6.99	0.41
FS-1008	51.87	4.46	9.83	0.45	<0.17		2.39	0.23	13.34	1.33	7.19	0.95
FS-1009	56.78	4.77	13.20	0.61	0.13	0.01	2.47	0.22	13.65	1.08	10.63	0.62
FS-1010	30.36	3.07	10.59	0.50	0.21	0.08	2.11	0.19	12.06	0.99	6.93	0.39
FS-1011	62.94	5.16	10.73	0.49	0.11	0.01	2.29	0.20	14.06	1.12	6.85	0.75
FS-1012	55.30	4.56	12.62	0.59	0.11	0.01	2.26	0.20	12.31	1.03	8.19	0.52
FS-1013	37.04	4.04	11.46	0.54	0.16	0.08	2.12	0.19	12.64	1.07	6.71	0.39
FS-1014	53.74	4.51	8.65	0.40	0.20	0.07	1.85	0.18	9.05	0.79	5.03	0.45
FS-1015	55.78	4.52	12.47	0.57	0.27	0.06	1.94	0.17	10.15	1.48	7.41	0.45
FS-1016	49.80	4.53	10.37	0.49	0.26	0.06	1.60	0.14	8.71	0.70	4.20	0.27
FS-1017	60.14	4.99	10.47	0.48	0.24	0.04	1.79	0.16	9.26	0.79	4.48	0.55
FS-1018	51.08	4.29	9.61	0.43	0.38	0.02	1.37	0.12	8.11	0.84	4.47	0.34
FS-1019	32.67	3.99	7.56	0.36	0.53	0.06	1.22	0.16	6.18	0.54	3.89	0.26
FS-1020	43.76	3.94	6.46	0.30	0.52	0.03	1.14	0.11	4.61	0.51	2.96	0.30
FS-1021	47.84	4.31	10.60	0.50	<0.13		1.99	0.18	12.17	1.06	8.66	0.49
FS-1022	34.27	3.84	13.01	0.60	0.08	0.01	2.61	0.24	15.47	1.25	9.86	0.53
FS-1023	59.71	5.14	9.93	0.46	<0.13		2.27	0.21	14.13	1.26	9.00	0.49
FS-1024	46.42	4.18	0.81	0.06	0.41	0.19	1.98	0.18	11.14	1.18	10.14	0.55
FS-1025	33.14	3.71	11.66	0.55	0.17	0.08	2.27	0.22	13.62	1.05	8.44	0.47
FS-1026	44.96	4.15	10.68	0.50	0.19	0.08	2.40	0.22	14.19	1.14	8.32	0.60
FS-1027	58.36	5.02	13.21	0.61	0.10	0.01	2.34	0.21	13.34	1.11	9.95	0.56
FS-1028	31.01	3.41	10.82	0.50	0.21	0.06	2.04	0.19	12.08	1.06	6.73	0.38
FS-1029	40.23	3.90	9.41	0.43	0.19	0.05	2.02	0.18	11.72	1.77	7.13	0.71
FS-1030	58.42	4.79	12.08	0.56	0.17	0.08	2.50	0.23	12.89	1.24	9.07	0.50
FS-1031	71.58	5.65	13.05	0.60	0.18	0.02	2.65	0.24	14.03	1.19	7.73	0.40
FS-1032	47.91	4.26	11.27	0.51	0.28	0.05	1.95	0.18	11.65	1.36	6.10	0.57
FS-1033	38.79	3.34	7.84	0.37	0.21	0.05	1.18	0.11	6.56	0.60	5.62	0.50
FS-1034	52.68	4.27	8.06	0.37	0.28	0.11	1.61	0.14	7.73	0.66	4.60	0.27
FS-1035	36.65	3.52	6.90	0.31	0.31	0.05	1.11	0.11	6.66	0.63	3.34	0.40
FS-1036	52.14	4.28	9.40	0.44	0.31	0.04	1.26	0.12	6.22	0.54	4.58	0.29
FS-1037	49.76	4.08	7.56	0.36	0.40	0.04	1.27	0.12	6.38	0.54	3.64	0.29
FS-1036	57.22	5.02	8.77	0.41	0.84	0.05	1.19	0.12	5.80	0.65	3.65	0.37

	Th	Standard Deviation	U	Standard Deviation	Be	Standard Deviation	Cd	Standard Deviation	Pb	Standard Deviation
FS-1001	31.95	1.44	8.63	0.30	7.20	1.40	<1.00		57.00	6.00
FS-1002	28.99	1.16	8.74	0.31	0.82	0.16	<1.00		<14.00	
FS-1003	21.32	0.85	5.98	0.21	6.40	1.30	<1.00		44.00	4.00
FS-1004	31.20	1.31	7.85	0.27	6.00	1.20	<1.00		48.00	5.00
FS-1005	22.56	2.46	7.26	0.25	4.90	1.00	<1.00		41.00	4.00
FS-1006	25.20	1.01	7.02	0.25	5.10	1.00	<1.00		43.30	4.20
FS-1007	30.08	1.23	7.31	0.26	6.30	1.30	<1.00		26.00	3.00
FS-1008	22.27	2.85	7.27	0.25	7.00	1.40	<1.00		54.00	5.00
FS-1009	27.67	1.11	7.59	0.27	5.60	1.10	<1.00		52.00	5.00
FS-1010	27.30	1.09	7.30	0.26	6.10	1.20	<1.00		39.00	4.00
FS-1011	24.54	0.98	7.41	0.26	5.95	1.20	<1.00		32.50	4.00
FS-1012	26.09	1.04	6.91	0.24	6.00	1.20	<1.00		30.90	3.00
FS-1013	25.93	1.06	7.12	0.25	6.10	1.20	<1.00		27.00	3.00
FS-1014	16.25	2.08	5.05	0.18	4.00	0.80	<1.00		19.00	4.00
FS-1015	19.67	0.79	4.73	0.17	4.60	0.90	<1.00		25.00	2.00
FS-1016	19.55	0.80	4.32	0.16	3.50	0.70	<1.00		<14.00	
FS-1017	16.32	0.67	4.37	0.16	2.90	0.60	<1.00		22.00	2.00
FS-1018	15.43	0.63	3.28	0.12	2.70	0.50	<1.00		27.00	3.00
FS-1019	19.94	0.96	5.61	0.20	5.00	1.00	<1.00		31.00	3.00
FS-1020	15.62	0.61	5.08	0.18	4.90	1.00	<1.00		32.00	3.00
FS-1021	27.13	1.09	7.80	0.27	6.40	1.30	<1.00		49.00	5.00
FS-1022	37.06	1.52	10.13	0.35	0.72	0.10	<1.00		<14.00	
FS-1023	27.17	1.09	8.33	0.29	7.50	1.50	<1.00		51.10	5.10
FS-1024	29.39	1.26	6.65	0.24	5.70	1.10	<1.00		45.60	4.60
FS-1025	29.76	1.22	7.75	0.28	6.12	1.20	<1.00		39.30	4.00
FS-1026	28.42	1.33	6.93	0.24	6.30	1.00	<1.00		45.90	4.40
FS-1027	29.53	1.18	7.41	0.26	5.40	1.00	<1.00		36.00	3.60
FS-1028	29.87	1.28	7.14	0.25	5.20	1.00	<1.00		40.40	4.00
FS-1029	26.37	1.05	6.58	0.23	5.70	1.00	<1.00		31.00	3.10
FS-1030	22.10	2.83	7.27	0.25	5.60	1.10	<1.00		51.00	5.10
FS-1031	27.64	1.11	6.98	0.24	6.00	1.00	<1.00		24.00	2.00
FS-1032	21.50	0.90	4.71	0.16	3.90	0.80	<1.00		26.00	3.00
FS-1033	19.14	0.77	4.82	0.17	3.90	0.80	<1.00		29.70	3.00
FS-1034	20.53	0.82	4.45	0.16	3.50	0.70	<1.00		22.00	2.00
FS-1035	15.05	0.71	3.18	0.12	0.42	0.10	<1.00		<14.00	
FS-1036	12.90	0.80	3.40	0.12	1.40	0.80	<1.00		18.00	4.00
FS-1037	15.05	0.62	3.17	0.12	2.50	0.50	<1.00		21.00	2.00
FS-1036	14.50	0.64	2.88	0.11	2.05	0.40	<1.00		36.00	4.00

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FRAMEWORK SOIL SAMPLES ORDERED BY FS NUMBER

SAMPLE NUMBER	DATE COLLECTED	NEUTRON ACTIVATION ANALYSIS SAMPLE WEIGHT (g) TARE	GROSS	NET	COMMENTS
FS-2000	92 08 07 09 54	2.259	6.977	4.718	ULAC-08
FS-2000F	92 08 07 09 54	2.264	5.633	3.369	ULAC-08 Fine fraction
FS-2001	92 06 24 10 12	2.235	6.927	4.692	TA-16 base colluvium-14
FS-2002	92 06 24 14 10	2.257	4.533	2.276	TA-49 CB-06
FS-2003	92 06 24 14 02	2.257	6.890	4.633	TA-49 altered B-05 (Bandelier Tuff)
FS-2004	92 06 24 13 25	2.257	5.778	3.521	TA-49 BW-02
FS-2005	92 06 24 12 59	2.236	4.871	2.635	TA-49 Bwk-04
FS-2006	92 06 24 09 50	2.256	6.039	3.783	TA-16 WTT1 CO3 Zone
FS-2007	92 06 24 09 16	2.260	5.558	3.298	TA-16 CO3 Zone
FS-2008	92 06 15 16 00	2.257	6.334	4.077	TA-16 WTT1 oxd. CVZP-10
FS-2009	92 06 15 15 45	2.262	6.498	4.236	TA-16 WTT1 reduced CVZP-01
FS-2010	92 08 07 14 22	2.259	5.727	3.468	EGG Btb-06
FS-2011	92 08 07 14 16	2.255	6.605	4.350	EGG Bw-03
FS-2012	92 08 07 14 22	2.262	6.347	4.085	EGG CB-04
FS-2013	92 08 07 14 12	2.257	6.646	4.389	EGG Bt-02
FS-2014F	92 08 01 15 49	2.236	4.530	2.294	ULAC BAb-05 Fine Fraction
FS-2015F	92 08 01 15 53	2.261	6.658	4.397	ULAC Bwb-06 Fine Fraction
FS-2016F	92 08 01 15 55	2.260	6.411	4.151	ULAC C-07 Fine Fraction
FS-2017F	92 08 01 15 41	2.200	5.073	2.873	ULAC A2-02 Fine Fraction
FS-2018F	92 08 01 15 38	2.261	5.010	2.749	ULAC A1-01 Fine Fraction
FS-2019F	92 08 01 15 46	2.263	5.942	3.679	ULAC BW-04 Fine Fraction
FS-2020F	92 08 01 15 44	2.262	6.603	4.341	ULAC BA-03 Fine Fraction
FS-2021	92 08 07 14 06	2.258	6.638	4.380	EGG A-01
FS-2022	92 08 07 15 27	2.257	5.767	3.510	EGG CBb-07
FS-2023	92 08 07 14 26	2.258	5.977	3.719	EGG C-05
FS-2024	92 08 01 15 44	2.268	6.572	4.304	ULAC BA-03 Fine Fraction, FS-2020F Duplicate
FS-2025	92 06 24 09 50	2.264	6.115	3.851	TA-16 WTT1 CO3 Zone, FS-2006 Duplicate
FS-2026	92 06 10 12 50	2.256	5.988	3.732	TA-69-25S weathered R
FS-2027	92 06 08 14 39	2.252	6.699	4.447	TA-16-10 BW
FS-2028	92 06 08 14 10	2.261	6.893	4.632	TA-69 Bt2
FS-2029	92 06 10 13 29	2.257	5.687	3.430	TA-69-25S fracture fill
FS-2030	92 06 18 14 00	2.263	5.206	2.943	TA-16-10 CO3 rich
FS-2031	92 06 10 12 10	2.257	7.330	5.073	TA-69 South 24 C1 Bt
FS-2032	92 06 12 12 17	2.258	6.775	4.517	TA-39-36-A1
FS-2033	92 06 05 16 20	2.260	6.484	4.224	TA-69-2M
FS-2034	92 06 12 13 14	2.257	7.068	4.811	TA-39-40 Bwkb
FS-2035	92 06 08 14 51	2.262	7.212	4.950	TA-69NA-11
FS-2036	92 06 08 14 51	2.258	7.115	4.857	TA-69NA-11, FS-2035 Duplicate
FS-2037		2.257	6.742	4.485	TA-69E
FS-2038		2.262	6.058	3.796	TA-69 South Br
FS-2039		2.256	5.823	3.567	TA-69 Crb
FS-2040		2.258	5.954	3.696	TA-69 BC
FS-2041	92 06 18 11 30	2.259	5.865	3.606	TA-16-06
FS-2042		2.257	6.985	4.728	TA-69-A (11)
FS-2043	92 06 08 13 48	2.259	6.006	3.747	TA-69-07N 2Bt3b
FS-2044	92 06 10 11 50	2.256	6.867	4.611	TA-69S-23 2Bt2b
FS-2045	92 06 10 11 05	2.259	6.701	4.442	TA-69S-19 A
FS-2046	92 06 12 13 30	2.255	6.167	3.912	TA-39-S-41 Btkb
FS-2047	92 06 12 13 30	2.262	6.264	4.002	TA-39-S-41 Btkb, FS-2046 Duplicate
FS-2048	92 06 18 11 15	2.260	5.922	3.662	TA-16 WTT1-05
FS-2049	92 06 18 11 45	2.238	6.505	4.267	TA-16 WTT1-07
FS-2050	92 06 10 11 35	2.259	6.242	3.983	TA-16 Org. Mat.
FS-2051		2.260	6.486	4.226	TA-16-07
FS-2052		2.261	7.321	5.060	TA-69 AE
FS-2053	92 06 12 12 34	2.257	7.037	4.780	TA-39-37-A2
FS-2054	92 06 18 13 45	2.263	5.953	3.690	TA-16-A-09
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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	Na	Standard Deviation	Mg	Standard Deviation	Al	Standard Deviation	Cl	Standard Deviation	K	Standard Deviation	Ca	Standard Deviation
FS-2000	27380.00	1259.48	<3815.00		69530.00	1946.84	<177.30		32050.00	2531.95	5988.00	562.87
FS-2000F	25130.00	1331.89	<2667.00		66160.00	1918.64	<134.70		33890.00	2677.31	6475.00	582.75
FS-2001	14770.00	620.34	4949.00	608.73	64430.00	1804.04	<77.85		25280.00	1971.84	4691.00	394.04
FS-2002	23530.00	1105.91	8239.00	1128.74	87080.00	2525.32	854.10	78.58	31780.00	2764.86	14190.00	1007.49
FS-2003	14600.00	744.60	5543.00	598.64	66990.00	1875.72	<79.98		23240.00	1905.68	3434.00	326.21
FS-2004	15990.00	671.58	6648.00	784.46	88760.00	2485.28	111.20	15.46	19860.00	1827.12	12430.00	770.66
FS-2005	19270.00	905.69	6870.00	858.75	85100.00	2382.80	325.20	63.74	26770.00	2543.15	18940.00	1174.28
FS-2006	16665.00	875.03	6719.00	645.95	89265.00	2499.42	129.00	22.06	24270.00	2529.73	9609.50	643.97
FS-2007	19020.00	817.86	5634.00	777.49	88020.00	2464.56	208.90	23.40	23140.00	2013.18	14170.00	2840.89
FS-2008	19310.00	868.95	<3767.00		69380.00	1942.64	<162.80		26430.00	2220.12	3278.00	406.47
FS-2009	18180.00	927.18	4434.00	576.42	67790.00	1898.12	<78.61		24040.00	1971.28	2914.00	294.31
FS-2010	20280.00	872.04	3237.00	702.43	75150.00	2104.20	152.60	21.97	32330.00	2974.36	5410.00	1920.55
FS-2011	22750.00	978.25	4271.00	751.70	68240.00	1910.72	104.10	48.82	29660.00	2402.46	3675.00	389.55
FS-2012	22460.00	1033.16	5753.00	811.17	71800.00	2010.40	193.90	24.24	31860.00	2516.94	4882.00	468.67
FS-2013	23840.00	1263.52	3032.00	551.82	73520.00	2058.56	158.30	21.05	31980.00	2462.46	5598.00	453.44
FS-2014F	21320.00	916.76	<3027.00		60360.00	1750.44	<131.20		29610.00	2694.51	13870.00	957.03
FS-2015F	27580.00	1323.84	<3279.00		66310.00	1856.68	<152.60		35760.00	2860.80	3368.00	399.78
FS-2016F	28530.00	1540.62	<1971.00		67540.00	1891.12	<104.90		36210.00	2860.59	1911.00	328.69
FS-2017F	20140.00	866.02	3400.00	710.60	59970.00	1739.13	<124.70		21790.00	2070.05	18670.00	1138.87
FS-2018F	20490.00	963.03	<4325.00		59710.00	1731.59	<198.20		27670.00	2434.96	13850.00	997.20
FS-2019F	26180.00	1256.64	1807.00	495.12	70850.00	1983.80	<111.30		34900.00	3036.30	5836.00	501.90
FS-2020F	27050.00	1204.07	<2906.00		67255.00	1883.14	<128.35		29150.00	2539.21	6687.00	550.51
FS-2021	24540.00	1153.38	<3287.00		67700.00	1895.60	203.90	34.05	31960.00	2620.72	4238.00	436.51
FS-2022	19420.00	1009.84	3607.00	595.16	71290.00	1996.12	202.50	23.08	28340.00	2380.56	6782.00	522.21
FS-2023	22950.00	963.90	4099.00	705.03	73390.00	2054.92	198.20	35.48	29480.00	2505.80	7088.00	545.78
FS-2026	18860.00	810.98	6084.00	748.33	104900.00	2937.20	239.60	24.44	21460.00	2103.08	5921.00	473.68
FS-2027	13530.00	676.50	<2693.00		58090.00	1626.52	<119.10		22260.00	1958.88	4454.00	400.86
FS-2028	12270.00	625.77	6441.00	573.25	91170.00	2461.59	69.12	15.76	21030.00	1976.82	5156.00	391.86
FS-2029	3392.00	149.25	13410.00	871.65	113600.00	3067.20	127.60	20.93	13040.00	1447.44	9127.00	2418.66
FS-2030	17090.00	769.05	8150.00	986.15	77800.00	2178.40	241.60	34.79	23010.00	2324.01	17070.00	1890.57
FS-2031	15150.00	818.10	3490.00	471.15	68400.00	1915.20	<80.92		26180.00	2853.62	2010.00	245.22
FS-2032	15020.00	630.84	5029.00	663.83	60890.00	1704.92	<83.99		21740.00	2174.00	6357.00	470.42
FS-2033	10120.00	495.88	10610.00	870.02	109200.00	2948.40	<110.00		17160.00	1767.48	8748.00	586.12
FS-2034	16040.00	802.00	5828.00	582.80	71260.00	1995.28	<79.81		20410.00	1796.08	10230.00	611.80
FS-2035	14745.00	662.82	1785.00	442.68	51680.00	1472.84	<114.57		23130.00	2090.34	3956.50	395.61
FS-2037	15560.00	871.36	2347.00	424.81	55360.00	1550.08	<79.86		20780.00	2057.22	1932.00	245.36
FS-2038	10300.00	463.50	6404.00	627.59	79110.00	2215.08	<78.04		15090.00	1690.08	12000.00	712.00
FS-2039	26860.00	1262.42	<3670.00		81180.00	2273.04	855.60	68.45	42000.00	4116.00	<3002.00	
FS-2040	22090.00	1148.68	5070.00	633.75	92220.00	2582.16	939.50	72.34	26880.00	3118.08	5165.00	456.02
FS-2041	14780.00	650.32	7443.00	826.17	94120.00	2635.36	123.40	18.51	20640.00	2621.28	7021.00	570.93
FS-2042	13430.00	604.35	<2631.00		49680.00	1391.04	<114.80		22420.00	2354.10	3543.00	354.30
FS-2043	16880.00	725.84	5652.00	678.24	99700.00	2791.60	573.70	50.49	24880.00	1666.96	5742.00	451.62
FS-2044	10850.00	509.95	6106.00	622.81	79360.00	2222.08	<100.80		19350.00	1296.45	5520.00	447.12
FS-2045	14740.00	781.22	<1597.00		54510.00	1526.28	<79.37		23090.00	1547.03	5468.00	421.64
FS-2046	8286.00	368.41	12770.00	913.74	100470.00	2762.26	85.70	16.63	18630.00	1369.10	13425.00	772.22
FS-2048	16960.00	898.88	6956.00	681.69	88720.00	2484.16	159.50	19.94	25760.00	1751.68	8316.00	590.44
FS-2049	14720.00	632.96	5172.00	636.16	87870.00	2460.36	110.60	49.00	23960.00	1605.32	6299.00	466.13
FS-2050	10710.00	492.66	5470.00	672.81	69440.00	1944.32	<107.00		18800.00	1391.20	8071.00	564.97
FS-2051	13880.00	707.88	6732.00	605.88	93850.00	2533.95	114.30	16.46	21480.00	1460.64	7357.00	529.70
FS-2052	15070.00	648.01	1787.00	427.09	52940.00	1482.32	<76.91		23010.00	1541.67	3605.00	342.48
FS-2053	14190.00	652.74	4123.00	560.73	59180.00	1657.04	<115.80		21950.00	1492.60	6453.00	490.41
FS-2054	17740.00	940.22	3995.00	547.32	76830.00	2151.24	162.30	20.45	24770.00	1709.13	9582.00	632.41
FS-2055	13420.00	577.06	4405.00	572.65	50280.00	1458.12	<85.43		18860.00	1339.06	6587.00	520.37
FS-2056	11990.00	563.53	6625.00	689.00	85930.00	2406.04	<102.90		21460.00	1459.28	6274.00	470.55
FS-2057	13580.00	645.86	5508.00	614.71	69245.00	1938.86	<81.01		22935.00	1559.58	13150.00	755.97

