APPENDIX A

RESPONSES TO COMMENTS

REMEDIAL INVESTIGATION/FEASIBILITY STUDY
FOR SITES FTIR-38 and FTIR-40
NATIONAL TRAINING CENTER
FORT IRWIN, CALIFORNIA

From: Department of Toxic Substances (DTSC)

Comments from John P. Christopher, DTSC , Dated 10 April 2002.

GENERAL COMMENTS

Comment No 1: *This RI/FS is well conceived, thorough, and well written. It can be made acceptable with relatively small changes to several tables and passages of text, as mentioned in the Specific Comments below. The most important corrections are those required to be made for Table 7-18. Some errors and omissions in this crucial table weaken the Army's recommendations regarding the ecological risk assessment*

MW Response: Agreed. Table 7-18 has been revised as described under our response to Specific Comment No. 4, below.

SPECIFIC COMMENTS

Comment No. 1: *Metals in Plant Tissue, Sec. 4.2.1, p. 4-3. The Army states that data from co-located plant and soil samples indicate that plants are not bioaccumulating metals, even though soil concentrations for some metals are elevated. We agree that these plants do not show bioaccumulation for the seven metals analyzed (Table 4-3 vs. 4-4). The Army should change the language of the sentence on page 4-3 to limit their conclusion to the data collected.*

MW Response: Agreed. Text in the last paragraph of Section 4.2.1 on Page 4-3 has been revised to restrict conclusions regarding the relative concentrations of metals in co-located soil and plant samples to the specific metals that were analyzed

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Comment No. 2: *Human Health Risk Characterization for Sites FTIR-38 and -40, Sec. 6.5.2, pp. 6-27 ff. We concur that the Army's estimates of 1 E-6 to 1 E-5 for cancer risks at these sites, which falls within the "risk management range" of 1 E-6 for workers to 4 E-5 for potential future residents, driven mainly by arsenic and chromium in soil. Non-cancer hazard indices are less than the benchmark of 1.0 for both groups of receptors. We also*

concur with the Army's estimates for Site FTIR-40 shown in Table 6-23. Cancer risks range from 3 E-6 for workers to 3 E-5 for residents, driven almost entirely by As and Cr in soil. For future residents exposed to surface soil at FTIR-40 Area 1.1, the hazard index for non-carcinogenic toxic effects is 2.5, driven by As and Cd. Hazard Indices for future workers are less than the benchmark of 1.0. Because NTC Ft. Irwin is an open base, risk managers should rely mainly on the risk estimates for workers.

Maximum concentrations of Pb in soil were 6,430 mg/kg at FTIR-38 Area 2 and 38,400 mg/kg at FTIR-40, Area 1.1 (Table 6-24). These values are higher than 3,475 mg/kg, the risk-based clean-up level in soil based on LeadSpread 7, and two to three orders of magnitude higher than the upper range of ambient values for Pb in soil, 7 mg/kg. These hot spots were due to the presence of spent ammunition. We agree with the Army's recommendation to evaluate these two sub-sites further in the Feasibility Study, based on the presence of Pb in soil.

MW Response: Concur.

Comment No. 3: *<u>Defining Chemical of Ecological Concern (COEC), Sec. 7.6, p. 7-20</u>: the Army shows two bullets at the top of page 7-21 as the defining conditions for a COEC, but we are not clear whether one or both conditions must be met. It seems that both conditions is proper, so an "and" should be inserted after the first bullet.*

MW Response: Agreed. Both of the stated conditions must be met in order for a chemical to be identified as a chemical of ecological concern (COEC). Text in Section 7.6 has been revised accordingly.

Comment No. 4. *<u>Errors and Omission in Table 7-18</u>: This crucial table contains logical errors and is missing important data. The errors involve two of the three decision criteria shown in the footnotes, which do not correspond logically with accepting or rejecting a detected metal as a COEC. It appears to us that reversing the sense of the inequality signs would make these two criteria consonant with the entries in the far right column of the table:*

"Yes(a) -- HQ based on TRV_{ARMY} is >1.0 and site concentrations ..."
"Yes(b) -- HQ based on TRV_{BTAG} IS >1.0 and site concentrations ..."

The third criterion, "No", appears to be consistent with the right-hand column.

The omission involves HQs at Reference Area 2. Table 7-18 shows hazard quotients (HQ) for six metals at Site FTIR-40 Area 1, but HQs for only two metals are given for the corresponding Reference Area 2. The complete context of hazards at the reference area must be provided in order to make proper risk management decisions for the site

MW Response: Agreed. The sense of the inequality signs in footnote "a" should be reversed in order for a chemical to meet this criterion as a COEC. In addition, footnote "a" should specify that site concentrations must be "greater than" reference concentrations to meet this criterion as a COEC. Table 7-18 has been revised accordingly.

Please note that the only chemicals that were included in Table 7-18 were those with chemical-specific HQ estimates greater than or equal to 1. For Reference Area 2, HQ estimates for copper and lead were less than 1 based on the Army TRVs. Similarly, HQ estimates for cadmium, copper and zinc at Reference Area 2 were less than 1 based on the BTAG TRV-Low. Hence, these COPECs were excluded from Table 7-18. However, we understand the HERD's point that these COPECs and their corresponding HQ estimates should be included for purposes of comparison. Therefore, Table 7-18 has been revised to include these COPECs and their corresponding HQ estimates.

Comment No. 5: *<u>Risk Characterization for Mojave Ground Squirrel at Site FTIR-38 and -40, Sec. 7.6, pp. 7-20 ff</u>: The summary of potential hazards for the Mojave ground squirrel is adequately presented in Table 7-18, except as noted in Comment 4 above. The Army presents summed HQs (ΣHQ) for the Mojave Ground Squirrel at each of the three areas of interest, comparing one set of exposure doses to three separate sets of toxicity reference values (TRV). The Army developed one set of TRVs. The other two designated TRV-Low and TRV-High, come from USEPA Region 9 Biological Technical Assistance Group (BTAG).*

<u>a) Using Army TRVs</u>: For Site FTIR-38 Area 2, ΣHQ = 38 compared with 33 for Reference Area 1. Drivers were Al and Sb. For Site FTIR-40 Area 1.1, ΣHQ = <1 driven by Al, Sb, Cu, and Pb, compared to ΣHQ = 22 at Reference Area 2. [No HQs are presented for Cu and Pb for Reference Area 2, see Comment 4 above.] ΣHQ<1.0 at Site FTIR-40 Area 2.

<u>b) Using BTAG TRV-Low</u>: For Site FTIR-38 Area 2, ΣHQ = 795, 794 of which is due to Pb. This should be compared with ΣHQ =7 for Reference Area 1, 6 of which is due to Pb. For Site FTIR-40 Area 1.1, ΣHQ = 8,074, driven almost entirely by Pb (HQ = 8,055) with contributions from Al, Sb, and Cu. This should be compared with

$\Sigma HQ=7$ for Reference Area 2, nearly all of which is due to Pb (HQ=6). [No HQs are presented for Cd, Cu, and Pb for Reference Area 2; see Comment 4 above.] At Site FTIR-40 area 2, HQ = 22 due to Pb This should be compared with $\Sigma HQ=7$ for Reference Area 2, nearly all of which is due to Pb (HQ=6)

c) Using BTAG TRV-High: $\Sigma HQ<1.0$ at all three sites.

Some metals at some sites yielded hazard quotients (HQ) greater than 1 0, compared with Army TRVs and/or BTAG TRV-Low, but their concentrations in soil and plants did not differ from those at their respective reference areas (Table 7-16 through 7-18). Although any HQ>1.0 is of interest, only those COEC which differ from the reference area should proceed to the Feasibility Study, where methods to lower these concentrations are presented. We concur with the final selection of COECs for the Feasibility Study shown in Table 7-19. At Site FTIR-38 Area 2, concentrations of Sb are within the range of ambient, thus, only Al and Pb should be retained as COEC. At Site FTIR-40 Area 1.1, Al and Sb fall within the ambient range, leaving Cd, Cu, Pb, and Zn as COEC. At Site FTIR-40 Area 2, Pb concentrations fall within the ambient range, leaving no COEC. These selections of COEC are consistent with the set of comparisons against BTAG TRV-Low and the comparisons with ambient ranges.

MW Response: Agreed. Additional text has been added to the results discussion in Section 7.6 comparing HQ estimates for Sites FTIR-38 Area 2, FTIR-40 Area 1.1 and FTIR-40 Area 2 with HQ estimates for corresponding reference areas. In addition, Table 7-18 has been revised to include HQ estimates for copper, cadmium, lead and zinc, as described in our response to Specific comment No. 4, above.

Comment No 6. *Quantitative Risk Reduction, Secs. 11 & 12. We did not see any presentation of quantitative reduction in risk for any of the alternatives considered for any of the sites. This is the purpose of a baseline risk assessment - to have a basis for comparing alternatives To the extent possible, the Army should add such quantitative comparisons to these sections.*

MW Response: Agreed. Quantitative estimates of risk reduction associated with the evaluated remedial alternatives have been presented in revisions to Sections 11 and 12

Comment No. 7. *Remedial Alternative for Site FTIR-38 Area 2, Sec. 12.2.1, p. 12-2. We agree that No Action and Institutional Controls would not achieve remedial action objectives (RAO) at this site. Alternative 3, Excavation and Disposal, is particularly attractive because of its minimal impact on the habitat of the Mojave ground squirrel and other burrowing creatures. The principal added risk associated with this alternative is potential injury to workers during removal of unexploded ordnance (UXO).*

MW Response: Concur.

Comment No. 8: *Remedial Alternatives for Site FTIR-40 Area 1.1, Sec. 12.2.2, p. 12-2: We agree that No Action, Removal and Surface Debris, and Institutional Controls would not achieve RAOs at this site. Both Limited Soil Excavation with Removal of Surface Debris and Clean Closure would achieve RAOs with minimal disturbance of habitat. As with the previous site, this alternative carries some risk injury to workers during removal of UXO*

MW Response: Concur.

CONCLUSIONS AND RECOMMENDATIONS

Comment No. 1: *This RI/FS is very well presented. We require a few revised passages and tables before the document can be acceptable.*

MW Response: Concur.

Comment No. 2: *Table 7-18, which contains a summary of the ecological risk assessment, seems to contain logical errors in its definitions of decision criteria. Also, HQs for some metals in the reference areas were omitted. This table is crucial to the Army'' overall presentation and must be corrected.*

MW Response: Concur. Table 7-18 has been revised as described under our response to Specific Comment No. 4, above.

Comment No. 3: *The Army should present estimates of quantitative risk reduction associated with each alternative. For some alternatives it might be*

possible to present only semi-quantitative or even qualitative estimates In any event, we require that these estimates be presented.

MW Response: Concur. Please see response to Specific Comment No. 6, above.

REVIEW COMMENTS ON:
DRAFT REMEDIAL INVESTIGATION/FEASIBILITY STUDY FOR SITES FTIR-38 AND FTIR-40
FORT IRWIN NATIONAL TRAINING CENTER

From: Department of Toxic Substances Control (DTSC)

Comments from Curtis Plotkin, DTSC, Dated 9 May 2002.

SPECIFIC COMMENTS

Comment No. 1 *Section 4, Page 4-2, 4.2.1, sentence 1. Delete the 'at' in the sentence.*

MW Response: Comment noted. The "at" has been deleted.

Comment No. 2 *Section 5, page 5-1, paragraph 2 'Metals', sentence 2. 'Most metals are precipitated, complexed with iron oxides, and sorbed onto soils soon after introduction to the environment' The Department feels this statement is too general and requests it to be deleted or modified.*

Adsorption of metal ions on a mineral surface may or may not be strongly controlled by electrostatic attraction / repulsion and pH, as well as an abundance of favorable bonding sites. Additionally, the reaction of metal ions on a mineral surface is controlled by the amount of iron bonding sites available in the system at a given time, mostly as amorphous iron oxyhydroxides or goethite The statement contained in the report implies that all metals will be sorbed in some manner soon upon introduction into the environment, which may or may not be true. Additionally, from studies in arid desert environments, the organic content of alluvial fan material is extremely low; thus retardation of anthropogenic metals or organics will be very small.

Carroll, S.A.; O'Day, P.A.; Piechowski, M., Rock-water Interactions Controlling Zinc, Cadmium and Lead in surface water and sediments, U.S. Tri-State Mining District 2, Geochemical Interpretation, Environmental Science and Technology 32, No. 7 (01 APR 1998), p 956-965
Connors, K.A., Chemical Kinetics, p 480, VCH, New York, 1990
Lasaga, A.C., Ab initio methods in mineral surface reactions, Rev., Geophysics, vol 30, p 269-303, 1992
Lasaga, A.C Fundamental approaches in describing in describing mineral dissolution and precipitation rates, in Chemical Weathering Rates of Silicate minerals, Rev. Mineral, Vol 31, edited by A.F. White and S.L. Brantley, p 23-81, Mineral Society of America, Washington, D.C., 1995.

O'Day, P A. Molecular Environmental Geochemistry, Reviews of Geophysics 37, No 2 (1999) p 249-274.

MW Response: MWH concurs. The text in Section 5.0 has been revised with additional details on the fate and transport of metals.

Comment No. 3: *Section 5.0, page 5-1, paragraph 3. Please delete or modify this section or provide the following:*

a. Laboratory analyses performed to support your claim
b. Details on the thermodynamic calculations performed to convert lead (Pb) to cerussite (PbCO3) and field data supporting the claim.
c. Provide laboratory data and calculations performed to derive your Kd for the arid desert environment where the Base is located.

MW Response: The text in Section 5.0 has been revised to add more details, as follows:

Total lead is the indicator metal identified in soils in the RI. At Fort Irwin, desert soils tend to be alkaline (pH ranging from 7.5 to 8.5) and calcareous (mineralogy dominated by carbonates). In this environment, any dissolved lead tends to quickly and almost completely form lead precipitates or relatively insoluble hydroxide and carbonate minerals. Lead in these mineral phases is sparingly soluble and is unlikely to migrate downward in the soil profile. Given the relatively low solubility of lead hydroxide and lead carbonate (EPA, 1992, Santillan-Medrano and Jurinak, 1975, Dragun, 1988, Harter, 1983, Martel and Smith, 1982) solid to liquid distribution coefficients (Kd) are observed in the range of 3,000 to 35,000 liters per gram (L/g) for California soils (Gao, *et. al*, 1995). All available literature indicates that lead partitions strongly to the solid rather than the liquid phase, and given the low rainfall and high evaporation conditions present in the desert, site data suggests that downward migration of lead in soils is limited to the upper 3 feet of soil, as observed in Figure 4-5.

The following references have been added in the reference section:

EPA 1992. Behavior of Metals in Soils. EPA/540/S-92/018

Santillan-Medrano, J. and J. J. Jurinak, 1975. The Chemistry of Lead and Cadmium in Soils: Solid Phase Formation. Soil Science Society of America Journal Vol. 50, p 24-28.

Dragun, J 1988. The Soil Chemistry of Hazardous Materials. HMCRI, Silver Sprinf, Md.

Harter, R.D. 1983. The effect of Soil pH on adsorption of lead, copper, zinc and nickel. Soil Science Society of America Journal Vol. 47, p 47-51.

Martel A.E. and R.M.Smilth, 1982 Critical Stability Constants Plenum Press, New York

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Comment No. 4: *Section 5.0, page 5-2, paragraph 2, sentence 1* *'In summary, metals, SVOCs and TRPH are considered to be relatively immobile in desert soils' Please delete this statement as per Specific Comment 2 above.*

MW Response: Comment noted. This sentence has been deleted.

Comment No. 5: *Section 6.4.3.2, page 6-2, sentence 2.* *Cal-EPA's Risk Assessment Spreadsheet (Bloodpb7.xls). Please clarify if this is Lead Spread 7*

MW Response: "Bloodpb7.xls" is the name of the Lead Spread 7 spreadsheet. The text has been modified accordingly for clarification.

REVIEW COMMENTS ON:
DRAFT REMEDIAL INVESTIGATION/FEASIBILITY STUDY FOR SITES FTIR-38 AND FTIR-40
FORT IRWIN NATIONAL TRAINING CENTER

From: U.S. Army Corps of Engineers (USACE)

Comments from Kee Chan, USACE, Dated 10 September 2002.

SPECIFIC COMMENTS

Comment No. 1: *Page 1-1, paragraph 2. Were the Draft Workplan and RI ever finalized? They should. If not, why not? Please specify.*

MW Response: The Draft Workplan became final without further changes in June 2001. The RI for Sites FTIR-32A and FTIR-39 was finalized in May 2001 and the text on page 1-1 and in the reference section has been revised accordingly

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Comment No. 2: *Page 1-2, paragraphs 2 and 6: Please specify the maximum vertical depth of the RI for human and ecological risk evaluation.*

MW Response: Samples were collected to a maximum depth of 5 and 10 feet at Sites FTIR-38 Area 1 and FTIR-40 Area 2, respectively. The text has been revised to specify these depths.

Comment No. 3. *Page 2-4, paragraph 3:*

1. *The paragraph says August 1998 while Page 4-1, Paragraph 3 says July 1998. Was any report written for that effort? Please provide reference*
2. *According to Figure 2-1, there were 5 sample locations. If so, who collected the other three additional samples? What were the depths and analyses?*

MW Response: The samples were collected on July 16, 1998. The text on page 2-4 has been corrected. This RI/FS report describes this sampling effort in further detail in Section 4.1.1.

There were five sample locations at this site during the SI, from where surface soil samples were collected. Two additional samples were collected during July 1998 by the USACE following recommendations in the SI. These samples were collected from the subsurface near the

location of 38-1-SS-2 at depths of 2 feet bgs and 5 feet bgs. These results are included in this document.

Comment No 4: *Page 2-5, paragraph 2 Were there any VOC and SVOC detections?*

MW Response: VOCs were not detected in soil samples collected at Site FTIR-40 Area 2 during the excavation of the test pit in the area of the former septic tank. Several SVOCs were detected in soil samples. Benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, indeno(1,2,3-cd)pyrene, and pyrene were detected at concentrations below the PRGs and concentrations decreased with depth Text to summarize the VOC and SVOC results has been added in this paragraph.

Comment No. 5. *Page 2-5, paragraph 3 The preceding Paragraph says TRPH was found. If so, TRPH results should be depicted in Figure 2-2*

MW Response: Comment noted. The figure has been revised to include the detection of TRPH at 270 mg/kg in the 5-foot sample collected from the test pit.

Comment No. 6. *Page 3-2, paragraph 4. Of the 5 potential food sources for the squirrel, only Desert Thorn was collected and analyzed. Thus, will it affect the soil-to-plane transfer coefficients calculation? Please revise presentation accordingly. Also, where are the calculated coefficients?*

MW Response: We agree that it would have been optimal to collect individual samples, or a composite sample, of all five targeted plant species, however it was logistically impossible to do so. As described in Section 3.2.1, these dietary plant species are preferentially consumed at different times of the year depending upon plant life stage, seasonal variability, and moisture content. Thus, all five targeted plant species do not occur simultaneously, at the stage in which they are consumed. As described in Section 3.2.3, desert thorn (*Lycium sp.*) was the only plant species present in sufficient abundance for sampling at the time of collection. Where targeted plant species were not present at a site, similar non-targeted plant species were collected in consultation with a qualified onsite biologist (please refer to Section 3.2.2). The collection of similar, non-targeted plant species is not anticipated to affect exposure estimates appreciably, due to the variability inherent in biological sampling However, this issue does contribute to a degree of uncertainty in the exposure assessment for the Mojave ground squirrel. Text in Section 3.2.3 has been revised accordingly.

Section 3.2.2, Paragraph 1, states that soil-to-plant transfer coefficients were calculated. However, exposure doses were actually modeled based on *measured* concentrations of COPECs in plant tissues, as described in Section 7.2.7. Measured plant exposure point concentrations are presented in Tables 7-2, 7-4 and 7-6. Dose and hazard quotient calculations based on measured soil and plant concentrations are presented in Tables 7-10 through 7-15. Text in Section 3.2.2 has been revised accordingly

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Comment No. 7: *Page 3-4, paragraph 3. Why were Shadscale, Spinescale and Hop-sage plants collected given they were not identified as potential food sources for the squirrel? Will these plants affect the validity of the soil-to-plane transfer coefficients? Please revise the Target Plant Species Section accordingly.*

MW Response: Please refer to our response to Comment No. 6 above.

Comment No. 8: *Page 3-5, paragraph 3. What was the reason for STLC and TCLP? Was it for waste disposal? Please clarify.*

MW Response: STLC and TCLP samples were collected to characterize the soil for potential future disposal. The text in Section 3.3 has been revised for clarification

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Comment No. 9: *Page 3-6, paragraph 1. Where did the action level of 50 ppm come from?*

MW Response: The action level was based on a stepping-out procedure to try to characterize the site. In many cases soil sample locations were collected until we reached a concentration that was close to background levels. Because of the discrepancy between the Army TRV and BTAG TRV, a level of 50 ppm was used as the action level to ensure the site was adequately characterized

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Comment No. 10: *Page 3-7, paragraph 2. What does "impacted soil sample mean? How was it determined? Is it different than the regular soil sample?*

MW Response: Impacted soil refers to areas of the berm where there appear to have been more bullets impacting the berm. The text has been revised to indicate this distinction.

Comment No. 11. *Page 3-7, paragraph 3. The words, "locations were surveyed by ethylene dibromide (EDB) and Associates from Rancho Cordova" do not make sense because EDB is a chemical.*

MW Response: Comment noted. EDB and Associates is the name of the land surveyor used to survey the sample locations. The text has been changed.

Comment No. 12. *Page 3-7, paragraph 3 The survey data should be provided.*

MW Response: Comment noted. The survey data has been included in Appendix F of this report.

Comment No. 13. *Page 3-8, paragraph 4 Replace 7471 with 7471A.*

MW Response: Comment noted. The text has been changed.

Comment No. 14. *Page 3-9, paragraph 3. Replace 1994 with 1999 for organic data review*

MW Response: Comment noted. The text has been changed.

Comment No. 15. *Page 3-11, paragraph 1 Positive or no-detect result has no bearing on whether or not to flag the result when initial calibration failed. Therefore, replace the last sentence with "The exceedance was considered negligible (30 67 vs. 30%), thus the associated results were not flagged."*

MW Response: Comment noted. The text has been changed

Comment No. 16. *Page 3-12, paragraph 1. The parent sample with 0% matrix recovery should be rejected unless the sample concentration exceeds the spike concentration by greater than four times. Please identify those samples.*

MW Response: Comment noted. MWH has analyzed the data. A sentence has been added on page 3-12 to state "For recoveries below 30 percent, detected results were qualified as estimated and flagged "J", and non-detects were qualified as not usable and flagged "R"." In addition, "J" flags have been added to the following samples in both Table G-4 and the 99-3593 Qualifiers table (included in Section I): samples 40-2-PT-10, 40-2-PT-6, 40-2-PT-7, 40-2-PT-8, 40-2-PT-9, 40-2-SS-6, 40-2-SS-7, and 40-2-SS-8.

Comment No. 17. *Page 4-1, paragraph 4, page 4-2, paragraph 4, page 4-7, paragraph 4. The BUTLs for the chemicals of concern should be provided for comparison.*

MW Response: The BUTLs are included in Table 4-1

Comment No 18: *Page 4-1, paragraph 3, page 4-2, paragraph 3, page 4-4, paragraph 5, page 4-6, paragraph 2, page 4-7, paragraph 3. The soil and plant tissue results should be depicted in figure.*

MW Response: Comment noted. Figures showing posted data have been included.

Comment No. 19: *Page 4-8, paragraph 2. Replace side.wall with sidewalls*

MW Response: Comment noted. The text has been changed.

Comment No. 20: *Page 6-4, paragraph 7. If only surface soils were evaluated, then why subsurface (1 –10 feet bgs) samples were collected at 10 feet depth? How was the subsurface data used?*

MW Response: Subsurface soil samples were used in the Ecological Risk Assessment in the evaluation of risks to burrowing animals.

Comment No 21: *Page 6-6. The Report should have provided a section to specify how the data was selected and treated in statistical calculation when uncertainties occur such as field duplicate, non-detect, and sample quantitation limit exceeding the maximum detection in data set. Thus, the following should be included in the report:*

Data Selection Criteria

All validated chemical data were evaluated for inclusion in the calculation. The evaluation was based on a conservative approach and to meet project data quality objectives. All valid data were treated as follows:

- *In the case of a pair of duplicate samples, the highest unqualified values was selected;*
- *The non-detect result was not used if the sample quantitation limit exceeded the maximum detected concentration in same data sample set,*[(a)]
- *Full values of the detected and one half of non-detect were included.*

(a) USEPA, 1989 Risk Assessment Guidance for Superfund (RAGS). Volume I – Human Heath Evaluation Manuel (Part A). EPA/5401-89/002 December

MW Response: Comment noted. This information has been added to Section 6.2.1.

Comment No. 22. *Page 6-35 The Report seems to have two sets of risk calculation. One is for surface. The other is for subsurface. If so, the Report should state the depths for each set. Also, was the recommendation as shown on Page 12-1 based on one or both sets of risk calculations? Please clarify*

MW Response: Section 6.1.2 of the HHRA discusses the scope of the risk assessment and defines surface (0-1 foot bgs) and subsurface (1-10 feet bgs) soil samples. The distinction between soil samples is necessary for the various exposure pathways discussed in the risk assessment. The recommendations are based on both sets of calculations.

Comment No. 23 *Table 4-1. Please provide the PRGs.*

MW Response: Comment noted. The PRGs are included in Table 4-1.

Comment No 24 *Tables 4-2 and 4-3. The BUTLs should be provided for comparison.*

MW Response: Table 4-1 which provides the BUTLs can be used for comparison to the results in Tables 4-2 through 4-11.

Comment No 25 *Table 6-7. Replace #REF! With No.*

MW Response: Comment noted. The table has been changed.

Comment No 26 *Appendix E. Copy of method detection limit study for all the chemicals of concern should be provided It is to ensure the reported PQL are valid and updated per Title 40, CFR Part 136, Appendix B.*

MW Response: Attaining copies of MDL studies from 3 years ago for all instruments on which analyses were conducted and for each chemical of concern would not be a feasible option at this time.

Comment No. 27. *Table E-2 is incomplete The Table is incomplete. For example, Samples 38-2-SS-CNF-36, -37, -41, -42, -43, -45, -47, -49 and –53 were collected,*

accordingly to Chain-of-Custody (COC) records. However, their results were not tabulated. Please review the COC records and ensure all the results of the samples are summarized.

MW Response: Comment noted. Results have been added to Table G-2 as needed.

Comment No. 28. *Appendix G. Laboratory Project ID 99-3622: Positive or no-detect result has no bearing on whether or not to flag the result when initial calibration failed. Therefore, replace the sentence regarding the initial calibration with "The exceedance was considered negligible (30.67 vs. 30%), thus the associated results were not flagged."*

Also, replace Inorganic Data Review (February 1994) with Organic Data Review (October 1999).

In addition, the statement regarding that raw data were not reviewed, is incorrect because raw data should have been reviewed under validation level IV. Please review the raw data and revise the report accordingly.

MW Response: Comment noted. The text has been revised for each.

Comment No. 29 *Table H-1. The Table is incomplete. For example, sample and duplicates of Samples 38-2-182, 38-2-SS-207, 38-2-SS-51-3, 38-2-SS-22 is not in the Table. Please include all the duplicates along with their respective RPD values.*

MW Response: Table H-1 is a compilation of all confirmation samples collected. Data for all XRF soil samples (including the samples listed above) and associated field duplicates can be found in Table 4-5

REVIEW COMMENTS ON:
DRAFT REMEDIAL INVESTIGATION/FEASIBILITY STUDY FOR SITES FTIR-38 AND FTIR-40
FORT IRWIN NATIONAL TRAINING CENTER

From: U.S. Army Corps of Engineers (USACE)

Comments from Neal Navarro, USACE, Dated 10 September 2002.

GENERAL COMMENTS

Comment No 1. *This document makes decisions based on the BTAG TRVs. I thought that risk calculations using the BTAG TRVS would be presented, but all decisions would be based on the Army's values (See specific comments below for more information.) Please clarify.*

When the eco risk for a site or reference area is presented using the BTAG TRVs, only those metals with BTAG values are used to calculate the total HI. In this manner some metals that actually exceed background are not being addressed. Is this appropriate? Shouldn't all metals that exceed background be used? Please clarify. By not using all of the metals (using only those with BTAG values) it sometimes indicates that using the BTAG TRVs is less conservative than using the Army values. Recommend that all metals over background be used for calculating risks for both the Army TRVs and the BTAG TRVs (use the Army's TRV for those metals that do not have a BTAG value)

The cancer risk range of 1×10^{-6} to 1×10^{-4} is described throughout the document as "USEPA's acceptable cancer risk range." It is more correctly and accurately described as a "risk management range." Please clarify the text.

MWH Response: Actually, remedial decisions were based upon the *Army* TRVs. Please refer to Page ES-5, Paragraph 1, which states ". .the Army TRVs were selected as the criteria upon which final COECs would be selected because risks based on Army TRVs fell in between those calculated using BTAG low and BTAG high TRVs, but still favored a minimal level of potential effects." Also, please refer to Section 8.2.2.1 and Table 8-1 for the rationale used in the selection of COECs based on the Army TRVs.

We agree that it would have been appropriate to combine Army and BTAG TRVs if a *hierarchy* of TRVs was used in the ecological risk assessment. However, the decision of the USACE during the April 11, 2001 meeting between the USACE, DTSC and MWH was to present HQs and HIs calculated for COPECs in *parallel*. Consequently, MWH

calculated individual sets of HQs and HIs for COPECs using either the Army or BTAG TRVs We believe that this resulted in the clearest comparison of site HIs between those calculated using the Army or the BTAG TRVs. As discussed above, final COEC selection and remedial decisions were ultimately based upon the *Army* TRVs.

Furthermore, references to "USEPA's acceptable cancer risk range" have been deleted, and replaced with language cited in USEPA's *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions* (USEPA, 1991)

SPECIFIC COMMENTS

Comment No. 1: *Section 6.2.5 page 6-9 Manganese should be magnesium.*

MW Response: Comment noted. The COPC for subsurface soils at site FTIR-38 Area 1 includes manganese as shown in Table 6-4.

Comment No. 2: *Section 6.3.2 and Section 6.3.5.2 Section 6.3.2 indicates that the two receptors considered were residential and industrial receptor However, section 6.3.5.2 appears to indicate that military personnel (field training/maneuvers) were also considered. Please clarify.*

MW Response: Comment noted. The military personnel scenario was used in conjunction with the future industrial worker for exposure dose calculations.

Comment No. 3: *Section 6.4.4 Should refer to appendix J.*

MW Response: Comment noted. The text has been changed.

Comment No. 4: *Section 7.2.4 page 7-7 Suggest that "VOCs" be removed.*

MW Response: Comment noted. The text has been changed.

Comment No. 5: *Section 7.3 pages 7-12. The last sentence of the first paragraph states, "In both documents, emphasis was placed on studies in which reproductive and developmental endpoints were considered." This was stated in the BTAG document, however, I'm not sure that that was actually*

the outcome. So, if this can't be substantiated then suggest that the statement be clarified or deleted.

MW Response: Concur. Text has been revised as follows: "In both documents, *initial* emphasis was placed on studies in which reproductive and developmental endpoints were considered. However, in some cases where limited studies were available, or non-reproductive effects occurred at doses lower than those causing reproductive effects, TRVs were based on non-reproductive endpoints."

Comment No. 6: *<u>Section 7.6 pages 7-20 to 7-21</u>. It is stated that "risks predicted in the Phase I ERA were considered validated and the chemical was identified as a chemical of ecological concern, if the chemical:*

"exhibited a hazard quotient greater than one, based on either the Army TRV or the BTAG TRV." Do we really want to consider a risk as being validated based on a phase II assessment using the BTAG TRVs? I would suggest not. Please clarify. Furthermore, the process, as carried out here, is using the BTAG TRVs as a basis for decision making. Later on in subsequent sections, the BTAG TRVS are just not considered anymore without adequate justification/explanation. I would suggest that this is the point where the BTAG TRVs are eliminated from consideration with adequate explanation/justification. (note: Table 7-18 would need to be revised)

"Was present in concentrations greater than reference concentrations" DTSC usually requires comparisons of both max/UTL <u>and</u> population to population. The process considered here appears to look at each separately. Please clarify.

MW Response: Agreed. Reference to the term "validated" on Page 7-20, Paragraph 5, has been deleted.

As described in our response to Comment No. 1, above, the decision to present risks in the ERA based on Army and BTAG TRVs in parallel was based on the results of the April 11, 2001 meeting between the USACE, DTSC and MWH. However, final COEC selection and remedial decisions were ultimately based upon the *Army* TRVs. Given the April 11, 2001 decision, MWH believes that it was most appropriate to select cleanup goals in the feasibility study portion of the RI/FS for Sites 38 and 40, rather than in the risk assessment.

Please note that hazard estimates and statistical comparisons to reference concentrations were integrated, as discussed in Sections 7.6.1 through

7.6.3. This issue has been clarified in revisions to Paragraph 4 of Section 7.6

Comment No. 7. *<u>Sections 7.6.1 to 7.6.3</u>. Suggest that these sections be revised to incorporate the previous comment to section 7.6*

MW Response: Please refer to our response to Comment No. 6, above.

Comment No. 8: *<u>Section 8.2.1 page 8-13</u>. The last paragraph on this page should be revised to correct confusion of routes and pathways actually considered in the assessment. It appears that a pathway between humans and animals/plants was addressed and that human exposure did not include inhalation. Please clarify.*

MW Response: Agreed. Text in Section 8.2.1 has been revised to clarify the completed exposure pathways for human and ecological receptors.

Comment No. 9: *<u>Section 8.2.2.1</u>. Please see comment to section 7.6 above. Suggest that this section be revised once comment to 7.6 addressed*

MW Response: Please refer to our response to Comment No. 6, above.

REVIEW COMMENTS ON:
DRAFT REMEDIAL INVESTIGATION/FEASIBILITY STUDY FOR SITES FTIR-38 AND FTIR-40
FORT IRWIN NATIONAL TRAINING CENTER

From: U.S. Army Corps of Engineers (USACE)

Comments from Curtis Payton, USACE, Dated 10 September 2002.

SPECIFIC COMMENTS

Comment No. 1. *Page ES-2, first paragraph, first bullet. UXO avoidance is generally practiced at our IRP sites NOT clearance. Text in subsequent sections correctly uses avoidance.*

MW Response: Comment noted. The text has been changed to state "UXO avoidance".

Comment No. 2: *Page 2-4, section 2.3.1, second paragraph, third sentence. "...these samples, collected ~~near~~ at the location ...".*

MW Response: Comment noted. The text has been changed.

Comment No. 3: *Page 3-3, section 3.2.2, first paragraph, fourth sentence. "...sampling locations for Site FTIR-38 Area 2 ... ~~can be shown~~ **are presented** on Figures 3-1 and 3-2 ..."*

MW Response: Comment noted. The text has been changed.

Comment No. 4: *Page 3-8, section 3.6.1, first paragraph, first sentence. "...and 67 XRF confirmation samples were collected at Sites FTIR-38 Area __(?),__ FTIR_40 ..."*

MW Response: Comment noted. The text has been revised to reflect samples collected from FTIR-38 Area 2.

Comment No. 5: *Page 3-9, first paragraph. Please also note that beyond 250 parts per million the XRF analysis becomes more conservative since the results for lab analysis universally came back higher than the XRF.*

MW Response: Comment noted.

Comment No. 6: *Page 3-12, Field Duplicates. Briefly describe why no qualification was applied to the results when the RPDs were outside the specified limits of the CDAP*

MW Response: Qualification criteria for field duplicate RPD results are not specified in the *National Functional Guidelines for Organic Review* (February 1994), in the *National Functional Guidelines for Inorganic Review* (February 1994), or in the USACE document Appendix I – Shell for Analytical Chemistry Requirements, *Requirements for the Preparation of Sampling and Analysis Plans* (February 2001). Therefore, qualifications were not applied for deviations from specified limits of the CDAP

Comment No. 7: *Page 3-13, Representativeness, first bullet. Please note that selenium is used in glassware manufacturing to make glass clear. Therefore the selenium may be lab-introduced*

MW Response: Comment noted. Selenium concentrations have not historically been a concern at these sites and selenium is not a known lab contaminant.

Comment No. 8: *Page 4-4 last sentence of top paragraph (beginning on page 4-3). Delete "were higher".*

MW Response: Comment noted. The text has been changed.

Comment No. 9: *Page 4-6, first sentence top of page "...concentrations of cadmium and zinc **in** sample 40-1-PT-2...".*

MW Response: Comment noted. The text has been changed.

Comment No. 10: *Page 5-2, Total Recoverable Hydrocarbons Please also include in the discussion that 418.1 analysis frequently generates false positives due to total organic carbon and natural oils in the soil.*

MW Response: Comment noted. This information has been added.

Comment No. 11. *Page 6-21, section 6.4.1, last sentence. The word policy is not really appropriate here. Try one of the following. doctrine, practice, standard, method.*

MW Response: Comment noted. The text has been changed to say "practice" in place of policy.

Comment No. 12: *Page 6-32 & 33 The paragraph beginning with "A total of 13 surface soil* samples... " is repeated. Delete one of them.

MW Response: Comment noted. The text has been changed.

Comment No. 13: *Page 7-5, section 7.2.2, first paragraph, last sentence. predictive NOT predicted.*

MW Response: Comment noted. The text has been changed.

Comment No. 14: *Page 10-3, Section 10.1.3. Since XRF has already been proven useful at the site, it should be used as a method for analysis during excavation work Please incorporate this into the discussion of this remedial alternative.*

MW Response: Comment noted. The method of analyzing confirmation samples will be decided if this remedial alternative is going to be implemented. Text has been added in Section 10.1.3 to indicate that analysis using the XRF method will be considered.

Comment No. 15: *Page 11-4, first bullet (begins on page 11-3), second to last sentence. "Cooperation ~~from~~ between the Army and ... ".*

MW Response: Comment noted. The text has been changed.

Comment No. 16: *Pages 11-7 and 11-8 The costs for Alternatives 4 and 5 are too high. Consider that the effort at FTIR-02 and 04 only cost $1.1 million and these were much larger in scale.*

MW Response: Concur. The costs were calculated using the incorrect scale presented on Figure 8-2. The costs for Alternatives 4 and 5 have been revised and are now lower at $488,000 and $902,802, respectively.

Comment No 17 *Figure 8-2. Scale should not be in miles (perhaps this is why Alternatives 4 & 5 are so high is cost ☺).*

MW Response: Comment noted. The figure has been revised.

Comment No. 18: *Tables 6-1 and 6-2* Would it be appropriate/useful to discuss why the analyte lists in the tables are different?

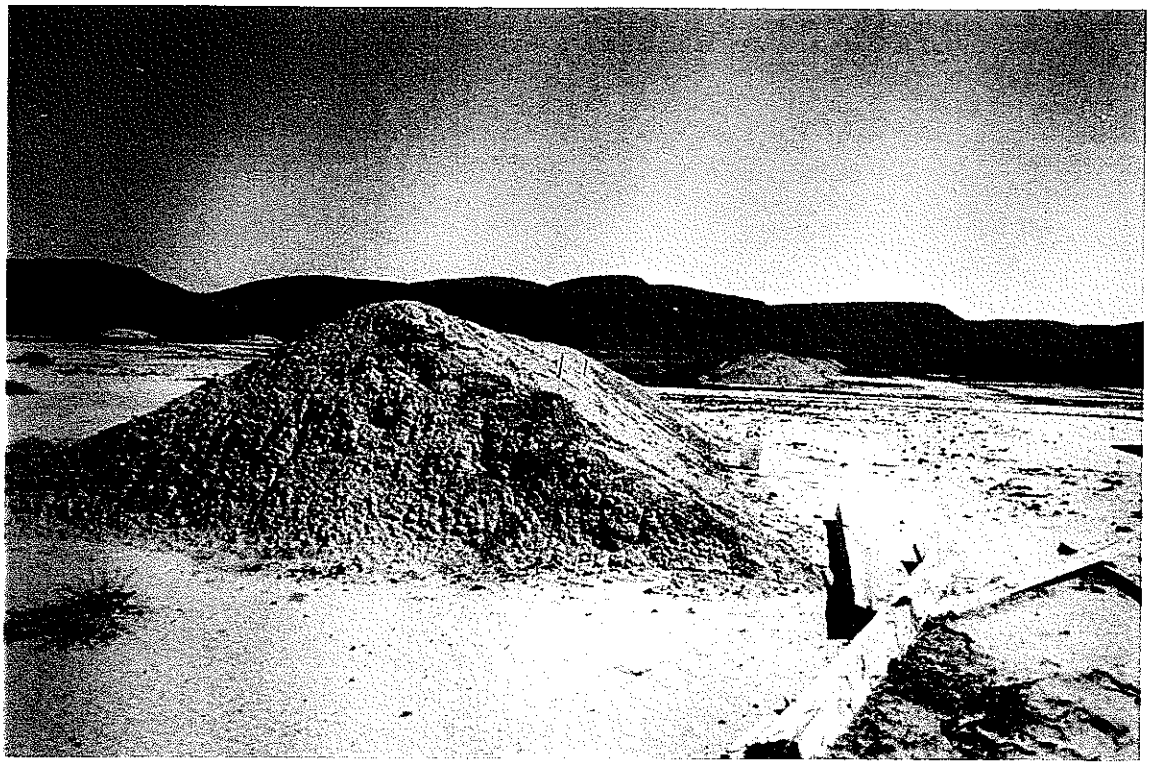
MW Response: Comment noted. Analytes listed as COPCs in the HHRA include inorganic chemicals detected at concentrations greater than their respective background upper tolerance limit. The distinction between surface and subsurface COPCs is necessary for the exposure pathway discussion in the risk assessment.

Comment No. 19: *Table 6-3. The footnote explanation for "c" is not clear. Please revise.*

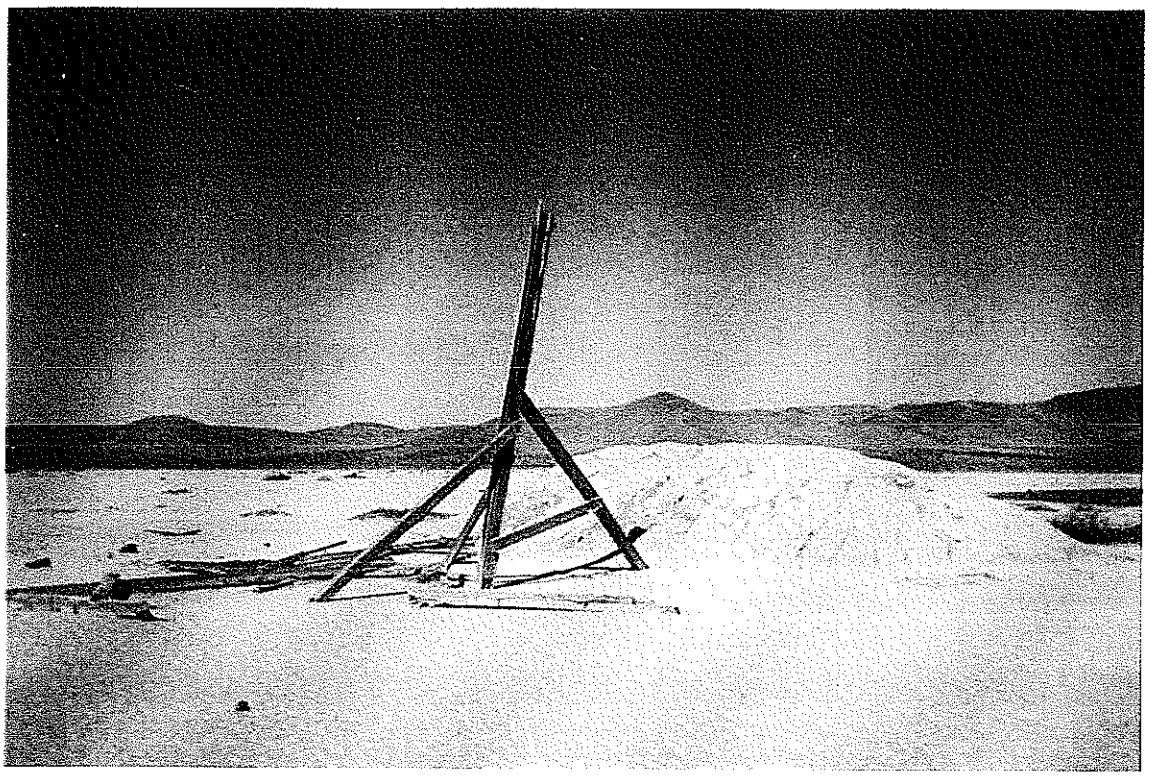
MW Response: Comment noted. The footnote has been revised to show that subsurface soil depth is equal to >1ft bgs.

APPENDIX B

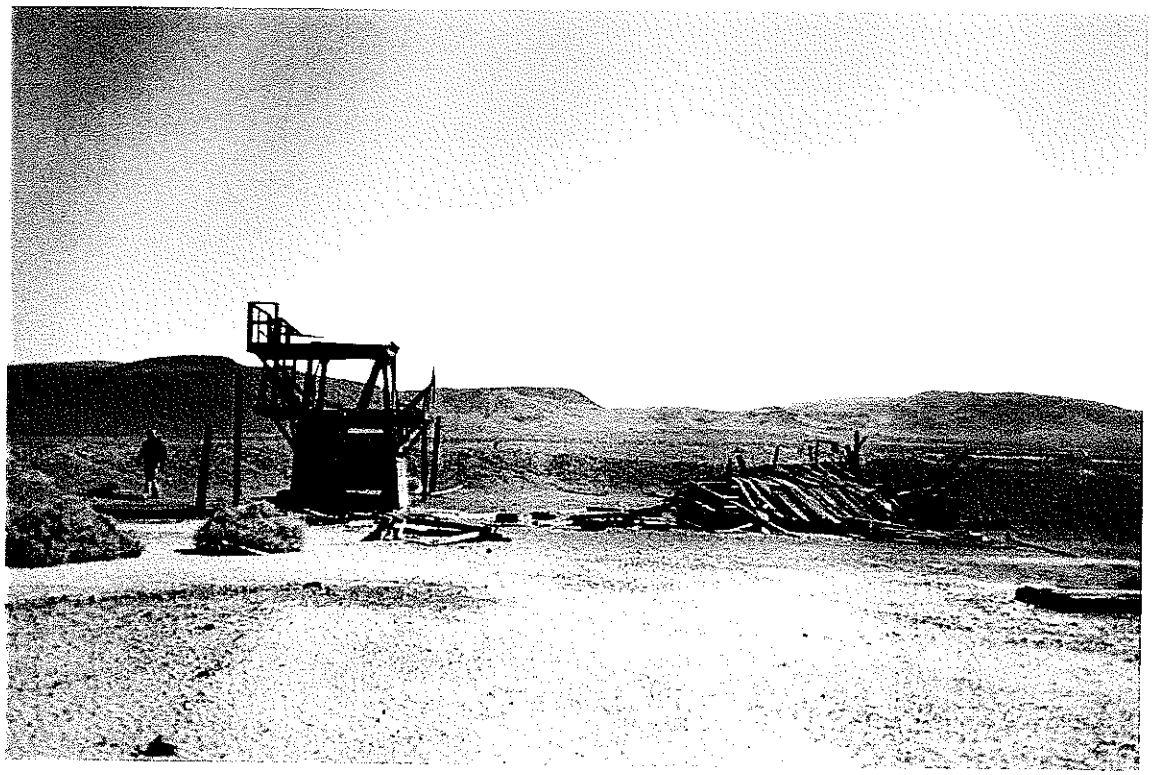
SITE PHOTOGRAPHS



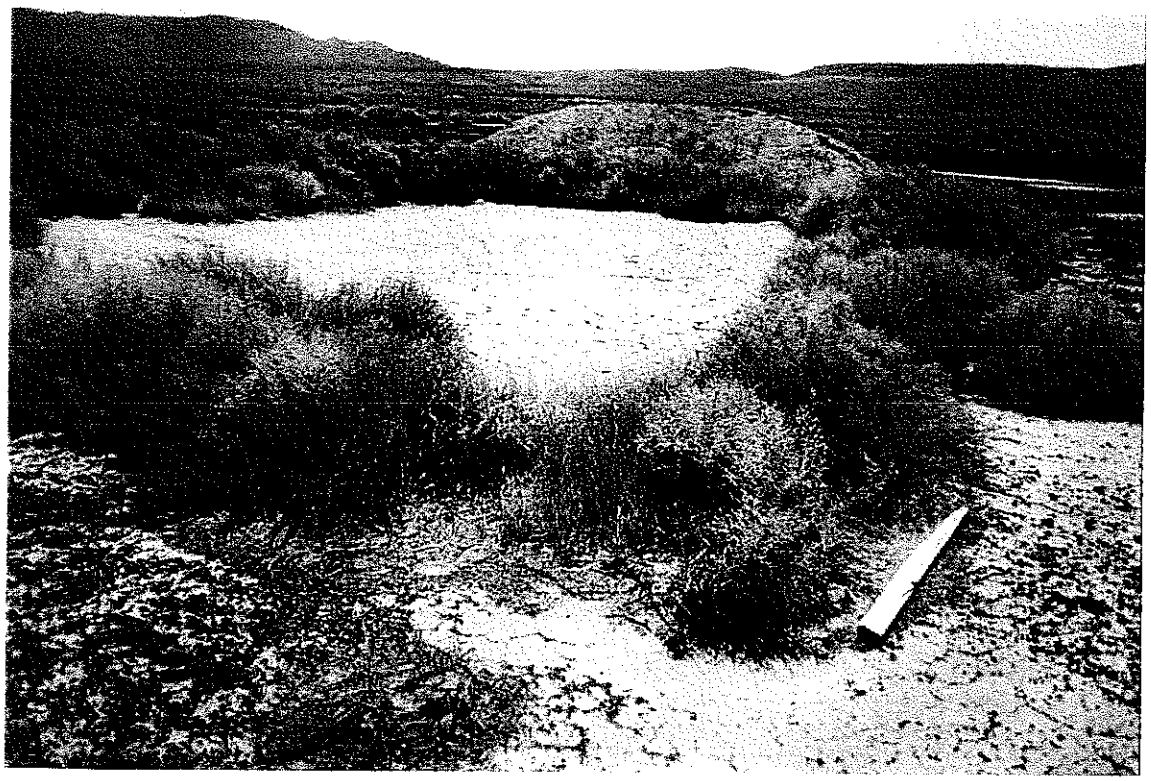
Photograph 1: Soil Berms at Site FTIR-38 Area 2



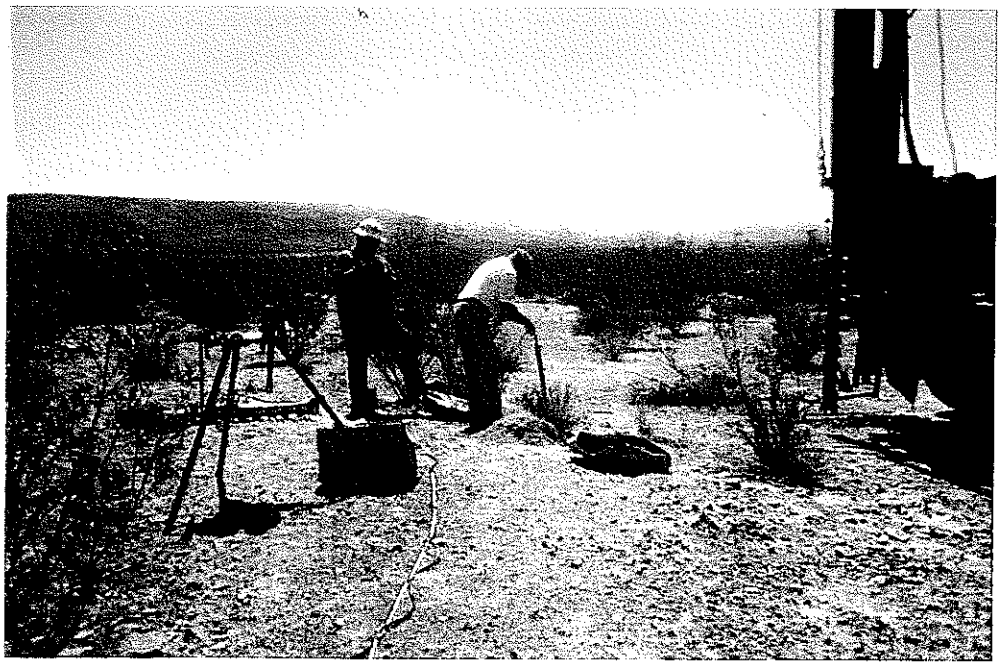
Photograph 2: Wooden Strafe in Front of Berm at Site FTIR-38 Area 2



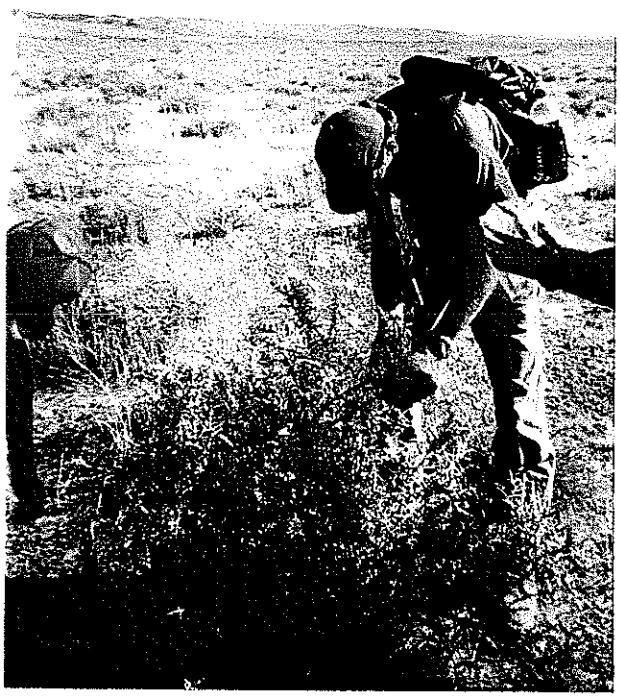
Photograph 3: Range Observation Tower at Site FTIR-38 Area 2



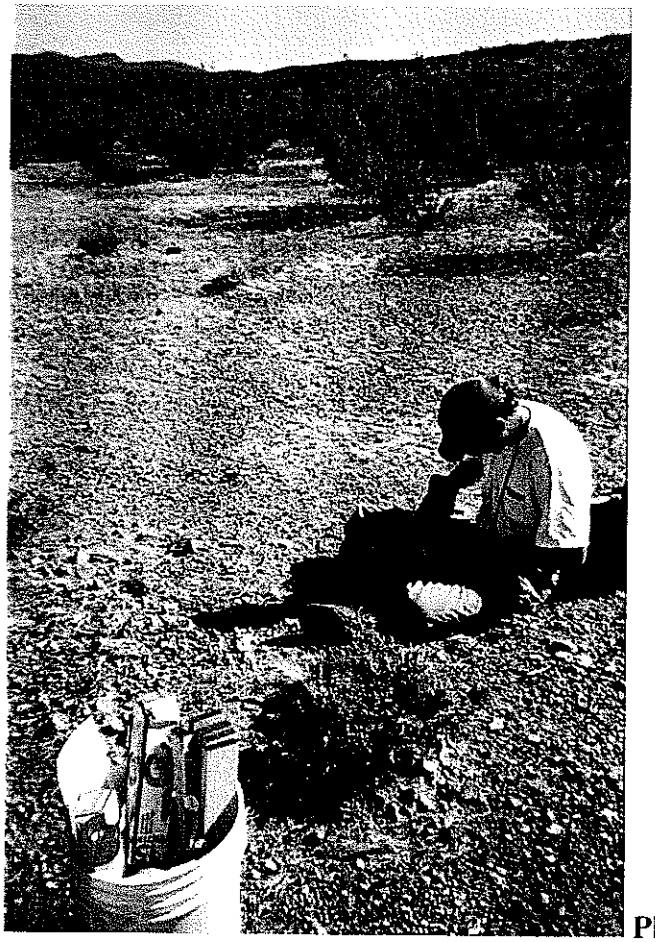
Photograph 4: Vegetation and Barren Area Behind Berm at Site FTIR-38 Area 2



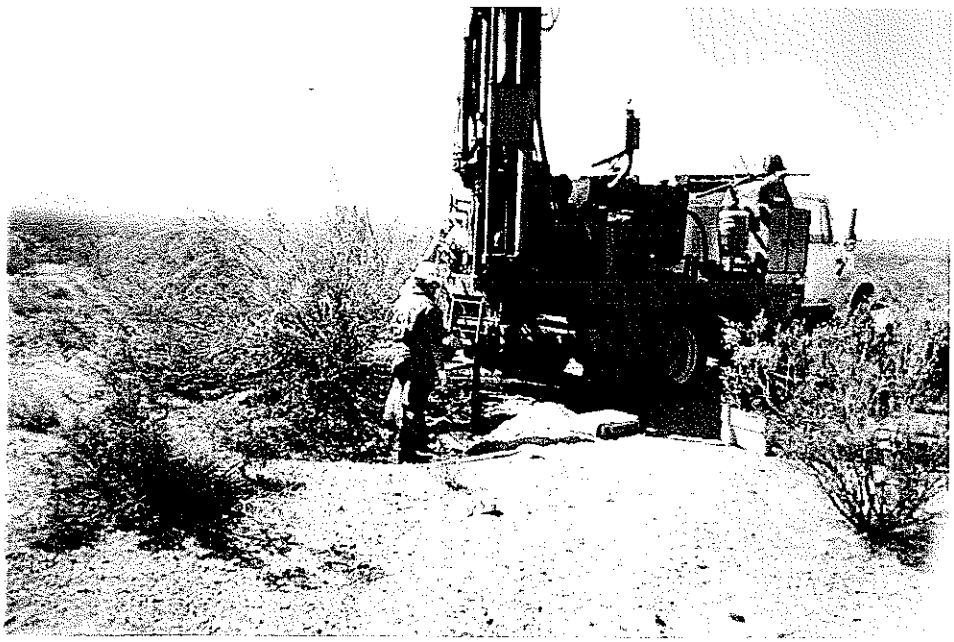
Photograph 5: UXO Clearance at Site FTIR-40 Area 2



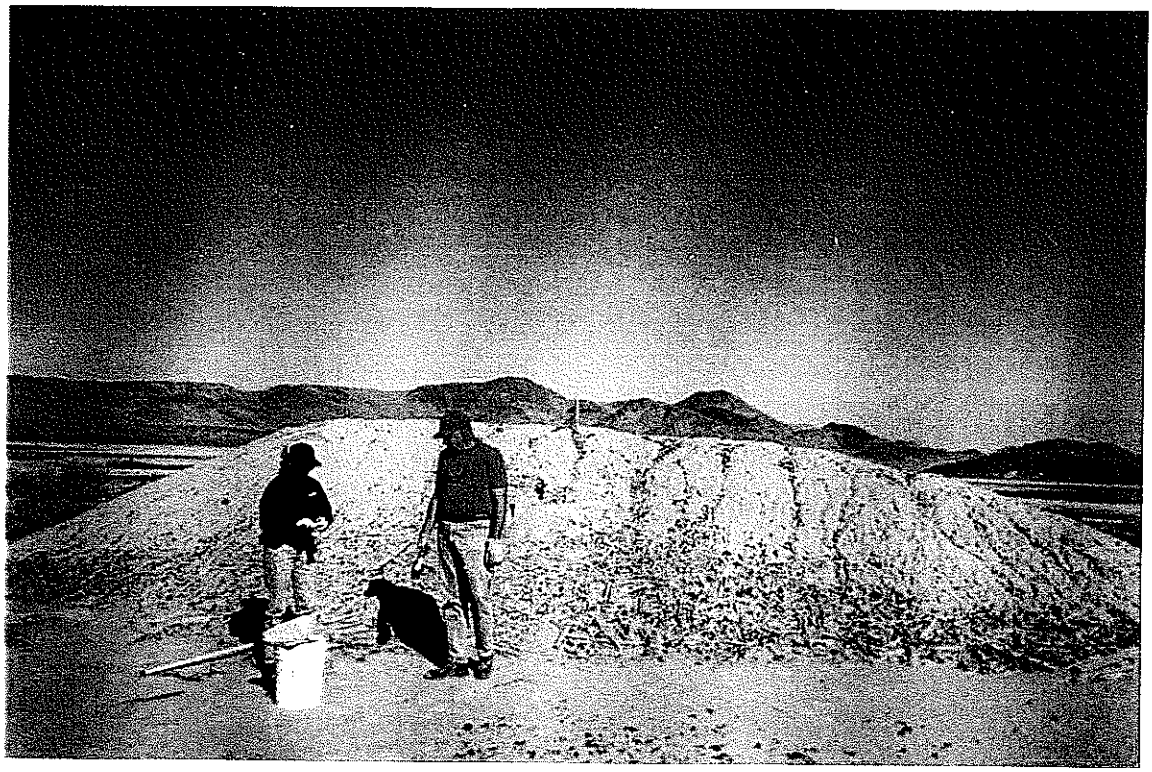
Photograph 6: Plant Tissue Sampling (Saltbush) at Reference Area 1



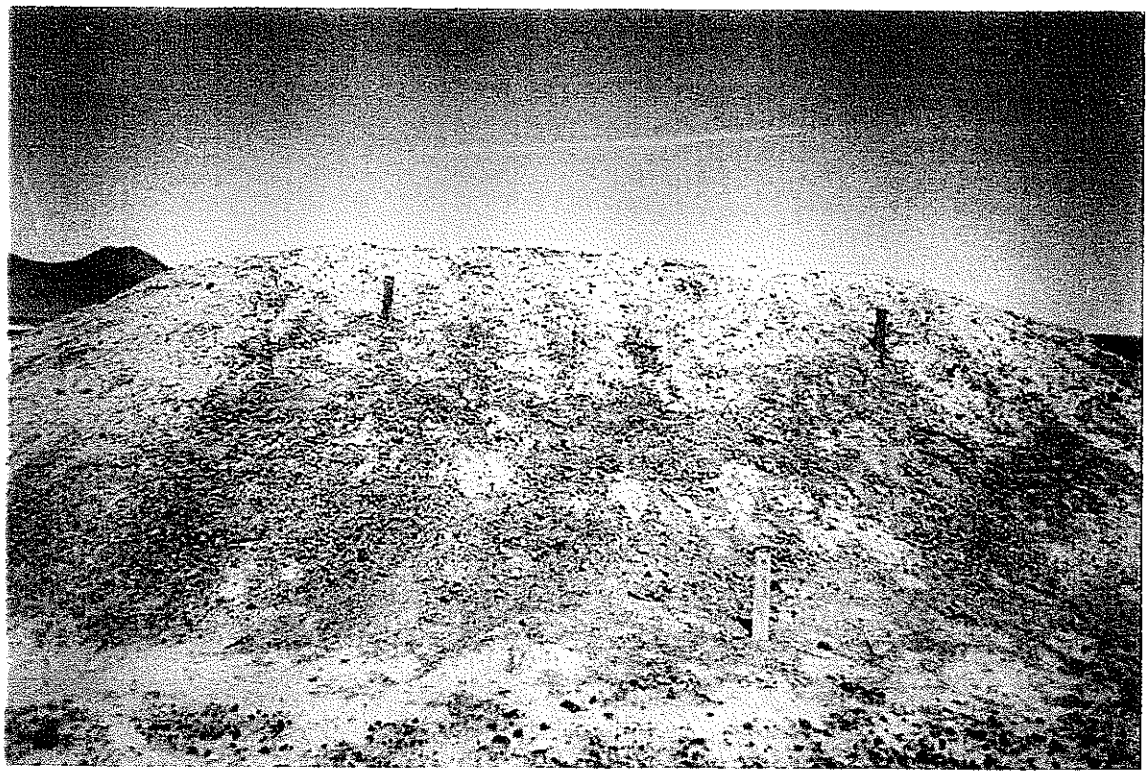
Photograph 7: Plant Tissue Sampling (Desert Thorn) at Site FTIR-40 Area 2



Photograph 8: Soil Boring Drilling at Site FTIR-40 Area 2



Photograph 9: XRF Sampling at Site FTIR-38 Area 2



Photograph 10: XRF Sample Locations at a Berm at Site FTIR-38 Area 2

Photograph 11: Goldstone Well A Prior to Abandonment at Site FTIR-40 Area 2

Photograph 12: Abandoned Goldstone Well A at Site FTIR-40 Area 2

APPENDIX C

DTSC LETTER REGARDING RISK DRIVING METALS

Department of Toxic Substances Control

Jesse R. Huff, Director
5796 Corporate Avenue
Cypress, California 90630

Gray Davis
Governor

Winston H. Hickox
Secretary for
Environmental
Protection

January 27, 1999

Mr. Curtis Payton
US Army Corps of Engineers
1325 J Street 12th Floor
Sacramento, California 95814-2922

Dear Mr. Payton:

PROPOSED VALIDATION SAMPLING FOR FORT IRWIN SITES FTIR-32A, FTIR-38, FTIR-39 AND FTIR-40

This letter transmits comments from the Department of Toxic Substances Control (DTSC), Human and Ecological Risk Division (HERD) on the above-referenced document. The HERD comments are enclosed.