	Sc	Standard Deviation	Ti	Standard Deviation	V	Standard Deviation	Cr	Standard Deviation	Mn	Standard Deviation	Fe	Standard Deviation
FS-2000	2.98	0.16	1284.00	296.60	18.94	2.48	10.90	0.82	1161.00	45.28	15120.00	1026.44
FS-2000F	3.88	0.22	1951.00	360.93	20.61	2.82	22.54	1.60	1552.00	74.50	16030.00	817.53
FS-2001	6.74	0.36	3688.00	505.26	59.40	2.97	45.25	2.85	507.30	20.80	22260.00	1494.42
FS-2002	5.88	0.31	2718.00	453.91	36.54	2.92	19.42	1.48	480.10	19.68	21750.00	1457.25
FS-2003	8.09	0.44	4102.00	537.36	60.50	2.90	57.41	3.56	647.70	28.50	27230.00	1470.42
FS-2004	7.76	0.41	2975.00	428.40	66.69	3.47	45.51	3.00	503.50	24.17	29820.00	1997.94
FS-2005	6.70	0.37	3226.00	474.22	49.35	3.31	32.29	2.10	513.10	20.52	25320.00	1291.32
FS-2006	7.80	0.43	3471.00	468.58	59.56	3.04	46.53	2.95	545.80	24.84	28545.00	1498.56
FS-2007	6.81	0.36	3157.00	467.24	56.57	3.17	34.55	2.31	486.90	19.96	26470.00	1508.79
FS-2008	6.36	0.35	3585.00	526.99	51.85	3.37	29.24	1.90	1329.00	51.83	23830.00	1691.91
FS-2009	6.78	0.37	3374.00	441.99	41.55	2.24	47.73	2.96	185.70	8.17	15900.00	810.90
FS-2010	5.94	0.31	2507.00	363.52	34.94	2.38	30.36	2.06	473.00	23.65	21730.00	1260.34
FS-2011	4.29	0.23	1783.00	285.28	24.61	1.94	20.00	1.42	400.80	17.64	18300.00	1152.90
FS-2012	4.82	0.26	1970.00	311.26	31.73	2.44	20.71	1.37	478.00	19.12	19730.00	1302.18
FS-2013	4.91	0.26	2298.00	324.02	34.25	2.16	31.34	2.04	483.40	23.69	21830.00	1266.14
FS-2014F	3.42	0.18	2066.00	382.21	25.17	2.77	14.72	1.31	772.80	36.32	14070.00	759.78
FS-2015F	2.28	0.12	1205.00	219.31	16.25	1.84	9.08	0.72	396.00	15.84	11920.00	701.28
FS-2016F	2.80	0.15	1802.00	282.91	14.62	1.78	18.51	1.28	451.70	21.68	14340.00	711.34
FS-2017F	3.97	0.21	1571.00	391.18	26.25	2.91	20.12	1.51	1449.00	56.51	16020.00	865.08
FS-2018F	3.75	0.21	2323.00	448.34	23.77	2.90	19.71	1.40	1323.00	51.60	14940.00	761.94
FS-2019F	3.83	0.21	1922.00	313.29	22.62	2.06	22.61	1.54	574.70	24.71	16150.00	823.65
FS-2020F	3.02	0.16	1524.00	273.50	15.24	1.96	13.83	1.03	499.90	21.90	14865.00	877.49
FS-2021	3.70	0.20	2472.00	385.63	21.09	2.13	16.75	1.17	501.40	19.55	17870.00	1304.51
FS-2022	5.86	0.33	2812.00	402.12	40.95	2.50	39.25	2.51	494.40	26.70	20820.00	1499.04
FS-2023	5.00	0.27	1606.00	287.47	24.42	2.20	24.60	1.72	429.20	18.03	19520.00	1112.64
FS-2026	7.12	0.38	2372.00	379.52	47.93	2.92	32.40	2.24	404.10	17.78	29270.00	1931.82
FS-2027	5.46	0.29	4648.00	613.54	57.66	3.11	39.03	2.46	530.10	20.67	17430.00	1167.81
FS-2028	9.53	0.54	3885.00	501.17	76.79	3.38	60.04	3.72	251.80	10.83	34390.00	3129.49
FS-2029	13.80	0.73	2310.00	328.02	84.23	3.79	58.35	3.79	194.30	9.72	43370.00	2558.81
FS-2030	5.78	0.32	2634.00	395.10	46.73	3.04	24.04	1.68	472.60	19.85	22390.00	1567.10
FS-2031	6.15	0.35	4070.00	533.17	60.41	2.90	49.86	3.09	703.30	31.65	25580.00	2199.00
FS-2032	5.44	0.29	3707.00	511.57	54.22	2.82	43.13	2.76	557.40	21.74	19590.00	1638.27
FS-2033	11.32	0.61	3647.00	488.70	72.70	3.42	43.94	2.77	205.80	8.23	40310.00	2015.50
FS-2034	7.09	0.39	3672.00	481.03	55.46	2.77	50.29	3.12	468.00	20.59	21680.00	1586.56
FS-2035	4.57	0.24	3743.00	528.16	61.42	3.22	39.83	2.51	1053.55	42.14	21365.00	1173.13
FS-2037	5.12	0.28	4553.00	587.34	50.32	2.52	46.10	2.90	454.60	21.37	15680.00	799.68
FS-2038	8.01	0.42	1617.00	245.78	48.36	2.56	29.16	2.10	189.30	8.33	25110.00	1456.38
FS-2039	4.25	0.23	1434.00	285.37	18.87	2.25	10.86	0.91	326.20	13.37	19170.00	1303.56
FS-2040	7.10	0.42	1645.00	254.98	34.64	2.32	26.74	1.85	232.20	9.98	27010.00	1566.58
FS-2041	7.64	0.41	3025.00	432.58	57.67	3.11	35.65	2.42	438.30	20.16	28090.00	1685.40
FS-2042	4.74	0.26	4413.00	600.17	45.34	2.68	37.61	2.33	658.80	26.35	15580.00	810.16
FS-2043	8.38	0.44	1815.00	284.95	47.35	2.65	30.95	2.14	227.20	11.81	30920.00	2195.32
FS-2044	8.41	0.45	5029.00	658.80	79.45	3.50	46.85	2.90	412.80	16.92	29750.00	1636.25
FS-2045	5.34	0.29	4454.00	579.02	44.54	2.45	52.12	3.18	586.60	25.81	18000.00	918.00
FS-2046	12.41	0.67	2969.00	408.90	83.44	3.75	57.29	3.58	375.70	16.16	40255.00	2310.73
FS-2048	7.59	0.42	2854.00	385.29	52.88	2.75	41.83	2.68	393.00	17.68	28090.00	1460.68
FS-2049	7.44	0.41	2982.00	420.46	62.17	3.11	41.57	2.70	446.20	19.63	26890.00	1532.73
FS-2050	7.18	0.39	4492.00	597.44	68.78	3.30	42.57	2.64	440.60	17.62	25620.00	1639.68
FS-2051	8.77	0.49	3285.00	433.62	62.38	2.93	49.69	3.13	483.50	20.31	32120.00	1670.24
FS-2052	4.42	0.23	4557.00	606.08	55.74	2.79	36.78	2.32	688.80	28.93	15490.00	882.93
FS-2053	5.94	0.32	4386.00	578.95	56.66	2.89	43.97	2.68	615.50	25.24	20850.00	1063.35
FS-2054	6.19	0.34	2904.00	400.75	45.16	2.62	35.99	2.30	493.00	23.17	23710.00	1849.38
FS-2055	4.46	0.24	4193.00	574.44	43.46	2.56	37.38	2.43	531.80	21.80	15110.00	831.05
FS-2056	8.95	0.48	4008.00	525.05	76.78	3.38	45.50	2.82	246.40	10.35	32650.00	1697.00
FS-2057	7.33	0.40	3797.50	509.52	62.10	3.04	49.33	3.10	543.85	22.58	23935.00	1411.04