Please direct any questions or requests regarding these comments to me at (714) 484-5452 or John Christopher at (916) 327-2491.

Sincerely,

Omoruyi Patrick
Hazardous Substances Engineer
Federal Facilities Unit A
Southern California Operations
Office of Military Facilities

Enclosure

cc: Commander NTC & Fort Irwin
Directorate of Public Works
ATTN: AFZJ-PW-EN (Ms. Tiffany Gates-Tull)
P.O. Box 105097
Fort Irwin, California 92310-5097

Department of Toxic Substances Control

Jesse R. Huff, Director
400 P Street, P. O. Box 806
Sacramento, California 95812-0806

Gray Davis
Governor

Winston H. Hickox
Secretary for
Environmental
Protection

MEMORANDUM

TO: Omoruyi Patrick
Office of Military Facilities (OMF)
5796 Corporate Avenue
Cypress, CA 90630

FROM: John P. Christopher, Ph.D., D.A.B.T.
Staff Toxicologist
Human and Ecological Risk Division (HERD)

DATE: 26 January 1999

SUBJECT: Ft. Irwin: Need for Validation Sampling at Sites FTIR-32A, -38, -39, and -40
PCA: 14740 Site: 400063-47

Background

National Training Center (NTC) Fort Irwin is an open military facility in San Bernardino County. Cleanup activities at this base are being conducted by the U.S. Army Corps of Engineers.

In a memorandum dated 7 May 1998, we presented our comments on the ecological risk assessment for Goat Mountain Landfill and three other sites at NTC Ft. Irwin. These comments were discussed at a project meeting on 12 June 1998, and we accepted the Army's reasoning that further assessment of risks to the desert tortoise is unnecessary. In a memorandum dated 16 October 1998 on the final report for these sites, we noted that the Army had revised downward its estimates of risk for the herbivorous Mohave ground squirrel. Hazard indices (HI) for the ground squirrel fell into the range of 4 to 110, driven by inorganic chemicals of potential ecological concern (COPEC). The sites were recommended for further evaluation in the form of a Phase II Validation Study. The current document is a letter in which the Army's contractor contends that a Phase II Study at these sites will serve no purpose.

Document Reviewed

We reviewed "Technical Considerations Regarding Proposed Validation Sampling for Fort Irwin Sites FTIR-32A, FTIR-38, FTIR-39, and FTIR-40". This document, dated 3 December

1998, was prepared by Montgomery Watson, contractors to the Army. HERD received a work request to review this document on 15 December 1998.

General Comment

The Army makes two arguments to support its contention that a Phase II Validation Study is not needed. First, concentrations of metals in plants yielding hazard quotients (HQ) of 1.0 are difficult to detect analytically. Second, many of the metals of interest occur naturally in plant tissue at concentrations yielding HQ≥1.0. The Army's arguments have some merit, but they do not obviate the need to refine the estimates of exposure to the Mohave ground squirrel. Predictive estimates of risks to this species are driven mainly by cadmium, copper, lead, and zinc at sites FTIR-32A, -38, -39, and -40. Soils at these sites contain concentrations of these metals up to 1,000 times higher than the upper end of the ambient range. We believe the Army can design and carry out a Phase II Validation Study to determine if these metals are present in the food supply of a herbivorous rodent at or near toxicologically significant levels.

Specific Comments

1. **Identifying Risk Drivers:** Consideration of the need for a Phase II Validation Study should focus on the risk drivers for the Mohave ground squirrel, as identified in the Phase I Predictive Ecological Assessment. To identify the risk drivers and the environmental media where they present a possible concern, we assembled Tables 1 through 9 (attached) from several sources. An Excel spreadsheet with these calculations is available upon request for the Army's examination.

   Table 1 shows toxicity reference values (TRV) calculated two ways. We used the Army's values for NOAEL-based TRVs from Table 7 of their letter. For comparison, we also used values converted allometrically for a 108 g ground squirrel from TRV-Low as recommended by USEPA Region IX Biological Technical Assistance Group (BTAG).

   Tables 2 through 8 contain a site-by-site presentation of doses, division of dose by pathway, HQs, and comparison of site to ambient concentrations. Metals of concern, maximum detected concentrations in site soils (C_{MAX}), and 95% upper tolerance limits of concentrations in ambient soils are taken from the final report, Tables 6-5, 6-6, 6-8, 6-10, 6-13, 6-15, and 6-19. Numerators for HQs are the Army's data on dose from ingestion of food (*i.e.* plants), incidental ingestion of soil, and dermal contact with soil. These data were taken from Appendix C to the final report, Tables C-1a, C-2a, C-3a, C-4a, C-5b, C-6b, and C-7b. Tables 2 through 8 show that HQ>1.0 occurs at one or more of the four sites for 11 of the 15 metals detected using BTAG TRV-Los and 5 of the 15 using the Army's TRVs. No HQ>1.0 were seen for beryllium, mercury, and molybdenum.

Table 9 is derived from Table 1 in the Army's letter, but concentrations in plants corresponding to HQ=1.0 are shown (rather than HQ=0.1), based on both Army TRV-NOAEL and BTAG TRV-Low.

2. **Site FTIR-32A:** Tables 2 and 3 show ΣHQ>1.0 using either Army or BTAG TRVs for the Mohave ground squirrel at this site. Estimated risks are driven principally by copper, lead, manganese, and zinc. Table 9 shows that levels of copper, manganese, and zinc in plants corresponding to HQ=1.0 can be detected readily. Therefore, no impediment exists to a Phase II Validation Study in which copper, manganese, and zinc can be estimated in plants from Site FTIR-32A.

   Table 9 shows that the level of lead in plants corresponding to HQ=1.0 is either 100 or 0.016 mg/kg, depending on the source of the TRV. Analytical detection limits do not go below 0.1 mg/kg for plant tissue. The BTAG TRV-Low, which yields the value of 0.016, is based on a soluble form of lead. The work plan for a Phase II Validation study can address how the Army might attempt to deal with the less soluble forms of lead that are likely to be present in plants and soil at NTC Ft. Irwin.

3. **Site FTIR-38, Area 2:** Table 4 shows ΣHQ>1.0 using either Army or BTAG TRVs for the Mohave ground squirrel at this site. Estimated risks are driven principally by aluminum, cobalt, copper, lead, and zinc.

   Most of the dose of aluminum comes from incidental ingestion of soil, and concentrations of aluminum in site soils differ little from ambient conditions. Thus, any concern over aluminum could be verified with data on levels in soil.

   For copper, lead, and zinc, most of the doses is estimated to come from plants, while for cobalt contributions are nearly equal from ingestion of plants and incidental soil ingestion. Table 9 shows levels of copper and zinc corresponding to HQ=1.0 can be detected readily in plant tissue. Thus, no impediment exists to conducting a validation study for these metals at Site FTIR-38. Distinguishing between soluble and insoluble forms of lead might be necessary in a validation study, as described above for Site FTIR-32A, Area 2.

4. **Site FTIR-39:** Table 5 shows ΣHQ>1.0 using either Army or BTAG TRVs for the Mohave ground squirrel at this site. Estimated risks are driven principally by cadmium, copper, and zinc. Table 9 shows levels of these metals corresponding to HQ=1.0 can be detected readily in plant tissue. Thus, no impediment exists to conducting a validation study for these metals at Site FTIR-39.

5. **Site FTIR-40, Area 1:** Tables 6 and 7 show ΣHQ>1.0 using either Army or BTAG TRVs for the Mohave ground squirrel at this site. Depending on which TRVs are used as

the bases of the estimates, as many as 13 metals show HQ>1.0, depending on the source of the TRV. The most important risk drivers are cadmium, copper, lead, and zinc.

Doses of aluminum, chromium, and cobalt are driven more by incidental ingestion of soil than by ingestion of plants, so analyses of plants will be of limited value for these metals. In the case of aluminum, the contribution from ingestion of plants still contributes an HQ=8.6. However, the levels of aluminum in plants fall within the naturally occurring range reported by the Army in Table 9.

For antimony, arsenic, cadmium, nickel, and selenium, most of the dose comes from ingestion of plants, and reporting levels in plants are less than the concentrations corresponding to HQ=1.0 (Table 9). Among these five, the highest HQ in the predictive phase came from cadmium. Table 9 indicates that analytical reporting levels in plant tissue should be able to detect HQ=1.0.

For barium, copper, manganese, and zinc, reporting levels in plants are lower than the level yielding HQ=1.0 (Table 9); these metals should pose no difficulties for a Phase II Validation Study. Lead is an important risk driver at this site (Table 6), but the level of lead in plants corresponding to HQ=1.0 might be lower than analytical reporting limits, depending on the source of TRVs (Table 9). A work plan for a Validation Study should propose a method for distinguishing between soluble and insoluble lead, as described above for Site FTIR-32A.

In summary, a validation study directed at plant tissue should resolve most issues regarding toxicologically important doses to the Mohave ground squirrel from soils and plants at Site FTIR-40, Area 1. A validation study should be able to characterize doses from the most important risk drivers.

6. **Site FTIR-40, Area 2:** Table 8 shows ΣHQ>1.0 using either Army or BTAG TRVs for the Mohave ground squirrel at this site. Estimated risks are greatest for cadmium and zinc in plant tissue. Table 9 shows levels of these metals corresponding to HQ=1.0 can be detected readily in plant tissue. Thus, no impediment exists to conducting a validation study for these metals at Site FTIR-40, Area 2.

7. **Naturally Occurring Levels of Metals in Plants:** Table 9 presents ranges of concentrations occurring naturally in plants for five metals, aluminum, antimony, arsenic, cadmium, and selenium. Of the five, only aluminum has a naturally occurring range higher than the level estimated to yield HQ=1.0. However, hazard quotients for aluminum are driven mainly by ingestion of soil; so aluminum would probably not be eliminated as a metal of concern based on its level in plants. For the remaining four metals, only one, cadmium, is a significant risk driver at any site. If a validation study were to show that levels of cadmium are near or above their naturally occurring levels, the risk manager

might decide it is better not to remediate. Because the naturally occurring range for cadmium is very wide, the risk manager is better off with data on naturally occurring ranges collected at or near the sites in question.

Lastly, the Army presents no information on naturally occurring levels of copper, lead, and zinc, the metals which produced the highest HQs in the Predictive Assessment.

Conclusions and Recommendations

We recommend that Phase II Validation Studies be carried out Sites FTIR-32A, -38, -39, and –40 at NTC Ft. Irwin. The validation study should measure levels of all the metals which yielded HQ>1.0 in the Predictive Assessment, but the greatest emphasis should be placed on cadmium, copper, lead, and zinc. These four metals occurred repeatedly as risk drivers at the four sites of interest in the Phase I Predictive Assessment. Cadmium, copper, lead, and zinc were found in soils at these sites at concentrations levels up to 1,000 times ambient levels. The Army's data on analytical reporting limits indicate that toxicologically significant doses of cadmium, copper, and zinc due to ingestion of plant material can be determined readily. Reporting limits for lead might be higher than the level in plants corresponding to HQ=1.0 for lead based on the BTAG TRV-Low. The work plan for the validation study should address the issue of soluble vs. insoluble lead to resolve any questions about lead. HERD believes that the Army should not have any difficulty designing a Phase II Validation Study to verify whether copper, lead, and zinc present risks to herbivores as high as those estimated in the Phase I Predictive Assessment.

Reviewed by: Brian K. Davis, Ph.D. Brian K. Davis
Staff Toxicologist, HERD

cc: Dr. M. Wade, HERD
Ms. S. Ellis, Dept. Fish & Game

Table 1: Toxicity Reference Values (TRV) for Metals of Concern at Sites FTIR-32A, -38, -39, and –40, National Training Center Fort Irwin

Chemical	Source Data from BTAG				Allometrically Derived TRVs for Mohave Ground Squirrel				
	Test Species	Body Weight (g)	TRV-Low mg/kg-day	TRV-High mg/kg-day	Body Weight (g)	From BTAG TRV-Low mg/kg-day	Army TRV-NOAEL mg/kg-day	From BTAG TRV-high mg/kg-day	Army TRV-LOAEL mg/kg-day
Aluminum	-	-	-	-	108	-	1.30 E+0	-	1.30 E+1
Antimony	-	-	-	-	108	-	8.20 E+0	-	8.20 E-1
Arsenic	Rat	332	3.20 E-1	-	108	4.7 E-1	8.3 E-2	-	-
	Rat	110	-	4.70 E+0	108	-	-	4.7 E+0	8.3 E-1
Barium	-	-	-	-	108	-	7.5 E+0	-	2.9 E+1
Beryllium	-	-	-	-	108	-	9.7 E-1	-	NA
Cadmium	Mouse	32.2	6.00 E-2	-	108	4.0 E-2	1.2 E-1	-	-
	Mouse	31.4	-	2.64 E+0	108	-	-	1.7 E+0	1.5 E+1
Chromium	-	-	-	-	108	-	4.8 E+0	-	1.9 E+1
Cobalt	Rat	275	1.20 E+0	-	108	1.6 E+0	NA	-	-
	Rat	200	-	2.00 E+1	108			2.5 E+1	NA
Copper	Mouse	30	2.67 E+0	-	108	1.7 E+0	2.4 E+1	-	-
	Mouse	24.7	-	6.32 E+2	108	-	-	3.9 E+2	3.2 E+1
Lead	Rat	2.08 E+2	1.50 E-3	-	108	1.9 E-3	1.2 E+1	-	-
	Mouse	1.87 E+1	-	2.41 E+2	108			1.3 E+2	1.2 E+2
Manganese	Mouse	3.46 E+1	1.37 E+1	-	108	9.4 E+0	1.3 E+2	-	-
	Mouse	2.97 E+1	-	1.59 E+2	108	-	-	1.0 E+2	4.2 E+2
Mercury	Rat	1.88 E+2	2.50 E-1	-	108	3.0 E-1	8.6 E+0	-	-
	Rat	4.28 E+2	-	4.00 E+0	108	-	-	6.3 E+0	NA
Molybdenum	-	-	-	-	108	-	NA	-	1.7 E+0
Nickel	Rat	2.49 E+2	1.33 E-1	3.16 E+1	108	1.8 E-1	5.9 E+1	4.2 E+1	1.2 E+2
Selenium	Mouse	2.46 E+1	5.00 E-2	-	108	3.1 E-2	4.9 E-2	-	-
	Mouse	2.46 E+1	-	1.21 E+0	108	-	-	7.4 E-1	4.9 E-1
Zinc	Mouse	2.55 E+1	9.60 E+0	-	108	5.9 E+0	2.4 E+2	-	-
	Rat	1.75 E+2	-	4.11 E+2	108	-	-	4.8 E+2	4.7 E+2

Table 2: Risk Evaluation for Mohave Ground Squirrel Exposed to Metals in Surface Soil at Site FTIR-32A National Training Center Fort Irwin

Chemical	Dose (mg/kg-day) to Ground Squirrel from:				Percent of Total Dose to Ground Squirrel			Hazard Quotient		C_{MAX} at Site / UTL Ambient
	Ingestion of Plants (mg/kg-day)	Ingestion of Soil (mg/kg-day)	Dermal Contact with Soil (mg/kg-day)	Total Dose (mg/kg-day)	Ingestion Of Plants	Ingestion Of Soil	Dermal Contact with Soil	vs. Allometrically Converted BTAG TRV-Low	vs. TRV-NOAEL (Army)	
Arsenic	3.16 E-2	1.81 E-2	9.30 E-7	4.97 E-2	63.6	36.4	0.0	0.11	0.60	1.1
Barium	2.20 E+0	3.37 E-1	1.70 E-5	2.54 E+0	86.7	13.3	0.0	0.34	0.34	0.1
Cadmium	6.65 E-2	2.78 E-3	1.40 E-7	6.93 E-2	96.0	4.0	0.0	1.73	0.58	3.6
Copper	1.35 E+1	7.76 E-1	4.00 E-5	1.43 E+1	94.6	5.4	0.0	8.19	0.59	14.6
Lead	2.13 E-1	1.09 E-1	5.60 E-6	3.22 E-1	66.1	33.9	0.0	0.69	0.03	8.0
Manganese	1.46 E+1	1.34 E+0	6.90 E-5	1.59 E+1	91.6	8.4	0.0	1.70	0.12	2.0
Selenium	4.63 E-3	4.26 E-3	2.20 E-7	8.89 E-3	52.1	47.9	0.0	0.29	0.18	-
Zinc	1.81 E+2	2.78 E+0	1.40 E-4	1.84 E+2	98.5	1.5	0.0	30.97	0.77	29.4
						Hazard	Index:	44.0	3.2	

Table 3: Risk Evaluation for Mohave Ground Squirrel Exposed to Metals in Subsurface Soil at Site FTIR-32A National Training Center Fort Irwin

Chemical	Dose (mg/kg-day) to Ground Squirrel from:				Percent of Total Dose to Ground Squirrel			Hazard Quotient		C_{MAX} at Site / UTL Ambient
	Ingestion of Plants (mg/kg-day)	Ingestion of Soil (mg/kg-day)	Dermal Contact with Soil (mg/kg-day)	Total Dose (mg/kg-day)	Ingestion Of Plants	Ingestion Of Soil	Dermal Contact with Soil	vs. Allometrically Converted BTAG TRV-Low	vs. TRV-NOAEL (Army)	
Arsenic	1.15 E-1	6.59 E-2	3.40 E-6	1.81 E-1	63.6	36.4	0.0	0.39	2.18	3.9
Barium	3.02 E+0	4.63 E-1	2.40 E-5	3.48 E+0	86.7	13.3	0.0	0.46	0.46	1.4
Cadmium	1.42 E-1	5.93 E-3	3.10 E-7	1.48 E-1	96.0	4.0	0.0	3.69	1.23	7.7
Copper	7.60 E+1	4.37 E+0	2.30 E-4	8.04 E+1	94.6	5.4	0.0	46.13	3.35	82.2
Lead	3.73 E-1	1.91 E-1	9.80 E-6	5.64 E-1	66.1	33.9	0.0	1.21	0.05	14.1
Manganese	9.97 E+0	9.17 E-1	4.70 E-5	1.09 E+1	91.6	8.4	0.0	1.16	0.08	1.4
Selenium	3.42 E-3	3.15 E-3	1.60 E-7	6.57 E-3	52.1	47.9	0.0	0.22	0.13	-
Zinc	2.32 E+2	3.56 E+0	1.80 E-4	2.36 E+2	98.5	1.5	0.0	39.70	0.98	37.6
						Hazard	Index:	93.0	8.5	

Table 4: Risk Evaluation for Mohave Ground Squirrel Exposed to Metals in Surface Soil at Site FTIR-38 Area 2 National Training Center Fort Irwin

Chemical	Dose (mg/kg-day) to Ground Squirrel from:				Percent of Total Dose to Ground Squirrel			Hazard Quotient		C_{MAX} at Site / UTL Ambient
	Ingestion of Plants (mg/kg-day)	Ingestion of Soil (mg/kg-day)	Dermal Contact with Soil (mg/kg-day)	Total Dose (mg/kg-day)	Ingestion Of Plants	Ingestion Of Soil	Dermal Contact with Soil	vs. Allometrically Converted BTAG TRV-Low	vs. TRV-NOAEL (Army)	
Aluminum	8.25 E+0	4.74 E+1	2.40 E-3	5.57 E+1	14.8	85.2	0.0	42.81	42.81	1.1
Antimony	2.58 E-1	2.96 E-2	1.50 E-6	2.88 E-1	89.7	10.3	0.0	0.62	0.62	2.5
Arsenic	4.00 E-2	2.30 E-2	1.20 E-6	6.30 E-2	63.5	36.5	0.0	0.14	0.76	1.4
Barium	2.84 E+0	4.35 E-1	2.20 E-5	3.28 E+0	86.7	13.3	0.0	0.44	0.44	1.3
Beryllium	1.05 E-3	2.41 E-3	1.20 E-7	3.46 E-3	30.3	69.7	0.0	0.00	0.00	1.1
Cobalt	2.51 E-2	2.89 E-2	1.50 E-6	5.40 E-2	46.5	53.5	0.0	1.35	0.45	1.2
Copper	8.86 E+1	5.09 E+0	2.60 E-4	9.37 E+1	94.6	5.4	0.0	53.78	3.90	95.8
Lead	2.33 E+1	1.19 E+1	6.10 E-4	3.52 E+1	66.2	33.8	0.0	75.65	2.93	87.7
Manganese	1.51 E+1	1.39 E+0	7.20 E-5	1.65 E+1	91.6	8.4	0.0	1.76	0.13	2.1
Molybdenum	1.13 E-1	1.04 E-2	5.30 E-7	1.23 E-1	91.6	8.4	0.0	0.07	0.07	1.2
Selenium	2.01 E-3	1.85 E-3	9.50 E-8	3.86 E-3	52.1	47.9	0.0	0.13	0.08	-
Zinc	4.17 E+1	6.39 E-1	3.30 E-5	4.23 E+1	98.5	1.5	0.0	7.14	0.18	6.8
						Hazard Index:		183.9	52.4	

Table 5: Risk Evaluation for Mohave Ground Squirrel Exposed to Metals in Surface Soil at Site FTIR-39 National Training Center Fort Irwin

Chemical	Dose (mg/kg-day) to Ground Squirrel from:				Percent of Total Dose to Ground Squirrel			Hazard Quotient		C_{MAX} at Site / UTL Ambient
	Ingestion of Plants (mg/kg-day)	Ingestion of Soil (mg/kg-day)	Dermal Contact with Soil (mg/kg-day)	Total Dose (mg/kg-day)	Ingestion Of Plants	Ingestion Of Soil	Dermal Contact with Soil	vs. Allometrically Converted BTAG TRV-Low	vs. TRV-NOAEL (Army)	
Cadmium	6.20 E-1	2.59 E-2	1.30 E-6	6.46 E-1	96.0	4.0	0.0	16.11	5.38	33.7
Cobalt	2.48 E-2	2.85 E-2	1.50 E-6	5.33 E-2	46.5	53.5	0.0	1.33	0.44	1.2
Copper	1.22 E+1	7.02 E-1	3.60 E-5	1.29 E+1	94.6	5.4	0.0	7.41	0.54	13.2
Lead	1.56 E-1	7.96 E-2	4.10 E-6	2.36 E-1	66.2	33.8	0.0	0.51	0.02	5.9
Manganese	9.40 E+0	8.65 E-1	4.50 E-5	1.03 E+1	91.6	8.4	0.0	1.10	0.08	1.3
Molybdenum	1.61 E-1	1.48 E-2	7.60 E-7	1.76 E-1	91.6	8.4	0.0	0.10	0.10	1.7
Zinc	9.57 E+1	1.47 E+0	7.60 E-5	9.72 E+1	98.5	1.5	0.0	16.38	0.40	15.5
						Hazard Index:		42.9	7.0	

Table 6: Risk Evaluation for Mohave Ground Squirrel Exposed to Metals in Surface Soil at Site FTIR-40 Area 1 National Training Center Fort Irwin

Chemical	Dose (mg/kg-day) to Ground Squirrel from: Ingestion of Plants (mg/kg-day)	Ingestion of Soil (mg/kg-day)	Dermal Contact with Soil (mg/kg-day)	Total Dose (mg/kg-day)	Percent of Total Dose to Ground Squirrel: Ingestion Of Plants	Ingestion Of Soil	Dermal Contact with Soil	Hazard Quotient: vs. Allometrically Converted BTAG TRV-Low	vs. TRV-NOAEL (Army)	C_{MAX} at Site / UTL Ambient
Aluminum	1.12 E+1	6.43 E+1	3.30 E-3	7.55 E+1	14.8	85.2	0.0	58.08	58.08	1.5
Antimony	1.52 E+0	1.74 E-1	9.00 E-6	1.69 E+0	89.7	10.3	0.0	3.64	3.64	14.9
Arsenic	8.51 E-2	4.89 E-2	2.50 E-6	1.34 E-1	63.5	36.5	0.0	0.29	1.61	2.9
Barium	1.49 E+1	2.28 E+0	1.20 E-4	1.72 E+1	86.7	13.3	0.0	2.29	2.29	7.0
Cadmium	2.39 E+0	9.98 E-2	5.10 E-6	2.49 E+0	96.0	4.0	0.0	62.12	20.75	129.6
Chromium	5.70 E-2	1.75 E-1	9.00 E-6	2.32 E-1	24.6	75.4	0.0	0.05	1.93	3.4
Cobalt	3.01 E-2	3.46 E-2	1.80 E-6	6.47 E-2	46.5	53.5	0.0	1.61	0.54	1.4
Copper	4.16 E+2	2.39 E+1	1.20 E-3	4.40 E+2	94.6	5.4	0.0	252.51	18.33	449.5
Lead	1.39 E+2	7.11 E+1	3.70 E-3	2.10 E+2	66.2	33.8	0.0	451.56	17.51	5,238.7
Manganese	2.78 E+1	2.56 E+0	1.30 E-4	3.04 E+1	91.6	8.4	0.0	3.24	0.23	3.8
Molybdenum	5.51 E-1	1.41 E-2	7.20 E-7	5.65 E-1	97.5	2.5	0.0	0.33	0.33	37.6
Nickel	2.30 E-1	2.11 E-2	1.10 E-6	2.51 E-1	91.6	8.4	0.0	1.43	0.00	2.5
Selenium	3.80 E-1	1.46 E-1	7.50 E-6	5.26 E-1	72.2	27.8	0.0	17.23	10.73	2.7
Zinc	1.01 E+3	1.62 E+1	8.30 E-4	1.02 E+3	98.4	1.6	0.0	172.28	4.26	171.4
						Hazard Index:		1,026.6	140.2	

JAN-26-1999 10:32 916 327 2509 97%

JAN-26-1999 10:32 916 327 2509 97% P 11

Table 7: Risk Evaluation for Mohave Ground Squirrel Exposed to Metals in Subsurface Soil at Site FTIR-40 Area 1 National Training Center Fort Irwin

Chemical	Dose (mg/kg-day) to Ground Squirrel from:				Percent of Total Dose to Ground Squirrel			Hazard Quotient		C_{MAX} at Site / UTL Ambient
	Ingestion of Plants (mg/kg-day)	Ingestion of Soil (mg/kg-day)	Dermal Contact with Soil (mg/kg-day)	Total Dose (mg/kg-day)	Ingestion Of Plants	Ingestion Of Soil	Dermal Contact with Soil	vs. Allometrically Converted BTAG TRV-Low	vs. TRV-NOAEL (Army)	
Arsenic	3.09 E-2	1.78 E-2	9.20 E-7	4.87 E-2	63.4	36.5	0.0	0.10	0.59	1.1
Barium	3.03 E+0	4.65 E-1	2.40 E-5	3.50 E+0	86.7	13.3	0.0	0.47	0.47	1.4
Cadmium	2.61 E-1	1.09 E-2	5.60 E-7	2.72 E-1	96.0	4.0	0.0	6.78	2.27	14.2
Copper	7.15 E+0	4.11 E-1	2.10 E-5	7.56 E+0	94.6	5.4	0.0	4.34	0.32	7.7
Lead	5.58 E-1	2.85 E-1	1.50 E-5	8.43 E-1	66.2	33.8	0.0	1.81	0.07	5.4
Manganese	1.07 E+1	9.85 E-1	5.10 E-5	1.17 E+1	91.6	8.4	0.0	1.25	0.09	72.6
Mercury	1.52 E-2	3.89 E-4	2.00 E-8	1.56 E-2	97.5	2.5	0.0	0.05	0.00	0.0
Selenium	1.51 E-3	1.39 E-3	7.20 E-7	2.90 E-3	52.1	47.9	0.0	0.09	0.06	-
Zinc	9.20 E+1	1.41 E+0	7.30 E-5	9.34 E+1	98.5	1.5	0.0	15.74	0.39	14.9
						Hazard	Index:	30.6	4.2	

Table 8: Risk Evaluation for Mohave Ground Squirrel Exposed to Metals in Subsurface Soil at Site FTIR-40 Area 2 National Training Center Fort Irwin

Chemical	Dose (mg/kg-day) to Ground Squirrel from:				Percent of Total Dose to Ground Squirrel			Hazard Quotient		C_{MAX} at Site / UTL Ambient
	Ingestion of Plants (mg/kg-day)	Ingestion of Soil (mg/kg-day)	Dermal Contact with Soil (mg/kg-day)	Total Dose (mg/kg-day)	Ingestion Of Plants	Ingestion Of Soil	Dermal Contact with Soil	vs. Allometrically Converted BTAG TRV-Low	vs. TRV-NOAEL (Army)	
Arsenic	5.70 E-2	3.28 E-2	1.70 E-6	8.98 E-2	63.5	36.5	0.0	0.19	1.08	1.9
Cadmium	2.70 E-1	1.13 E-2	5.80 E-7	2.81 E-1	96.0	4.0	0.0	7.02	2.34	14.7
Copper	2.54 E+0	1.46 E-1	7.50 E-6	2.69 E+0	94.6	5.4	0.0	1.54	0.11	2.7
Lead	4.82 E-1	2.46 E-1	1.30 E-5	7.28 E-1	66.2	33.8	0.0	1.56	0.06	18.1
Molybdenum	7.69 E-1	1.97 E-2	1.00 E-6	7.88 E-1	97.5	2.5	0.0	0.46	0.46	2.3
Mercury	5.37 E-2	1.37 E-3	7.10 E-8	5.51 E-2	97.5	2.5	0.0	0.18	0.01	3.7
Zinc	2.79 E+2	4.28 E+0	2.20 E-4	2.83 E+2	98.5	1.5	0.0	47.74	1.18	45.3
						Hazard	Index:	58.7	5.2	

Table 9: Levels of Metals of Concern Significant for the Mohave Ground Squirrel at National Training Center Fort Irwin

Metal	Typical Concentrations Naturally Occurring in Plants (mg/kg)	Concentration in Plants Which Yields HQ = 1.0 with Army TRVs (mg/kg)	Concentration in Plants Which Yields HQ = 1.0 with BTAG TRVs (mg/kg)	Range of Analytical Reporting Limits in Plant Tissue (mg/kg)
Aluminum	2.6 – 14,5600	2	-	1.38 – 4.2
Antimony	0.002 – 0.32	1	-	0.123 – 0.25
Arsenic	0.009 – 1.5	1	5.6	0.07 – 0.25
Barium	-	80	-	0.1 - <8
Cadmium	0.01 – 1.26	1	0.33	0.1 – 0.33
Chromium	-	15	-	0.1 - <1.5
Copper	-	290	21	0.1 – <29
Lead	-	100	0.016	0.1 - <10
Manganese	-	1,480	107	0.1 – <148
Mercury	-	104	3.63	0.012 - <10.4
Nickel	-	533	1.6	0.1 - <53.3
Selenium	0.002 – 0.88	0.3	0.18	0.06 – 0.25
Zinc	-	2,910	72	0.2 - <291

APPENDIX D

PLANT TISSUE SAMPLING SUMMARY

May *Consulting Services*

P.O. Box 1156 Walnut Grove, CA 95690
Phone: (916) 776-2500 - Fax: (916) 776-1541

June 30, 1999

Kristin Shelton
Montgomery Watson, Inc
777 Campus Commons, Suite 250
Sacramento, CA 95825

RE: PLANT TISSUE COLLECTION AT FORT IRWIN, SAN BERNARDINO COUNTY, CALIFORNIA.

Dear Ms. Shelton,

May Consulting Services is pleased to provide you with this letter report regarding plant tissue collection at Fort Irwin National Training Center in San Bernardino County, California. This letter report describes the methods used and plant species sampled at each of the three study and two reference sites.

Please contact me if you have any questions regarding this report or require additional information. We thank you for the opportunity to assist you on this project and look forward to working with you again in the future.

Sincerely,

Matthew Gause
Senior Botanist

Enclosures: *Exhibit A*

Exhibit A

INTRODUCTION

May Consulting Services was retained by Montgomery Watson Inc., to assist in plant species identification during plant tissue collection at Fort Irwin National Training Center in the Mojave Desert, San Bernardino County Vegetation tissue collection was performed at three study- sites (FTIR 38 Area 2, FTIR 40 Areas 1 and 2) and two reference sites (RF 1 and RF 2) within the Goldstone area of Fort Irwin. Plant species targeted for tissue sampling were species identified by the California Department of Fish and Game as potential forage species for the Mojave ground squirrel (*Spermophilis mohavensis*). Targeted plant species included: fruiting bodies and seeds of the Joshua tree (*Yucca brevifolia*), fiddleneck (*Amsinckia* spp.), box-thorn (*Lycium* spp.), Coreopsis (*Coreopsis* spp.), and russian-thistle (*Salsola* spp.).

ENVIRONMENTAL SETTING

The study and reference sites are located within the Goldstone area of the Fort Irwin National Training Center in the Mojave Desert approximately 40 miles north-northeast of Barstow, California.

Vegetation in the region is typical of the Mojave Desert Region with Creosote Bush Scrub dominating the hills and slopes and Saltbush Scrub dominating the flat areas and edges of dry lakebeds.

Vegetation types within each of the study, and corresponding reference sites, are briefly described below.

FTIR 38 Area 2. This study site is within the Goldstone dry-lake lakebed and is largely unvegetated except for the areas immediately adjacent to the former firing range target berms. Vegetation around these berms appears to be limited to areas where material was borrowed from the lakebed to construct the berms (i.e., depressional areas). Dominant shrub species in these areas include spinescale (*Atriplex spinifera*) and shadscale (*Atriplex confertifolia*). Only one individual plant of Anderson's box-thorn (*Lycium andersonii*) was observed at this study site. Herbaceous vegetation was largely absent at the time of surveys except for limited annual grass seedlings.

FTIR 40 Area 1. This study site is a former refuse disposal site that served as a former housing area. Vegetation at this site can be best characterized as disturbed creosote bush scrub. Dominant shrubs in this area include creosote bush (*Larrea tridentata*), Anderson's box-thorn, ephedra (*Ephedra* spp.), and white bursage (*Ambrosia dumosa*). Herbaceous plants were largely absent during the survey except for scattered annual buckwheats (*Eriogonum* spp.).

FTIR 40 Area 2. This study site is a former housing area. Vegetation at this site is best characterized as creosote bush scrub. Creosote bush is the dominant shrub at this site with white bursage and Anderson's box-thorn being sub-dominant species. Cooper's box-thorn (*Lycium cooperi*) is also present at the site in limited numbers. Herbaceous plants were largely absent at the time of the survey except for scattered desert trumpet (*Eriogonum inflatum*) and dried fiddleneck plants (*Amsinckia* spp.).

Reference Area 1 (RF1). This reference area lies along the edge of the Goldstone dry lakebed. Dominant vegetation in this area consists chiefly of saltbushes (*Atriplex confertifolia* and *A. spinifera*) and white bursage. Anderson's box-thorn is also present at this site in limited numbers. Herbaceous vegetation at this reference site was limited to scattered individuals of golondrina (*Chamaesyce polycarpa*).

Reference Area 2 (RF2). This reference area roughly surrounds study site FTIR 40 – Area 1 and vegetation consists chiefly of creosote bush scrub. Dominant shrubs in the area consist of creosote bush, white bursage, and Anderson's box-thorn. Herbaceous plants were largely absent at the time of sampling except for scattered desert trumpet and other buckwheat plants (*Eriogonum* spp.).

METHODS

Target plants were identified using "The Jepson Manual Higher Plants of California" (Hickman 1993) and "Desert Wildflowers" (Jaeger 1941). Plant tissue samples (i.e., leaves) were stripped by hand from stem clippings from each specimen plant. Plant tissue was then placed and sealed in a pre-weighed 1-gallon ziplock type freezer bag and labeled with the plant species name and a sample accession label. Between 10 and 25 grams of plant tissue was collected from each specimen plant for laboratory analysis.

RESULTS

Targeted Mojave ground-squirrel forage species were infrequently encountered or had already senesced by the time of surveys at the study and reference sites. Dried specimens of what appeared to be fiddleneck (Amsinckia spp.) were present at all of the study sites, however, because the specimens were dry at the time of the field study they could not be sampled for use in the analysis. Last year's russian thistle (*Salsola* sp.) plants were observed at FTIR 38 – Area 2, however, no live plants were observed during the survey. Coreopsis plants were not observed during the survey at either the study or reference sites. Russian thistle was not observed at any of the other study or reference sites. Joshua tree was only present within RF1; however, it was not in fruit at the time of the survey so the species could not be sampled.

Anderson's box-thorn was the most abundant targeted plant species among the three study and two reference sites. Anderson's box-thorn was present in suitable numbers to be sampled at all the study and reference sites with the exception of FTIR 38 – Area 2,

where only one plant was located. Because of the lack of targeted plant species at FTIR 38 – Area 2, tissue sampling had to be performed using alternative species. The only species that were present both at FTIR 38 – Area 2 and its reference area (RF1) were shadscale, spinescale and very limited number of spiny hop-sage (*Grayia spinosa*). Because these species were present in both FTIR 38 – Area 2 and its reference area, they were sampled as an alternative to the target species. Table 1 below lists the plant species sampled in each of the study and reference sites.

Table 1. Plant Species Sampled by Site

Plant Species	FTIR 38 – Area 2	RF1	FTIR 40 – Area 1	FTIR 40 – Area 2	RF2
Atriplex confertifolia "shadscale"	X	X			
Atriplex spinifera "spinescale"	X	X			
Grayia spinosa "spiny hop-sage"	X	X			
Lycium andersonii "Anderson's box-thorn"	X(1 plant)	X	X	X	X
Lycium cooperi "Cooper's box-thorn"				X	

REFERENCES

Hickman, J., ed. 1993. *The Jepson Manual: Higher Plants of California*. University of California Press. Berkeley, California.

Jaeger, Edmund C., 1941. *Desert Wild Flowers*. Stanford University Press. Stanford, California

APPENDIX E

XRF TECHNICAL PROCEDURE AND CORRELATION RESULTS

STANDARD OPERATING PROCEDURES FOR DETERMINING METALS IN SOILS BY XRF

1.0 Introduction

The Spectrace 6000 X-ray fluorescent (XRF) unit is a table top direct energy x-ray fluorescent system made by Spectrace, Mountain View, CA. The hardware consists of the XRF unit with a rhodium x-ray tube and dedicated computer and software. The methods and techniques for initial calibration, daily calibration, sample preparation, and unknown sample analysis/ analytical run procedures are described below.

The Spectrace 6000 XRF provides a method of analysis for individual metals in soil and aqueous matrices. Sensitivity of the unit increases with increasing run time, as well as with increasing atomic number of the element(s) of interest. However, interference will decrease instrument sensitivity.

The following procedures focus on the use of this instrument for the assessment of metals in soil samples.

1.1 Scope and Application

X-Ray fluorescence, as a field screening tool, can be used to detect the presence of metals in both solid and aqueous samples. Different matrices require different sample preparation. Sensitivity is directly proportional to the atomic number and detection limits are inversely proportional to the atomic number of the element of interest. The machine is more sensitive to elements of higher atomic number and can, in theory, achieve lower detection limits for these elements.

In addition, results can be directly downloaded to spreadsheet formats using the software provided by Spectrace.

1.2 Initial Calibration

After the unit, computer, and software have been set up and are operational, initial calibration consists of the following steps:

- Calibration of the energy scale of the XRF unit and hardware (energy calibration)
- Establishing methods of analysis for individual elements at low, mid, and high atomic numbers
- Obtaining reference spectra for target elements and potential overlapping or interfering elements from reference standards
- Determining detection limits

In general, resolution and detection limits of the machine for particular analytes increases with increasing sample run time. However, in obtaining reference spectra for the initial calibration, a run time of 400 seconds for each range (low, mid, and high) should provide adequate resolution.

1.3 Daily Calibration/Working Procedures

Daily calibration and daily working procedures include the following:

- Performing energy calibration of the XRF unit and hardware (see manual)
- Running the unit without a sample in the chamber to monitor presence of contamination on detector window.
- Running designated standard in the "unknown" mode to monitor drift from previous standard results
- Printing hard copy of the system status screen to monitor drift in analysis modes (see manual)
- Downloading analytical results from hard drive to floppy disks.

These tasks must be performed on a daily basis in order to monitor precision and accuracy of the XRF unit. The software associated with this system currently does not protect from overwriting. The frequency of downloading may be established as needed, but is recommended that it be performed daily to avoid overwriting of data.

1.4 Interferences

Samples often suitable for XRF analysis may have matrix effects. Matrix effects are dealt with by the use of software that computes corrected intensities for elements present in complex matrices.

Please refer to discussion of alternate methods (section 1.13) for ideas on decreasing variation and increasing sample homogeneity and precision and accuracy.

1.5 Sample Handling and Preservation

According to SW846 and RCRA soil samples being analyzed for metals do not require any preservation in the field or during storage other than placing them in a cool, dry, and dark atmosphere. Since this application is designed as a screening method, the basic assumption is the sample will undergo analysis immediately after collection. Samples that have undergone preparation and are in appropriate analysis containers can be held for up to six months, with the exception of elements such as mercury (Hg) with a holding time of 28 days.

1.6 Sample Preparation

Sample preparation is dependent upon moisture content. Samples must have low moisture content and be homogenized in order to be analyzed accurately by XRF. For soils with low to moderate moisture content (no standing or free flowing water), drying can be accomplished by spreading the sample on a paper plate and micro waving until visibly dry (several minutes on high power).

The sample must then be homogenized by removing any large debris or rocks. One method involves use of a 10 or 20 mesh sieve, or finer, and crushing with a mortar and pestle or some grinding device. The mixed soil must be re-sieved through a number 10 mesh (or smaller) and should then be homogenized by thorough mixing. The XRF sample cup must

then be completely filled. The open end of the container must be covered with XRF film and secured using plastic rings. The film must be stretched tightly and free of fingerprints, oil, punctures, etc., and the securing ring must sit flush with the film. The sample is then ready for analysis. (Note: Please refer to alternate sample preparation methods, section 1.13, for a brief description of increasing homogeneity).

1.7 Instrument Parameters

Ambient temperature should remain constant in the area of the unit. The hardware for the Spectrace 6000 XRF must be left on for the duration of the project. In order to perform a planned shut down, please consult the user's manual. Should shutdown occur due to power failure, do not continue to analyze samples. Contact the manufacturer for the correct procedure to bring the machine back "on-line."

1.8 Analysis of Samples

Once a sample has been prepared, it can be loaded into the XRF unit. The procedure menu must be set to "soil unknowns" and the "run" key will then initiate analysis. In general, a sample analysis time of 150 seconds per level (low, mid, and high) provides more than adequate resolution at a moderate sample turn around time.

1.9 Analytical Sequence

Analytical run sequences for the analysis of samples are dependent upon the data quality objectives of the particular project. Presented below is an example of a routine run sequence, including quality assessment/quality control (QA/QC) samples. Note: It is important to run a daily energy calibration, at least one standard (more than one preferred) which was used to calibrate the machine and contains high concentrations of elements of interest, and an analytical duplicate.

<u>Daily Sequence:</u>
Energy Calibration
Standard A (Run Twice)
Samples (up to 10)
Standard A or B
Samples
Duplicate (1 every 20 samples)
Etc.
Standard A or B

The above sequence is only an example. Objectives for quality and statistical analysis must be established prior to the project and modified if necessary.

Important: Results for standards should be given with values for peak, background, and total concentration in order to calculate detection limits for the elements of interest.

1.10 Calculations

The software for the Spectrace 6000 XRF performs all necessary calculations to obtain the analyte concentrations. The only calculation the operator will be responsible for is the detection limits for elements of interest. The following is an explanation for accomplishing this task.

Detection limits are calculated by determining the concentration of a sample detected by the instrument compared to the standard concentration. For example, suppose a standard for chromium has been determined to be at a concentration of 100 parts per million (ppm). The following equation will give the detection limit:

$$DL = \frac{(3 \times \text{sqrt}(2B))}{N} \times (\text{standard concentration}=100\text{ppm})$$

where:

DL = detection limit
sqrt = square root
B = background count
N = net counts (or peak counts)
standard concentration = actual certified concentration of element of interest present in a standard (in this example, 100 ppm)

The three is used to guarantee that the calculated amount of the element of interest is present at least three standard deviations away from a zero measurement.

1.11 Quality Control

Refer to analytical sequence and daily calibration procedures for information. QA/QC requirements must be established prior to the project.

Recommendations include running daily standards to monitor drift and to calculate detection limits, performing daily energy calibration, printing copy of the unit's status screen (PHA Screen) daily, and following an analytical run sequence.

Relative percent difference criteria can be established for results obtained from duplicate samples and multiple standard re-analysis. Criteria should take into account variance inherent in sampling technique, sample preparation, and final sample state (i.e. cylindrical sample containers or fixed thin film slides).

Use of split samples for second laboratory confirmation is an additional option to ensure representativeness of samples (PARCC citeria). However, if split sample analysis/analyses are not performed using the same technology (i.e. XRF versus wet chemistry extraction and subsequent analyses) unrepresentative results may be obtained.

1.12 Corrective Action Procedures

During an analytical run sequence, limits must be set which require corrective action initiation. For example, if limits of standard precision are set to be less than 25%, than the standard must be re-analyzed should these limits not be met. If re-analysis does not solve the problem, further corrective action must be taken, such as instrument calibration, cleanliness of detector window, etc.... Table 1 summarizes minimum corrective action procedures.

Corrective action procedures for hardware or software are presented in the operating manual or can be obtained from the manufacturer.

Table 1. Example Corrective Action Procedures

Parameter	Frequency	Acceptance Criteria	Corrective Act
Initial Calibration	Daily	Within X % of standard	Re-analyze standard
Energy Calibration	Daily	System calibrated at < 1.5 eV	Check hardware and system status; re-analyze
Continuing Calibration	1:10 samples	Within X % of standard	Re-analyze standard; if remains out then check calibration
Calibration blank	1:10 samples	< Detection limit	Stop analysis; determine cause of contamination and re-analyze sample
Analytical Duplicate	1:20 samples	RPD < 50%	Re-analyze duplicate; if remains outside limit then review calibration

RPD - Relative Percent Difference
eV - electron volt
X % - refers to a pre-determined percentage criteria

1.13 Alternate Sample Preparation Methods

There is ongoing research as to the most effective method for sample preparation in order to increase homogeneity and representativeness. One such method involves grinding samples to a mesh sizes of 200-400 and then spreading a thin film onto a flat sample slide. This smaller particle size helps to decrease the interferences associated with soil inconsistencies and will theoretically increase the homogeneity of the sample, while fixing the sample as a thin film ensures that the same surface area is analyzed by the X-ray during subsequent analytical runs.

DESCRIPTION OF X-RAY FLUORESCENCE (XRF) TECHNIQUE AND STATISTICAL EVALUATION

The Small Arms Firing Ranges Investigation at the Presidio of San Francisco California used a relatively new technique for analyzing samples; X-ray fluorescence (XRF) The Army decided to use the XRF technique to rapidly and cost effectively analyze samples collected from the firing ranges. The results from the XRF analysis and, conventional laboratory methods using acid digestion and inductively coupled argon plasma (ICP) spectroscopy are compared in this appendix. The following items will be covered:

- XRF technique, sampling and sample preparation
- Action levels used in this investigation
- Analysis of results that show the value of the technique as a decision tool

Although lead is one of several metals found in spent bullets, it is the primary metal component (85 to 99 2 percent) and can be hazardous to human health and the environment. Therefore, lead analysis is the focus of this investigation, particularly the comparison between the analytical techniques.

1.0 XRF TECHNIQUE AND APPLICATION

Energy dispersive X-ray fluorescence spectrometry (edXRF) instrumentation provided the quantity and quality of data necessary to define the lateral and vertical extent of lead contamination in the firing range footprint and the existing impact berms XRF field analysis produced real time data (i.e., provided analytical data within minutes to tens of minutes) to assess subsequent courses of action to delineate the vertical and lateral extent of contamination

Developed in the early 1970s, XRF is a flexible elemental analysis method used for qualitative and quantitative composition determinations of solid, liquid, thin film and powder samples It is capable of analyzing elements with atomic number 11 (sodium) and higher in the periodic table in concentrations ranging from a few parts per million (ppm) to 100 percent by weight. This analytical technique is used extensively for the following applications:

- quality assurance and quality control of incoming materials and finished products (e.g , magnetic media film thicknesses, dry copier toner, lubricants, alloy identification, and pharmaceuticals)
- environmental samples (e g., metals in contaminated soil and remediation processes, air filters, dust wipes, sludge assessment, and lead in paint)
- process streams (e g., catalyst depletion, plating baths, petroleum refining, and ion exchange column control)

Several advantages of the XRF method compared to other elemental analysis techniques are:

- non-destructiveness
- little or no sample preparation
- rapid analysis turnaround time
- direct interpretation of X-ray emission spectra acquired from a sample
- detection limits approaching those achieveable using traditional laboratory methods

The interaction of X-ray excitation with matter and solid state X-ray detectors and supporting electronics are brought together in XRF spectrometry. Figure B-1, a schematic representation of the process, illustrates the interaction of these principles.

1.1 X-RAY EXCITATION

Two X-ray excitation sources are used in XRF spectrometry:

- X-ray tubes coupled with primary radiation filters
- sealed radioisotope sources

The X-ray tube is an evacuated glass envelope comprised of a filament with adjustable current control, a pure metal anode, and a beryllium window. It provides a stable high intensity X-ray source The gradual deceleration of electrons as they strike the anode provides a continuum of X-rays from the source. When the electron energy imparted to the anode atoms is sufficient to eject inner shell electrons, characteristic X-rays are emitted. Alternatively, unstable isotopes can be used to emit X-rays upon radioactive decay. X-rays produced by a radioisotope source can be one or more discrete emission lines Consequently, the elemental analysis is limited by the radioisotope source. This is in contrast to the broad distribution of energies output from the X-ray tube. X-ray tubes provide a high spectral flux (photons/unit time) output with small power supply requirements (50 watt

maximum). The ability to adjust the X-ray tube power supply coupled with the use of radiation filters allows for the optimization of the excitation conditions for the elements of interest in a sample.

The distribution of X-rays emitted from the X-ray tube and allowed to excite a sample is modified by the addition of a radiation filter which is placed between the excitation source (i.e., the X-ray tube) and the sample (Figure B-1). Radiation filters optimize analytical efficiency by:

- reducing background beneath element emission lines in a spectral region
- eliminating X-ray tube anode characteristic line radiation which may interfere with the element of interest
- transmitting X-rays of sufficient energy to excite the elements of interest

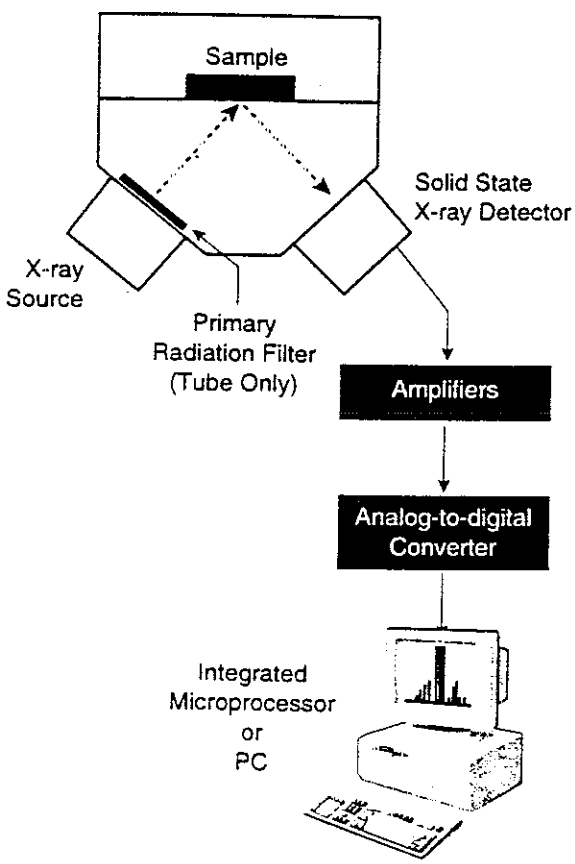


Figure B-1

1.2 INTERACTION OF X-RAYS WITH MATTER

A prerequisite for X-ray emission is excitation of the atoms in the sample. XRF analysis relies on the absorption of radiation from the primary X-ray source for this excitation. This photoelectric absorption induces the atom to eject a photoelectron from the electron cloud. (A specific amount of energy is required to excite an electron in any particular atom and more energy is required to eject K shell electrons, more tightly held than electrons in the neighboring L shell, further from the atom's nucleus.)

Following photoelectric absorption, a vacancy is created in the electron orbital and the atom is in an excited unstable energy state. In order to return to the ground state and fill the electron vacancy, the excited atom must undergo electronic rearrangement. One relaxation process is photon emission.

An electronic rearrangement producing an X-ray photon is termed a fluorescence transition. An X-ray photon emitted by such a transition is designated a characteristic X-ray, and its energy indicates the atomic number of the emitting atom and the specific fluorescence transition giving rise to the X-ray emission. The XRF spectrophotometer analyzes characteristic X-ray photons emitted by fluorescence transitions to determine the X-ray spectrum of a sample while quantitative analysis relies on the intensity. A solid state detector converts X-ray photon energy into output pulses that are measured with an alternating direct current (ADC), then sorted with respect to their magnitude. This spectral data is collected in the computer memory for display and further processing.

2.0 SAMPLE PREPARATION

The field analysis laboratory was located at Montgomery Watson's Field Operations Center at the intersection of Marshall and Old Mason on the Presidio. Three hundred and eighty-one samples were collected for XRF analysis. The laboratory supported the field effort from February 20, 1996 through March 13, 1996. Twenty percent of the samples (62 total samples) were analyzed in a laboratory following XRF analysis. A Spectrace 6000 energy dispersive X-ray fluorescence (edXRF) unit was used to analyze samples for lead, antimony, barium, copper, and zinc. Confirmation split samples were sent to Applied Physical and Chemical Laboratories (APCL) in Fresno, California for lead analysis.

Field personnel collected sample aliquots in 1 liter polyethylene bags and scrutinized each sample for projectiles and bullet fragments. Samples were handled and processed according to the chain of custody procedures outlined in the Site-Specific Work Plan for Environmental Soil Investigation of the Small Arms Firing Ranges (Montgomery Watson, 1996b). Visible historical artifacts (i e., ammunition, bullet fragments, and other historical evidence) were removed from the sample collected in plastic ziplock bags, documented, photographed, weighed, and transferred to the National Park Service (NPS) Archaeologist for identification. The samples for field analysis were delivered to the chemist on duty for analysis. A chain of custody form was signed by the field supervisor and the chemist to document the delivery.

Upon receipt of the samples the chemist sieved each sample using an American Society for Testing and Materials (ASTM) Sieve #4 (4 45 mm). Ammunition projectiles and bullet fragments retained on the sieve were collected in plastic ziplock bags and handled as described in the preceding paragraph. After the sample was sieved it was dried in a microwave and ground to a fine powder consistency using a decontaminated mortar and pestle. A portion of the dried sample was transferred to an XRF sample cup and analyzed using the Spectrace 6000. The remaining portion of the dried sample was retained for confirmation at an offsite laboratory.

3.0 ACTION LEVELS

The action level of 400 milligrams per kilogram (mg/kg) is the United States Environmental Protection Agency (USEPA) Region IX Preliminary Remediation Goal (PRG) for lead. As cleanup levels for heavy metals in soil have not been finalized for the Main Installation in the Remedial Investigation, the PRG was chosen as an action level for the investigation.

4.0 EVALUATION OF RESULTS

As discussed before, XRF is a valuable decision tool, as the results compare favorably to laboratory results and it can easily meet the action levels selected for this project. This evaluation includes the following items:

- Accuracy of XRF relative to laboratory results
- Comparison results using the entire data set
- Discussion of XRF as a decision tool

Descriptive statistics are shown on Table B-1 below. Results below reporting limits were included using the reporting limit as the value for the statistical calculation.

Table B-1
Statistical Summary Firing Ranges Investigation
Presidio of San Francisco, California

	Lead Concentration, mg/kg	
Statistic	XRF	Laboratory
Mean	176	205
Standard Error	55 0	111
Median	55	34 5
Standard Deviation	433	875
Skewness	6 4	6 8
Minimum	10	3
Maximum	3300	6660
Number of Samples	62	62

These statistics show the two methods produce similar results although the results are strongly skewed positively. The laboratory results are slightly more skewed than the XRF. Figure B-2, showing the cumulative frequency distribution of both sets of results, also illustrates the similarity between the two data sets.

A common method of quantifying the similarity between two data sets is linear regression by the least-squares method (Kleinbaum and Kupper, 1978). Linear regression analysis assumes the two data sets can be represented by a straight line. In other words, they are related linearly per the following equation:

$$Y = mX + b$$

where: Y is the dependent variable
X is the independent variable
m is the slope of the line and
b is the Y-intercept (the value when X = 0)

The equations used to calculate, m and b are shown in many texts on statistics. The coefficient of determination, r^2 is the measure of how well the two variables relate. A good relation is one in which r^2 is greater than 0.8.

Table B-2 shows the results of the least-squares analysis. We considered the laboratory data as the "X-variable" or independent variable and the XRF data as the "Y-variable" or dependent variable.

Figure B-2

Cumulative Frequency Distributions for Lead Analysis
Firing Range Investigation
Presidio of San Francisco, California

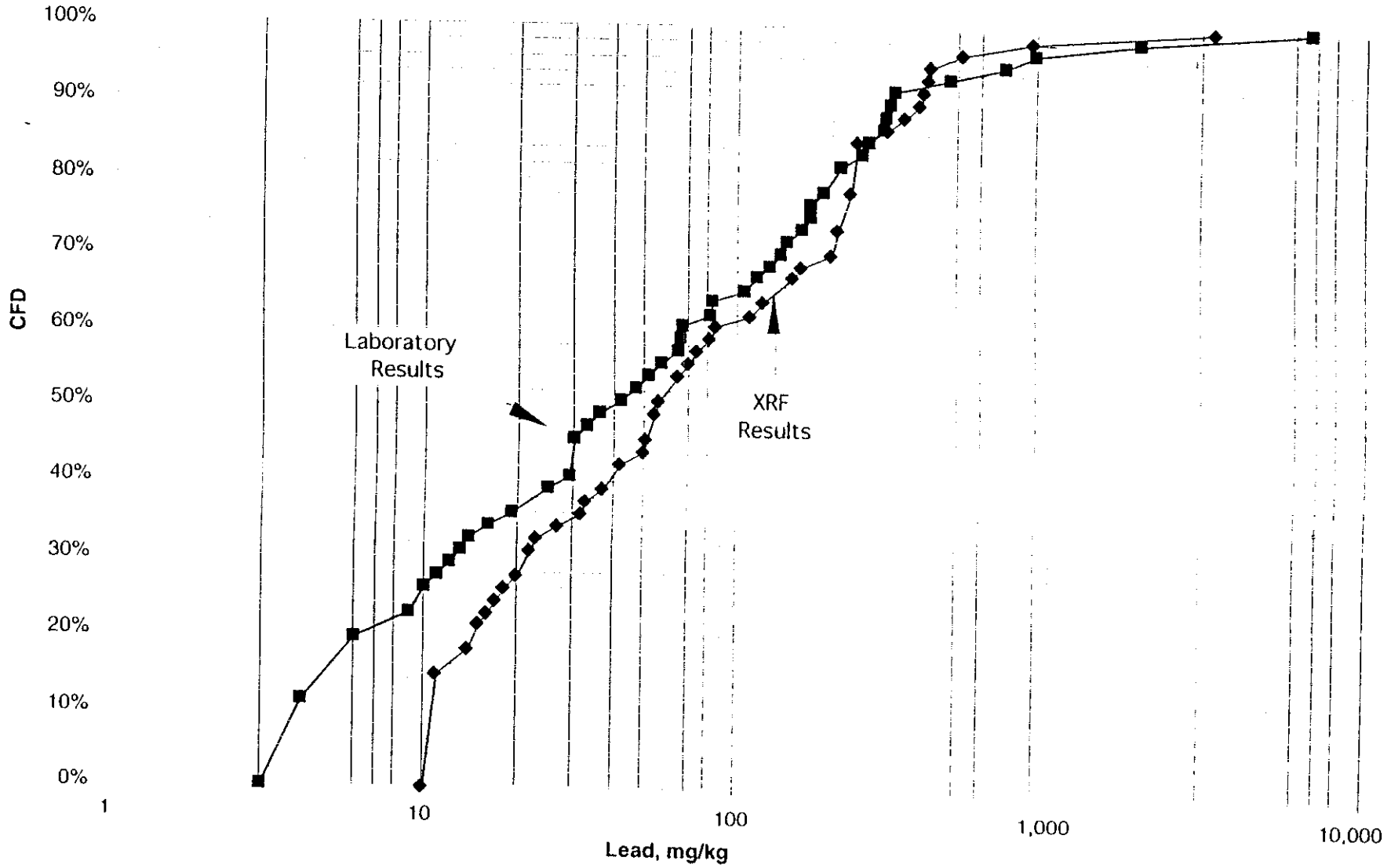


Table B-2
Linear Regression Results Firing Ranges Investigation
Presidio of San Francisco, California

Statistic	Value
Correlation Coefficient r^2	0.926
Slope, m	0.476
Intercept, b	61.3

The coefficient of determination, r^2, shows there is a strong relationship between the two methods.