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	Co	Standard Deviation	Cu	Standard Deviation	Zn	Standard Deviation	Ga	Standard Deviation	As	Standard Deviation	Se	Standard Deviation
FS-2000	2.80	0.21	<402.90		54.57	22.81	<60.79		<1.98		<3.41	
FS-2000F	4.06	0.22	<349.00		64.74	9.06	<45.31		1.63	0.43	<4.63	
FS-2001	8.58	0.46	<204.30		55.22	8.12	<33.64		4.38	0.56	<2.58	
FS-2002	5.93	0.44	<456.60		<13.48		<83.90		4.76	0.88	<5.94	
FS-2003	9.82	0.53	<215.30		<19.20		<35.48		7.01	0.82	<5.38	
FS-2004	9.10	0.48	<238.30		58.92	9.13	<41.37		2.24	0.44	<3.05	
FS-2005	7.55	0.48	<400.10		<10.92		<75.61		4.86	0.80	<5.72	
FS-2006	9.12	0.49	<238.25		<21.22		<43.65		5.33	0.68	<5.59	
FS-2007	8.59	0.54	<262.50		53.35	8.59	<46.46		3.73	0.60	<2.99	
FS-2008	10.26	0.56	<387.20		<28.15		<63.24		7.36	0.91	<4.67	
FS-2009	4.00	0.22	<210.30		<20.36		<40.80		1.42	0.32	<4.98	
FS-2010	6.67	0.37	<258.30		70.29	10.19	<48.42		2.06	0.39	<2.79	
FS-2011	4.27	0.24	<228.70		57.12	8.34	<41.28		1.53	0.33	<2.24	
FS-2012	4.87	0.31	<335.10		<35.21		<63.77		2.51	0.54	<4.22	
FS-2013	5.94	0.31	<245.20		45.16	6.64	<42.02		2.51	0.45	<4.76	
FS-2014F	4.12	0.24	<321.90		64.31	10.03	<55.96		<3.23		<2.91	
FS-2015F	1.95	0.19	<348.50		<23.40		<66.71		2.13	0.51	<3.24	
FS-2016F	3.04	0.17	<266.90		41.60	6.07	<46.54		2.03	0.46	<3.86	
FS-2017F	4.83	0.28	<330.20		146.20	19.59	<50.69		<2.94		<2.71	
FS-2018F	3.87	0.33	<453.70		94.92	39.01	<78.60		3.78	0.70	<4.62	
FS-2019F	4.01	0.23	<284.30		45.38	6.76	<50.46		<2.58		<4.52	
FS-2020F	3.03	0.20	<306.85		60.89	8.71	<61.28		<3.43		<2.78	
FS-2021	3.87	0.26	<344.50		<32.04		<70.13		2.80	0.58	<3.85	
FS-2022	6.78	0.37	<252.00		<20.27		<47.78		4.99	0.67	<5.37	
FS-2023	5.29	0.30	<258.10		61.44	9.09	<51.55		3.64	0.62	<2.56	
FS-2026	9.31	0.53	<245.10		65.90	9.75	<51.54		4.91	0.69	<2.88	
FS-2027	10.91	0.59	<276.50		<8.09		<60.63		7.56	0.92	<4.13	
FS-2028	7.39	0.39	<186.40		<21.10		<42.93		8.51	0.96	<5.57	
FS-2029	6.82	0.48	<158.90		106.70	14.83	<44.23		10.30	1.54	<3.53	
FS-2030	6.92	0.44	<367.50		<15.23		<83.28		4.95	0.75	<5.00	
FS-2031	12.32	0.64	<216.50		<16.69		<41.49		7.64	0.88	<4.67	
FS-2032	8.29	0.45	<209.10		49.72	7.51	<44.48		2.99	0.47	<2.48	
FS-2033	7.12	0.41	<250.50		60.40	25.97	<69.66		8.23	0.96	<5.45	
FS-2034	9.75	0.52	<207.40		65.70	9.20	<44.25		4.21	0.58	<4.89	
FS-2035	13.73	0.73	<273.30		<7.78		<54.17		7.58	0.93	<3.19	
FS-2037	22.53	1.19	<207.80		<16.24		<45.99		5.25	0.65	<4.01	
FS-2038	4.19	0.39	<180.50		66.97	9.71	<49.31		3.26	0.52	<2.71	
FS-2039	1.72	0.22	<384.20		<34.34		<99.75		<5.21		<4.17	
FS-2040	4.28	0.24	<256.20		<20.43		<61.53		4.90	0.69	<5.31	
FS-2041	7.54	0.41	<231.40		<10.28		<71.07		3.90	0.63	<3.06	
FS-2042	7.29	0.41	<271.40		<10.22		<80.74		5.68	0.75	<1.96	
FS-2043	5.24	0.29	<220.40		76.30	10.91	<20.15		3.71	0.51	<2.82	
FS-2044	8.19	0.45	<249.70		<23.06		17.68	3.34	7.33	0.83	<4.62	
FS-2045	8.22	0.48	<208.50		<16.77		<16.54		5.35	0.60	<4.69	
FS-2046	10.95	0.60	<216.35		62.80	25.75	20.13	3.51	8.27	0.91	<4.32	
FS-2048	7.24	0.39	<229.30		<21.55		<20.33		4.45	0.56	<5.39	
FS-2049	7.75	0.42	<212.00		<8.99		<18.67		4.58	0.58	<2.64	
FS-2050	7.91	0.45	<261.30		<13.52		<25.08		7.26	0.82	<4.65	
FS-2051	9.02	0.48	<208.70		<21.89		13.99	3.72	5.36	0.63	<5.43	
FS-2052	14.65	0.79	<199.20		19.97	4.23	<17.55		5.11	0.61	<2.20	
FS-2053	9.41	0.52	<271.10		<21.93		<26.60		5.04	0.63	<4.28	
FS-2054	6.56	0.35	<242.20		<20.14		<21.64		3.36	0.67	<5.10	
FS-2055	7.06	0.39	<212.30		43.67	7.03	<20.12		3.91	0.51	<2.56	
FS-2056	7.00	0.40	<244.20		<37.68		17.06	3.75	9.80	1.08	<4.86	
FS-2057	9.16	0.49	<207.50		<14.39		7.81	2.35	5.12	0.61	<1.89	

	Br	Standard Deviation	Rb	Standard Deviation	Sr	Standard Deviation	Zr	Standard Deviation	Ag	Standard Deviation	In	Standard Deviation
FS-2000	6.52	0.78	113.90	5.81	<498.80		293.00	49.61	<2.46		<0.17	
FS-2000F	11.69	1.26	103.90	5.61	<380.90		314.50	42.77	<3.62		<0.27	
FS-2001	<2.36		108.10	5.95	<236.00		399.20	53.49	<2.75		<0.21	
FS-2002	4.90	0.71	151.00	8.15	<501.70		174.00	39.50	<4.73		<0.41	
FS-2003	<2.02		134.40	6.85	<221.20		485.20	98.98	<4.25		<0.17	
FS-2004	7.35	0.85	126.90	6.98	<278.30		225.00	42.53	<3.44		<0.25	
FS-2005	11.62	1.30	131.70	7.51	<455.60		319.30	60.99	<4.62		<0.17	
FS-2006	2.43	0.45	143.15	7.44	<231.65		279.70	59.59	<4.66		<0.13	
FS-2007	1.45	0.42	132.40	7.28	<291.10		246.50	56.20	<3.36		<0.26	
FS-2008	<3.79		119.10	6.19	<526.20		439.80	77.40	<3.67		<0.16	
FS-2009	1.97	0.41	121.50	6.20	<170.50		441.00	53.80	<3.88		<0.15	
FS-2010	3.10	0.55	131.10	7.08	<279.30		290.70	47.97	<3.07		<0.26	
FS-2011	1.67	0.41	122.40	6.36	<241.20		265.10	37.64	<2.34		<0.23	
FS-2012	6.74	0.98	124.80	6.49	<365.20		392.70	50.27	<3.17		<0.30	
FS-2013	2.12	0.34	120.50	6.27	<219.40		377.50	47.19	<3.54		<0.19	
FS-2014F	9.79	1.31	101.50	5.99	<383.90		203.70	66.41	<2.92		<0.33	
FS-2015F	2.54	0.42	106.00	5.41	<356.00		273.20	63.38	<2.27		<0.31	
FS-2016F	2.39	0.46	104.00	5.30	<229.50		327.80	45.89	<2.89		<0.20	
FS-2017F	12.13	1.37	93.13	5.77	<444.70		238.10	37.14	<2.83		<0.14	
FS-2018F	6.26	0.81	104.60	5.75	<609.90		332.40	47.53	<3.52		<0.42	
FS-2019F	3.05	0.42	111.40	5.90	<255.50		323.10	41.68	<3.42		<0.21	
FS-2020F	3.08	0.49	88.79	4.79	<328.95		296.15	48.10	<2.34		<0.29	
FS-2021	<3.93		109.80	5.71	<373.10		456.00	54.72	<2.85		<0.31	
FS-2022	2.10	0.61	136.10	7.08	<236.00		432.00	78.19	<4.24		<0.20	
FS-2023	7.74	1.26	130.70	6.93	<271.50		226.00	70.29	<2.75		<0.26	
FS-2026	2.79	0.43	93.07	5.96	<255.90		281.00	44.96	<3.23		<0.25	
FS-2027	2.74	0.70	90.69	5.17	<339.80		585.90	69.72	<3.20		<0.25	
FS-2028	9.28	1.18	110.70	6.20	<164.90		488.90	58.67	<4.60		0.07	0.03
FS-2029	9.34	1.17	104.80	6.92	<185.90		<175.70		<4.41		<0.17	
FS-2030	8.90	1.01	122.90	6.76	<417.30		282.90	67.61	<4.05		<0.33	
FS-2031	4.14	0.56	105.90	5.82	<221.20		522.20	60.05	<3.72		<0.17	
FS-2032	2.73	0.60	90.73	5.17	<250.70		449.70	70.60	<2.57		<0.21	
FS-2033	10.29	1.15	112.30	6.63	<270.00		344.30	54.06	<4.70		<0.23	
FS-2034	7.24	0.81	114.30	6.17	<198.80		344.20	77.45	<3.95		<0.16	
FS-2035	1.58	0.39	89.81	5.21	<370.15		620.55	74.15	<2.70		<0.26	
FS-2037	2.03	0.29	87.75	5.09	<196.60		636.70	78.31	<3.66		<0.16	
FS-2038	4.61	0.65	64.97	4.68	<191.90		<128.40		<3.22		<0.19	
FS-2039	<4.67		98.15	5.50	<383.20		336.40	45.75	<3.25		<0.34	
FS-2040	4.86	0.57	107.80	6.14	<199.90		277.70	41.10	<4.46		<0.19	
FS-2041	2.66	0.58	122.60	7.11	<261.20		169.50	29.66	<3.36		<0.24	
FS-2042	<3.23		83.60	4.60	<351.30		666.80	76.02	<2.89		<0.25	
FS-2043	5.06	0.78	87.40	5.42	<216.80		279.80	49.24	<2.59		<0.22	
FS-2044	3.97	0.48	114.70	5.96	<295.10		440.20	88.48	<3.82		<0.23	
FS-2045	<1.77		87.68	4.82	170.40	55.55	704.30	78.18	<3.47		<0.16	
FS-2046	12.26	1.40	111.00	6.49	<259.05		247.00	47.42	1.61	0.51	<0.21	
FS-2048	2.89	0.52	139.80	7.27	<213.40		260.20	66.09	<4.53		<0.18	
FS-2049	1.71	0.66	121.20	6.54	<235.60		192.90	61.92	<2.97		<0.21	
FS-2050	9.14	0.99	104.30	5.63	<317.80		400.40	52.45	<3.74		<0.24	
FS-2051	3.71	0.44	139.80	7.27	<204.80		276.70	50.36	<4.63		<0.16	
FS-2052	<2.21		87.68	5.00	<247.50		445.90	77.59	<2.24		<0.21	
FS-2053	4.59	0.61	102.00	5.41	<339.00		670.00	76.38	<3.21		<0.25	
FS-2054	2.53	0.35	118.30	6.39	<223.10		288.70	49.37	<4.17		<0.18	
FS-2055	2.53	0.41	73.69	4.50	<257.00		438.30	53.91	<2.62		<0.22	
FS-2056	9.80	1.08	104.50	5.75	<267.60		435.50	59.23	<3.99		<0.22	
FS-2057	18.91	2.05	99.21	5.55	<224.10		417.75	52.54	<3.53		<0.18	