The two-sided sign test is a hypothesis-testing method used to compare two data sets, x_1 and x_2 (Gilbert, 1987). The sign test begins with the null hypothesis:

H_o: The median of the population of all possible differences is zero. In other words, for any pair of data, x_{1i} is as likely to be larger than x_{2i} and vice versa. The statistic B is used to quantify the number of pairs for which x_{1i} is less than x_{2i}. The alternative hypothesis is:

H_A: The median difference is not zero. That is, x_{1i} is more likely to be larger than x_{2i} or vice versa.

For a given significance level, a, reject H_o and accept H_A if:

$$B \leq l - 1 \text{ or } B \geq u$$

where B is the sign test statistic and l and u are integers for lower and upper confidence limits of the true median of a data set for a given a.

Table B-3 summarizes the parameters and the results of the sign test using a 95 percent significance level. The alternative hypothesis is that the XRF results are larger than the laboratory results.

It is clear from Table B-3, that for the majority of the data, the XRF results are greater than the laboratory results. This is expected since the XRF technique is better able to measure the metal in forms that cannot be digested using acid as part of the normal laboratory procedure. This is important, since XRF is a field analytical method and it is conservative to have a field analytical method that reports results that are higher than laboratory methods. Therefore the user and regulatory agencies in the project can be confident that the field method will not cause false negative results.

Table B-3
Results of Two-Sided Sign Test Firing Ranges Investigation
Presidio of San Francisco, California

Parameter	All Data [a]	Results Below Reporting Limits Censored	Results Below Reporting Limits Only [a]
n	62	52	10
a	95%	95%	95%
B	51	44	7
l	23	19	2
$l-1$	22	18	1
u	40	34	9
Result	$B > u$	$B > u$	$B > l - 1$ and $B < u$
	Accept alternative hypothesis	Accept alternative hypothesis	Reject alternative hypothesis

Notes: [a] Results below reporting limits are considered to be the reporting limit.

When close to the detection limit, the null hypothesis is accepted and the data sets should be considered equal at a 95% confidence level. The 10 pairs of results with at least one result below detection limits were all below 23 mg/kg. In 7 of the 10 pairs the laboratory result was lower than the XRF result. So, there is still a high level of confidence that the XRF result is more conservative than the laboratory result.

5.0 DECISION-MAKING EVALUATION

Field decisions are a constant process in the environmental field and it is useful to know whether the XRF is a valid decision making tool when compared to laboratory analysis. In all phases of environmental work, field personnel make decisions on whether to investigate or remediate further. Rapid and reliable decision-making tools are important to maximize the effectiveness of field programs.

A correct decision is defined as a pair of analytical results that lie on the same side of the threshold value For example, if the XRF and laboratory results are both greater than the threshold then a decision based on the XRF result is correct. The percentage of correct decisions relative to the action level of 400 mg/kg for this investigation was 93 5 percent–an excellent result Therefore the user of XRF results can make field decisions confidently

6.0 CONCLUSIONS

The benefits of XRF as compared to conventional laboratory results are its cost-effectiveness due to the speed of analysis since it can be used on site. This allows the project team to collect samples and evaluate the results as the investigation is occurring This real-time analytical approach can also minimize the number of investigations, ideally to a just single investigation.

XRF is also a valid method when compared to laboratory results It is a good decision-making tool based on its accuracy relative to the laboratory results, the percentage of correct decisions and the conservative or higher measured results.

References:

Gilbert Richard, 1987 Statistical Methods for Environmental Pollution Monitoring, Van Nostrand Reinhold New York.

Kleinbaum David G and Kupper, Lawrence L. 1978 Applied Regression Analysis and Other Multivariable Methods Duxbury Press, Boston

Figure E-1: A Scatter Plot Showing the Correlation Between EDXRF and ICP Lead Concentration Results

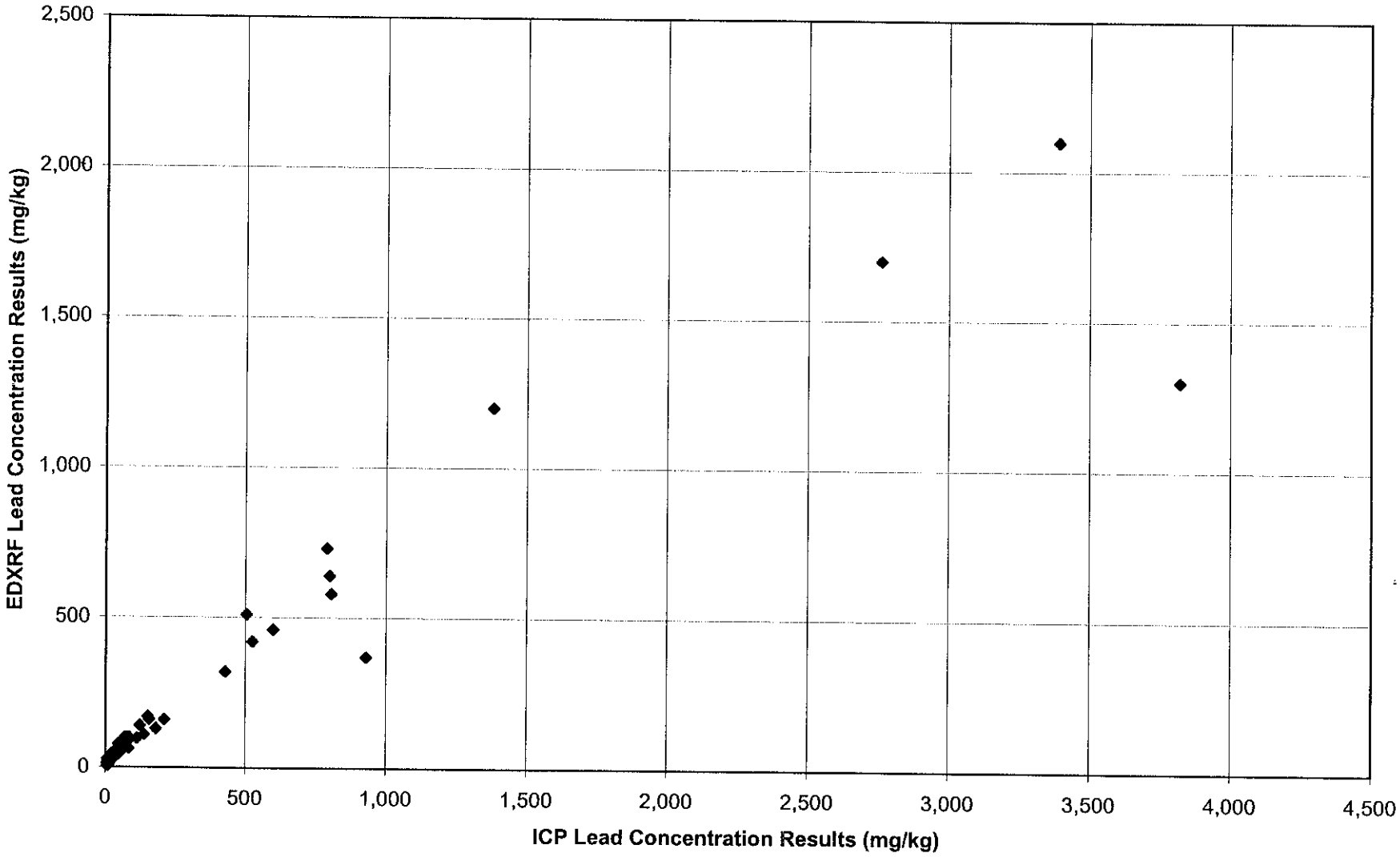


TABLE E-1

SITE FTIR-38 AREA 2
SURFACE SAMPLE CONFIRMATION RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN
(Page 1 of 2)

APCL Sample ID No.	Onsite Sample ID No.	Date Sampled	Lead Concentration (mg/kg) ICP Results (Stationary Lab)	Lead Concentration (mg/kg) EDXRF Results (Onsite)
38-2-SS-CNF-11-1	38-2-SS-11-1	5/13/99	2,760	1,700
38-2-SS-CNF-12-1	38-2-SS-12-1	5/13/99	3,820	1,300
38-2-SS-CNF12-5	38-2-SS-12-5	5/20/99	21.1	22
38-2-SS-CNF-14-1	38-2-SS-14-1	5/13/99	210	160
38-2-SS-CNF-20	38-2-SS-20	5/13/99	9.6	12
38-2-SS-CNF-22	38-2-SS-22	5/13/99	7.6	29
38-2-SS-CNF-23	38-2-SS-23	5/13/99	180	130
38-2-SS-CNF-25	38-2-SS-25	5/13/99	524	420
38-2-SS-CNF26-2	38-2-SS-26-2	5/17/99	39.7	51
38-2-SS-CNF27-3	38-2-SS-27-3	5/20/99	70.7	100
38-2-SS-CNF-28	38-2-SS-28	5/13/99	798	640
38-2-SS-CNF28-1	38-2-SS-28-1	5/16/99	1,380	1,200
38-2-SS-CNF-29	38-2-SS-29	5/13/99	24.3	26
38-2-SS-CNF-30	38-2-SS-30	5/13/99	122	140
38-2-SS-CNF-33	38-2-SS-33	5/13/99	10	27
38-2-SS-CNF-36	38-2-SS-36	5/13/99	6.1	15
38-2-SS-CNF37	38-2-SS-37	5/14/99	3,390	2,100
38-2-SS-CNF37-1	38-2-SS-37-1	5/15/99	805	580
38-2-SS-CNF37-2	38-2-SS-37-2	5/16/99	156	160
38-2-SS-CNF41	38-2-SS-41	5/14/99	48.2	60
38-2-SS-CNF42	38-2-SS-42	5/14/99	83.2	100
38-2-SS-CNF42-1	38-2-SS-42-1	5/15/99	22.4	45
38-2-SS-CNF43	38-2-SS-43	5/14/99	7.9	16
38-2-SS-CNF45	38-2-SS-45	5/14/99	10.8	17
38-2-SS-CNF47	38-2-SS-47	5/14/99	9.6	22
38-2-SS-CNF49	38-2-SS-49	5/14/99	428	320
38-2-SS-CNF49-1	38-2-SS-49-1	5/15/99	58.8	65
38-2-SS-CNF49-2	38-2-SS-49-2	5/16/99	138	110
38-2-SS-CNF50-2	38-2-SS-50-2	5/16/99	598	460
38-2-SS-CNF51-3	38-2-SS-51-3	5/18/99	7.9	5
38-2-SS-CNF53	38-2-SS-53	5/14/99	789	730
38-2-SS-CNF53-2	38-2-SS-53-2	5/16/99	503	510
38-2-SS-CNF64	38-2-SS-64	5/14/99	16.6	22
38-2-SS-CNF66	38-2-SS-66	5/14/99	112	97
38-2-SS-CNF68-1	38-2-SS-68-1	5/15/99	19.9	28
38-2-SS-CNF70-2	38-2-SS-70-2	5/20/99	8.2	16
38-2-SS-CNF74	38-2-SS-74	5/15/99	26.6	46
38-2-SS-CNF77-1	38-2-SS-77-1	5/19/99	5.7	14
38-2-SS-CNF79-1	38-2-SS-79-1	5/19/99	6.8	5
38-2-SS-CNF81-1	38-2-SS-81-1	5/18/99	13.7	22
38-2-SS-CNF82	38-2-SS-82	5/16/99	152	170
38-2-SS-CNF82-1	38-2-SS-82-1	5/18/99	18.6	25
38-2-SS-CNF84	38-2-SS-84	5/16/99	44.3	59
38-2-SS-CNF84-1	38-2-SS-84-1	5/18/99	10.0	15
38-2-SS-CNF91	38-2-SS-91	5/16/99	81.5	88
38-2-SS-CNF92	38-2-SS-92	5/16/99	38.1	47
38-2-SS-CNF101	38-2-SS-101	5/17/99	10.7	12

TABLE E-1

SITE FTIR-38 AREA 2
SURFACE SAMPLE CONFIRMATION RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN
(Page 2 of 2)

APCL Sample ID No.	Onsite Sample ID No.	Date Sampled	Lead Concentration (mg/kg) ICP Results (Stationary Lab)	Lead Concentration (mg/kg) EDXRF Results (Onsite)
38-2-SS-CNF126-1	38-2-SS-126-1	5/19/99	11.8	30
38-2-SS-CNF129	38-2-SS-129	5/18/99	15.0	12
38-2-SS-CNF133	38-2-SS-133	5/18/99	11.1	32
38-2-SS-CNF142	38-2-SS-142	5/19/99	41.5	53
38-2-SS-CNF143	38-2-SS-143	5/19/99	83.2	64
38-2-SS-CNF152	38-2-SS-152	5/20/99	56.9	68
38-2-SS-CNF155	38-2-SS-155	5/20/99	58.6	56
38-2-SS-CNF176	38-2-SS-176	5/21/99	45.4	78
38-2-SS-CNF179	38-2-SS-179	5/21/99	55.7	53
38-2-SS-CNF182	38-2-SS-182	5/22/99	23.0	32
38-2-SS-CNF185	38-2-SS-185	5/21/99	67.1	94
38-2-SS-CNF188	38-2-SS-188	5/21/99	39.3	58
38-2-SS-CNF191	38-2-SS-191	5/21/99	929	370
38-2-SS-CNF193	38-2-SS-193	5/22/99	70.3	73
38-2-SS-CNF196	38-2-SS-196	5/22/99	72.4	80
38-2-SS-CNF200	38-2-SS-200	5/22/99	75.7	100
38-2-SS-CNF203	38-2-SS-203	5/22/99	36.4	35
38-2-SS-CNF210	38-2-SS-210	5/22/99	84.8	100
			Correlation:	0.9440

APPENDIX F

LAND SURVEY DATA

LAND SU EY DATA
SITES FTIR-38 AND FTIR-40
NATIONAL TRAINING CENTER, FORT IRWIN

State Plane, 1927, Zone V, Feet

ID	Northing	Easting	Latitude	Longitude	Elev	ID2
10	665535.819	2323869.757	35.324	-116.914	3161	DISC 10
13	677881.635	2331463.787	35.358	-116.888	3031	DISC 13
109	664342.393	2321558.185	35.321	-116.922	3235	DISC 9
110	665535.817	2323869.599	35.324	-116.914	3161	DISC 10
111	671652.551	2329337.796	35.341	-116.896	3024	DISC 11
112	672073.150	2330270.258	35.342	-116.893	3022	
113	677881.638	2331463.792	35.358	-116.888	3031	DISC 13
114	678792.992	2333128.364	35.360	-116.883	3028	DISC 14
500	664861.029	2322732.988	35.322	-116.918	3170	40-1-SS/PT-7
501	664840.969	2322750.320	35.322	-116.918	3172	40-1-SS/PT-1
502	664794.669	2322736.827	35.322	-116.918	3177	40-1-SS/PT-6
503	664857.423	2322775.811	35.322	-116.918	3171	40-1-SS/PT-2
504	664804.356	2322841.234	35.322	-116.918	3177	40-1-SS/PT-4
505	664844.928	2322835.154	35.322	-116.918	3170	40-1-SS/PT-5
506	664857.263	2322843.896	35.322	-116.918	3169	40-1-SS/PT-3
507	664895.618	2322856.169	35.322	-116.918	3164	40-1-SS/PT-8
508	664859.466	2322906.900	35.322	-116.918	3174	40-1-SS/PT-10
509	664948.965	2322931.853	35.322	-116.918	3160	40-1-SS/PT-9
510	665239.613	2323137.060	35.323	-116.917	3146	RF2-SS/PT-9
511	665208.191	2323112.779	35.323	-116.917	3147	RF2-SS/PT-8
512	665238.376	2322920.892	35.323	-116.918	3162	RF2-SS/PT-7
513	665176.447	2322876.078	35.323	-116.918	3164	RF2-SS/PT-5
514	665200.794	2322852.993	35.323	-116.918	3164	RF2-SS/PT-6
515	665132.639	2322848.763	35.323	-116.918	3165	RF2-SS/PT-3
516	665115.505	2322861.187	35.323	-116.918	3161	RF2-SS/PT-4
517	665107.636	2322771.158	35.323	-116.918	3166	RF2-SS/PT-2
518	665089.803	2322709.610	35.323	-116.918	3168	RF2-SS/PT-1
519	665014.399	2322806.836	35.323	-116.918	3169	RF2-SS/PT-10
520	665080.640	2323912.489	35.323	-116.914	3125	40-2-SS/PT-8
521	665151.407	2323870.979	35.323	-116.914	3126	40-2-SS/PT-10
522	665146.822	2323932.020	35.323	-116.914	3125	40-2-SS/PT-9
523	665181.274	2324135.896	35.323	-116.913	3117	40-2-SS/PT-5

State Plane, 1927, Zone V, Feet

ID	Northing	Easting	Latitude	Longitude	Elev	ID2
524	665175.891	2324163.683	35.323	-116.913	3116	40-2-SS/PT-2
525	665076.766	2324148.559	35.323	-116.913	3118	40-2-SS/PT-3
526	665020.696	2324244.435	35.323	-116.913	3113	40-2-SS/PT-4
527	665063.627	2324629.862	35.323	-116.912	3100	40-2-SS/PT-6
528	664892.715	2324431.078	35.322	-116.913	3108	40-2-SS/PT-7
529	664895.074	2324243.646	35.322	-116.913	3114	40-2-SB-5
530	664896.991	2324206.555	35.322	-116.913	3115	40-2-SB-2
531	664863.508	2324166.746	35.322	-116.913	3116	40-2-SB-4
532	664905.836	2324185.210	35.322	-116.913	3115	40-2-SB-1
533	664959.154	2324199.456	35.322	-116.913	3114	40-2-SB-3
534	664906.978	2323969.331	35.322	-116.914	3123	40-2-SS/PT-1
600	680248.992	2333239.263	35.364	-116.882	3029	RF1-SS/PT-1
601	679046.506	2334547.412	35.361	-116.878	3041	RF1-SS/PT-9A
602	679212.489	2334317.920	35.361	-116.879	3039	RF1-SS/PT-1A
603	679263.646	2334274.751	35.361	-116.879	3038	RF1-SS/PT-2A
604	679350.292	2334325.601	35.362	-116.879	3039	RF1-SS/PT-3A
605	679389.478	2334392.447	35.362	-116.879	3040	RF1-SS/PT-4A
606	679532.276	2334362.490	35.362	-116.879	3039	RF1-SS/PT-5A
607	679587.275	2334390.328	35.362	-116.879	3040	RF1-SS/PT-6A
608	679609.809	2334440.009	35.362	-116.878	3041	RF1-SS/PT-7A
609	679431.987	2334754.255	35.362	-116.877	3044	RF1-SS/PT-8A
610	678341.466	2334008.584	35.359	-116.880	3040	38-2-SS-55
611	678423.522	2333922.891	35.359	-116.880	3039	38-2-SS-56
612	678524.367	2333824.358	35.359	-116.881	3037	38-2-SS-57
613	678590.002	2333772.482	35.360	-116.881	3038	38-2-SS-58
614	677580.912	2331587.542	35.357	-116.888	3021	38-2-SS-107
615	677674.494	2331606.365	35.357	-116.888	3021	38-2-SS-86
616	677633.973	2331645.433	35.357	-116.888	3025	38-2-SS-31
617	677629.634	2331641.874	35.357	-116.888	3025	38-2-SS-16
618	677625.110	2331637.139	35.357	-116.888	3025	38-2-SS-32
619	677625.558	2331646.039	35.357	-116.888	3022	38-2-SS-42
620	677593.489	2331672.536	35.357	-116.888	3021	38-2-SS-64

LAND SU EY DATA
SITES FTIR-38 AND FTIR-40
NATIONAL TRAINING CENTER, FORT IRWIN

State Plane, 1927, Zone V, Feet

ID	Northing	Easting	Latitude	Longitude	Elev	ID2
621	677682.926	2331692.018	35.357	-116.888	3021	38-2-SS-106
622	677768.077	2331707.312	35.357	-116.888	3021	38-2-SS-85
623	677797.898	2331679.151	35.357	-116.888	3021	38-2-SS-119
624	677731.559	2331750.621	35.357	-116.887	3021	38-2-SS-41
625	677729.210	2331742.517	35.357	-116.888	3024	38-2-SS-30
626	677734.476	2331746.581	35.357	-116.888	3024	38-2-SS-15
627	677740.546	2331751.192	35.357	-116.887	3024	38-2-SS-29
628	677701.398	2331778.915	35.357	-116.887	3021	38-2-SS-63
629	677793.460	2331796.000	35.357	-116.887	3021	38-2-SS-105
630	677820.247	2331766.725	35.358	-116.887	3021	38-2-SS-138
631	677812.085	2331815.620	35.358	-116.887	3021	38-2-SS-161
632	677803.511	2331858.247	35.357	-116.887	3021	38-2-SS-193
633	677820.821	2331874.519	35.358	-116.887	3021	38-2-SS-164
634	677807.080	2331887.984	35.357	-116.887	3021	38-2-SS-62
635	677779.799	2331916.812	35.357	-116.887	3021	38-2-SS-74
636	677838.597	2331892.909	35.358	-116.887	3021	38-2-SS-194
637	677837.307	2331861.340	35.358	-116.887	3022	38-2-SS-40
638	677843.943	2331855.187	35.358	-116.887	3025	38-2-SS-14
639	677855.282	2331840.606	35.358	-116.887	3022	38-2-SS-160
640	677869.212	2331823.923	35.358	-116.887	3021	38-2-SS-162
641	677880.914	2331809.064	35.358	-116.887	3021	38-2-SS-84
642	677908.590	2331780.597	35.358	-116.887	3021	38-2-SS-118
643	677934.753	2331750.444	35.358	-116.887	3021	38-2-SS-137
644	677883.985	2331884.584	35.358	-116.887	3021	38-2-SS-163
645	677901.491	2331901.696	35.358	-116.887	3021	38-2-SS-104
646	677917.124	2331918.306	35.358	-116.887	3021	38-2-SS-165
647	677908.967	2331963.714	35.358	-116.887	3021	38-2-SS-195
648	677923.992	2331978.185	35.358	-116.887	3021	38-2-SS-168
649	677910.371	2331991.175	35.358	-116.887	3021	38-2-SS-61
650	677882.288	2332019.451	35.358	-116.887	3021	38-2-SS-73
651	677849.483	2332047.464	35.358	-116.886	3021	38-2-SS-144
652	677941.445	2331996.200	35.358	-116.887	3021	38-2-SS-196

State Plane, 1927, Zone V, Feet

ID	Northing	Easting	Latitude	Longitude	Elev	ID2
653	677939.879	2331964.529	35.358	-116.887	3022	38-2-SS-39
654	677946.394	2331958.444	35.358	-116.887	3025	38-2-SS-13
655	678006.519	2331961.874	35.358	-116.887	3021	38-2-SS/PT-1A
656	677961.029	2331945.241	35.358	-116.887	3021	38-2-SS-159
657	677975.483	2331931.081	35.358	-116.887	3021	38-2-SS-166
658	677989.635	2331914.758	35.358	-116.887	3021	38-2-SS-83
659	678002.742	2331899.786	35.358	-116.887	3021	38-2-SS-197
660	678018.159	2331884.860	35.358	-116.887	3021	38-2-SS-117
661	677992.162	2331990.923	35.358	-116.887	3021	38-2-SS-167
662	678007.814	2332009.149	35.358	-116.887	3021	38-2-SS-103
663	678024.938	2332026.558	35.358	-116.887	3021	38-2-SS-169
664	678034.095	2331978.588	35.358	-116.887	3021	38-2-SS-135
665	678062.314	2331998.737	35.358	-116.887	3021	38-2-SS-170
666	678149.438	2331960.972	35.358	-116.887	3021	38-2-SS-136
667	678134.597	2331976.875	35.358	-116.887	3021	38-2-SS-171
668	678119.800	2331991.728	35.358	-116.887	3021	38-2-SS-116
669	678092.536	2332020.006	35.358	-116.887	3021	38-2-SS-82
670	678080.072	2332034.216	35.358	-116.887	3021	38-2-SS-199
671	678067.116	2332051.242	35.358	-116.886	3021	38-2-SS-158
672	678070.210	2332056.736	35.358	-116.886	3022	38-2-SS/PT-3
673	678052.894	2332064.754	35.358	-116.886	3024	38-2-SS-12
674	678045.602	2332070.411	35.358	-116.886	3021	38-2-SS-38
675	678028.404	2332081.637	35.358	-116.886	3021	38-2-SS-200
676	678016.464	2332066.244	35.358	-116.886	3021	38-2-SS-198
677	678013.108	2332093.320	35.358	-116.886	3021	38-2-SS-60
678	677980.455	2332116.205	35.358	-116.886	3022	38-2-SS-72
679	678041.282	2332097.685	35.358	-116.886	3021	38-2-SS-201
680	678097.039	2332099.390	35.358	-116.886	3021	38-2-SS-172
681	678114.828	2332112.731	35.358	-116.886	3021	38-2-SS-102
682	678131.744	2332130.493	35.358	-116.886	3021	38-2-SS-173
683	678161.978	2332112.783	35.358	-116.886	3021	38-2-SS/PT-2
684	678174.382	2332156.464	35.358	-116.886	3021	38-2-SS-157

State Plane, 1927, Zone V, Feet

ID	Northing	Easting	Latitude	Longitude	Elev	ID2
685	678160.208	2332173.276	35.358	-116.886	3025	38-2-SS-11
686	678155.953	2332177.517	35.358	-116.886	3022	38-2-SS-37
687	678124.585	2332177.750	35.358	-116.886	3021	38-2-SS-202
688	678127.716	2332206.266	35.358	-116.886	3021	38-2-SS-59
689	678099.493	2332234.590	35.358	-116.886	3021	38-2-SS-71
690	678160.412	2332208.504	35.358	-116.886	3021	38-2-SS-203
691	678206.958	2332199.734	35.359	-116.886	3022	38-2-SS-174
692	678226.117	2332211.858	35.359	-116.886	3022	38-2-SS-101
693	678200.965	2332125.211	35.359	-116.886	3022	38-2-SS-81
694	678223.758	2332096.349	35.359	-116.886	3022	38-2-SS-115
695	678252.711	2332067.765	35.359	-116.886	3021	38-2-SS-134
696	678383.155	2331835.570	35.359	-116.887	3021	38-2-SS-3
697	678387.740	2331831.655	35.359	-116.887	3024	38-2-SS-17
698	678383.471	2331825.321	35.359	-116.887	3025	38-2-SS-36
699	678392.372	2331835.495	35.359	-116.887	3024	38-2-SS-35
700	677992.512	2332869.167	35.358	-116.884	3024	BSERVATIONTOWE
701	677983.749	2332926.682	35.358	-116.884	3028	BERM COR.
702	678028.448	2332886.939	35.358	-116.884	3028	BERM COR.
703	677972.085	2332769.382	35.358	-116.884	3028	BERM COR.
704	677887.947	2332832.032	35.358	-116.884	3028	BERM COR.
705	678420.930	2331785.317	35.359	-116.887	3021	38-2-SS-128
706	678539.366	2331892.617	35.359	-116.887	3021	38-2-SS-127
707	678503.175	2331938.763	35.359	-116.887	3024	38-2-SS-33
708	678499.090	2331934.921	35.359	-116.887	3024	38-2-SS-18
709	678494.431	2331930.119	35.359	-116.887	3025	38-2-SS-34
710	678494.905	2331939.905	35.359	-116.887	3022	38-2-SS-44
711	678576.088	2332310.876	35.360	-116.886	3021	38-2-SS-133
712	678576.078	2332310.861	35.360	-116.886	3021	38-2-SS-133
713	679067.473	2332514.779	35.361	-116.885	3022	38-2-SS-45
714	679069.822	2332503.911	35.361	-116.885	3026	38-2-SS-93
715	679069.900	2332503.739	35.361	-116.885	3026	38-2-SS-93
716	679073.936	2332507.351	35.361	-116.885	3026	38-2-SS-19

State Plane, 1927, Zone V, Feet

ID	Northing	Easting	Latitude	Longitude	Elev	ID2
717	679077.665	2332511.028	35.361	-116.885	3026	38-2-SS-94
718	679117.378	2332468.016	35.361	-116.885	3021	38-2-SS-129
719	679219.646	2332566.164	35.361	-116.885	3021	38-2-SS-130
720	679176.121	2332609.048	35.361	-116.885	3026	38-2-SS-95
721	679181.141	2332613.198	35.361	-116.885	3026	38-2-SS-20
722	679185.056	2332616.366	35.361	-116.885	3026	38-2-SS-96
723	679172.782	2332619.063	35.361	-116.885	3022	38-2-SS-46
724	679283.033	2332722.728	35.362	-116.884	3024	38-2-SS-47
725	679292.839	2332720.913	35.362	-116.884	3026	38-2-SS-98
726	679287.823	2332716.745	35.362	-116.884	3026	38-2-SS-21
727	679283.206	2332712.393	35.362	-116.884	3026	38-2-SS-97
728	679329.459	2332675.245	35.362	-116.884	3022	38-2-SS-131
729	679439.483	2332785.216	35.362	-116.884	3023	38-2-SS-132
730	679392.708	2332818.341	35.362	-116.884	3027	38-2-SS-99
731	679396.935	2332823.269	35.362	-116.884	3027	38-2-SS-22
732	679399.986	2332827.320	35.362	-116.884	3027	38-2-SS-100
733	679390.759	2332828.664	35.362	-116.884	3024	38-2-SS-48
734	679267.621	2332849.902	35.361	-116.884	3024	38-2-SS/PT-1
735	679217.690	2333121.937	35.361	-116.883	3026	38-2-SS-87
736	679199.614	2333133.439	35.361	-116.883	3025	38-2-SS-219
737	679184.352	2333146.940	35.361	-116.883	3025	38-2-SS-156
738	679203.480	2333149.546	35.361	-116.883	3025	38-2-SS/PT-9
739	679212.836	2333190.989	35.361	-116.883	3027	38-2-SS-192
740	679230.999	2333205.153	35.361	-116.883	3027	38-2-SS-108
741	679259.531	2333233.404	35.361	-116.882	3027	38-2-SS-139
742	679288.901	2333261.426	35.362	-116.882	3027	38-2-SS-150
743	679173.332	2333157.506	35.361	-116.883	3029	38-2-SS-23
744	679169.186	2333161.552	35.361	-116.883	3027	38-2-SS-49
745	679151.278	2333174.914	35.361	-116.883	3026	38-2-SS-191
746	679135.395	2333185.532	35.361	-116.883	3026	38-2-SS-65
747	679104.608	2333211.607	35.361	-116.883	3027	38-2-SS-75
748	679071.885	2333235.765	35.361	-116.882	3027	38-2-SS-120