	Sb	Standard Deviation	I	Standard Deviation	Cs	Standard Deviation	Ba	Standard Deviation	La	Standard Deviation	Ce	Standard Deviation
FS-2000	<0.38		<12.98		3.15	0.18	314.20	68.50	49.52	2.82	91.17	4.10
FS-2000F	0.46	0.08	<22.70		3.57	0.23	516.70	34.10	49.25	2.66	93.69	4.12
FS-2001	0.46	0.07	<13.83		4.01	0.35	478.60	146.45	44.25	2.48	91.94	4.05
FS-2002	0.47	0.13	<32.97		5.09	0.32	629.00	42.77	42.11	2.32	85.66	4.01
FS-2003	1.05	0.10	<12.97		6.29	0.38	745.10	43.96	75.92	3.87	84.88	3.98
FS-2004	0.28	0.07	<16.62		6.04	0.35	553.20	138.85	43.29	2.42	81.92	3.69
FS-2005	0.43	0.09	<30.49		5.67	0.36	697.50	43.94	41.40	2.40	78.10	3.67
FS-2006	0.62	0.09	<13.85		6.73	0.39	768.15	53.54	48.12	2.45	88.25	4.06
FS-2007	<0.25		7.06	2.18	5.32	0.45	477.10	39.12	44.05	2.51	88.07	3.96
FS-2008	0.53	0.09	<34.89		5.35	0.34	587.00	36.98	48.76	2.83	101.30	4.56
FS-2009	0.52	0.08	<9.93		4.86	0.29	635.00	45.08	56.42	2.82	70.37	3.10
FS-2010	0.27	0.08	<16.37		5.31	0.35	258.60	72.41	47.14	2.64	93.72	4.12
FS-2011	0.31	0.07	<14.17		3.73	0.23	230.50	88.97	54.42	2.88	105.80	4.66
FS-2012	0.54	0.11	<24.48		4.29	0.27	319.10	26.80	51.47	3.04	95.81	4.31
FS-2013	0.45	0.08	<12.98		4.12	0.26	387.10	36.00	55.78	2.68	105.10	4.73
FS-2014F	<0.30		<22.55		3.27	0.20	296.90	48.39	43.98	2.55	84.55	3.80
FS-2015F	<0.38		<23.60		2.87	0.18	206.30	20.63	41.81	2.34	82.01	3.69
FS-2016F	<0.27		<13.56		2.76	0.17	288.30	23.93	48.68	2.48	97.42	4.29
FS-2017F	<0.27		<26.59		2.91	0.20	343.20	97.13	45.65	2.42	85.68	3.86
FS-2018F	0.43	0.10	<40.59		3.23	0.22	493.00	56.69	43.06	2.37	81.71	3.84
FS-2019F	0.34	0.09	<15.01		3.61	0.21	416.90	29.60	55.04	2.70	103.30	4.55
FS-2020F	<0.31		<20.74		2.68	0.22	339.85	25.76	45.33	2.38	84.34	3.79
FS-2021	0.37	0.08	<24.77		3.51	0.20	279.90	51.50	55.88	3.07	100.90	4.54
FS-2022	0.71	0.09	<13.80		5.12	0.30	542.50	37.43	48.58	2.57	99.60	4.58
FS-2023	0.27	0.07	<15.87		4.38	0.32	386.20	45.19	52.65	2.79	101.70	4.47
FS-2026	0.52	0.08	<15.59		5.19	0.49	434.60	102.57	53.74	2.90	132.90	5.85
FS-2027	0.97	0.10	<22.15		3.70	0.21	587.80	122.85	36.69	2.05	76.51	3.52
FS-2028	1.01	0.09	6.52	1.56	7.23	0.41	634.50	45.05	66.27	3.38	117.30	5.40
FS-2029	1.27	0.11	6.89	1.56	8.65	0.61	183.80	39.33	41.48	2.32	66.65	3.07
FS-2030	0.40	0.09	29.42	4.06	4.97	0.30	828.90	51.39	37.61	2.26	72.07	3.19
FS-2031	1.11	0.10	<13.13		4.65	0.26	764.00	45.08	42.94	2.10	99.55	4.58
FS-2032	0.47	0.07	<14.83		3.14	0.24	463.70	112.68	39.56	2.22	70.72	3.18
FS-2033	0.73	0.10	<18.58		7.86	0.45	524.70	86.58	49.04	3.14	93.92	4.32
FS-2034	0.60	0.08	<11.85		5.31	0.30	610.80	39.70	40.17	1.93	76.08	3.50
FS-2035	0.81	0.08	<23.57		2.79	0.22	528.00	74.75	37.73	2.08	73.51	3.35
FS-2037	0.75	0.08	<11.68		3.41	0.20	690.00	43.47	39.89	1.99	100.30	4.61
FS-2038	1.15	0.10	6.36	1.81	4.97	0.34	288.00	34.85	36.49	1.82	82.35	3.71
FS-2039	<0.43		<25.62		3.24	0.20	374.50	83.51	70.87	4.11	116.80	5.26
FS-2040	0.64	0.10	<12.14		5.10	0.29	558.70	43.02	53.99	2.81	107.50	4.95
FS-2041	0.29	0.07	<15.49		5.87	0.44	560.00	45.36	47.98	2.49	80.56	3.63
FS-2042	1.08	0.09	<23.28		2.86	0.18	609.90	45.13	35.32	2.05	68.96	3.17
FS-2043	0.53	0.10	<13.26		5.59	0.37	356.20	82.99	51.35	2.77	102.90	4.51
FS-2044	0.72	0.09	<18.85		6.35	0.36	543.60	48.92	37.70	2.11	67.78	3.12
FS-2045	0.88	0.10	<12.42		3.33	0.20	614.90	36.89	36.52	1.90	71.59	3.15
FS-2046	0.72	0.09	<16.77		8.26	0.61	371.50	45.32	42.03	2.39	99.81	4.54
FS-2048	0.47	0.10	<12.48		6.03	0.36	723.70	44.15	44.67	2.28	84.82	3.90
FS-2049	0.46	0.08	<13.70		5.97	0.39	508.80	138.39	47.55	2.47	79.84	3.59
FS-2050	1.00	0.11	<20.70		5.45	0.32	493.90	46.43	39.86	2.15	61.55	2.89
FS-2051	0.59	0.08	<12.16		7.11	0.48	648.10	45.37	42.89	2.27	81.82	3.76
FS-2052	0.61	0.09	<14.73		2.49	0.18	548.80	35.12	37.10	1.97	74.64	3.28
FS-2053	<0.34		<22.38		3.54	0.25	502.10	33.64	39.31	2.20	81.09	3.71
FS-2054	0.52	0.11	<13.41		4.79	0.28	579.70	38.26	39.32	2.12	87.41	4.11
FS-2055	0.89	0.10	<15.22		2.66	0.22	415.30	33.22	32.95	1.98	58.19	2.62
FS-2056	1.03	0.10	<17.94		6.36	0.36	511.20	71.06	54.60	3.06	104.40	4.70
FS-2057	0.60	0.09	5.64	2.07	5.09	0.39	631.40	80.83	40.70	2.14	74.56	3.19

	Nd	Standard Deviation	Sm	Standard Deviation	Eu	Standard Deviation	Tb	Standard Deviation	Dy	Standard Deviation	Yb	Standard Deviation
FS-2000	38.64	3.40	7.33	0.34	0.46	0.05	1.05	0.11	5.49	0.50	4.43	0.28
FS-2000F	33.68	3.33	5.96	0.29	0.70	0.06	1.00	0.10	4.21	0.45	3.02	0.20
FS-2001	26.35	3.29	5.89	0.28	1.04	0.08	0.84	0.10	3.37	0.37	3.33	0.46
FS-2002	31.65	3.67	5.48	0.28	0.82	0.06	<0.16		4.07	0.44	3.12	0.27
FS-2003	53.21	4.52	9.04	0.42	1.65	0.09	1.29	0.12	5.93	0.48	4.20	0.24
FS-2004	27.34	3.85	5.41	0.27	0.91	0.08	0.59	0.08	5.43	0.56	3.04	0.38
FS-2005	26.79	2.60	5.48	0.25	0.79	0.05	0.68	0.07	3.74	0.43	1.61	0.26
FS-2006	37.76	3.66	5.68	0.27	1.14	0.06	0.90	0.09	4.96	0.45	3.43	0.20
FS-2007	24.19	3.82	5.32	0.27	0.85	0.08	0.63	0.07	3.69	0.47	3.50	0.26
FS-2008	38.22	3.63	7.50	0.35	0.93	0.05	0.90	0.08	4.91	0.51	3.96	0.25
FS-2009	43.48	3.83	6.47	0.31	1.24	0.09	0.93	0.09	5.37	0.43	3.34	0.21
FS-2010	35.84	4.16	6.11	0.28	0.74	0.04	1.14	0.11	6.12	0.61	4.49	0.28
FS-2011	38.33	3.91	7.24	0.34	0.59	0.05	1.18	0.12	7.21	0.63	4.28	0.54
FS-2012	41.69	3.79	8.14	0.38	0.63	0.05	1.06	0.10	6.02	0.55	4.98	0.30
FS-2013	41.82	3.72	6.91	0.32	0.72	0.05	1.15	0.10	6.05	0.49	3.75	0.14
FS-2014F	18.17	2.11	4.79	0.23	0.51	0.03	0.74	0.09	3.43	0.53	2.26	0.41
FS-2015F	34.73	3.20	6.01	0.29	0.40	0.04	0.88	0.09	5.23	0.48	3.89	0.26
FS-2016F	35.11	3.23	5.38	0.26	0.57	0.05	0.91	0.09	4.71	0.42	2.57	0.18
FS-2017F	29.97	4.05	5.11	0.25	0.62	0.06	0.88	0.11	3.35	0.52	3.04	0.24
FS-2018F	26.02	2.39	6.82	0.33	0.58	0.04	0.88	0.08	4.91	0.56	3.97	0.26
FS-2019F	39.52	3.64	6.28	0.30	0.64	0.03	0.86	0.08	4.50	0.42	3.06	0.20
FS-2020F	31.31	3.25	5.08	0.24	0.56	0.04	0.64	0.06	3.61	0.41	2.63	0.28
FS-2021	43.08	3.83	8.42	0.40	0.57	0.07	1.21	0.12	6.13	0.59	4.75	0.28
FS-2022	47.14	4.29	6.89	0.33	0.91	0.07	1.27	0.14	6.53	0.63	4.48	0.40
FS-2023	32.73	4.09	6.55	0.31	0.57	0.06	1.12	0.11	6.67	0.63	3.85	0.46
FS-2026	20.28	3.93	5.67	0.26	0.79	0.08	0.76	0.09	3.77	0.46	3.34	0.22
FS-2027	21.96	2.24	5.74	0.28	0.92	0.09	<0.10		4.14	0.40	3.62	0.22
FS-2028	45.76	4.21	7.05	0.33	1.31	0.07	0.94	0.10	5.55	0.46	3.25	0.32
FS-2029	44.13	6.05	4.70	0.22	0.66	0.05	0.40	0.09	4.71	0.44	2.66	0.23
FS-2030	28.83	3.57	5.35	0.27	0.75	0.05	0.68	0.07	3.93	0.42	3.83	0.26
FS-2031	29.93	3.02	5.24	0.25	1.06	0.07	0.69	0.08	3.85	0.34	2.81	0.17
FS-2032	32.01	3.94	5.65	0.27	0.87	0.06	0.75	0.08	5.82	0.56	3.97	0.36
FS-2033	36.27	3.92	6.34	0.30	0.92	0.06	0.71	0.10	4.53	0.54	3.36	0.24
FS-2034	31.55	3.22	5.20	0.25	1.03	0.07	0.82	0.08	4.72	0.40	3.28	0.24
FS-2035	31.65	3.52	5.05	0.24	0.86	0.09	0.70	0.09	3.94	0.44	3.54	0.19
FS-2037	31.70	3.30	5.10	0.24	1.06	0.08	0.76	0.07	4.34	0.43	3.41	0.19
FS-2038	12.44	1.68	4.22	0.21	0.50	0.05	0.43	0.07	3.23	0.36	2.08	0.26
FS-2039	54.83	4.93	11.41	0.54	0.87	0.05	1.26	0.12	6.58	0.63	4.82	0.30
FS-2040	37.03	3.81	5.30	0.27	0.65	0.06	0.74	0.07	4.53	0.39	3.01	0.20
FS-2041	25.26	4.22	5.42	0.25	0.85	0.06	0.64	0.07	4.07	0.46	3.42	0.21
FS-2042	25.06	2.86	5.47	0.26	0.82	0.04	0.71	0.08	4.34	0.40	4.01	0.23
FS-2043	22.07	3.46	5.97	0.27	[illegible]	0.06	[illegible]	0.08	4.47	0.77	2.78	0.35
FS-2044	31.09	3.11	6.15	0.29	[illegible]	[illegible]	[illegible]	0.07	4.42	0.56	3.60	0.23
FS-2045	35.71	3.29	4.93	0.23	[illegible]	[illegible]	0.90	0.09	4.02	0.36	3.52	0.25
FS-2046	32.96	3.85	6.89	0.32	[illegible]	[illegible]	0.84	0.09	5.84	0.65	3.52	0.31
FS-2048	36.55	3.55	5.22	0.25	[illegible]	[illegible]	0.81	0.08	4.91	0.50	2.85	0.23
FS-2049	13.69	1.59	5.57	0.26	0.97	0.07	0.68	0.09	3.37	0.56	3.05	0.39
FS-2050	27.25	2.43	6.12	0.29	1.08	0.05	0.75	0.08	5.22	0.46	3.95	0.26
FS-2051	33.94	3.36	5.41	0.26	0.98	0.07	0.83	0.08	4.34	0.38	2.76	0.17
FS-2052	27.12	3.17	4.68	0.22	0.90	0.07	0.57	0.06	4.06	0.45	2.93	0.20
FS-2053	34.13	3.28	6.98	0.33	1.03	0.08	0.83	0.08	5.48	0.48	4.63	0.38
FS-2054	32.90	3.32	4.76	0.22	0.96	0.06	0.77	0.07	4.04	0.38	2.70	0.19
FS-2055	23.03	3.34	4.08	0.19	0.80	0.08	0.58	0.08	3.86	0.45	2.33	0.27
FS-2056	47.09	4.24	8.80	0.40	1.30	0.08	1.18	0.11	6.81	0.58	4.56	0.27
FS-2057	32.58	3.55	5.89	0.27	1.07	0.06	0.85	0.09	4.45	0.44	3.37	0.28

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	Lu	Standard Deviation	Hf	Standard Deviation	Ta	Standard Deviation	W	Standard Deviation	Au	Standard Deviation	Hg	Standard Deviation
FS-2000	0.47	0.03	8.42	0.45	3.13	0.21	13.74	2.84	<0.01		<0.54	
FS-2000F	0.45	0.03	8.19	0.43	2.34	0.15	<6.95		<0.01		<0.74	
FS-2001	0.59	0.04	13.73	0.91	1.50	0.10	<4.71		<0.01		<0.51	
FS-2002	0.45	0.03	5.43	0.55	3.18	0.20	<13.21		<0.02		<0.93	
FS-2003	0.67	0.04	13.28	0.81	1.59	0.13	<5.57		<0.01		<0.84	
FS-2004	0.48	0.03	9.40	0.63	2.73	0.20	<5.76		<0.01		<0.63	
FS-2005	0.47	0.03	6.70	0.43	2.98	0.19	<11.86		<0.02		<0.92	
FS-2006	0.54	0.03	8.88	0.53	3.01	0.23	6.25	1.94	<0.01		<0.90	
FS-2007	0.42	0.03	7.68	0.40	2.87	0.24	<1.47		<0.01		<0.61	
FS-2008	0.51	0.03	10.60	0.78	2.24	0.15	<9.56		<0.01		<0.75	
FS-2009	0.55	0.03	11.80	0.68	1.86	0.16	<5.92		<0.01		<0.78	
FS-2010	0.56	0.04	8.93	0.43	3.17	0.21	<6.23		<0.01		<0.57	
FS-2011	0.57	0.03	9.74	0.67	3.37	0.24	13.26	5.69	<0.01		<0.45	
FS-2012	0.56	0.03	9.60	0.62	3.13	0.19	<9.70		<0.01		<0.67	
FS-2013	0.64	0.03	11.09	0.98	3.12	0.19	<6.20		<0.01		<0.72	
FS-2014F	0.30	0.03	7.45	0.31	2.26	0.15	<7.41		<0.01		<0.57	
FS-2015F	0.42	0.02	7.60	0.51	2.84	0.17	<9.97		<0.01		<0.50	
FS-2016F	0.42	0.02	8.68	0.52	2.49	0.15	<6.62		<0.01		<0.60	
FS-2017F	0.33	0.03	7.72	0.35	2.00	0.17	<6.62		<0.01		<0.54	
FS-2018F	0.49	0.03	8.26	0.63	2.47	0.18	12.99	3.68	<0.02		<0.74	
FS-2019F	0.48	0.03	9.23	0.36	2.46	0.16	8.72	2.18	<0.01		<0.71	
FS-2020F	0.42	0.03	8.82	0.57	2.27	0.16	<8.17		<0.01		<0.48	
FS-2021	0.57	0.03	10.85	0.74	3.02	0.20	<10.26		<0.01		<0.60	
FS-2022	0.66	0.04	11.62	0.73	3.15	0.21	5.47	2.08	<0.01		<0.85	
FS-2023	0.64	0.04	9.13	0.68	3.06	0.24	<6.54		<0.01		<0.52	
FS-2026	0.30	0.03	10.22	0.76	2.46	0.22	<6.39		<0.01		<0.60	
FS-2027	0.47	0.03	14.60	1.05	1.69	0.12	<8.43		<0.01		<0.70	
FS-2028	0.58	0.04	11.94	0.69	2.06	0.17	<6.02		<0.01		<0.91	
FS-2029	0.22	0.04	5.76	0.33	1.91	0.13	<5.80		<0.01		<0.78	
FS-2030	0.45	0.03	6.98	0.38	2.78	0.17	6.28	2.29	<0.01		<0.85	
FS-2031	0.48	0.03	13.02	0.82	1.87	0.14	2.82	0.87	<0.01		<0.75	
FS-2032	0.47	0.03	13.72	1.26	1.50	0.14	<5.36		<0.01		<0.50	
FS-2033	0.44	0.03	9.59	0.62	2.66	0.17	<9.68		<0.01		<0.93	
FS-2034	0.58	0.03	11.69	0.78	2.02	0.12	<5.89		0.02		<0.79	
FS-2035	0.50	0.03	15.90	1.19	1.53	0.13	<7.21		<0.01		<0.56	
FS-2037	0.57	0.04	15.71	1.04	1.71	0.12	<5.92		0.04		<0.76	
FS-2038	0.27	0.03	5.06	0.31	1.51	0.11	<5.67		<0.01		<0.58	
FS-2039	0.57	0.04	8.40	0.71	2.53	0.17	<13.06		<0.01		<0.70	
FS-2040	0.44	0.03	8.40	0.46	2.84	0.20	<7.75		<0.01		<0.67	
FS-2041	0.45	0.04	7.30	0.39	2.74	0.19	<5.72		<0.01		<0.63	
FS-2042	0.51	0.03	15.93	1.55	1.53	0.10	<10.34		<0.01		<0.65	
FS-2043	0.30	0.03	7.47	0.38	2.33	0.20	7.23	1.21	<0.01		<0.59	
FS-2044	0.44	0.03	11.03	0.84	2.06	0.13	2.13	0.51	<0.01		<0.75	
FS-2045	0.58	0.03	18.56	1.02	1.62	0.11	8.53	2.58	<0.01		<0.73	
FS-2046	0.39	0.03	7.93	0.39	2.26	0.17	2.96	0.73	<0.01		<0.81	
FS-2048	0.46	0.03	7.49	0.49	2.94	0.19	2.02	0.66	<0.01		<0.87	
FS-2049	0.41	0.03	8.50	0.37	2.56	0.22	<3.91		<0.01		<0.54	
FS-2050	0.46	0.03	11.18	0.79	1.86	0.12	<5.83		<0.01		<0.76	
FS-2051	0.50	0.03	8.12	0.50	2.89	0.21	3.19	0.69	<0.01		<0.87	
FS-2052	0.46	0.03	14.97	1.30	1.58	0.13	<3.61		<0.01		<0.44	
FS-2053	0.57	0.03	16.79	1.23	1.78	0.11	<6.08		<0.01		<0.68	
FS-2054	0.49	0.03	8.48	0.47	2.59	0.18	2.22	0.64	<0.01		<0.83	
FS-2055	0.29	0.02	13.69	0.79	1.27	0.09	<3.98		<0.01		<0.50	
FS-2056	0.54	0.03	11.32	0.80	1.93	0.13	<6.41		<0.01		<0.80	
FS-2057	0.51	0.03	11.03	0.63	1.96	0.14	<4.01		<0.01		<0.67	