State Plane, 1927, Zone V, Feet

ID	Northing	Easting	Latitude	Longitude	Elev	ID2
749	679138.302	2333161.673	35.361	-116.883	3026	38-2-SS-218
750	679139.684	2333121.972	35.361	-116.883	3026	38-2-SS-217
751	679123.765	2333106.456	35.361	-116.883	3026	38-2-SS-109
752	679107.805	2333088.604	35.361	-116.883	3026	38-2-SS-190
753	679080.324	2333037.493	35.361	-116.883	3025	38-2-SS-155
754	679107.758	2333010.297	35.361	-116.883	3023	38-2-SS-88
755	679125.679	2333017.966	35.361	-116.883	3025	38-2-SS/PT-8
756	679066.803	2333052.767	35.361	-116.883	3028	38-2-SS-24
757	679062.026	2333057.902	35.361	-116.883	3025	38-2-SS-50
758	679066.930	2333090.394	35.361	-116.883	3025	38-2-SS-216
759	679028.349	2333080.500	35.361	-116.883	3025	38-2-SS-66
760	678996.415	2333105.306	35.361	-116.883	3025	38-2-SS-76
761	679035.322	2333011.377	35.361	-116.883	3025	38-2-SS-189
762	679021.008	2332998.042	35.361	-116.883	3025	38-2-SS-110
763	679065.729	2332848.166	35.361	-116.884	3024	38-2-SS-148
764	679033.149	2332878.576	35.361	-116.884	3024	38-2-SS-124
765	679005.263	2332905.814	35.361	-116.884	3024	38-2-SS-89
766	678975.150	2332937.603	35.361	-116.883	3024	38-2-SS-154
767	678982.295	2332946.091	35.361	-116.883	3024	38-2-SS/PT-7
768	678963.673	2332948.184	35.361	-116.883	3028	38-2-SS-25
769	678958.137	2332956.301	35.361	-116.883	3024	38-2-SS-51
770	678962.004	2332993.307	35.361	-116.883	3024	38-2-SS-215
771	678927.375	2332982.651	35.361	-116.883	3024	38-2-SS-67
772	678898.175	2333008.703	35.360	-116.883	3025	38-2-SS-77
773	678869.065	2333036.120	35.360	-116.883	3025	38-2-SS-121
774	678925.091	2332955.147	35.361	-116.883	3024	38-2-SS-214
775	678927.362	2332902.686	35.361	-116.884	3024	38-2-SS-213
776	678911.658	2332887.250	35.360	-116.884	3023	38-2-SS-111
777	678881.565	2332914.037	35.360	-116.884	3024	38-2-SS-187
778	678929.755	2332872.549	35.361	-116.884	3024	38-2-SS-186
779	678947.275	2332859.955	35.361	-116.884	3023	38-2-SS-145
780	678894.645	2332869.465	35.360	-116.884	3024	38-2-SS-212

State Plane, 1927, Zone V, Feet

ID	Northing	Easting	Latitude	Longitude	Elev	ID2
781	678959.685	2332738.911	35.361	-116.884	3023	38-2-SS-143
782	678926.680	2332766.796	35.361	-116.884	3023	38-2-SS-125
783	678898.830	2332795.521	35.360	-116.884	3023	38-2-SS-90
784	678880.505	2332810.171	35.360	-116.884	3022	38-2-SS-185
785	678863.822	2332822.229	35.360	-116.884	3023	38-2-SS-153
786	678879.454	2332829.573	35.360	-116.884	3022	38-2-SS/PT-6
787	678852.356	2332838.303	35.360	-116.884	3026	38-2-SS-26
788	678847.210	2332846.597	35.360	-116.884	3023	38-2-SS-52
789	678848.555	2332874.133	35.360	-116.884	3023	38-2-SS-211
790	678814.978	2332873.445	35.360	-116.884	3023	38-2-SS-68
791	678785.998	2332900.712	35.360	-116.884	3024	38-2-SS-78
792	678757.059	2332927.683	35.360	-116.884	3024	38-2-SS-122
793	678815.880	2332844.202	35.360	-116.884	3023	38-2-SS-210
794	678816.421	2332799.256	35.360	-116.884	3023	38-2-SS-209
795	678800.187	2332785.339	35.360	-116.884	3023	38-2-SS-112
796	678771.682	2332816.038	35.360	-116.884	3023	38-2-SS-184
797	678814.982	2332769.554	35.360	-116.884	3023	38-2-SS-183
798	678826.252	2332754.507	35.360	-116.884	3023	38-2-SS-142
799	678859.017	2332725.941	35.360	-116.884	3022	38-2-SS-147
800	678848.369	2332635.571	35.360	-116.884	3022	38-2-SS-141
801	678817.005	2332663.615	35.360	-116.884	3022	38-2-SS-126
802	678786.238	2332689.290	35.360	-116.884	3022	38-2-SS-91
803	678769.902	2332704.684	35.360	-116.884	3022	38-2-SS-181
804	678755.124	2332719.165	35.360	-116.884	3022	38-2-SS-152
805	678765.283	2332737.723	35.360	-116.884	3024	38-2-SS/PT-5
806	678785.028	2332768.347	35.360	-116.884	3023	38-2-SS-208
807	678745.080	2332768.847	35.360	-116.884	3023	38-2-SS-207
808	679004.816	2332986.109	35.361	-116.883	3024	38-2-SS-188
809	679263.810	2333180.437	35.361	-116.883	3026	38-2-SS-140
810	678745.872	2332735.198	35.360	-116.884	3025	38-2-SS-27
811	678741.026	2332741.603	35.360	-116.884	3023	38-2-SS-53
812	678711.213	2332773.600	35.360	-116.884	3023	38-2-SS-69

LAND S EY DATA
SITES FTIR-38 AND FTIR-40
NATIONAL TRAINING CENTER, FORT IRWIN

State Plane, 1927, Zone V, Feet

ID	Northing	Easting	Latitude	Longitude	Elev	ID2
813	678697.183	2332788.272	35.360	-116.884	3023	38-2-SS-182
814	678683.744	2332802.270	35.360	-116.884	3023	38-2-SS-79
815	678657.854	2332832.204	35.360	-116.884	3024	38-2-SS-123
816	678708.893	2332738.600	35.360	-116.884	3023	38-2-SS-206
817	678704.935	2332698.240	35.360	-116.884	3023	38-2-SS-180
818	678690.637	2332683.123	35.360	-116.884	3023	38-2-SS-113
819	678707.281	2332669.800	35.360	-116.884	3023	38-2-SS-179
820	678721.170	2332656.200	35.360	-116.884	3023	38-2-SS-146
821	678674.407	2332667.885	35.360	-116.884	3023	38-2-SS-177
822	678704.418	2332564.863	35.360	-116.885	3023	38-2-SS-149
823	678673.521	2332590.115	35.360	-116.885	3022	38-2-SS-92
824	678663.507	2332606.009	35.360	-116.885	3021	38-2-SS-178
825	678651.264	2332622.805	35.360	-116.885	3022	38-2-SS-151
826	678642.537	2332614.807	35.360	-116.885	3022	38-2-SS/PT-4
827	678592.200	2332585.718	35.360	-116.885	3023	38-2-SS-114
828	678609.016	2332601.167	35.360	-116.885	3023	38-2-SS-175
829	678629.209	2332640.578	35.360	-116.884	3023	38-2-SS-54
830	678634.395	2332634.138	35.360	-116.884	3026	38-2-SS-28
831	678627.837	2332668.430	35.360	-116.884	3023	38-2-SS-205
832	678614.005	2332651.838	35.360	-116.884	3023	38-2-SS-176
833	678601.193	2332639.711	35.360	-116.884	3023	38-2-SS-204
834	678595.396	2332663.812	35.360	-116.884	3023	38-2-SS-70
835	678565.448	2332692.410	35.360	-116.884	3023	38-2-SS-80

APPENDIX G

ANALYTICAL RESULTS

TABLE G-1

SITE FTIR-38 AREA 1
SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	38-1-SS-2-2 07/19/98	38-1-SS-2-5 07/19/98
GENERAL CHEMISTRY		
Moisture content (%)	17.5	20.4
METALS (mg/Kg)		
Aluminum	30000	14400
Antimony	< 7.3	< 7.5
Arsenic	< 12.1	< 14.6
Barium	198	64.5
Beryllium	1.6	0.57
Cadmium	< 0.61	< 0.63
Calcium	26500	110000
Chromium	33.5	14.5
Cobalt	14.1	7.4
Copper	49.9	22.8
Iron	39200	30500
Lead	105	23.2
Magnesium	14400	23500
Manganese	801	362
Mercury	< 0.1	< 0.1
Molybdenum	< 2.4	< 2.5
Nickel	28.8	14.4
Potassium	10300	7170
Selenium	< 24.3	< 25.1
Silver	< 1.2	< 1.3
Sodium	6590	4440
Thallium	< 243	< 251
Vanadium	35.6	421
Zinc	149	215

< - Indicates sample result is less than the stated reporting limit
mg/Kg - milligrams per kilogram

TABLE G-2

SITE FTIR-38 AREA 2
PLANT TISSUE AND SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	38-2-PT-1 05/10/99	38-2-PT-1A 05/11/99	38-2-PT-2A 05/11/99	38-2-PT-3A 05/11/99	38-2-PT-3A Duplicate 05/11/99	38-2-PT-4 05/11/99	38-2-PT-5 05/11/99	38-2-PT-6 05/11/99
GENERAL CHEMISTRY								
Moisture content (%)	NA	NA	NA	NA	NA	NA	NA	NA
METALS (mg/Kg)								
Aluminum	129	83.1	107	43.9	108	122	111	59
Antimony	0.17 J	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Arsenic	0.099 J	< 0.3	0.1 J	< 0.3	< 0.3	0.13 J	0.11 J	0.1 J
Barium	32.2	7.6	9.6	4	10.7	4.7	8.2	4.5
Cobalt	< 0.5	0.15 J	0.16 J	< 0.5	< 0.5	0.12 J	< 0.5	< 0.5
Copper	4.2	2.1	2	1.6	2.3	2.3	2.4	2
Lead	0.63	0.14 J	0.11 J	0.15 J	0.37	0.28 J	0.71	0.1 J
Zinc	5.3	6.9	7.3	4	4.6	6.8	9.5	6
SOLUBLE METALS (µg/L)								
STLC Lead	NA	NA	NA	NA	NA	NA	NA	NA
TCLP Lead	NA	NA	NA	NA	NA	NA	NA	NA

TABLE G-2

SITE FTIR-38 AREA 2
PLANT TISSUE AND SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	38-2-PT-7 05/11/99	38-2-PT-8 05/11/99	38-2-PT-9 05/11/99	38-2-SS-1 05/10/99	38-2-SS-1A 05/11/99	38-2-SS-2 05/11/99	38-2-SS-3 05/11/99	38-2-SS-3 Duplicate 05/11/99
GENERAL CHEMISTRY								
Moisture content (%)	NA	NA	NA	1.6	10.3	12.9	9.6	23.3
METALS (mg/Kg)								
Aluminum	63.8	116	38.4	13500	22700	38000	26400	41400
Antimony	< 5	< 5	< 5	< 5.1	0.49 J	1.4 J	1.7 J	1.1 J
Arsenic	0.15 J	< 0.3	< 0.3	4.5	9.4	9.2	9.3	11.3
Barium	7.2	5.8	15	161	187	214	200	231
Cobalt	0.24 J	0.12 J	< 0.5	8.3	11.8	13.1	13.2	16.9
Copper	4.4	2.5	1.5	16.3	45.7	43.6	50.7	81.1
Lead	1	0.21 J	0.18 J	7.4	58.7	33.4	174	239
Zinc	10.8	6.5	6.5	40.5	70.8	85.4	76.5	102
SOLUBLE METALS (µg/L)								
STLC Lead	NA	NA	NA	NA	NA	NA	NA	NA
TCLP Lead	NA	NA	NA	NA	NA	NA	NA	NA

TABLE G-2

SITE FTIR-38 AREA 2
PLANT TISSUE AND SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	38-2-SS-4 05/11/99	38-2-SS-5 05/11/99	38-2-SS-6 05/11/99	38-2-SS-7 05/11/99	38-2-SS-8 05/11/99	38-2-SS-9 05/11/99	38-2-SS-CNF-11-1' 05/13/99
GENERAL CHEMISTRY							
Moisture content (%)	4.3	4.6	3.6	3	4.3	4.4	< 0.5
METALS (mg/Kg)							
Aluminum	18400	20100	20400	22500	19300	11800	NA
Antimony	0.88 J	0.74 J	0.85 J	1.4 J	0.62 J	0.63 J	NA
Arsenic	5.5	5.7	5.3	5.3	3.9	4	NA
Barium	168	180	155	163	120	152	NA
Cobalt	10	9.9	11.5	10.3	8.5	7.8	NA
Copper	31.7	44.3	41.9	54	19.4	17	NA
Lead	53.4	108	67.5	189	17.5	40.6	2760 J
Zinc	52.8	57.6	62.3	61.2	47.3	37.7	NA
SOLUBLE METALS (µg/L)							
STLC Lead	NA	NA	NA	NA	NA	NA	NA
TCLP Lead	NA	NA	NA	NA	NA	NA	NA

TABLE G-2

SITE FTIR-38 AREA 2
PLANT TISSUE AND SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	38-2-SS-CNF-12-1' 05/13/99	38-2-SS-CNF-14 05/13/99	38-2-SS-CNF-14-1' 05/13/99	38-2-SS-CNF-20 05/13/99	38-2-SS-CNF-22 05/13/99	38-2-SS-CNF-23 05/13/99
GENERAL CHEMISTRY						
Moisture content (%)	I		2.3	0.5	0.6	0.7
METALS (mg/Kg)						
Aluminum	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA	NA
Arsenic	NA	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA	NA
Cobalt	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA
Lead	3820	NA	210	9.6 J	7.6 J	180 J
Zinc	NA	NA	NA	NA	NA	NA
SOLUBLE METALS (µg/L)						
STLC Lead	NA	22000	NA	NA	NA	NA
TCLP Lead	NA	124	NA	NA	NA	NA

TABLE G-2

SITE FTIR-38 AREA 2
PLANT TISSUE AND SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	38-2-SS-CNF-25 05/13/99	38-2-SS-CNF-27 05/13/99	38-2-SS-CNF-28 05/13/99	38-2-SS-CNF-29 05/13/99	38-2-SS-CNF-30 05/13/99	38-2-SS-CNF-33 05/13/99
GENERAL CHEMISTRY						
Moisture content (%)	< 0.5		< 0.5	2.4	2.5	0.6
METALS (mg/Kg)						
Aluminum	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA	NA
Arsenic	NA	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA	NA
Cobalt	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA
Lead	524 J	NA	798 J	24.3 J	122 J	10 J
Zinc	NA	NA	NA	NA	NA	NA
SOLUBLE METALS (µg/L)						
STLC Lead	NA	768000	NA	NA	NA	NA
TCLP Lead	NA	21500	NA	NA	NA	NA

TABLE G-2

SITE FTIR-38 AREA 2
PLANT TISSUE AND SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	38-2-SS-CNF-36 05/13/99	38-2-SS-CNF101 05/17/99	38-2-SS-CNF12-5 05/20/99	38-2-SS-CNF126-1 05/19/99	38-2-SS-CNF129 05/18/99	38-2-SS-CNF133 05/18/99
GENERAL CHEMISTRY						
Moisture content (%)	2.2	2	< 0.5	< 0.5	0.8	0.9
METALS (mg/Kg)						
Aluminum	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA	NA
Arsenic	NA	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA	NA
Cobalt	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA
Lead	6.1 J	10.7 J	21.1	11.8	15	11.1
Zinc	NA	NA	NA	NA	NA	NA
SOLUBLE METALS (µg/L)						
STLC Lead	NA	NA	NA	NA	NA	NA
TCLP Lead	NA	NA	NA	NA	NA	NA

TABLE G-2

SITE FTIR-38 AREA 2
PLANT TISSUE AND SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	38-2-SS-CNF143 05/19/99	38-2-SS-CNF152 05/20/99	38-2-SS-CNF155 05/20/99	38-2-SS-CNF176 05/21/99	38-2-SS-CNF179 05/21/99	38-2-SS-CNF182 05/22/99
GENERAL CHEMISTRY						
Moisture content (%)	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
METALS (mg/Kg)						
Aluminum	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA	NA
Arsenic	NA	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA	NA
Cobalt	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA
Lead	83.2	56.9	58.6	45.4	55.7	23
Zinc	NA	NA	NA	NA	NA	NA
SOLUBLE METALS (µg/L)						
STLC Lead	NA	NA	NA	NA	NA	NA
TCLP Lead	NA	NA	NA	NA	NA	NA

TABLE G-2

SITE FTIR-38 AREA 2
PLANT TISSUE AND SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	38-2-SS-CNF188 05/21/99	38-2-SS-CNF191 05/21/99	38-2-SS-CNF193 05/22/99	38-2-SS-CNF196 05/22/99	38-2-SS-CNF200 05/22/99	38-2-SS-CNF203 05/22/99
GENERAL CHEMISTRY						
Moisture content (%)	< 0.5	< 0.5	< 0.5	I	0.5	I
METALS (mg/Kg)						
Aluminum	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA	NA
Arsenic	NA	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA	NA
Cobalt	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA
Lead	39.3	929	70.3	72.4	75.7	36.4
Zinc	NA	NA	NA	NA	NA	NA
SOLUBLE METALS (µg/L)						
STLC Lead	NA	NA	NA	NA	NA	NA
TCLP Lead	NA	NA	NA	NA	NA	NA

TABLE G-2

SITE FTIR-38 AREA 2
PLANT TISSUE AND SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	38-2-SS-CNF26-2' 05/17/99	38-2-SS-CNF27-1 05/20/99	38-2-SS-CNF28-1 05/16/99	38-2-SS-CNF37 05/14/99	38-2-SS-CNF37-1 05/15/99	38-2-SS-CNF37-2 05/16/99
GENERAL CHEMISTRY						
Moisture content (%)	1.3	0.5	0.7	< 0.5	3.7	2.2
METALS (mg/Kg)						
Aluminum	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA	NA
Arsenic	NA	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA	NA
Cobalt	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA
Lead	39.7	70.7	1380 J	3390	805 J	156 J
Zinc	NA	NA	NA	NA	NA	NA
SOLUBLE METALS (µg/L)						
STLC Lead	NA	NA	NA	NA	NA	NA
TCLP Lead	NA	NA	NA	NA	NA	NA

TABLE G-2

SITE FTIR-38 AREA 2
PLANT TISSUE AND SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	38-2-SS-CNF203 05/22/99	38-2-SS-CNF41 05/14/99	38-2-SS-CNF42 05/14/99	38-2-SS-CNF42-1 05/15/99	38-2-SS-CNF43 05/14/99	38-2-SS-CNF45 05/14/99
GENERAL CHEMISTRY						
Moisture content (%)	1	0.9	< 0.5	< 0.5	1.8	0.7
METALS (mg/Kg)						
Aluminum	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA	NA
Arsenic	NA	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA	NA
Cobalt	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA
Lead	36.4	48.2	83.2	22.4 J	7.9	10.8
Zinc	NA	NA	NA	NA	NA	NA
SOLUBLE METALS (µg/L)						
STLC Lead	NA	NA	NA	NA	NA	NA
TCLP Lead	NA	NA	NA	NA	NA	NA

TABLE G-2

SITE FTIR-38 AREA 2
PLANT TISSUE AND SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	38-2-SS-CNF47 05/14/99	38-2-SS-CNF49 05/14/99	38-2-SS-CNF49-1 05/15/99	38-2-SS-CNF50-2 05/16/99	38-2-SS-CNF51-3' 05/18/99	38-2-SS-CNF53 05/14/99
GENERAL CHEMISTRY						
Moisture content (%)	0.8	0.8	< 0.5	0.7	0.7	0.9
METALS (mg/Kg)						
Aluminum	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA	NA
Arsenic	NA	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA	NA
Cobalt	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA
Lead	9.6	428	58.8 J	598 J	7.9	789 J
Zinc	NA	NA	NA	NA	NA	NA
SOLUBLE METALS (µg/L)						
STLC Lead	NA	NA	NA	NA	NA	NA
TCLP Lead	NA	NA	NA	NA	NA	NA

TABLE G-2

SITE FTIR-38 AREA 2
PLANT TISSUE AND SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	38-2-SS-CNF53-2 05/16/99	38-2-SS-CNF64 05/14/99	38-2-SS-CNF66 05/14/99	38-2-SS-CNF70-1 05/20/99	38-2-SS-CNF74 05/15/99	38-2-SS-CNF77-1 05/19/99
GENERAL CHEMISTRY						
Moisture content (%)	1.6	2.2	< 0.5	< 0.5	0.7	< 0.5
METALS (mg/Kg)						
Aluminum	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA	NA
Arsenic	NA	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA	NA
Cobalt	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA
Lead	503 J	16.6 J	112 J	8.2	26.6 J	5.7
Zinc	NA	NA	NA	NA	NA	NA
SOLUBLE METALS (µg/L)						
STLC Lead	NA	NA	NA	NA	NA	NA
TCLP Lead	NA	NA	NA	NA	NA	NA

TABLE G-2

SITE FTIR-38 AREA 2
PLANT TISSUE AND SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	38-2-SS-CNF79-1 05/19/99	38-2-SS-CNF81-1' 05/18/99	38-2-SS-CNF82 05/16/99	38-2-SS-CNF84 05/16/99	38-2-SS-CNF84-1' 05/18/99	38-2-SS-CNF91 05/16/99	38-2-SS-CNF92 05/16/99
GENERAL CHEMISTRY							
Moisture content (%)	< 0.5	1.6	2.9	1.2	2.4	1.1	< 0.5
METALS (mg/Kg)							
Aluminum	NA	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA	NA	NA
Arsenic	NA	NA	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA	NA	NA
Cobalt	NA	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA	NA
Lead	6.8	13.7	152 J	44.3 J	10	81.5 J	38.1 J
Zinc	NA	NA	NA	NA	NA	NA	NA
SOLUBLE METALS (µg/L)							
STLC Lead	NA	NA	NA	NA	NA	NA	NA
TCLP Lead	NA	NA	NA	NA	NA	NA	NA

< - Indicates sample result is less than the stated reporting limit.
J - Result is an estimate.
mg/Kg - milligrams per kilogram
µg/Kg - micrograms per kilogram
NA - Not Applicable
STLC - Soluble Threshold Limit Concentration
TCLP - Toxicity Characteristic Leaching Procedure

TABLE G-3

SITE FTIR-40 AREA 1
PLANT TISSUE AND SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	40-1-PT-1 05/11/99	40-1-PT-10 05/11/99	40-1-PT-2 05/11/99	40-1-PT-3 05/11/99	40-1-PT-3 Duplicate 05/11/99	40-1-PT-4 05/11/99	40-1-PT-5 05/11/99	40-1-PT-6 05/11/99
GENERAL CHEMISTRY								
Moisture content (%)	NA	NA	NA	NA	NA	NA	NA	NA
METALS (mg/Kg)								
Aluminum	33.6	27.1	30.5	29.2	24	28.9	40	26.1
Antimony	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Arsenic	0.087 J	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Barium	15.7	21	7.6	15.8	16.4	27.8	14.1	19.5
Cadmium	0.072 J	0.06 J	0.69	0.048 J	0.05 J	< 0.2	0.36	< 0.2
Chromium	0.91	0.83	1.6	0.82	1.1	1.1	1.8	0.8
Cobalt	< 0.5	< 0.5	0.14 J	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Copper	3.3	1.8	6.5	1.8	1.3	1.7	4.6	2
Lead	0.2 J	0.095 J	0.61	0.06 J	0.15 J	0.13 J	0.52	0.087 J
Manganese	6.6	17.4	23.8	22.1	5.8	9.4	12.8	13.2
Mercury	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Nickel	0.48	0.2 J	2	0.22 J	0.18 J	0.13 J	0.35	0.13 J
Selenium	0.42 UJ	0.38 UJ	0.3 UJ	0.26 UJ	0.26 UJ	0.18 UJ	0.51 U	0.33 UJ
Silver	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Zinc	7.4	2.8	53.3	7.1	3.8	2.4	19.7	3.4

TABLE G-3

SITE FTIR-40 AREA 1
PLANT TISSUE AND SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	40-1-PT-7 05/11/99	40-1-PT-8 05/11/99	40-1-PT-9 05/11/99	40-1-SS-1 05/11/99	40-1-SS-10 05/11/99	40-1-SS-2 05/11/99	40-1-SS-3 05/11/99
GENERAL CHEMISTRY							
Moisture content (%)	NA	NA	NA	4.3	3	3.8	2.2
METALS (mg/Kg)							
Aluminum	32.3	20.2	52.5	12400	13300	11500	12200
Antimony	< 5	0.07 J	< 5	< 4.2	< 4.1	0.97 J	< 4.1
Arsenic	< 0.3	< 0.3	< 0.3	5.2	4.9	8.4	4.2
Barium	18	9.7	17.6	178	178	205	156
Cadmium	0.066 J	0.21	< 0.2	< 0.42	0.21 J	0.93	0.26 J
Chromium	1.9	1.1	0.53	12.1	13.6	13.2	11.3
Cobalt	< 0.5	< 0.5	< 0.5	7.8	8.8	8.2	7.5
Copper	1.6	2.8	2.1	18	16	45.9	18
Lead	0.18 J	0.3 J	0.26 J	10.4	10.4	116	13
Manganese	27.9	6.5	5.4	433	505	368	417
Mercury	< 0.1	< 0.1	< 0.1	0.11	0.11	< 0.1	0.13
Nickel	0.15 J	0.59	0.13 J	11	11.6	14.1	10.2
Selenium	0.32 UJ	0.21 UJ	0.34 UJ	0.58 J	0.54 J	< 2.1	0.98 J
Silver	< 0.5	< 0.5	< 0.5	< 2.1	0.73 J	2.9	2.4
Zinc	4.3	11	4.8	52.5	54.1	1060	61

TABLE G-3

SITE FTIR-40 AREA 1
PLANT TISSUE AND SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	40-1-SS-3 Duplicate 05/11/99	40-1-SS-4 05/11/99	40-1-SS-5 05/11/99	40-1-SS-6 05/11/99	40-1-SS-7 05/11/99	40-1-SS-8 05/11/99	40-1-SS-9 05/11/99
GENERAL CHEMISTRY							
Moisture content (%)	3.7	3.3	2	2.9	1.9	2.9	1.2
METALS (mg/Kg)							
Aluminum	11600	12300	9600	11300	12700	13600	8770
Antimony	< 4.2	< 4.1	< 4.1	< 4.1	< 4.1	1.8 J	< 4
Arsenic	3.4	4.2	3.8	3.5	5	4.3	2.8
Barium	152	154	153	144	159	241	131
Cadmium	0.19 J	< 0.41	0.31 J	< 0.41	0.22 J	3.5	0.21 J
Chromium	11.1	10.2	9.1	10.1	12.3	15.3	7.7
Cobalt	7.7	6.9	6.8	6.7	8	7.8	5.4
Copper	17.4	13.2	18.1	14.7	23.8	127	22.9
Lead	10.2	11.2	12.5	8.9	12.2	124	7.8
Manganese	403	366	401	386	458	468	290
Mercury	0.1	0.11	0.11	< 0.1	< 0.1	0.87	< 0.1
Nickel	10.1	9.2	7.8	8.8	11.3	13	8
Selenium	0.42 J	0.51 J	< 2	< 2.1	0.52 J	< 2.1	< 2
Silver	1.5 J	0.83 J	1.7 J	< 2.1	< 2	41.3	0.92 J
Zinc	53.9	50.9	55.2	43.7	65.6	306	47

< - Indicates sample result is less than the stated reporting limit.
J - Result is an estimate.
mg/Kg - milligrams per kilogram
NA - Not Applicable
U - Compound was analyzed for but not detected at or above the stated limit.
UJ - Compound was analyzed for but not detected. The sample detection limit is an estimated value.

TABLE G-4

SITE FTIR-40 AREA 2
PLANT TISSUE AND SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	40-2-PT-1 05/10/99	40-2-PT-10 05/11/99	40-2-PT-2 05/10/99	40-2-PT-2 Duplicate 05/10/99	40-2-PT-3 05/10/99	40-2-PT-4 05/10/99	40-2-PT-5 05/10/99	40-2-PT-6 05/11/99
GENERAL CHEMISTRY								
Moisture content (%)	NA	NA	NA	NA	NA	NA	NA	NA
METALS (mg/Kg)								
Arsenic	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	0.12 J	< 0.3	0.15 J
Cadmium	0.1 J	0.049 J	0.22	0.25	0.13 J	0.095 J	0.081 J	0.081 J
Lead	0.51	0.14 J	0.4	0.35	0.5	0.43	0.23 J	0.28 J
Zinc	5.7	3 J	19.7	21.8	15.4	10.9	16.7	5.9 J

TABLE G-4

SITE FTIR-40 AREA 2
PLANT TISSUE AND SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	40-2-PT-7 05/11/99	40-2-PT-8 05/11/99	40-2-PT-9 05/11/99	40-2-SS-1 05/10/99	40-2-SS-10 05/11/99	40-2-SS-2 05/10/99	40-2-SS-2 Duplicate 05/10/99
GENERAL CHEMISTRY							
Moisture content (%)	NA	NA	NA	2.2	3.2	2	1.7
METALS (mg/Kg)							
Arsenic	< 0.3	< 0.3	0.12 J	8.7	9.2	8.9	10.9
Cadmium	0.058 J	0.11 J	0.12 J	0.2 J	0.26 J	0.24	0.31
Lead	0.13 J	0.17 J	0.29 J	11	10.5	13.3	17.2
Zinc	2.7 J	4.5 J	4.3 J	48.1	53	50.3	70.3

TABLE G-4

SITE FTIR-40 AREA 2
PLANT TISSUE AND SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	40-2-SS-3 05/10/99	40-2-SS-4 05/10/99	40-2-SS-5 05/10/99	40-2-SS-6 05/11/99	40-2-SS-7 05/11/99	40-2-SS-8 05/11/99	40-2-SS-9 05/11/99
GENERAL CHEMISTRY							
Moisture content (%)	2.8	4.4	3.3	2.6	2.6	2.6	3
METALS (mg/Kg)							
Arsenic	9.6	9.4	8.4	9.5	9.2	8.2	10
Cadmium	0.5	0.34	0.15 J	0.26	0.22	0.27	0.32 J
Lead	259	30.1	9.5	11.9	9.7	13.2	12.4
Zinc	213	74.5	49.8	54.2 J	46.7 J	74.4 J	55.3

< - Indicates sample result is less than the stated reporting limit.

J - Result is an estimate.

mg/Kg - milligrams per kilogram

NA - Not Applicable

TABLE G-5

SITE FTIR-40 AREA 2
SUBSURFACE SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	40-2-SB-1-10.0 05/12/99	40-2-SB-1-2.5 05/12/99	40-2-SB-1-5.0 05/12/99	40-2-SB-1-5.0 Duplicate 05/12/99	40-2-SB-2-10.0 05/12/99	40-2-SB-2-10.0 Duplicate 05/12/99
GENERAL CHEMISTRY						
Moisture content (%)	5.3	5.5	3	4.5	5.7	4.6
Nitrate as Nitrogen (mg/Kg)	158	13	238	263	141	134
Nitrite as Nitrogen (mg/Kg)	0.13	0.11	< 0.1	< 0.1	0.19	0.18
METALS (mg/Kg)						
Aluminum	12300	12600	10400	11600	8950	7310
Antimony	0.15 J	< 4.2	< 4.1	< 4.2	0.32 J	< 4.2
Arsenic	8.7	10	7.4	11.4	9	8
Barium	150	177	113	110	149	173
Beryllium	< 0.84	0.28 J	< 0.82	0.34 J	0.11 J	0.14 J
Cadmium	< 0.42	0.22 J	< 0.41	0.21 J	< 0.42	< 0.42
Calcium	26900	13200	18300	21400	40300	49800
Chromium	16.4	14.8	14	13	12.5	8.8
Cobalt	7.4	8.7	6.9	7.7	5.8	5.4
Copper	15.6	19.4	12.7	18.1	10	9.9
Iron	20400	20500	17600	21900	14400	12000
Lead	6.7	11.2	5.5	8.6	4.7	4.7
Magnesium	4660	4810	3990	4210	3750	3410
Manganese	296	370	238	250	237	249
Mercury	< 0.11	< 0.11	< 0.1	< 0.1	< 0.11	< 0.1
Molybdenum	0.55 J	0.95	0.54 J	0.6 J	< 0.85	< 0.84
Nickel	12.6	14.8	11.3	14.6	9.7	8.1
Potassium	2310	2200	1900	2140	1750	1430

TABLE G-5

SITE FTIR-40 AREA 2
SUBSURFACE SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	40-2-SB-1-10.0 05/12/99	40-2-SB-1-2.5 05/12/99	40-2-SB-1-5.0 05/12/99	40-2-SB-1-5.0 Duplicate 05/12/99	40-2-SB-2-10.0 05/12/99	40-2-SB-2-10.0 Duplicate 05/12/99
METALS (mg/Kg)(cont'd)						
Selenium	< 2.1	0.84 J	< 2.1	< 2.1	< 2.1	0.64 J
Silver	< 2.1	< 2.1	< 2.1	< 2.1	< 2.1	< 2.1
Sodium	495	205	365	409	433	468
Thallium	< 1.3	< 1.3	< 1.2	< 1.3	< 1.3	< 1.3
Vanadium	26.4	30.9	23.7	29	21	17
Zinc	41.8	52.6	38.5	47.4	30.6	24
SOLUBLE METALS (µg/L)						
STLC Aluminum	NA	NA	NA	NA	NA	NA
STLC Antimony	NA	NA	NA	NA	NA	NA
STLC Arsenic	NA	NA	NA	NA	NA	NA
STLC Barium	NA	NA	NA	NA	NA	NA
STLC Beryllium	NA	NA	NA	NA	NA	NA
STLC Cadmium	NA	NA	NA	NA	NA	NA
STLC Calcium	NA	NA	NA	NA	NA	NA
STLC Chromium	NA	NA	NA	NA	NA	NA
STLC Cobalt	NA	NA	NA	NA	NA	NA
STLC Copper	NA	NA	NA	NA	NA	NA
STLC Iron	NA	NA	NA	NA	NA	NA
STLC Lead	NA	NA	NA	NA	NA	NA
STLC Magnesium	NA	NA	NA	NA	NA	NA
STLC Manganese	NA	NA	NA	NA	NA	NA
STLC Mercury	NA	NA	NA	NA	NA	NA

TABLE G-5

SITE FTIR-40 AREA 2
SUBSURFACE SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	40-2-SB-1-10.0 05/12/99	40-2-SB-1-2.5 05/12/99	40-2-SB-1-5.0 05/12/99	40-2-SB-1-5.0 Duplicate 05/12/99	40-2-SB-2-10.0 05/12/99	40-2-SB-2-10.0 Duplicate 05/12/99
SOLUBLE METALS (µg/L)(cont'd)						
STLC Molybdenum	NA	NA	NA	NA	NA	NA
STLC Nickel	NA	NA	NA	NA	NA	NA
STLC Potassium	NA	NA	NA	NA	NA	NA
STLC Selenium	NA	NA	NA	NA	NA	NA
STLC Silver	NA	NA	NA	NA	NA	NA
STLC Sodium	NA	NA	NA	NA	NA	NA
STLC Thallium	NA	NA	NA	NA	NA	NA
STLC Vanadium	NA	NA	NA	NA	NA	NA
STLC Zinc	NA	NA	NA	NA	NA	NA
TCLP Arsenic	NA	NA	NA	NA	NA	NA
TCLP Barium	NA	NA	NA	NA	NA	NA
TCLP Cadmium	NA	NA	NA	NA	NA	NA
TCLP Chromium	NA	NA	NA	NA	NA	NA
TCLP Lead	NA	NA	NA	NA	NA	NA
TCLP Mercury	NA	NA	NA	NA	NA	NA
TCLP Selenium	NA	NA	NA	NA	NA	NA
TCLP Silver	NA	NA	NA	NA	NA	NA
SVOCs (µg/Kg)						
1,2,4,5-Tetrachlorobenzene	< 530	< 530	< 520	< 520	< 530	< 520
1,2,4-Trichlorobenzene	< 180	< 180	< 180	< 180	< 180	< 180
1,2-Dichlorobenzene	< 180	< 180	< 180	< 180	< 180	< 180
1,2-Diphenylhydrazine	< 530	< 530	< 520	< 520	< 530	< 520

TABLE G-5

SITE FTIR-40 AREA 2
SUBSURFACE SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	40-2-SB-1-10.0 05/12/99	40-2-SB-1-2.5 05/12/99	40-2-SB-1-5.0 05/12/99	40-2-SB-1-5.0 Duplicate 05/12/99	40-2-SB-2-10.0 05/12/99	40-2-SB-2-10.0 Duplicate 05/12/99
SVOCs (µg/Kg)(cont'd)						
1,3-Dichlorobenzene	< 180	< 180	< 180	< 180	< 180	< 180
1,4-Dichlorobenzene	< 180	< 180	< 180	< 180	< 180	< 180
1-Chloronaphthalene	< 530	< 530	< 520	< 520	< 530	< 520
1-Naphthylamine	< 530	< 530	< 520	< 520	< 530	< 520
2,3,4,6-Tetrachlorophenol	< 530	< 530	< 520	< 520	< 530	< 520
2,4,5-Trichlorophenol	< 180	< 180	< 180	< 180	< 180	< 180
2,4,6-Trichlorophenol	< 180	< 180	< 180	< 180	< 180	< 180
2,4-Dichlorophenol	< 180	< 180	< 180	< 180	< 180	< 180
2,4-Dimethylphenol	< 180	< 180	< 180	< 180	< 180	< 180
2,4-Dinitrophenol	< 180	< 180	< 180	< 180	< 180	< 180
2,4-Dinitrotoluene	< 180	< 180	< 180	< 180	< 180	< 180
2,6-Dichlorophenol	< 530	< 530	< 520	< 520	< 530	< 520
2,6-Dinitrotoluene	< 180	< 180	< 180	< 180	< 180	< 180
2-AminoNaphthalene	< 530	< 530	< 520	< 520	< 530	< 520
2-ChloroNaphthalene	< 180	< 180	< 180	< 180	< 180	< 180
2-Chlorophenol	< 180	< 180	< 180	< 180	< 180	< 180
2-Methylnaphthalene	< 180	< 180	< 180	< 180	< 180	< 180
2-Methylphenol	< 180	< 180	< 180	< 180	< 180	< 180
2-Nitroaniline	< 290	< 290	< 280	< 280	< 290	< 280
2-Nitrophenol	< 180	< 180	< 180	< 180	< 180	< 180
2-Picoline	< 1100	< 1100	< 1000	< 1000	< 1100	< 1000
3,3'-Dichlorobenzidine	< 240	< 240	< 240	< 240	< 240	< 240
3-Methylcholanthrene	< 530	< 530	< 520	< 520	< 530	< 520

TABLE G-5

SITE FTIR-40 AREA 2
SUBSURFACE SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	40-2-SB-1-10.0 05/12/99	40-2-SB-1-2.5 05/12/99	40-2-SB-1-5.0 05/12/99	40-2-SB-1-5.0 Duplicate 05/12/99	40-2-SB-2-10.0 05/12/99	40-2-SB-2-10.0 Duplicate 05/12/99
SVOCs (µg/Kg)(cont'd)						
3-Nitroaniline	< 2600	< 2600	< 2600	< 2600	< 2700	< 2600
4,6-Dinitro-2-methylphenol	< 300	< 300	< 290	< 290	< 300	< 290
4-Aminobiphenyl	< 530	< 530	< 520	< 520	< 530	< 520
4-Bromophenyl phenyl ether	< 180	< 180	< 180	< 180	< 180	< 180
4-Chloro-3-methylphenol	< 180	< 180	< 180	< 180	< 180	< 180
4-Chloroaniline	< 340	< 340	< 330	< 340	< 340	< 340
4-Chlorophenyl phenyl ether	< 180	< 180	< 180	< 180	< 180	< 180
4-methylphenol	< 180	< 180	< 180	< 180	< 180	< 180
4-Nitroaniline	< 260	< 260	< 260	< 260	< 270	< 260
4-Nitrophenol	< 180	< 180	< 180	< 180	< 180	< 180
7,12-Dimethylbenz(a)anthracene	< 530	< 530	< 520	< 520	< 530	< 520
Acenaphthene	< 180	< 180	< 180	< 180	< 180	< 180
Acenaphthylene	< 180	< 180	< 180	< 180	< 180	< 180
Acetophenone	< 530	< 530	< 520	< 520	< 530	< 520
Aniline	< 530	< 530	< 520	< 520	< 530	< 520
Anthracene	< 180	< 180	< 180	< 180	< 180	< 180
Benzidine	< 1100 UJ	< 1100 UJ	< 1000 UJ	< 1000 UJ	< 1100 UJ	< 1000 UJ
Benzo(a)anthracene	< 180	< 180	< 180	< 180	< 180	< 180
Benzo(a)pyrene	< 180	< 180	< 180	< 180	< 180	< 180
Benzo(b)fluoranthene	< 180	< 180	< 180	< 180	< 180	< 180
Benzo(g,h,i)perylene	< 180	< 180	< 180	< 180	< 180	< 180
Benzo(k)fluoranthene	< 180	< 180	< 180	< 180	< 180	< 180
Benzoic acid	< 180 UJ	< 180 UJ	< 180 UJ	< 180 UJ	< 180 UJ	< 180 UJ

TABLE G-5

SITE FTIR-40 AREA 2
SUBSURFACE SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	40-2-SB-1-10.0 05/12/99	40-2-SB-1-2.5 05/12/99	40-2-SB-1-5.0 05/12/99	40-2-SB-1-5.0 Duplicate 05/12/99	40-2-SB-2-10.0 05/12/99	40-2-SB-2-10.0 Duplicate 05/12/99
SVOCs (µg/Kg)(cont'd)						
Benzyl alcohol	< 180 UJ	< 180 UJ	< 180 UJ	< 180 UJ	< 180 UJ	< 180 UJ
Benzyl butyl phthalate	< 180	< 180	< 180	< 180	< 180	< 180
bis (2-Chloroethoxy) methane	< 180	< 180	< 180	< 180	< 180	< 180
bis (2-Chloroethyl) ether	< 530	< 530	< 520	< 520	< 530	< 520
bis (2-Chloroisopropyl) ether	< 180	< 180	< 180	< 180	< 180	< 180
bis (2-Ethylhexyl) phthalate	322	410	245	77 J	77 J	< 180
Chrysene	< 530	< 530	< 520	< 520	< 530	< 520
di-n-Butyl phthalate	< 180	< 180	< 180	< 180	< 180	< 180
di-n-Octylphthalate	256	333	205	< 180	57 J	< 180
Dibenz(a,h)anthracene	< 180	< 180	< 180	< 180	< 180	< 180
Dibenz(a,j)acridine	< 530	< 530	< 520	< 520	< 530	< 520
Dibenzofuran	< 180	< 180	< 180	< 180	< 180	< 180
Diethyl phthalate	< 180	< 180	< 180	< 180	< 180	< 180
Dimethyl phthalate	< 180	< 180	< 180	< 180	< 180	< 180
DimethylphenylNaphthalene	< 2600	< 2600	< 2600	< 2600	< 2700	< 2600
Diphenylamine	< 530	< 530	< 520	< 520	< 530	< 520
Ethyl methanesulfonate	< 530	< 530	< 520	< 520	< 530	< 520
Fluoranthene	< 180	< 180	< 180	< 180	< 180	< 180
Fluorene	< 180	< 180	< 180	< 180	< 180	< 180
Hexachlorobenzene	< 180	< 180	< 180	< 180	< 180	< 180
Hexachlorobutadiene	< 180	< 180	< 180	< 180	< 180	< 180
Hexachlorocyclopentadiene	< 180	< 180	< 180	< 180	< 180	< 180
Hexachloroethane	< 180	< 180	< 180	< 180	< 180	< 180

TABLE G-5

SITE FTIR-40 AREA 2
SUBSURFACE SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	40-2-SB-1-10.0 05/12/99	40-2-SB-1-2.5 05/12/99	40-2-SB-1-5.0 05/12/99	40-2-SB-1-5.0 Duplicate 05/12/99	40-2-SB-2-10.0 05/12/99	40-2-SB-2-10.0 Duplicate 05/12/99
SVOCs (µg/Kg)(cont'd)						
Indeno(1,2,3-c,d)pyrene	< 180	< 180	< 180	< 180	< 180	< 180
Isophorone	< 180	< 180	< 180	< 180	< 180	< 180
Methyl methanesulfonate	< 530	< 530	< 520	< 520	< 530	< 520
N-Nitroso-di-n-butylamine	< 530	< 530	< 520	< 520	< 530	< 520
N-Nitroso-di-n-propylamine	< 180	< 180	< 180	< 180	< 180	< 180
N-Nitrosodimethylamine	< 530	< 530	< 520	< 520	< 530	< 520
N-Nitrosodiphenylamine	< 180	< 180	< 180	< 180	< 180	< 180
N-Nitrosopiperidine	< 530	< 530	< 520	< 520	< 530	< 520
Naphthalene	< 180	< 180	< 180	< 180	< 180	< 180
Nitrobenzene	< 180	< 180	< 180	< 180	< 180	< 180
p-Dimethylaminoazobenzene	< 530	< 530	< 520	< 520	< 530	< 520
Pentachlorobenzene	< 2600	< 2600	< 2600	< 2600	< 2700	< 2600
Pentachlorophenol	< 510	< 510	< 490	< 500	< 510	< 500
Phenacetin	< 530	< 530	< 520	< 520	< 530	< 520
Phenanthrene	< 180	< 180	< 180	< 180	< 180	< 180
Phenol	< 180	< 180	< 180	< 180	< 180	< 180
Pronamide	< 530	< 530	< 520	< 520	< 530	< 520
Pyrene	< 180	< 180	< 180	< 180	< 180	< 180

TABLE G-5

SITE FTIR-40 AREA 2
SUBSURFACE SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	40-2-SB-2-5.0 05/12/99	40-2-SB-3-10.0 05/12/99	40-2-SB-3-2.5 05/12/99	40-2-SB-3-5.0 05/12/99	40-2-SB-4-10.0 05/12/99	40-2-SB-4-2.5 05/12/99	40-2-SB-4-5.0 05/12/99
GENERAL CHEMISTRY							
Moisture content (%)	5.1	4.9	4	3.7	4.9	3.4	4.9
Nitrate as Nitrogen (mg/Kg)	247	13	7	6	33	< 5.2	6
Nitrite as Nitrogen (mg/Kg)	0.24	0.12	< 0.1	0.11	0.27	0.28	0.2
METALS (mg/Kg)							
Aluminum	11900	10700	10300	9090	10000	10800	11500
Antimony	< 4.2	0.48 J	< 4.2	< 4.2	< 4.2	< 4.1	< 4.2
Arsenic	9.5	8.6	10	8.3	7.9	9.2	9.1
Barium	169	195	170	157	195	132	172
Beryllium	0.41 J	0.28 J	0.48 J	0.34 J	0.21 J	0.84	0.4 J
Cadmium	0.18 J	< 0.42	0.22 J	< 0.42	< 0.42	< 0.41	0.21 J
Calcium	12800	31600	15800	15700	30100	12400	14700
Chromium	16.1	18.6	14	13.2	15.7	10.9	13.9
Cobalt	7.7	6.7	7.5	6.2	6.2	6.6	7.4
Copper	17	13.2	16.2	13.2	12.1	13.9	16.3
Iron	21000	16600	19200	16400	16100	16800	19100
Lead	7.7	6.9	8.3	8	8.1	8.5	8.2
Magnesium	4890	4200	4260	3680	4090	4550	4940
Manganese	313	247	296	260	257	293	324
Mercury	< 0.11	< 0.11	< 0.1	< 0.1	< 0.11	< 0.1	< 0.11
Molybdenum	0.46 J	1.2	0.59 J	0.75 J	0.47 J	0.44 J	0.65 J
Nickel	13.6	11.2	14.1	10.7	10.5	11.6	12.7
Potassium	2500	2010	1850	1750	1850	1850	2220

TABLE G-5

SITE FTIR-40 AREA 2
SUBSURFACE SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	40-2-SB-2-5.0 05/12/99	40-2-SB-3-10.0 05/12/99	40-2-SB-3-2.5 05/12/99	40-2-SB-3-5.0 05/12/99	40-2-SB-4-10.0 05/12/99	40-2-SB-4-2.5 05/12/99	40-2-SB-4-5.0 05/12/99
METALS (mg/Kg)(cont'd)							
Selenium	< 2.1	< 2.1	< 2.1	< 2.1	< 2.1	< 2.1	0.53 J
Silver	< 2.1	< 2.1	< 2.1	< 2.1	< 2.1	< 2.1	< 2.1
Sodium	436	776	330	278	655	646	257
Thallium	< 1.3	0.65 J	< 1.2	< 1.2	< 1.3	< 1.2	< 1.3
Vanadium	31.4	24.9	27.9	23.9	23.1	25.8	28.6
Zinc	49.2	38.6	51.8	41.4	36.1	46.4	48.7
SOLUBLE METALS (µg/L)							
STLC Aluminum	NA	NA	NA	NA	NA	NA	NA
STLC Antimony	NA	NA	NA	NA	NA	NA	NA
STLC Arsenic	NA	NA	NA	NA	NA	NA	NA
STLC Barium	NA	NA	NA	NA	NA	NA	NA
STLC Beryllium	NA	NA	NA	NA	NA	NA	NA
STLC Cadmium	NA	NA	NA	NA	NA	NA	NA
STLC Calcium	NA	NA	NA	NA	NA	NA	NA
STLC Chromium	NA	NA	NA	NA	NA	NA	NA
STLC Cobalt	NA	NA	NA	NA	NA	NA	NA
STLC Copper	NA	NA	NA	NA	NA	NA	NA
STLC Iron	NA	NA	NA	NA	NA	NA	NA
STLC Lead	NA	NA	NA	NA	NA	NA	NA
STLC Magnesium	NA	NA	NA	NA	NA	NA	NA
STLC Manganese	NA	NA	NA	NA	NA	NA	NA
STLC Mercury	NA	NA	NA	NA	NA	NA	NA

TABLE G-5

SITE FTIR-40 AREA 2
SUBSURFACE SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	40-2-SB-2-5.0 05/12/99	40-2-SB-3-10.0 05/12/99	40-2-SB-3-2.5 05/12/99	40-2-SB-3-5.0 05/12/99	40-2-SB-4-10.0 05/12/99	40-2-SB-4-2.5 05/12/99	40-2-SB-4-5.0 05/12/99
SOLUBLE METALS (µg/L)(cont'd)							
STLC Molybdenum	NA	NA	NA	NA	NA	NA	NA
STLC Nickel	NA	NA	NA	NA	NA	NA	NA
STLC Potassium	NA	NA	NA	NA	NA	NA	NA
STLC Selenium	NA	NA	NA	NA	NA	NA	NA
STLC Silver	NA	NA	NA	NA	NA	NA	NA
STLC Sodium	NA	NA	NA	NA	NA	NA	NA
STLC Thallium	NA	NA	NA	NA	NA	NA	NA
STLC Vanadium	NA	NA	NA	NA	NA	NA	NA
STLC Zinc	NA	NA	NA	NA	NA	NA	NA
TCLP Arsenic	NA	NA	NA	NA	NA	NA	NA
TCLP Barium	NA	NA	NA	NA	NA	NA	NA
TCLP Cadmium	NA	NA	NA	NA	NA	NA	NA
TCLP Chromium	NA	NA	NA	NA	NA	NA	NA
TCLP Lead	NA	NA	NA	NA	NA	NA	NA
TCLP Mercury	NA	NA	NA	NA	NA	NA	NA
TCLP Selenium	NA	NA	NA	NA	NA	NA	NA
TCLP Silver	NA	NA	NA	NA	NA	NA	NA
SVOCs (µg/Kg)							
1,2,4,5-Tetrachlorobenzene	< 530	< 530	< 520	< 520	< 530	< 520	< 530
1,2,4-Trichlorobenzene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
1,2-Dichlorobenzene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
1,2-Diphenylhydrazine	< 530	< 530	< 520	< 520	< 530	< 520	< 530

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SITE FTIR-40 AREA 2
SUBSURFACE SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	40-2-SB-2-5.0 05/12/99	40-2-SB-3-10.0 05/12/99	40-2-SB-3-2.5 05/12/99	40-2-SB-3-5.0 05/12/99	40-2-SB-4-10.0 05/12/99	40-2-SB-4-2.5 05/12/99	40-2-SB-4-5.0 05/12/99
SVOCs (µg/Kg)(cont'd)							
1,3-Dichlorobenzene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
1,4-Dichlorobenzene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
1-Chloronaphthalene	< 530	< 530	< 520	< 520	< 530	< 520	< 530
1-Naphthylamine	< 530	< 530	< 520	< 520	< 530	< 520	< 530
2,3,4,6-Tetrachlorophenol	< 530	< 530	< 520	< 520	< 530	< 520	< 530
2,4,5-Trichlorophenol	< 180	< 180	< 180	< 180	< 180	< 180	< 180
2,4,6-Trichlorophenol	< 180	< 180	< 180	< 180	< 180	< 180	< 180
2,4-Dichlorophenol	< 180	< 180	< 180	< 180	< 180	< 180	< 180
2,4-Dimethylphenol	< 180	< 180	< 180	< 180	< 180	< 180	< 180
2,4-Dinitrophenol	< 180	< 180	< 180	< 180	< 180	< 180	< 180
2,4-Dinitrotoluene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
2,6-Dichlorophenol	< 530	< 530	< 520	< 520	< 530	< 520	< 530
2,6-Dinitrotoluene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
2-AminoNaphthalene	< 530	< 530	< 520	< 520	< 530	< 520	< 530
2-ChloroNaphthalene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
2-Chlorophenol	< 180	< 180	< 180	< 180	< 180	< 180	< 180
2-Methylnaphthalene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
2-Methylphenol	< 180	< 180	< 180	< 180	< 180	< 180	< 180
2-Nitroaniline	< 280	< 280	< 280	< 280	< 280	< 280	< 280
2-Nitrophenol	< 180	< 180	< 180	< 180	< 180	< 180	< 180
2-Picoline	< 1100	< 1100	< 1000	< 1000	< 1100	< 1000	< 1100
3,3'-Dichlorobenzidine	< 240	< 240	< 240	< 240	< 240	< 240	< 240
3-Methylcholanthrene	< 530	< 530	< 520	< 520	< 530	< 520	< 530

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SITE FTIR-40 AREA 2
SUBSURFACE SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	40-2-SB-2-5.0 05/12/99	40-2-SB-3-10.0 05/12/99	40-2-SB-3-2.5 05/12/99	40-2-SB-3-5.0 05/12/99	40-2-SB-4-10.0 05/12/99	40-2-SB-4-2.5 05/12/99	40-2-SB-4-5.0 05/12/99
SVOCs (µg/Kg)(cont'd)							
3-Nitroaniline	< 2600	< 2600	< 2600	< 2600	< 2600	< 2600	< 2600
4,6-Dinitro-2-methylphenol	< 290	< 290	< 290	< 290	< 290 UJ	< 290	< 290 UJ
4-Aminobiphenyl	< 530	< 530	< 520	< 520	< 530	< 520	< 530
4-Bromophenyl phenyl ether	< 180	< 180	< 180	< 180	< 180	< 180	< 180
4-Chloro-3-methylphenol	< 180	< 180	< 180	< 180	< 180	< 180	< 180
4-Chloroaniline	< 340	< 340	< 330	< 330	< 340	< 330	< 340
4-Chlorophenyl phenyl ether	< 180	< 180	< 180	< 180	< 180	< 180	< 180
4-methylphenol	< 180	< 180	< 180	< 180	< 180	< 180	< 180
4-Nitroaniline	< 260	< 260	< 260	< 260	< 260	< 260	< 260
4-Nitrophenol	< 180	< 180	< 180	< 180	< 180	< 180	< 180
7,12-Dimethylbenz(a)anthracene	< 530	< 530	< 520	< 520	< 530	< 520	< 530
Acenaphthene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
Acenaphthylene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
Acetophenone	< 530	< 530	< 520	< 520	< 530	< 520	< 530
Aniline	< 530	< 530	< 520	< 520	< 530	< 520	< 530
Anthracene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
Benzidine	< 1100 UJ	< 1100 UJ	< 1000 UJ	< 1000 UJ	< 1100	< 1000 UJ	< 1100
Benzo(a)anthracene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
Benzo(a)pyrene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
Benzo(b)fluoranthene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
Benzo(g,h,i)perylene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
Benzo(k)fluoranthene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
Benzoic acid	< 180 UJ	< 180 UJ	< 180 UJ	< 180 UJ	< 180 UJ	< 180 UJ	< 180 UJ

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SITE FTIR-40 AREA 2
SUBSURFACE SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	40-2-SB-2-5.0 05/12/99	40-2-SB-3-10.0 05/12/99	40-2-SB-3-2.5 05/12/99	40-2-SB-3-5.0 05/12/99	40-2-SB-4-10.0 05/12/99	40-2-SB-4-2.5 05/12/99	40-2-SB-4-5.0 05/12/99
SVOCs (µg/Kg)(cont'd)							
Benzyl alcohol	< 180 UJ	< 180 UJ	< 180 UJ	< 180 UJ	< 180	< 180 UJ	< 180
Benzyl butyl phthalate	< 180	< 180	< 180	< 180	< 180	< 180	< 180
bis (2-Chloroethoxy) methane	< 180	< 180	< 180	< 180	< 180	< 180	< 180
bis (2-Chloroethyl) ether	< 530	< 530	< 520	< 520	< 530	< 520	< 530
bis (2-Chloroisopropyl) ether	< 180	< 180	< 180	< 180	< 180	< 180	< 180
bis (2-Ethylhexyl) phthalate	235	95 J	< 180	96 J	170 J	< 180	110 J
Chrysene	< 530	< 530	< 520	< 520	< 530	< 520	< 530
di-n-Butyl phthalate	< 180	< 180	< 180	< 180	< 180	< 180	< 180
di-n-Octylphthalate	196	< 180	< 180	88 J	< 180	< 180	< 180
Dibenz(a,h)anthracene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
Dibenz(a,j)acridine	< 530	< 530	< 520	< 520	< 530	< 520	< 530
Dibenzofuran	< 180	< 180	< 180	< 180	< 180	< 180	< 180
Diethyl phthalate	< 180	< 180	< 180	< 180	< 180	< 180	< 180
Dimethyl phthalate	< 180	< 180	< 180	< 180	< 180	< 180	< 180
DimethylphenylNaphthalene	< 2600	< 2600	< 2600	< 2600	< 2600	< 2600	< 2600
Diphenylamine	< 530	< 530	< 520	< 520	< 530	< 520	< 530
Ethyl methanesulfonate	< 530	< 530	< 520	< 520	< 530	< 520	< 530
Fluoranthene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
Fluorene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
Hexachlorobenzene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
Hexachlorobutadiene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
Hexachlorocyclopentadiene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
Hexachloroethane	< 180	< 180	< 180	< 180	< 180	< 180	< 180

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SITE FTIR-40 AREA 2
SUBSURFACE SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	40-2-SB-2-5.0 05/12/99	40-2-SB-3-10.0 05/12/99	40-2-SB-3-2.5 05/12/99	40-2-SB-3-5.0 05/12/99	40-2-SB-4-10.0 05/12/99	40-2-SB-4-2.5 05/12/99	40-2-SB-4-5.0 05/12/99
SVOCs (µg/Kg)(cont'd)							
Indeno(1,2,3-c,d)pyrene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
Isophorone	< 180	< 180	< 180	< 180	< 180	< 180	< 180
Methyl methanesulfonate	< 530	< 530	< 520	< 520	< 530	< 520	< 530
N-Nitroso-di-n-butylamine	< 530	< 530	< 520	< 520	< 530	< 520	< 530
N-Nitroso-di-n-propylamine	< 180	< 180	< 180	< 180	< 180	< 180	< 180
N-Nitrosodimethylamine	< 530	< 530	< 520	< 520	< 530	< 520	< 530
N-Nitrosodiphenylamine	< 180	< 180	< 180	< 180	< 180	< 180	< 180
N-Nitrosopiperidine	< 530	< 530	< 520	< 520	< 530	< 520	< 530
Naphthalene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
Nitrobenzene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
p-Dimethylaminoazobenzene	< 530	< 530	< 520	< 520	< 530	< 520	< 530
Pentachlorobenzene	< 2600	< 2600	< 2600	< 2600	< 2600	< 2600	< 2600
Pentachlorophenol	< 510	< 500	< 500	< 500	< 500	< 500	< 500
Phenacetin	< 530	< 530	< 520	< 520	< 530	< 520	< 530
Phenanthrene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
Phenol	< 180	< 180	< 180	< 180	< 180	< 180	< 180
Pronamide	< 530	< 530	< 520	< 520	< 530	< 520	< 530
Pyrene	< 180	< 180	< 180	< 180	< 180	< 180	< 180

TABLE G-5

SITE FTIR-40 AREA 2
SUBSURFACE SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	40-2-SB-5-10.0 05/12/99	40-2-SB-5-2.5 05/12/99	40-2-SB-5-5.0 05/12/99	40-2-SB-CUTTINGS 05/12/99
GENERAL CHEMISTRY				
Moisture content (%)	7.5	4.1	4.3	3.4
Nitrate as Nitrogen (mg/Kg)	17	6	6	NA
Nitrite as Nitrogen (mg/Kg)	0.23	0.24	0.24	NA
METALS (mg/Kg)				
Aluminum	10800	11300	12400	NA
Antimony	< 4.3	0.35 J	< 4.2	NA
Arsenic	9	10.5	10.9	NA
Barium	187	194	176	NA
Beryllium	< 0.86	0.37 J	0.53 J	NA
Cadmium	< 0.43	0.27 J	0.37 J	NA
Calcium	47800	16600	19000	NA
Chromium	9.2	16.3	15.6	NA
Cobalt	5.9	9.3	8	NA
Copper	10	16.9	18.7	NA
Iron	13300	19300	21400	NA
Lead	5.1	9.7	8.5	NA
Magnesium	4830	4890	4710	NA
Manganese	252	502	331	NA
Mercury	0.11	0.12	0.11	NA
Molybdenum	0.43 J	0.55 J	0.89	NA
Nickel	8.6	14.1	13.7	NA
Potassium	2060	2220	2280	NA

TABLE G-5

SITE FTIR-40 AREA 2
SUBSURFACE SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	40-2-SB-5-10.0 05/12/99	40-2-SB-5-2.5 05/12/99	40-2-SB-5-5.0 05/12/99	40-2-SB-CUTTINGS 05/12/99
METALS (mg/Kg)(cont'd)				
Selenium	< 2.2	< 2.1	0.52 J	NA
Silver	< 2.2	< 2.1	< 2.1	NA
Sodium	1530	< 170	493	NA
Thallium	< 1.3	< 1.3	< 1.3	NA
Vanadium	20.3	30.1	30.7	NA
Zinc	31.2	50.7	49.5	NA
SOLUBLE METALS (µg/L)				
STLC Aluminum	NA	NA	NA	13100
STLC Antimony	NA	NA	NA	< 50
STLC Arsenic	NA	NA	NA	50.9
STLC Barium	NA	NA	NA	972
STLC Beryllium	NA	NA	NA	< 5
STLC Cadmium	NA	NA	NA	< 10
STLC Calcium	NA	NA	NA	2110000
STLC Chromium	NA	NA	NA	701
STLC Cobalt	NA	NA	NA	29.1
STLC Copper	NA	NA	NA	836
STLC Iron	NA	NA	NA	10400
STLC Lead	NA	NA	NA	11.3 J
STLC Magnesium	NA	NA	NA	7680
STLC Manganese	NA	NA	NA	327
STLC Mercury	NA	NA	NA	0.059 J