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	Th	Standard Deviation	U	Standard Deviation	Be	Standard Deviation	Cd	Standard Deviation	Pb	Standard Deviation
FS-2000	14.00	0.74	3.61	0.13	2.10	0.40	<1.00		26.50	2.00
FS-2000F	13.30	0.64	3.26	0.12	2.10	0.40	<1.00		26.50	2.00
FS-2001	15.08	0.65	3.33	0.12	2.00	0.40	<1.00		25.00	2.00
FS-2002	23.23	1.72	4.91	0.19	2.85	0.50	<1.00		26.00	3.00
FS-2003	13.68	0.57	3.92	0.14	2.00	0.40	<1.00		27.00	3.00
FS-2004	22.35	1.30	3.10	0.12	2.00	0.30	<1.00		24.50	2.00
FS-2005	18.39	0.72	3.90	0.15	2.45	0.50	<1.00		26.60	2.70
FS-2006	19.42	0.81	3.93	0.15	2.60	0.50	1.70	0.80	25.90	2.50
FS-2007	22.21	0.87	4.36	0.16	2.40	0.40	<1.00		28.00	3.00
FS-2008	16.23	0.63	3.45	0.13	2.10	0.40	<1.00		22.00	2.00
FS-2009	14.12	0.59	3.21	0.12	2.70	0.50	<1.00		32.00	3.00
FS-2010	19.64	0.84	3.55	0.13	2.70	0.50	<1.00		32.00	3.00
FS-2011	18.87	1.04	3.56	0.13	1.00	0.20	<1.00		<14.00	
FS-2012	16.46	0.68	3.51	0.13	2.60	0.50	<1.00		26.00	3.00
FS-2013	17.64	0.72	3.49	0.13	2.40	0.50	<1.00		25.00	2.00
FS-2014F	13.17	0.63	2.84	0.12	1.80	0.40	<1.00		22.00	2.00
FS-2015F	12.24	0.48	3.30	0.12	2.30	0.40	<1.00		24.00	2.00
FS-2016F	12.62	0.53	2.84	0.10	2.10	0.40	<1.00		28.00	3.00
FS-2017F	12.95	0.53	2.65	0.10	2.30	0.40	<1.00		25.00	2.00
FS-2018F	12.48	0.50	4.25	0.16	2.40	0.40	<1.00		56.00	6.00
FS-2019F	13.85	0.58	3.05	0.11	1.90	0.40	<1.00		28.00	3.00
FS-2020F	12.20	0.53	2.81	0.10	1.80	0.40	1.60	0.80	26.00	2.00
FS-2021	15.06	0.59	3.66	0.13	2.60	0.50	<1.00		21.00	2.00
FS-2022	17.38	0.82	4.20	0.16	2.70	0.50	<1.00		26.00	3.00
FS-2023	18.81	0.81	3.77	0.14	3.40	0.60	<1.00		29.00	3.00
FS-2026	16.77	0.69	2.54	0.10	2.50	0.50	<1.00		29.00	3.00
FS-2027	13.66	1.60	3.45	0.13	1.60	0.30	<1.00		30.00	3.00
FS-2028	17.96	0.77	3.19	0.12	2.30	0.40	<1.00		33.00	3.00
FS-2029	17.18	0.69	2.17	0.09	3.30	0.70	<1.00		23.00	2.00
FS-2030	16.34	0.64	4.79	0.18	2.40	0.50	<1.00		26.00	3.00
FS-2031	14.62	0.66	2.96	0.11	1.70	0.30	<1.00		25.00	2.00
FS-2032	13.03	0.52	3.46	0.13	1.80	0.40	<1.00		25.00	2.00
FS-2033	17.16	0.67	2.19	0.08	3.00	0.60	<1.00		29.00	3.00
FS-2034	15.56	0.61	3.09	0.11	2.00	0.40	<1.00		30.00	3.00
FS-2035	12.74	0.51	3.43	0.12	1.55	0.30	<1.00		26.50	3.00
FS-2037	13.84	0.58	3.59	0.13	1.50	0.30	<1.00		25.00	2.00
FS-2038	12.40	0.50	3.47	0.13	2.20	0.40	<1.00		21.00	2.00
FS-2039	13.14	0.57	2.92	0.11	2.10	0.40	<1.00		26.00	3.00
FS-2040	16.84	0.67	2.74	0.10	2.30	0.40	<1.00		28.00	3.00
FS-2041	20.04	0.88	3.51	0.13	2.80	0.60	<1.00		25.00	2.00
FS-2042	11.05	0.70	3.57	0.13	1.40	0.30	<1.00		<14.00	
FS-2043	18.10	1.00	2.36	0.09	3.10	0.60	<1.00		34.00	3.00
FS-2044	14.35	0.56	3.21	0.12	2.20	0.40	<1.00		28.00	3.00
FS-2045	13.53	0.57	3.84	0.14	1.00	0.20	<1.00		20.00	2.00
FS-2046	19.91	0.82	2.52	0.09	3.90	0.70	1.20	0.80	35.00	3.00
FS-2048	19.96	0.78	3.57	0.13	2.95	0.60	<1.00		25.50	2.50
FS-2049	19.27	0.81	3.64	0.13	3.00	0.60	<1.00		32.00	3.00
FS-2050	12.72	0.50	3.28	0.12	1.90	0.40	<1.00		26.00	3.00
FS-2051	19.93	0.78	3.48	0.13	3.20	0.60	<1.00		30.00	3.00
FS-2052	12.52	0.55	3.81	0.13	1.40	0.30	<1.00		25.00	2.00
FS-2053	12.80	0.50	3.67	0.13	1.60	0.30	<1.00		23.00	2.00
FS-2054	17.20	0.67	3.96	0.14	2.00	0.40	<1.00		44.00	4.00
FS-2055	10.46	0.42	3.56	0.13	1.10	0.20	<1.00		33.00	3.00
FS-2056	14.82	0.58	2.89	0.10	2.10	0.40	<1.00		30.00	3.00
FS-2057	15.28	0.68	3.12	0.12	1.95	0.40	<1.00		27.00	2.00

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Sigma Mesa: Background Elemental Concentrations in Soil and Vegetation, 1979

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TABLE I. Sampling Locations and Samples Collected

Sample		Type of Sample Collected				
Designation	Location	Soil	Grass	Juniper	Piñon	Oak
1N	250 ft	X	X	X		
2N	500 ft	X	X		X	X
3N	1000 ft	X	X		X	
4N	Gravel pit	X	X		X	
5N	Above pit	X	X	X		
1NE	250 ft	X	X	X		
2NE	500 ft	X	X	X		X
3NE	1000 ft	X	X	X		
4NE	1500 ft	X	X		X	
5NE	2000 ft	X	X		X	
6NE	2640 ft	X	X		X	
1E	250 ft	X	X	X		
2E	500 ft	X	X	X		X
3E	1000 ft	X	X	X		
4E	1500 ft	X	X	X		
5E	2000 ft	X	X	X		
6E	2640 ft	X	X		X	
7E	Knoll	X	X	X		
1SE	250 ft	X	X	X		X
2SE	500 ft	X	X		X	X
3SE	TA-35, above ponds	X	X		X	
1S	250 ft	X	X	X		X
2S	500 ft	X	X		X	X
3S	TA-35	X	X		X	
1SW	250 ft	X	X	X		X
2SW	500 ft	X	X			X
3SW	Trailers at TA-35	X	X		X	
1W	Wellhead	X	X	X		
2W	250 ft	X	X	X		
3W	500 ft	X	X	X		
4W	1000 ft	X	X	X		
5W	1500 ft	X	X		X	
6W	2000 ft	X	X	X		
7W	2640 ft	X	X	X		
1NW	250 ft	X	X	X		
2NW	500 ft	X	X		X	
3NW	1000 ft	X	X		X	
4NW	1500 ft	X	X		X	
5NW	2000 ft	X	X		X	
6NW	2640 ft	X	X		X	

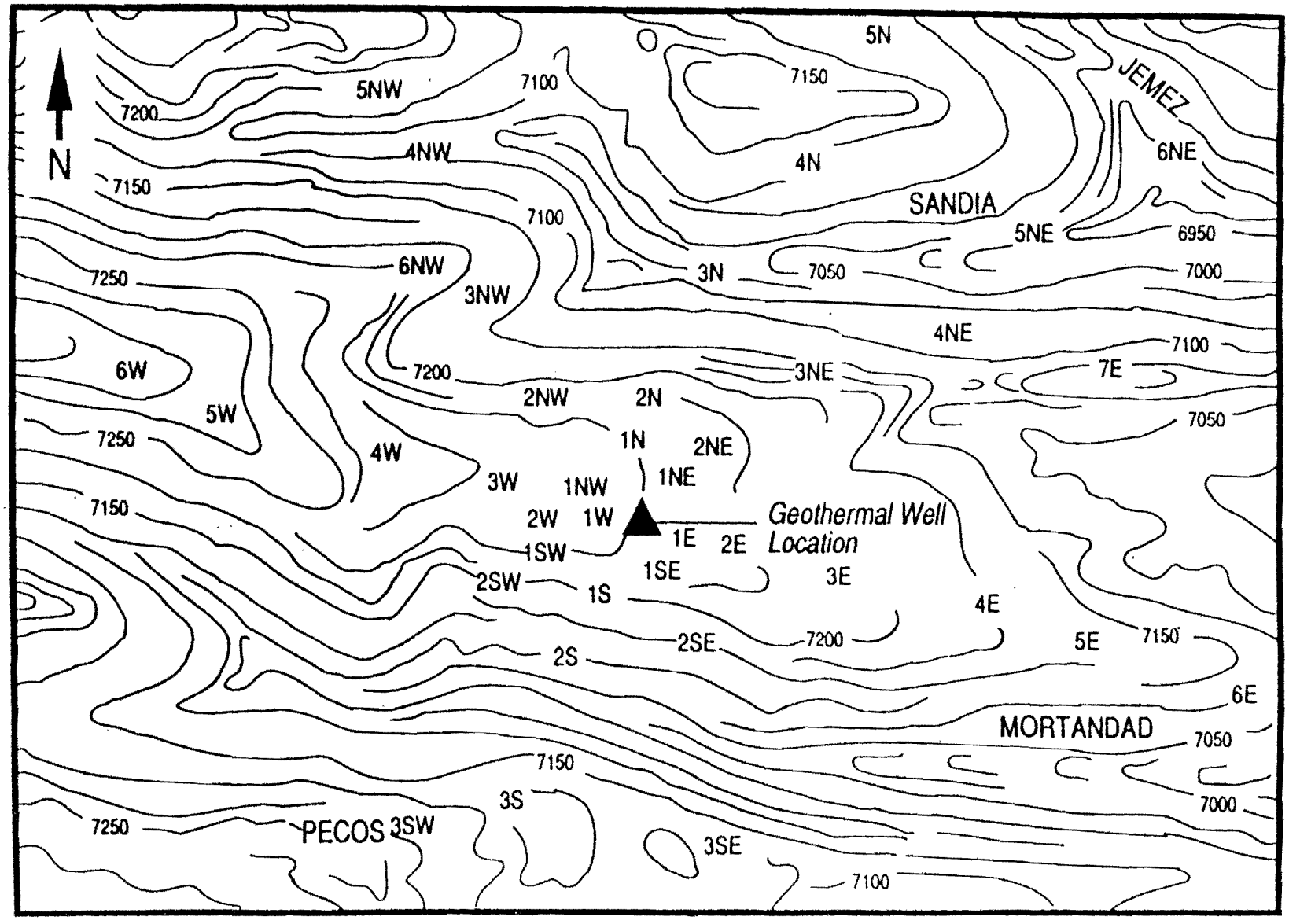

Fig. 2. Locations of sampling sites.

TABLE III. Elemental Concentrations in Grass

Element[a]	Mean	Standard Deviation	No. of Samples	Maximum	Minimum
Al	650	770	39	4400	150
As (ppb)	360	210	38	960	60
B	14	7.0	29	34	7.0
Ba	73	50	15	200	13
Be (ppb)	12	10	14	42	4.0
Br	40	41	40	160	2.7
Cd	<200		15		
Cl (%)	0.19	0.12	40	0.60	0.034
Cr	5.5	3.2	40	13	1.6
Cu	6.8	3.0	16	14	3.3
F	1.1	0.60	40	3.4	0.60
Fe	260	190	40	810	60
Li (ppb)	40	190	11	750	200
Mg (%)	0.12	0.028	16	0.17	0.061
Mn	48	35	40	180	13
Ni	26	11	15	55	7.0
NO_3	420	380	37	1300	60
Pb	1.7	1.1	11	4.0	1.0
PO_4 (%)	0.19	0.083	40	0.47	0.070
Rb	5.6	3.2	37	18	2.1
SO_4	690	360	40	1500	120
Ti	46	60	15	250	12
Zn	21	11	15	52	9.4

[a]Data are reported in parts per million (ppm) unless otherwise noted.

TABLE V. Elemental Concentrations in Piñon Pine

Element[a]	Mean	Standard Deviation	No. of Samples	Maximum	Minimum
Al	200	65	18	310	100
As (ppb)	150	60	17	300	80
B	22	7.0	18	46	11
Ba	24	6.0	3	28	17
Be (ppb)	16	7.0	4	24	8.0
Br	13	14	18	55	1.7
Cd (ppb)	110	60	4	200	50
Cl	570	860	18	4000	230
Cr	3.2	1.5	18	6.8	1.0
Cu	3.9	2.2	4	7.0	2.2
F (ppb)	190	160	18	700	100
Fe	87	33	18	150	40
Li	3.4	2.7	5	7.0	0.70
Mg (%)	0.19	0.064	6	0.31	0.12
Mn	200	160	18	540	58
Ni	5.5	4.4	4	12	2.2
NO_3 [b]					
Pb [b]					
PO_4 (%)	0.18	0.077	17	0.32	0.080
Rb	4.4	2.2	16	9.8	1.5
SO_4	750	380	17	1700	19
Ti	94	160	4	340	11
Zn	34	26	6	69	4.0

[a]Data are reported in parts per million (ppm) unless otherwise noted.
[b]No average was calculated (see data in the Appendix).

TABLE VII. Elemental Abundance in the Earth's Crust

Element	Concentrations (ppm)			
	Mason[a]	Vinogradov[b]	Vinogradov[c]	Wedepohl[d]
Al	81 300	104 500	71 300	78 300
As	1.8	6.6	5	1.7
Ba	425	800	500	590
Be	2.8	7	6	2
Br	2.5	6	5	2.9
Cd	0.2	0.3	0.5	0.1
Cl	130	160	100	320
Cr	100	160	200	70
Cu	55	57	20	30
F	625	500	200	720
Fe	50 000	33 300	38 000	35 400
Hg	0.08	0.4	0.01	0.03
Li	20	60	30	30
Mg	20 900	13 400	6 300	13 900
Mn	950	670	850	690
Ni	75	95	40	44
Pb	13	20	10	15
Rb	90	400	100	120
Ti	4 400	4 500	4 600	4 700
Zn	70	80	50	60
Ag	0.07	0.9	0.1	0.06
Au	0.004	—	—	0.004
Ca	36 300	25 300	13 700	28 700
Ce	60	30	50	75
Co	25	23	8	12
Cs	3	12	5	2.7
Dy	3	4	—	6.1
Eu	1.2	1	—	1.4
Ga	15	40	30	17
Gd	5.4	5	—	8
Ge	1.5	7	1	1.3
Hf	3	4	6	3
I	0.5	1	5	0.5
In	0.1	—	—	0.07
K	25 900	22 800	13 600	28 200
La	30	40	40	44
Lu	0.5	0.2	—	0.6
Mo	1.5	2	2	1
Na	28 300	6 600	6 300	24 500
Nb	20	20	—	20
Nd	28	18	—	>30
S	260	3 000	850	310
Sb	0.2	1	—	0.2
Sc	22	10	7	14
Se	0.05	0.6	—	0.09
Si	277 000	248 000	330 000	305 000

TABLE A-I. Soil: Elemental Concentrations[a]

Location	Al (%)	As (ppm)	B (ppm)	Ba (ppm)	Be (ppm)	Br (ppm)	Cd (ppb)	Cl (ppm)	Cr (ppm)	Cu (ppm)	F (ppm)	Fe (%)
1N	5.5 ± 0.5	5.8 ± 0.7	24 ± 5	680 ± 100	2.7 ± 0.2	4.0 ± 0.5	170 ± 20	<100	41 ± 4	16 ± 2	280 ± 30	2.4 ± 0.1
2N	5.8 ± 0.5	6.0 ± 0.7	27 ± 5	620 ± 90	<0.2	<0.3	150 ± 20	<100	43 ± 4	13 ± 1	260 ± 30	2.2 ± 0.1
3N	5.8 ± 0.5	3.0 ± 0.5	10 ± 5	210 ± 30	<0.2	0.87 ± 0.5	80 ± 20	<100	9.2 ± 1.1	6 ± 1	180 ± 20	1.3 ± 0.1
4N	5.9 ± 0.5	1.8 ± 0.4	10 ± 5	180 ± 30	2.6 ± 0.2	0.61 ± 0.5	290 ± 30	<100	9.0 ± 1.4	6 ± 1	50 ± 10	1.2 ± 0.1
5N	5.7 ± 0.5	3.1 ± 0.4	8 ± 5	400 ± 60	2.1 ± 0.2	1.3 ± 0.4	210 ± 20	<100	6.7 ± 1.0	15 ± 2	150 ± 10	1.2 ± 0.1
1NE	6.2 ± 0.5	4.8 ± 0.5	20 ± 5	570 ± 90	1.5 ± 0.2	5.7 ± 0.7	140 ± 20	<100	27 ± 2	13 ± 1	310 ± 30	2.0 ± 0.1
2NE	6.0 ± 0.5	6.2 ± 0.7	25 ± 5	620 ± 90	1.4 ± 0.2	3.3 ± 0.5	260 ± 20	<100	41 ± 4	18 ± 2	340 ± 30	2.1 ± 0.1
3NE	5.8 ± 0.5	1.3 ± 0.3	<5	150 ± 20	3.3 ± 0.3	0.72 ± 0.5	210 ± 20	<100	140 ± 11	6 ± 1	150 ± 10	1.1 ± 0.1
4NE	6.2 ± 0.5	1.8 ± 0.4	7 ± 5	120 ± 20	1.8 ± 0.2	1.5 ± 0.6	200 ± 20	<100	5.1 ± 1.1	5 ± 1	160 ± 20	1.1 ± 0.1
5NE	5.8 ± 0.5	2.7 ± 0.4	10 ± 5	180 ± 30	1.6 ± 0.2	0.99 ± 0.3	200 ± 20	<100	8.9 ± 1.1	6 ± 1	170 ± 20	1.2 ± 0.1
6NE	5.3 ± 0.5	3.7 ± 0.5	11 ± 5	240 ± 40	2.2 ± 0.2	1.6 ± 0.3		<100	13 ± 2	8 ± 1	190 ± 20	1.3 ± 0.1
1E	5.5 ± 0.5	5.7 ± 0.6	27 ± 5	720 ± 110	1.6 ± 0.2	2.2 ± 0.5	170 ± 20	<100	39 ± 4	15 ± 2	360 ± 40	2.1 ± 0.1
2E	6.2 ± 0.5	5.0 ± 0.6	23 ± 5	590 ± 90	<0.2	2.3 ± 0.4	80 ± 20	<100	40 ± 4	14 ± 1	210 ± 20	2.4 ± 0.1
3E	6.2 ± 0.5	4.1 ± 0.5	15 ± 5	390 ± 60	1.7 ± 0.2	1.4 ± 0.4	110 ± 20	<100	27 ± 2	9 ± 3	220 ± 20	2.1 ± 0.1
4E	5.7 ± 0.5	4.2 ± 0.6	13 ± 5	300 ± 50	2.1 ± 0.2	2.8 ± 0.6	60 ± 20	<100	15 ± 2	11 ± 1	210 ± 20	1.5 ± 0.1
5E	6.3 ± 0.5	2.8 ± 0.5	10 ± 5	260 ± 40	2.3 ± 0.2	0.57 ± 0.4	160 ± 20	<100	14 ± 2	6 ± 2	210 ± 20	1.7 ± 0.1
6E	5.9 ± 0.5	2.6 ± 0.5	9 ± 5	190 ± 30	2.0 ± 0.2	1.2 ± 0.4		<100	8.9 ± 1.2	3 ± 1	230 ± 20	1.0 ± 0.1
7E	6.2 ± 0.5	1.8 ± 0.5	10 ± 5	180 ± 30	2.6 ± 0.2	1.7 ± 0.6	100 ± 20	<100	6.8 ± 1.0	4 ± 1	300 ± 30	1.2 ± 0.1
1SE	6.0 ± 0.5	3.5 ± 0.4	14 ± 5	440 ± 70	1.8 ± 0.2	2.8 ± 0.4	160 ± 20	<100	18 ± 2	10 ± 1	240 ± 20	1.5 ± 0.1
2SE	5.4 ± 0.5	1.7 ± 0.3	9 ± 5	130 ± 20	2.1 ± 0.2	3.5 ± 0.5	140 ± 20	<100	4.4 ± 1.2	5 ± 1	190 ± 20	1.0 ± 0.1
3SE	6.0 ± 0.5	1.6 ± 0.3	7 ± 5	140 ± 20	2.2 ± 0.2	1.6 ± 0.3	260 ± 20	<100	4.3 ± 0.9	2 ± 2	270 ± 30	1.1 ± 0.1
1S	5.3 ± 0.5	4.3 ± 0.5	16 ± 5	390 ± 60	1.7 ± 0.2	3.6 ± 0.7	390 ± 30	<100	21 ± 2	14 ± 1	220 ± 20	1.7 ± 0.1
2S	5.4 ± 0.5	2.1 ± 0.4	9 ± 5	150 ± 20	1.9 ± 0.2	1.9 ± 0.6	180 ± 20	<100	4.2 ± 0.8	5 ± 1	140 ± 10	1.0 ± 0.1
3S	5.7 ± 0.5	1.7 ± 0.3	<5	350 ± 50	2.3 ± 0.2	0.70 ± 0.5	110 ± 20	<100	54 ± 4	7 ± 1	150 ± 10	2.6 ± 0.1
1SW	6.0 ± 0.5	4.5 ± 0.5	19 ± 5	590 ± 90	1.8 ± 0.2	2.9 ± 0.4	140 ± 20	<100	39 ± 4	11 ± 1	270 ± 30	2.2 ± 0.1
2SW	[illegible] ± 0.5	4.9 ± 0.6	18 ± 5	380 ± 60	2.0 ± 0.2	2.7 ± 0.5		<100	26 ± 3	16 ± 2	300 ± 30	1.9 ± 0.1
3SW	[illegible] ± 0.5	3.5 ± 0.4	13 ± 5	200 ± 30	2.4 ± 0.2	1.7 ± 0.5	100 ± 20	<100	16 ± 2	13 ± 1	320 ± 30	1.7 ± 0.1
1W	5.3 ± 0.5	6.7 ± 0.7	27 ± 5	810 ± 120	1.4 ± 0.2	2.8 ± 0.4	260 ± 20	<100	40 ± 4	17 ± 2	270 ± 30	2.2 ± 0.1
2W	5.9 ± 0.5	5.5 ± 0.6	24 ± 5	610 ± 90	0.9 ± 0.2	1.8 ± 0.4	190 ± 20	<100	48 ± 4	14 ± 1	320 ± 30	2.2 ± 0.1
3W	5.5 ± 0.5	4.8 ± 0.6	25 ± 5	570 ± 90	1.4 ± 0.2	0.44 ± 0.4	90 ± 20	<100	38 ± 3	11 ± 1	340 ± 30	1.9 ± 0.1
4W	6.0 ± 0.5	5.7 ± 0.6	20 ± 5	690 ± 100	1.7 ± 0.2	4.1 ± 0.6	30 ± 20	<100	42 ± 4	15 ± 2	390 ± 40	2.2 ± 0.1
5W	5.7 ± 0.5	5.7 ± 0.6	19 ± 5	700 ± 110	1.6 ± 0.2	1.0 ± 0.4	520 ± 50	<100	46 ± 4	14 ± 1	320 ± 30	2.0 ± 0.1
6W	5.5 ± 0.5	5.4 ± 0.6	25 ± 5	650 ± 100	1.8 ± 0.2	1.4 ± 0.4	130 ± 20	<100	41 ± 4	13 ± 1	160 ± 20	1.9 ± 0.1
7W	5.3 ± 0.5	5.3 ± 0.6	24 ± 5	620 ± 90	1.3 ± 0.2	3.0 ± 0.5	30 ± 20	<100	40 ± 4	12 ± 1	280 ± 30	2.0 ± 0.1
1NW	5.5 ± 0.5	5.6 ± 0.6	27 ± 5	660 ± 100	1.1 ± 0.2	2.4 ± 0.5		<100	32 ± 4	16 ± 2	310 ± 30	2.0 ± 0.1
2NW	5.4 ± 0.5	5.1 ± 0.6	26 ± 5	700 ± 110	1.4 ± 0.2	0.42 ± 0.3	150 ± 20	<100	45 ± 4	14 ± 1	250 ± 20	2.1 ± 0.1
3NW	5.7 ± 0.5	3.2 ± 0.4	9 ± 5	200 ± 30	1.5 ± 0.2	<0.3	250 ± 20	<100	7.6 ± 1.1	6 ± 1	180 ± 20	1.1 ± 0.1
4NW	5.8 ± 0.5	2.5 ± 0.4	10 ± 5	160 ± 20	2.1 ± 0.2	0.73 ± 0.5	100 ± 20	<100	8.8 ± 1.3	6 ± 1	160 ± 20	1.2 ± 0.1
5NW	6.3 ± 0.5	3.0 ± 0.4	11 ± 5	260 ± 40	2.4 ± 0.2	0.40 ± 0.4	150 ± 20	<100	11 ± 1	7 ± 1	220 ± 20	1.6 ± 0.1
6NW	6.2 ± 0.5	2.4 ± 0.4	8 ± 5	220 ± 30	2.1 ± 0.2	0.65 ± 0.5	140 ± 20	<100	8.5 ± 1.3	5 ± 1	190 ± 20	1.3 ± 0.1

TABLE A-II. Grass: Elemental Concentrations[a]

Location	Al (ppm)	As (ppm)	B (ppm)	Ba (ppm)	Be (ppb)	Br (ppm)	Cd (ppm)	Cl (ppm)	Cr (ppm)	Cu (ppm)	F (ppm)
1N	1300 ± 380	<0.08	<10			160 ± 20		2700 ± 400	5.0 ± 0.5		1.6 ± 0.2
2N	1500 ± 460	0.17 ± 0.05	22 ± 5			130 ± 10		1700 ± 260	4.3 ± 0.4		2.6 ± 0.3
3N	230 ± 70	0.06 ± 0.02	7 ± 5			16 ± 2	<0.2	1500 ± 220	3.1 ± 0.3		2.4 ± 0.2
4N	4400 ± 1300	<0.03	6 ± 5	44 ± 10	21 ± 2	31 ± 3	<0.2	2400 ± 360	4.0 ± 0.4	3.3 ± 0.3	2.2 ± 0.2
5N	320 ± 100	0.32 ± 0.06	14 ± 5	90 ± 20	11 ± 2	20 ± 2		2000 ± 300	3.7 ± 0.4	4.4 ± 0.4	1.3 ± 0.1
1NE	720 ± 220	0.57 ± 0.10	<5			110 ± 10		2400 ± 360	7.5 ± 0.8		0.8 ± 0.1
2NE	460 ± 140	0.25 ± 0.06	8 ± 5			32 ± 3		1500 ± 220	13 ± 1.3		0.9 ± 0.1
3NE	260 ± 80	0.55 ± 0.08	23 ± 5			10 ± 1		900 ± 140	9.7 ± 1.0		0.7 ± 0.1
4NE	280 ± 90	0.23 ± 0.05	<5			11 ± 1	0.07 ± 0.01	1500 ± 230	6.1 ± 0.6		0.6 ± 0.1
5NE	220 ± 70	0.51 ± 0.07	9 ± 5			10 ± 1		2600 ± 380	6.5 ± 0.7		0.6 ± 0.1
6NE	300 ± 90	0.53 ± 0.08	8 ± 5			13 ± 1		1500 ± 230	4.3 ± 0.4		0.7 ± 0.1
1E	1300 ± 380	0.17 ± 0.06	<5			51 ± 5		1400 ± 210	3.9 ± 0.4		0.9 ± 0.1
2E	310 ± 90	0.08 ± 0.05	<5			34 ± 3		960 ± 140	2.1 ± 0.2		1.5 ± 0.1
3E	2000 ± 610	0.15 ± 0.07	13 ± 5			29 ± 3	<0.2	2100 ± 310	9.6 ± 1.0		1.6 ± 0.2
4E	240 ± 70	0.50 ± 0.07	11 ± 5	50 ± 10	4 ± 2	12 ± 1		980 ± 150	2.1 ± 0.2	5.0 ± 0.5	1.1 ± 0.1
5E	290 ± 90	0.19 ± 0.07	<5			50 ± 5		2700 ± 400	2.5 ± 0.3		0.8 ± 0.1
6E	150 ± 50	0.31 ± 0.05	10 ± 5			6.2 ± 0.6	<0.2	1300 ± 190	1.6 ± 0.2		0.8 ± 0.1
7E	250 ± 80	0.61 ± 0.08	10 ± 5	42 ± 10	6 ± 2	13 ± 1	<0.2	1400 ± 220	3.5 ± 0.4	5.0 ± 0.5	1.0 ± 0.1
1SE	330 ± 100	0.33 ± 0.06	8 ± 5	13 ± 10	17 ± 2	12 ± 1	<0.2	1500 ± 220	3.3 ± 0.3	6.6 ± 0.7	0.9 ± 0.1
2SE	260 ± 80	0.24 ± 0.04	9 ± 5	86 ± 20	8 ± 2	2.7 ± 0.3	<0.2	400 ± 60	3.1 ± 0.3	4.8 ± 0.5	1.0 ± 0.1
3SE	240 ± 70	0.32 ± 0.06	14 ± 5	90 ± 20	8 ± 2	33 ± 3	<0.2	2100 ± 320	7.6 ± 0.8	14 ± 1.4	0.9 ± 0.1
1S	290 ± 90	0.19 ± 0.04	12 ± 5			13 ± 1		1100 ± 160	3.9 ± 0.4		0.6 ± 0.1
2S	250 ± 70	0.27 ± 0.04	10 ± 5			25 ± 2		1600 ± 240	3.5 ± 0.4		0.7 ± 0.1
3S	240 ± 70	0.39 ± 0.06	<5	90 ± 20	<3	15 ± 2	<0.3	6000 ± 890	13 ± 1.3	6.9 ± 0.7	0.7 ± 0.1
1SW	460 ± 140	0.31 ± 0.05	21 ± 5	22 ± 10	6 ± 2	3.9 ± 0.4	<0.2	340 ± 50	3.9 ± 0.4	9.2 ± 0.9	1.2 ± 0.1
2SW	250 ± 70	0.29 ± 0.05	9 ± 5	45 ± 10	6 ± 2	19 ± 2	<0.2	1300 ± 200	3.5 ± 0.4	7.6 ± 0.8	0.7 ± 0.1
3SW	240 ± 70	0.31 ± 0.07	<5	150 ± 30	5 ± 2	23 ± 2	<0.2	5600 ± 850	13 ± 1.3	3.9 ± 0.4	0.6 ± 0.1
1W	1500 ± 460	0.81 ± 0.12	34 ± 5			77 ± 8		1600 ± 250	6.9 ± 0.7		3.4 ± 0.3
2W	600 ± 180	0.37 ± 0.11	<5	100 ± 20	10 ± 2	98 ± 10	<0.5	1900 ± 280	4.1 ± 0.4	3.4 ± 0.3	1.3 ± 0.1
3W	1100 ± 340	0.72 ± 0.13	12 ± 5	44 ± 10	10 ± 2	150 ± 15	<0.2	4200 ± 630	5.9 ± 0.6	6.8 ± 0.7	1.2 ± 0.1
4W	810 ± 240	0.48 ± 0.10	26 ± 5			69 ± 7		940 ± 140	3.2 ± 0.3	9.7 ± 1.0	1.6 ± 0.2
5W		0.96 ± 0.14	12 ± 5			91 ± 9		2300 ± 340	13 ± 1.3	11 ± 1.1	1.5 ± 0.1
6W	1200 ± 350	0.59 ± 0.10	29 ± 5	200 ± 40	42 ± 4	72 ± 7	<0.2	2400 ± 370	2.1 ± 0.2	7.6 ± 0.8	1.0 ± 0.1
7W	710 ± 210	0.20 ± 0.06	11 ± 5	32 ± 10	16 ± 2	37 ± 4	<0.2	2000 ± 300	5.1 ± 0.5		0.8 ± 0.1
1NW	880 ± 260	0.29 ± 0.08	7 ± 5			47 ± 5		1900 ± 280	5.2 ± 0.5		1.1 ± 0.1
2NW	540 ± 160	0.62 ± 0.11	17 ± 5			24 ± 2		410 ± 60	6.3 ± 0.6		1.1 ± 0.1
3NW	190 ± 60	0.13 ± 0.04	11 ± 5			5.9 ± 0.6		1800 ± 270	8.1 ± 0.8		0.6 ± 0.1
4NW	390 ± 120	0.22 ± 0.04	<5			15 ± 2		970 ± 150	4.3 ± 0.4		0.9 ± 0.1
5NW	220 ± 70	0.25 ± 0.05	<5			17 ± 2		2300 ± 350	6.3 ± 0.6		0.7 ± 0.1
6NW	150 ± 50	0.32 ± 0.05	9 ± 5			19 ± 2		1900 ± 290	2.8 ± 0.3		0.7 ± 0.1

TABLE A-III. Juniper: Elemental Concentrations[a]

Location	Al (ppm)	As (ppm)	B (ppm)	Ba (ppm)	Be (ppb)	Br (ppm)	Cd (ppm)	Cl (ppm)	Cr (ppm)	Cu (ppm)	F (ppm)
1N	300 ± 90	0.17 ± 0.05	28 ± 5			26 ± 3		790 ± 120	3.7 ± 0.4		0.40 ± 0.04
5N	560 ± 160	0.08 ± 0.02	17 ± 5			9.5 ± 1.0	0.13 ± 0.01	780 ± 120	4.7 ± 0.5		0.30 ± 0.03
1NE	400 ± 120	0.10 ± 0.03	16 ± 5			33 ± 3		1200 ± 180	4.0 ± 0.4		0.40 ± 0.04
2NE	270 ± 80	0.05 ± 0.02	22 ± 5			5.5 ± 0.5		1100 ± 170	5.9 ± 0.6		0.30 ± 0.03
3NE	250 ± 70	0.06 ± 0.02	27 ± 5			6.3 ± 0.6	0.11 ± 0.02	1200 ± 180	3.0 ± 0.3		0.10 ± 0.01
1E	260 ± 80	0.10 ± 0.04	23 ± 5			38 ± 4	0.10 ± 0.02	1300 ± 200	2.0 ± 0.2		0.10 ± 0.01
2E	240 ± 70	0.06 ± 0.03	24 ± 5	22 ± 10	12 ± 2	42 ± 5	<0.20	920 ± 140	2.9 ± 0.3	4.7 ± 0.5	0.30 ± 0.03
3E	200 ± 60	0.06 ± 0.02	18 ± 5			7.6 ± 0.8	0.20 ± 0.02	460 ± 70	2.9 ± 0.3		0.10 ± 0.01
4E	140 ± 40	<0.02	16 ± 5			3.7 ± 0.4		350 ± 50	5.0 ± 0.5		0.10 ± 0.01
5E	150 ± 50	0.04 ± 0.02	15 ± 5			4.3 ± 0.4	0.22 ± 0.02	540 ± 80	3.5 ± 0.4		0.10 ± 0.01
7E	280 ± 80	0.15 ± 0.02	16 ± 5	52 ± 20	27 ± 2	3.8 ± 0.4	<0.20	480 ± 70	1.6 ± 0.2	3.6 ± 0.4	0.10 ± 0.01
1SE	480 ± 150	0.15 ± 0.04	17 ± 5	290 ± 50	29 ± 3	5.7 ± 0.6	<1.0	460 ± 70	1.5 ± 0.2	4.0 ± 2.0	0.20 ± 0.02
1S	250 ± 70	0.08 ± 0.02	21 ± 5			3.2 ± 0.3	0.10 ± 0.01	800 ± 120	5.9 ± 0.6		0.20 ± 0.02
1SW	330 ± 100	0.06 ± 0.02	23 ± 5	31 ± 10	14 ± 4	3.6 ± 0.4	0.10 ± 0.10	710 ± 110	1.7 ± 0.2	3.5 ± 0.4	0.10 ± 0.01
1W	310 ± 90	0.14 ± 0.04	22 ± 5			34 ± 3	0.13 ± 0.01	990 ± 150	2.9 ± 0.3		0.60 ± 0.06
2W	250 ± 70	<0.03	34 ± 5	28 ± 10	11 ± 2	30 ± 3	0.25 ± 0.10	1100 ± 170	2.5 ± 0.3	5.9 ± 0.6	0.40 ± 0.04
3W	520 ± 220	0.08 ± 0.03	27 ± 5	180 ± 40	12 ± 2	27 ± 3	<0.30	830 ± 120	4.0 ± 0.4	9.4 ± 0.9	0.30 ± 0.03
4W	460 ± 140	<0.03	50 ± 5	83 ± 20	24 ± 2	51 ± 5	0.10 ± 0.10	1400 ± 210	4.6 ± 0.5	7.7 ± 0.8	0.30 ± 0.03
6W	960 ± 290	0.06 ± 0.04	29 ± 5	220 ± 40	22 ± 2	65 ± 7	<0.70	2000 ± 290	4.7 ± 0.5	10 ± 1.0	0.40 ± 0.04
7W	430 ± 130	0.06 ± 0.02	22 ± 5	44 ± 10	14 ± 2	18 ± 2	<0.20	780 ± 120	1.9 ± 0.2	4.7 ± 0.5	0.30 ± 0.03
1NW	300 ± 90	0.08 ± 0.04	21 ± 5			32 ± 3		970 ± 150	4.1 ± 0.4		0.10 ± 0.01

TABLE A-IV. Piñon: Elemental Concentrations[a]

Location	Al (ppm)	As (ppm)	B (ppm)	Ba (ppm)	Be (ppb)	Br (ppm)	Cd (ppm)	Cl (ppm)	Cr (ppm)	Cu (ppm)	F (ppm)
2N	140 ± 40	<0.03	18 ± 5			19 ± 2		320 ± 50	2.9 ± 0.3		0.40 ± 0.04
3N	190 ± 60	0.09 ± 0.03	14 ± 5			7.9 ± 0.8		230 ± 30	3.6 ± 0.4		0.30 ± 0.03
4N	130 ± 40	0.18 ± 0.04	22 ± 5			5.0 ± 0.5	0.10 ± 0.01	420 ± 60	3.1 ± 0.3		0.30 ± 0.03
4NE	220 ± 70	0.15 ± 0.03	22 ± 5			15 ± 2		280 ± 40	4.2 ± 0.4		0.10 ± 0.01
5NE	140 ± 40	0.10 ± 0.02	21 ± 5			5.1 ± 0.5		470 ± 70	2.8 ± 0.3		0.10 ± 0.01
6NE	180 ± 60	0.11 ± 0.03	11 ± 5			9.9 ± 1		330 ± 50	2.3 ± 0.2		0.10 ± 0.01
6E	140 ± 40	0.15 ± 0.02	25 ± 5	27 ±10	18 ± 2	6.0 ± 0.6	<0.30	400 ± 60	1.4 ± 0.1	2.2 ± 0.2	0.10 ± 0.01
2SE	250 ± 70	0.20 ± 0.03	17 ± 5			5.1 ± 0.5	0.10 ± 0.02	260 ± 40	1.9 ± 0.2	7.0 ± 3.0	0.20 ± 0.02
3SE	310 ± 90	0.17 ± 0.03	28 ± 5	28 ±10	13 ± 2	8.3 ± 0.8	0.20 ± 0.01	370 ± 60	3.6 ± 0.4	2.5 ± 0.3	0.10 ± 0.01
2S	230 ± 70	0.08 ± 0.02	19 ± 5	17 ±10	8 ± 2	1.7 ± 0.2	<0.20	440 ± 70	1.0 ± 0.1		0.10 ± 0.01
3S	290 ± 90	0.30 ± 0.04	18 ± 5			7.3 ± 0.7	<0.50	230 ± 40	1.8 ± 0.2	4.0 ± 1.0	0.20 ± 0.02
3SW	220 ± 70	0.21 ± 0.03	46 ± 5			9.4 ± 0.9		4000 ± 600	4.1 ± 0.4		0.20 ± 0.02
5W	280 ± 80	0.19 ± 0.04	23 ± 5			55 ± 6	0.05 ± 0.01	710 ± 110	2.1 ± 0.2		0.70 ± 0.07
2NW	100 ± 30	0.18 ± 0.05	17 ± 5			41 ± 4		460 ± 70	6.8 ± 0.7		0.10 ± 0.01
3NW	290 ± 90	0.15 ± 0.03	17 ± 5			9.7 ± 1		390 ± 60	5.2 ± 0.5		0.10 ± 0.01
4NW	200 ± 60	0.14 ± 0.04	23 ± 5	<100	24 ± 4	29 ± 3	<8.0	450 ± 70	3.3 ± 0.3	<15	0.10 ± 0.01
5NW	230 ± 70	0.08 ± 0.02	25 ± 5			3.0 ± 0.3		250 ± 40	4.8 ± 0.5		0.20 ± 0.02
6NW	120 ± 40	0.09 ± 0.02	23 ± 5			3.6 ± 0.4		330 ± 50	2.7 ± 0.3		0.10 ± 0.01

TABLE A-V. Oak: Elemental Concentrations[a]

Location	Al (ppm)	As (ppm)	B (ppm)	Ba (ppm)	Be (ppb)	Br (ppm)	Cd (ppm)	Cl (ppm)	Cr (ppm)	Cu (ppm)	F (ppm)
2N	860 ±260	0.44 ± 0.07	81 ± 8			12 ± 1		65 ± 10	3.5 ± 0.4		0.60 ± 0.06
2NE	300 ± 90	0.07 ± 0.03	62 ± 6			3.1 ± 0.3		200 ± 30	2.9 ± 0.3		0.20 ± 0.02
2E	760 ±230	0.16 ± 0.04	69 ± 7			16 ± 2	0.34 ± 0.03	230 ± 30	2.4 ± 0.2		0.20 ± 0.02
1SE	370 ±110	0.20 ± 0.03	48 ± 5	25 ±10	18 ± 2	5.3 ± 0.5	<0.20	260 ± 40	2.2 ± 0.2	5.5 ± 0.6	0.10 ± 0.01
2SE	650 ±200	0.13 ± 0.03	63 ± 6	18 ±10	29 ± 3	3.4 ± 0.4	<0.20	360 ± 50	1.9 ± 0.2	7.3 ± 0.7	0.20 ± 0.02
1S	350 ±110	0.10 ± 0.04	66 ± 7			5.3 ± 0.5		280 ± 40	6.5 ± 0.7		0.20 ± 0.02
2S	580 ±180	0.14 ± 0.04	79 ± 8	73 ±20	90 ± 9	5.3 ± 0.5	<0.20	280 ± 40	3.3 ± 0.3	8.1 ± 0.8	0.40 ± 0.04
1SW	470 ±140	0.12 ± 0.04	48 ± 5			5.4 ± 0.5		380 ± 60	6.9 ± 0.7		0.20 ± 0.02
2SW	210 ± 60	0.14 ± 0.03	49 ± 5			2.2 ± 0.2		240 ± 40	6.4 ± 0.6		0.20 ± 0.02

Location	Fe (ppm)	Li (ppm)	Mg (ppm)	Mn (ppm)	Ni (ppm)	NO_3 (ppm)	Pb (ppm)	PO_4 (ppm)	Rb (ppm)	SO_4 (ppm)	Ti (ppm)	Zn (ppm)
2N	350 ± 70			430 ± 86		<0.9		190 ± 20		<0.6		
2NE	190 ± 40			220 ± 43		<0.9		1900 ± 190		230 ± 20		
2E	280 ± 60			390 ± 78		120 ± 10		2800 ± 280		930 ± 90	24 ± 3	18 ± 2
1SE	180 ± 40	0.31 ± 0.03	2300 ± 230	500 ± 100	4.8 ± 0.5	80 ± 10	<3.0	1100 ± 110	18 ± 2	200 ± 20	34 ± 10	26 ± 3
2SE	150 ± 30	7.1 ± 0.7	2400 ± 240	550 ± 110	4.0 ± 1.0	110 ± 10	<3.0	1400 ± 140	26 ± 3	290 ± 30		
1S	140 ± 30			450 ± 90		100 ± 10		1800 ± 180		490 ± 50		
2S	210 ± 40	5.4 ± 0.5	2800 ± 280	590 ± 120	4.4 ± 0.5	130 ± 10	3.0 ± 1	2500 ± 250	5.9 ± 1.2	990 ± 100	30 ± 3	30 ± 3
1SW	240 ± 50			500 ± 100		190 ± 20		1600 ± 160		250 ± 30		
2SW	170 ± 40			870 ± 170		120 ± 10		1600 ± 160		380 ± 40		

[a]Insufficient sample for analysis where no data are reported. Uncertainties represent analytical uncertainties.

(7)

Department of Energy
Los Alamos Area Office
Albuquerque Operations Office
Los Alamos, New Mexico 87544

AUG 5 1994

Barbara Hoditschek
RCRA Permits Program Manager
Hazardous and Radioactive Materials Bureau
New Mexico Environment Department
1190 St. Francis Dr., P. O. Box 26110
Santa Fe, NM 87502

Dear Ms. Hoditschek:

This transmits the report regarding the Technical Area (TA) 35, TSL-85 surface impoundment closure. The purpose of the report is threefold. First, it details the proposed plan to address the analytical interference from dielectric oil for the TA-35 TSL-85 surface impoundment at the Los Alamos National Laboratory. The primary concerns were that analytical limits of quantitation from some of the sampling exceed health-based action levels for six Semi-Volatile Organic Compounds (SVOC). These six SVOCs of concern are m-benzidine; n-nitrosodimethylamine; n-nitrosodi-n-propylamine; 3,3-dichlorobenzidine; 2,4-dinitrotoluene and 2,6-dinitrotoluene mixture; and hexachlorobenzene. The second purpose of the report is to address the three reasons for remediation of the dielectric oil that the New Mexico Environment Department listed in the Notice of Deficiency (NOD) dated May 5, 1994. The final purpose of the report is to discuss the issue of action levels, which are well below detection limits for the constituents.

It is requested that proposed plan, as well as the previously submitted responses to the NOD, be approved so that we can proceed with modifications to the amendment to the closure plan.

Should you have any questions, please feel free to contact Court Fennire, Environment, Safety and Health Branch, at 665-4718.

Sincerely,

Theodore J. Taylor
Program Manager
Environmental Restoration Program

LESH:TTT-034

Enclosure

cc:
See page 2

Received by ER RPF
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August 4, 1994

Proposed Plan to Address the Analytical Interference from Dielectric Oil for the TA-35, TSL-85 Surface Impoundment Closure

The purpose of this report is to address Item 4 of the Notice of Deficiency (NOD) from the New Mexico Environment Department (NMED) to the Los Alamos National Laboratory (LANL) dated May 5, 1994, for the "Amendment to the Closure Plan for the Technical Area 35, TSL-85 Surface Impoundment", dated October 1993. The following is Item 4 from the NOD:

> *Section 2.0, Response to NMED's Reason of Closure Plan Disapproval, page 2-3, paragraph 3.* ***"The presence of nonhazardous dielectric waste oil in the soils appears to have interfered with the SVOC analyses for the soils, resulting in samples with elevated LOQs."***
>
> *Remediation of the dielectric oil is necessary for the following seasons:*
>
> - *Inability to accurately determine the presence of semivolatiles as a result of the masking affect from the dielectric waste oil;*
> - *The presence of waste oil in the soil indicates that a leak occurred under the surface impoundment; and*
> - *Hazardous waste constituents were part of the over all waste stream generated at the surface impoundment.*

This report consists of three parts which collectively address the issues raised in Item 4 of the NOD. First, the report details the proposed plan to address the analytical interference from dielectric waste oil for the Technical Area 35 (TA-35), TSL-85 surface impoundment at LANL. The primary concerns were that analytical limits of quantitation (LOQ) from some of the sampling exceed health-based action levels for six semivolatile organic compounds (SVOCs). These six SVOCs of concern are m-benzidine; n-nitrosodimethylamine; n-nitrosodi-n-propylamine; 3,3-dichlorobenzidine; 2,4-dinitrotoluene and 2,6-dinitrotoluene mixture; and hexachlorobenzene. The second portion of the report addresses each of the three specific reasons for remediation of the dielectric waste oil that the NMED listed in Item 4 of the NOD. The final portion of this report discusses the issue of action levels which are well below detection limits for specific constituents.

The following is the proposed plan for addressing the analytical interference from the dielectric oil for the TA-35, TSL-85 surface impoundment closure. The plan is based on the previous work done at the site, the constituents of concern, and the concerns raised by the NMED in the May 5, 1994, NOD. The plan includes: resampling at the locations where elevated LOQs were obtained; analysis of the samples using techniques designed to reduce or eliminate interferences caused by petroleum products; a risk assessment, if necessary, to include any constituents detected; and remediation activities, as dictated by the risk assessment.

As detailed in the amendment to the closure plan, analytical data for the majority of the soil samples collected in Phases I through V either missed holding times, had surrogate recovery results outside of the U.S. Environmental Protection Agency's (EPA's) limits, or had interference

from nonhazardous constituents (dielectric waste oil). As a result, additional sampling, representative of the sampling that yielded poor analytical data, was proposed as Phase VI sampling in Section 3 of the amendment to the closure plan.

The previous sampling included only two locations for which the presence of total petroleum hydrocarbons (TPH) was assessed. At the two Phase V coreholes through the bottom of the impoundment, the surface samples, as well as a quality assurance surface sample, were found to contain TPH in the range of 97 to 314 parts per million. Therefore, it is proposed that all of the Phase VI samples be analyzed for TPH. This will help delineate the extent and magnitude of any TPH contamination in the areas where interference occurred. In addition, the samples collected during this event will be subjected to more rigorous analytical cleanup methods prior to analysis to ensure that the lowest possible LOQs are obtained. These cleanup methods include gel permeation chromatography (GPC) and, if necessary, acid/base partitioning. This approach is consistent with EPA's "Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A)" (RAGS) (EPA/540/1-89/002, December 1989). Section 5.3.2 of RAGS, which discusses unusually high quantitation limits, suggests reanalysis using cleanup methods to remove interferences.

GPC (EPA Method 3640) is a size exclusion cleanup technique for a broad range of semivolatile organics and pesticides. It is capable of separating high molecular weight material from the sample analytes. It has been used successfully for all of the semivolatile base, neutral, and acid compounds associated with the EPA priority pollutant and the Superfund target compound lists for gas chromatograph/mass spectrometer analysis for semivolatiles. This cleanup method will be applied to all of the Phase VI samples.

If the analytical results still indicate elevated LOQs, acid/base partitioning is proposed. Acid/base partitioning (EPA Method 3650) is a liquid-liquid cleanup method to separate analytes from base/neutral analytes using a pH adjustment. It can be used for cleanup of petroleum waste prior to analysis. Three of the SVOCs of concern (m-benzidine, n-nitrosodimethylamine, and n-nitrosodi-n-propylamine) are not included on the list of compounds currently known to be separated by this method. Therefore, it is proposed that this cleanup method first be applied to only a few samples collected at locations for which GPC cleanup was conducted but elevated LOQs were still obtained, if any. The results will then be evaluated to determine if the procedure has worked for all of the six SVOCs of concern. If so, the acid/base partitioning cleanup technique will be applied to samples collected from all of the previous locations for which high LOQs were obtained.

The final analytical results with the lowest LOQs possible will be evaluated to determine if any hazardous constituents were detected. Any constituents detected will be included in the aggregate risk calculation as detailed in Section 4 of the amendment to the closure plan. If the risk assessment shows an unacceptable risk, remediation activities will be initiated. A plan detailing the proposed cleanup actions will be submitted to NMED for approval.

If the analytical results still indicate elevated LOQs after the using acid/base partitioning cleanup technique, measures will be taken to remediate the TPH contamination. This will be conducted in association with any remediation activities driven by the risk assessment results. If the risk assessment does not indicate the need for cleanup measures, the TPH contamination will be remediated to a level which will not interfere with SVOC analysis. A plan for this remediation,

based on the analytical results for TPH, will be submitted to NMED for approval. This plan will include excavation of TPH-contaminated soils. An on-site mobile laboratory will provide quick turnaround TPH analyses. Once the soils with TPH contamination are removed to a level where no interference is present, confirmatory samples will be collected and sent to an analytical laboratory to determine the presence or absence of the SVOCs of concern. If the SVOCs are found to be present, the aggregate risk will be recalculated to determine if the site poses an unacceptable risk. If it does, remediation activities will be initiated and a plan submitted to NMED for approval.

NMED listed three reasons as to why remediation of the dielectric waste oil is necessary in the May 5, 1994, NOD. The following is a discussion of how the plan detailed above addresses each of the listed items.

The first reason NMED provided for the necessity of dielectric waste oil remediation is as follows:

> "Inability to accurately determine the presence of semivolatiles as a result of the masking affect from the dielectric waste oil."

The proposed plan, as detailed above, presents a course of action that includes various efforts to prevent further masking effects and to obtain representative data of high quality. This course of action includes extensive resampling of several areas associated with the former TSL-85 surface impoundment. These areas include the area beneath the location of the former surface impoundment, the area below the approximate location of the former underground storage tank and associated piping, and an area projecting downward into Mortandad Canyon along the most likely spill path. In addition to the Phase VI sampling event, rigorous cleanup techniques (i.e., GPC and acid-base partitioning, if necessary) are proposed prior to analysis of the samples collected during Phase VI to ensure the that lowest possible LOQs are obtained. Collectively, these efforts are specifically directed toward addressing the previous inability to determine the presence or absence of the SVOCs of concern and, thus, obtaining quality analytical data that can be used to further assess the need for additional closure activities at the TSL-85 surface impoundment site.

The second reason NMED gave for remediation of the dielectric waste oil is the following:

> "The presence of waste oil in the soil indicates that a leak occurred under the surface impoundment."

It is agreed that the presence of waste oil in the soil beneath the location of the former TSL-85 surface impoundment indicates that a leak may have occurred under the surface impoundment. However, analysis of the Phase V core samples from beneath the impoundment indicated that TPH contamination was only present in the surface soils. Therefore, the extent of vertical migration below the impoundment is not extensive. The proposed Phase VI sampling will include six soil samples collected at a depth of approximately two to three feet at locations within the former surface impoundment. Samples will be analyzed for volatile organic compounds (VOCs) by Method 8260, SVOCs by Method 8270, pesticides/herbicides and polychlorinated biphenols (PCBs) by Methods 8080/8150, and metals by Methods 6000/7000. This data will be used to determine the magnitude of any contamination below the impoundment.

It is also proposed to follow EPA guidance on evaluating aggregate risk as presented in EPA's RAGS. In accordance with RAGS, an aggregate risk will be calculated to determine if an unacceptable risk is being posed at the site. A discussion on the calculation of aggregate risk is included in Section 4.2 of the amendment to the closure plan. If it is determined that the site poses an unacceptable risk, additional cleanup will be performed to a degree agreed to by NMED and LANL. Cleanup of the site will be considered complete when it has been demonstrated that the site does not pose an unacceptable risk to human health or the environment.

The third and final reason for remediation of the dielectric waste oil is as follows:

> "Hazardous waste constituents were part of the overall waste stream generated at the surface impoundment."

Some confusion exists regarding this comment in that the word "generated" was used. No waste streams were generated at the former TSL-85 surface impoundment. LANL interprets this comment as referring to hazardous constituents that may have been present in the waste streams that entered the surface impoundment. Hazardous constituents may be present at the site because of their potential presence in the waste streams received in the impoundment. In addition, results of previous sampling and analysis indicated the presence of hazardous constituents at the site, although data quality was not high. The proposed Phase VI sampling will provide an accurate determination of the presence or absence of hazardous constituents at the site. If hazardous waste constituents are detected at the site, the aggregate risk potentially posed by these constituents will be evaluated in accordance with EPA's RAGS. The results of this in-depth risk assessment will be evaluated by NMED and LANL to determine whether the site poses an unacceptable risk to human health or the environment and whether or not further remediation activities will be necessary at the site.

Based on the results of the Phase VI sampling, an aggregate risk calculation may be necessary to determine if the site poses unacceptable risk. Any constituents detected will be included in the calculation. However, in some cases the constituent-specific action levels may be well below the quantitation limits attainable by the analytical laboratory. Sections 5.3.1 and 5.3.5 of RAGS discuss how to address action levels below quantitation limits when no hazardous constituents have been detected in any of the samples. The procedure for calculating aggregate risk and for dealing with action levels below LOQs, as presented in Section 4.0 of the amendment to the closure plan, is based on EPA's RAGS. The following is part of the procedure.

> If any of the sample-specific LOQs exceed the calculated health-based action level, additional consideration is necessary.
>
> - For a given constituent, if the action level is greater than or equal to one-half the LOQ for all samples, the constituent will not be included in the calculation of aggregate hazard index or aggregate risk. This is based on RAGS, which calls for one-half the LOQ to be used as the concentration for constituents below LOQs.