TABLE G-5

SITE FTIR-40 AREA 2
SUBSURFACE SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	40-2-SB-5-10.0 05/12/99	40-2-SB-5-2.5 05/12/99	40-2-SB-5-5.0 05/12/99	40-2-SB-CUTTINGS 05/12/99
SOLUBLE METALS (µg/L)(cont'd)				
STLC Molybdenum	NA	NA	NA	143
STLC Nickel	NA	NA	NA	91.5
STLC Potassium	NA	NA	NA	63800
STLC Selenium	NA	NA	NA	15.6 J
STLC Silver	NA	NA	NA	< 50
STLC Sodium	NA	NA	NA	6080000
STLC Thallium	NA	NA	NA	< 50
STLC Vanadium	NA	NA	NA	616
STLC Zinc	NA	NA	NA	122
TCLP Arsenic	NA	NA	NA	5.4 J
TCLP Barium	NA	NA	NA	431
TCLP Cadmium	NA	NA	NA	< 4
TCLP Chromium	NA	NA	NA	184
TCLP Lead	NA	NA	NA	< 10
TCLP Mercury	NA	NA	NA	0.44 J
TCLP Selenium	NA	NA	NA	< 20
TCLP Silver	NA	NA	NA	5.1 J
SVOCs (µg/Kg)				
1,2,4,5-Tetrachlorobenzene	< 540	< 520	< 520	NA
1,2,4-Trichlorobenzene	< 180	< 180	< 180	NA
1,2-Dichlorobenzene	< 180	< 180	< 180	NA
1,2-Diphenylhydrazine	< 540	< 520	< 520	NA

TABLE G-5

SITE FTIR-40 AREA 2
SUBSURFACE SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	40-2-SB-5-10.0 05/12/99	40-2-SB-5-2.5 05/12/99	40-2-SB-5-5.0 05/12/99	40-2-SB-CUTTINGS 05/12/99
SVOCs (µg/Kg)(cont'd)				
1,3-Dichlorobenzene	< 180	< 180	< 180	NA
1,4-Dichlorobenzene	< 180	< 180	< 180	NA
1-Chloronaphthalene	< 540	< 520	< 520	NA
1-Naphthylamine	< 540	< 520	< 520	NA
2,3,4,6-Tetrachlorophenol	< 540	< 520	< 520	NA
2,4,5-Trichlorophenol	< 180	< 180	< 180	NA
2,4,6-Trichlorophenol	< 180	< 180	< 180	NA
2,4-Dichlorophenol	< 180	< 180	< 180	NA
2,4-Dimethylphenol	< 180	< 180	< 180	NA
2,4-Dinitrophenol	< 180	< 180	< 180	NA
2,4-Dinitrotoluene	< 180	< 180	< 180	NA
2,6-Dichlorophenol	< 540	< 520	< 520	NA
2,6-Dinitrotoluene	< 180	< 180	< 180	NA
2-AminoNaphthalene	< 540	< 520	< 520	NA
2-ChloroNaphthalene	< 180	< 180	< 180	NA
2-Chlorophenol	< 180	< 180	< 180	NA
2-Methylnaphthalene	< 180	< 180	< 180	NA
2-Methylphenol	< 180	< 180	< 180	NA
2-Nitroaniline	< 290	< 280	< 280	NA
2-Nitrophenol	< 180	< 180	< 180	NA
2-Picoline	< 1100	< 1000	< 1000	NA
3,3'-Dichlorobenzidine	< 250	< 240	< 240	NA
3-Methylcholanthrene	< 540	< 520	< 520	NA

TABLE G-5

SITE FTIR-40 AREA 2
SUBSURFACE SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	40-2-SB-5-10.0 05/12/99	40-2-SB-5-2.5 05/12/99	40-2-SB-5-5.0 05/12/99	40-2-SB-CUTTINGS 05/12/99
SVOCs (µg/Kg)(cont'd)				
3-Nitroaniline	< 2700	< 2600	< 2600	NA
4,6-Dinitro-2-methylphenol	< 300 UJ	< 290 UJ	< 290 UJ	NA
4-Aminobiphenyl	< 540	< 520	< 520	NA
4-Bromophenyl phenyl ether	< 180	< 180	< 180	NA
4-Chloro-3-methylphenol	< 180	< 180	< 180	NA
4-Chloroaniline	< 350	< 330	< 330	NA
4-Chlorophenyl phenyl ether	< 180	< 180	< 180	NA
4-methylphenol	< 180	< 180	< 180	NA
4-Nitroaniline	< 270	< 260	< 260	NA
4-Nitrophenol	< 180	< 180	< 180	NA
7,12-Dimethylbenz(a)anthracene	< 540	< 520	< 520	NA
Acenaphthene	< 180	< 180	< 180	NA
Acenaphthylene	< 180	< 180	< 180	NA
Acetophenone	< 540	< 520	< 520	NA
Aniline	< 540	< 520	< 520	NA
Anthracene	< 180	< 180	< 180	NA
Benzidine	< 1100	< 1000	< 1000	NA
Benzo(a)anthracene	< 180	< 180	< 180	NA
Benzo(a)pyrene	< 180	< 180	< 180	NA
Benzo(b)fluoranthene	< 180	< 180	< 180	NA
Benzo(g,h,i)perylene	< 180	< 180	< 180	NA
Benzo(k)fluoranthene	< 180	< 180	< 180	NA
Benzoic acid	< 180 UJ	< 180 UJ	< 180 UJ	NA

TABLE G-5

SITE FTIR-40 AREA 2
SUBSURFACE SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	40-2-SB-5-10.0 05/12/99	40-2-SB-5-2.5 05/12/99	40-2-SB-5-5.0 05/12/99	40-2-SB-CUTTINGS 05/12/99
SVOCs (µg/Kg)(cont'd)				
Benzyl alcohol	< 180	< 180	< 180	NA
Benzyl butyl phthalate	< 180	< 180	< 180	NA
bis (2-Chloroethoxy) methane	< 180	< 180	< 180	NA
bis (2-Chloroethyl) ether	< 540	< 520	< 520	NA
bis (2-Chloroisopropyl) ether	< 180	< 180	< 180	NA
bis (2-Ethylhexyl) phthalate	79 J	140 J	150 J	NA
Chrysene	< 540	< 520	< 520	NA
di-n-Butyl phthalate	< 180	< 180	< 180	NA
di-n-Octylphthalate	71 J	99 J	120 J	NA
Dibenz(a,h)anthracene	< 180	< 180	< 180	NA
Dibenz(a,j)acridine	< 540	< 520	< 520	NA
Dibenzofuran	< 180	< 180	< 180	NA
Diethyl phthalate	< 180	< 180	< 180	NA
Dimethyl phthalate	< 180	< 180	< 180	NA
DimethylphenylNaphthalene	< 2700	< 2600	< 2600	NA
Diphenylamine	< 540	< 520	< 520	NA
Ethyl methanesulfonate	< 540	< 520	< 520	NA
Fluoranthene	< 180	< 180	< 180	NA
Fluorene	< 180	< 180	< 180	NA
Hexachlorobenzene	< 180	< 180	< 180	NA
Hexachlorobutadiene	< 180	< 180	< 180	NA
Hexachlorocyclopentadiene	< 180	< 180	< 180	NA
Hexachloroethane	< 180	< 180	< 180	NA

TABLE G-5

SITE FTIR-40 AREA 2
SUBSURFACE SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	40-2-SB-5-10.0 05/12/99	40-2-SB-5-2.5 05/12/99	40-2-SB-5-5.0 05/12/99	40-2-SB-CUTTINGS 05/12/99
SVOCs (µg/Kg)(cont'd)				
Indeno(1,2,3-c,d)pyrene	< 180	< 180	< 180	NA
Isophorone	< 180	< 180	< 180	NA
Methyl methanesulfonate	< 540	< 520	< 520	NA
N-Nitroso-di-n-butylamine	< 540	< 520	< 520	NA
N-Nitroso-di-n-propylamine	< 180	< 180	< 180	NA
N-Nitrosodimethylamine	< 540	< 520	< 520	NA
N-Nitrosodiphenylamine	< 180	< 180	< 180	NA
N-Nitrosopiperidine	< 540	< 520	< 520	NA
Naphthalene	< 180	< 180	< 180	NA
Nitrobenzene	< 180	< 180	< 180	NA
p-Dimethylaminoazobenzene	< 540	< 520	< 520	NA
Pentachlorobenzene	< 2700	< 2600	< 2600	NA
Pentachlorophenol	< 520	< 500	< 500	NA
Phenacetin	< 540	< 520	< 520	NA
Phenanthrene	< 180	< 180	< 180	NA
Phenol	< 180	< 180	< 180	NA
Pronamide	< 540	< 520	< 520	NA
Pyrene	< 180	< 180	< 180	NA

< - Indicates sample result is less than the stated reporting limit.
J - Result is an estimate.
mg/Kg - milligrams per kilogram
µg/Kg - micrograms per kilogram
µg/L - micrograms per liter

NA - Not Applicable
STLC - Soluble Threshold Limit Concentration
SVOCs - Semi-Volatile Organic Compounds
TCLP - Toxicity Characteristic Leaching Procedure
UJ - Compound was analyzed for but not detected. The sample detection limit is an estimated value.

TABLE G-6

SITE FTIR-38 REFERENCE AREA 1
PLANT TISSUE AND SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	RF1-PT-1 05/10/99	RF1-PT-1A 05/11/99	RF1-PT-2A 05/11/99	RF1-PT-3A 05/11/99	RF1-PT-4A 05/11/99	RF1-PT-4A Duplicate 05/11/99	RF1-PT-5A 05/11/99	RF1-PT-6A 05/11/99
GENERAL CHEMISTRY								
Moisture content (%)	NA	NA	NA	NA	NA	NA	NA	NA
METALS (mg/Kg)								
Aluminum	17.3	169 J	42.8 J	164 J	287	222 J	129	189 J
Antimony	< 5	0.07 J	< 5	0.086 J	< 5	< 5	< 5	0.071 J
Arsenic	< 0.3	0.1 J	< 0.3	0.21 J	0.29 J	0.28 J	0.14 J	0.14 J
Barium	10.5	8.3 J	6.8 J	12.3 J	15.2	14.1 J	12	10.1 J
Cobalt	< 0.5	0.11 J	< 0.5	0.15 J	0.2 J	0.18 J	< 0.5	0.12 J
Copper	1.3	1.6 J	1.9 J	2.2 J	2.6	2.4 J	1.8	1.9 J
Lead	0.2 J	0.26 J	0.14 J	0.28 J	0.39	0.37 J	0.77	0.55 J
Zinc	1.7	7	5.7	7.2	7.7	7.2	6.1	6.1

TABLE G-6

SITE FTIR-38 REFERENCE AREA 1
PLANT TISSUE AND SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	RF1-PT-7A 05/11/99	RF1-PT-8A 05/11/99	RF1-PT-9A 05/11/99	RF1-SS-1 05/10/99	RF1-SS-1A 05/11/99	RF1-SS-2A 05/11/99	RF1-SS-3A 05/11/99	RF1-SS-4A 05/11/99
GENERAL CHEMISTRY								
Moisture content (%)	NA	NA	NA	1.9	2.1	1	0.8	0.9
METALS (mg/Kg)								
Aluminum	219 J	187 J	32.1 J	5670	8610 J	7600 J	9670	10600
Antimony	< 5	< 5	< 5	< 5.1	0.35 J	0.3 J	0.34 J	< 5
Arsenic	0.19 J	0.17 J	< 0.3	2.8	3.8	3.3	3.7	3.6
Barium	15.2 J	22.8 J	4.1 J	122	119 J	128 J	116	124
Cobalt	0.16 J	0.13 J	< 0.5	5.6	7	6.8	7.3	7.9
Copper	2.2 J	2.1 J	1.5 J	8.3	11.7 J	10.4 J	12.4	12.6
Lead	0.3 J	0.31 J	0.22 J	8.8	10 J	9.4 J	9.1	7.6
Zinc	10.3	6.2	5	21.7	30.4	28.1	32.5	33.4

TABLE G-6

SITE FTIR-38 REFERENCE AREA 1
PLANT TISSUE AND SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	RF1-SS-4A Duplicate 05/11/99	RF1-SS-5A 05/11/99	RF1-SS-6A 05/11/99	RF1-SS-7A 05/11/99	RF1-SS-8A 05/11/99	RF1-SS-9A 05/11/99
GENERAL CHEMISTRY						
Moisture content (%)	1.4	0.6	2	0.9	2	2.2
METALS (mg/Kg)						
Aluminum	10600	7710	9980	8170	11600	13000
Antimony	0.25 J	0.067 J	< 5.1	< 5	0.18 J	< 5.1
Arsenic	4	3.2	3.9	3.6	4.1	3.7
Barium	121	113	127	116	135	125
Cobalt	8.1	6.8	7.6	6.7	8.5	8.8
Copper	13	11	12.6	11.2	14.1	16.1
Lead	7.6	9.5	8.8	9.1	8.4	6.8
Zinc	34.1	28	34.8	30	37.8	38.3

< - Indicates sample result is less than the stated reporting limit.
J - Result is an estimate.
mg/Kg - milligrams per kilogram
NA - Not Applicable

TABLE G-7

SITE FTIR-40 REFERENCE AREA 2 (RF2)
PLANT TISSUE AND SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	RF2-PT-1 05/11/99	RF2-PT-10 05/11/99	RF2-PT-2 05/11/99	RF2-PT-3 05/11/99	RF2-PT-4 05/11/99	RF2-PT-4 Duplicate 05/11/99	RF2-PT-5 05/11/99	RF2-PT-6 05/11/99
GENERAL CHEMISTRY								
Moisture content (%)	NA	NA	NA	NA	NA	NA	NA	NA
METALS (mg/Kg)								
Aluminum	48.5 J	60.8 J	21.7 J	59.3 J	46.1	48 J	28.6 J	30.3 J
Antimony	0.11 J	< 5	< 5	0.072 J	< 5	< 5	< 5	< 5
Arsenic	< 0.3	0.11 J	< 0.3	< 0.3	< 0.3	0.11 J	< 0.3	< 0.3
Barium	37 J	25.2 J	19.5 J	24.7 J	30.5	28.3 J	8.2 J	27.7 J
Cadmium	0.072 J	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Chromium	2.3	0.71	0.77	0.87	1.3 J	1.2	0.91	0.62
Cobalt	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Copper	1.8 J	1.7 J	1.4 J	1.5 J	1.6	2 J	1.1 J	1.5 J
Lead	0.2 J	0.23 J	0.12 J	0.19 J	0.63	0.26 J	0.11 J	0.059 J
Manganese	27 J	11.4 J	17.5 J	10.8 J	23.7 J	17.1 J	16.1 J	17 J
Mercury	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Nickel	0.39 J	0.24 J	0.12 J	0.15 J	0.33	0.46 J	0.22 J	0.15 J
Selenium	0.25 J	0.36 J	0.31 J	0.25 J	0.27 J	0.28 J	0.39 J	0.34 J
Silver	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Zinc	4	2.7	2.2	2.3	3.2	4.2	1.7	2.5

TABLE G-7

SITE FTIR-40 REFERENCE AREA 2 (RF2)
PLANT TISSUE AND SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	RF2-PT-7 05/11/99	RF2-PT-8 05/11/99	RF2-PT-9 05/11/99	RF2-SS-1 05/11/99	RF2-SS-10 05/11/99	RF2-SS-2 05/11/99	RF2-SS-3 05/11/99	RF2-SS-4 05/11/99
ENERAL CHEMISTRY								
Moisture content (%)	NA	NA	NA	3.1	3.5	2.7	4.7	3.3
ETALS (mg/Kg)								
Aluminum	57.2 J	38 J	36.7 J	12300	15200	11300	12100	11700
Antimony	< 5	< 5	< 5	< 4.1	0.65 J	< 4.1	< 4.2	< 4.1
Arsenic	< 0.3	< 0.3	< 0.3	6.6	10.7	6.6	6.6	7.9
Barium	34 J	24.1 J	37.5 J	180	192	140	153	177
Cadmium	0.045 J	< 0.2	< 0.2	< 0.41	< 0.41	< 0.41	< 0.42	0.19 J
Chromium	1.2	0.91	1.1	11.2	14.6	11.8	11.7	11.6
Cobalt	< 0.5	< 0.5	< 0.5	7.5	9.4	7.6	8.1	7.8
Copper	2.8 J	1.3 J	1.9 J	16	21.6	14.4	16.3	17.8
Lead	0.28 J	0.15 J	0.11 J	11	11.6	10.2	9.7	13.4
Manganese	18.5 J	14.6 J	11.2 J	346	422	359	374	376
Mercury	< 0.1	< 0.1	< 0.1	0.11	0.11	0.13	0.16	0.12
Nickel	0.21 J	0.19 J	0.15 J	11.1	16	11	12.8	12
Selenium	0.3 J	0.2 J	0.34 J	0.93 J	< 2.1	0.62 J	0.44 J	0.59 J
Silver	< 0.5	< 0.5	< 0.5	< 2.1	< 2.1	< 2.1	< 2.1	< 2.1
Zinc	3.7	3.5	3	45.8	64	42.6	46.7	52.6

TABLE G-7

SITE FTIR-40 REFERENCE AREA 2 (RF2)
PLANT TISSUE AND SOIL SAMPLE RESULTS
NATIONAL TRAINING CENTER, FORT IRWIN

Parameter	RF2-SS-4 Duplicate 05/11/99	RF2-SS-5 05/11/99	RF2-SS-6 05/11/99	RF2-SS-7 05/11/99	RF2-SS-8 05/11/99	RF2-SS-9 05/11/99
GENERAL CHEMISTRY						
Moisture content (%)	1.7	3.8	3.3	1.8	4.3	2.2
METALS (mg/Kg)						
Aluminum	8590	14000	10900	11100	12600	9520
Antimony	< 4.1	< 4.2	< 4.1	< 4.1	< 4.2	< 4.1
Arsenic	7	7.3	5.4	6.3	7.8	7.2
Barium	146	121	151	194	183	150
Cadmium	< 0.41	< 0.42	< 0.41	< 0.41	< 0.42	< 0.41
Chromium	8.2	16.2	10.4	10.6	12.1	9.3
Cobalt	6.3	9.8	7.4	7.2	8.4	6.8
Copper	11.7	19.1	13.9	15	17.8	13.8
Lead	8.4	11	9.9	12.7	12	9.7
Manganese	324	378	392	372	383	348
Mercury	0.13	0.11	0.12	0.11	0.12	0.1
Nickel	9.5	13.9	10.4	10.8	12.6	9.6
Selenium	< 2	< 2.1	0.64 J	< 2	< 2.1	< 2
Silver	< 2	< 2.1	< 2.1	< 2	< 2.1	< 2
Zinc	35.9	53.7	41.2	47.4	54.1	38.4

< - Indicates sample result is less than the stated reporting limit.

J - Result is an estimate.

mg/Kg - milligrams per kilogram

NA - Not Applicable

APPENDIX H

CHAIN OF CUSTODY FORMS

MONTGOMERY WATSON

CHAIN OF CUSTODY RECORD

MW CONTACT PERSON:
Ben Holland (9..., 921-3563

FED EX #: 8121 6953 4985 COOLER #: 1 LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
KRISTI SHELTON Kristi Shelton

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)	metals (6010/7000) (b)
40-2-SS-1	0	0.5	5/10/99	1610	1	A	NA		X	
40-2-SS-2	0	0.5	5/10/99	1630	1	A	NA		X	
40-2-SS-3	0	0.5	5/10/99	1700	1	A	NA		X	
40-2-SS-4	0	0.5	5/10/99	1715	1	A	NA		X	
40-2-SS-5	0	0.5	5/10/99	1730	1	A	NA		X	
40-2-SS-2-99	0	0.5	5/10/99	1600	1	A	NA		X	
38-2-SS-1	0	0.5	5/10/99	1445	1	A	NA			X
RFI-PT-1	—	—	5/10/99	0900	1	P	NA			X
RFI-PT-2	—	—	5/10/99	0930	1	P	NA			X
RFI-PT-3	—	—	5/10/99	0950	1	P	NA			X

Comments/Instructions:
(a) Metals include arsenic, cadmium, lead, zinc
(b) metals include aluminum, arsenic, antimony, barum, cobalt, copper, lead, zinc

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Kristi A. Shelton	KRISTIN SHELTON	Montgomery Watson	5/10/99	0700
RECEIVED BY:	Frank Monteith	FRANK Monteith	APCL	5/12/99	1030
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

MONTGOMERY WATSON

CHAIN OF CUSTODY RECORD

MW CONTACT PERSON:
Ben Holland (9[illegible]) 921-3563

FED EX #: 8121 6953 4985 COOLER #: 1 LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
KRISTI SHELTON Kristi Shelton

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)	metals 6010/7000 (b)
RFI-PT-4	—	—	5/10/99	1000	1	P	NA		X	
RFI-PT-5	—	—	5/10/99	1030	1	P	NA		X	
RFI-PT-6	—	—	5/10/99	1100	1	P	NA		X	
RFI-PT-7	—	—	5/10/99	1120	1	P	NA		X	
RFI-PT-8	—	—	5/10/99	1245	1	P	NA		X	
RFI-PT-9	—	—	5/10/99	1315	1	P	NA		X	
RFI-PT-10	—	—	5/10/99	1330	1	P	NA		X	
40-2-PT-1	—	—	5/10/99	1610	1	P	NA			X
40-2-PT-2	—	—	5/10/99	1630	1	P	NA			X
40-2-PT-3	—	—	5/10/99	1700	1	P	NA			X

Comments/Instructions:
(a) Metals include aluminum, antimony, arsenic, barium, cobalt, copper, lead, zinc
(b) metals include arsenic, cadmium, lead, zinc

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Kristin A Shelton	KRISTIN A SHELTON	Montgomery Watson	5/11/99	0700
RECEIVED BY:	Frank Monteith	FRANK Monteith	APCL	5/12/99	1030
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

№ 003

MONTGOMERY WATSON

CHAIN OF CUSTODY RECORD

MW CONTACT PERSON:
Ben Holland (916) 921-3563

FED EX #: 8121 6953 4985 COOLER #: 1 LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
KRISTI SHELTON Kristin Shelton

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)
RFI-SS-1	0	0.5	5/10/99	0900	1	A	NA		X
RFI-SS-2	0	0.5	5/10/99	0930	1	A	NA		X
RFI-SS-3	0	0.5	5/10/99	0950	1	A	NA		X
RFI-SS-4	0	0.5	5/10/99	1000	1	A	NA		X
RFI-SS-5	0	0.5	5/10/99	1030	1	A	NA		X
RFI-SS-6	0	0.5	5/10/99	1100	1	A	NA		X
RFI-SS-7	0	0.5	5/10/99	1120	1	A	NA		X
RFI-SS-8	0	0.5	5/10/99	1245	1	A	NA		X
RFI-SS-9	0	0.5	5/10/99	1315	1	A	NA		X
RFI-SS-10	0	0.5	5/10/99	1330	1	A	NA		X

Comments/Instructions:
(a) Metals include aluminum, antimony, arsenic, barium, cobalt, copper, lead, zinc

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Kristin A Shelton	KRISTIN A SHELTON	Montgomery Watson	5/11/99	0700
RECEIVED BY:	Frank Monteith	FRANK Monteith	APCL	5/12/99	1030
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

MONTGOMERY WATSON

CHAIN OF CUSTODY RECORD

MW CONTACT PERSON:
Ben Holland (9[illegible], 921-3563

FED EX #: 8121 6953 4985 COOLER #: 1 LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
KRISTI SHELTON Kristi Shelton

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)	metals (a)(b)/7000 (b)
40-2-PT-2-99	—	—	5/10/99	1600	1	P	NA		X	
40-2-PT-5	—	—	5/10/99	1730	1	P	NA		X	
38-2-PT-1	—	—	5/10/99	1445	1	P	NA			X
40-2-PT-4										

Comments/Instructions:
(a) Metals include arsenic, cadmium, lead, zinc
(b) metals include aluminum, antimony, arsenic, barium, cobalt, copper, lead, zinc

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Kristi A Shelton	KRISTIN A SHELTON	Montgomery Watson	5/11/99	0700
RECEIVED BY:	Frank Monteith	FRANK Monteith	APCL	5/12/99	1030
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

MON MERY WATSON

CHA F CUSTODY RECORD

MW CONTACT P ON:
Ben Holland (916) 921-3563

FED EX #: 8121 6953 4996 COOLER #: 2 LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
KRISTI SHELTON Kristin Shelton

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)
RFI-PT-4a	—	—	5/11/99	1645	1	P	m		X
RFI-PT-~~5a~~ 4a-99	—	—	5/11/99	1730					
RFI-PT-5a	—	—	5/11/99	1700					
RFI-PT-6a	—	—	5/11/99	1705					
RFI-PT-7a	—	—	5/11/99	1710					
RFI-PT-8a	—	—	5/11/99	1715					
RFI-PT-9a	—	—	5/11/99	1720					
~~38-2~~ 38-2-SS-1a	—	—	5/11/99	1510					
38-2-SS-2	—	—	5/11/99	1530					
38-2-SS-3	—	—	5/11/99	1535					

Comments/Instructions:
(a) Metals include aluminum, antimony, arsenic, barium, cobalt, copper, lead, zinc

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Kristin A Shelton	KRISTIN SHELTON	Montgomery Watson	5/12/99	0700
RECEIVED BY:				5/13/99	1000
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

№ 009

MONTGOMERY WATSON

CHAIN OF CUSTODY RECORD

MW CONTACT PERSON:
Ben Holland (5[illegible]), 921-3563

FED EX #: 812169534996 COOLER #: 2 LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
KRISTI SHELTON Kristi Shelton

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)
RF2-PT-10	—	—	5/11/99	1220	1	P	NA		X
40-1-PT-1	—	—	5/11/99	0915					
40-1-PT-2	—	—	5/11/99	0920					
40-1-PT-3	—	—	5/11/99	0930					
40-1-PT-~~4~~ MS 3-99	—	—	5/11/99	0910					
40-1-PT-4	—	—	5/11/99	0945					
40-1-PT-5	—	—	5/11/99	0955					
40-1-PT-6	—	—	5/11/99	1000					
40-1-PT-7	—	—	5/11/99	1015					
40-1-PT-8	—	—	5/11/99	1020					

Comments/Instructions:
(a) Metals include aluminum, antimony, arsenic, barium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, selenium, ~~sto~~ silver, zinc

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Kristin A Shelton	KRISTIN A SHELTON	Montgomery Watson	5/12/99	0700
RECEIVED BY:		ERIC Wendland	APC	5/13/99	1000
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

MON' 'MERY WATSON

CHAI' F CUSTODY RECORD

MW CONTACT P' ON:
Ben Holland (9.., 921-3563

FED EX #: 8121 6953 4996 COOLER #: 2 LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
KRISTI SHELTON Kristi Shelton

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)	metals 6010/7000 (b)	metals 6010/7000 (c)
40-1-PT-9	—	—	5/11/99	1030	1	P	NA		X		
40-1-PT-10	—	—	5/11/99	1035	1	P	NA		X		
40-2-PT-6	—	—	5/11/99	0830						X	
40-2-PT-7	—	—	5/11/99	0835						X	
40-2-PT-8	—	—	5/11/99	0840						X	
40-2-PT-9	—	—	5/11/99	0850						X	
40-2-PT-10	—	—	5/11/99	0900						X	
RFI-PT-1a	—	—	5/11/99	1630							X
RFI-PT-2a	—	—	5/11/99	1635							X
RFI-PT-3a	—	—	5/11/99	1640							X

3603

Comments/Instructions:
(a) Metals include aluminum, antimony, arsenic, barium, chromium, cadmium, cobalt, copper, lead, manganese, mercury, nickel, selenium, silver, zinc
(b) metals include arsenic, cadmium, lead, zinc
(c) metals aluminum, antimony, arsenic, barium, cobalt, copper, lead, zinc

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	[signature]		Montgomery Watson	5/13/99	1000
RECEIVED BY:					
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

MON MERY WATSON

CHAI F CUSTODY RECORD

MW CONTACT PL JN:
Ben Holland (916) 921-3563

FED EX #: 8121 6953 4996 COOLER #: 2 LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
KRISTI SHELTON Kristi Shelton

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)
38-2-SS-4X3-99	—	—	5/11/99	1500	1	P	NA		X
38-2-SS-4	—	—	5/11/99	1545	↓	↓	↓		X
38-2-SS-5	—	—	↓	1555	↓	↓	↓		X
38-2-SS-6	—	—	↓	1600	↓	↓	↓		X
38-2-SS-7	—	—	↓	1605	↓	↓	↓		X
38-2-SS-8	—	—	↓	1610	↓	↓	↓		X
38-2-SS-9	—	—	↓	1615	↓	↓	↓		X
RFI-SS-1a	—	—	↓	1630	↓	↓	↓		X
RFI-SS-2a	—	—	↓	1635	↓	↓	↓		X
RFI-SS-3a	—	—	↓	1640	↓	↓	↓		X

Comments/Instructions:
(a) Metals include aluminum, antimony, arsenic, barium, cobalt, copper, lead, zinc

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Kristi A Shelton	Kristin A Shelton	Montgomery Watson	5/12/99	0700
RECEIVED BY:				5/13/99	1000
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

MONTGOMERY WATSON

CHAIN OF CUSTODY RECORD

MW CONTACT PERSON:
Ben Holland (9 921-3563

FED EX #: 8121 6953 4996 COOLER #: 2 LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
KRISTI SHELTON Kristi Shelton

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)	Metals (arsenic/cadmium/lead/zinc) (b)
RFI-SS-4a	—	—	5/11/99	1645	1	P	NA		X	
RFI-SS-5a	—	—		1700					X	
RFI-SS-4a-99	—	—		1730					X	
RFI-SS-6a	—	—		1705					X	
RFI-SS-7a	—	—		1710					X	
RFI-SS-8a	—	—		1715					X	
RFI-SS-9a	—	—		1720					X	
40-2-SS-6	—	—		0830						X
40-2-SS-7	—	—		0835						X
40-2-SS-8	—	—		0840						X

Comments/Instructions:
(a) Metals include aluminum, antimony, arsenic, barium, cobalt, copper, lead, zinc
(b) metals arsenic, cadmium, lead, zinc

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Kristi A Shelton	KRISTIN A SHELTON	Montgomery Watson	5/12/99	0700
RECEIVED BY:				5/13/99	1100
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

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MONTGOMERY WATSON

CHAIN OF CUSTODY RECORD

MW CONTACT PERSON:
Ben Holland (9..., 921-3563

FED EX #: 8121 6953 4996 COOLER #: 2 LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
KRISTI SHELTON Kristi Shelton

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)
38-2-PT-1a	—	—	5/11/99	1510	1	P	NA		X
38-2-PT-2a	—	—	5/11/99	1530					
38-2-PT-3a	—	—	5/11/99	1535					
38-2-PT-3a-99	—	—	5/11/99	1500					
38-2-PT-4	—	—	5/11/99	1545					
38-2-PT-5	—	—	5/11/99	1535					
38-2-PT-6	—	—	5/11/99	1600					
38-2-PT-7	—	—	5/11/99	1605					
38-2-PT-8	—	—	5/11/99	1610					
38-2-PT-9	—	—	5/11/99	1615					

Comments/Instructions:
(a) Metals include aluminum, antimony, arsenic, barium, cobalt, copper, lead, zinc

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY	Kristin A Shelton	KRISTIN A. SHELTON	Montgomery Watson	5/11/99	0700
RECEIVED BY:				5/13/99	1000
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

MON' 'MERY WATSON

CHAI' 'F CUSTODY RECORD

MW CONTACT P' ON:
Ben Holland (9 , 921-3563

FED EX #: 8121 6953 4996 COOLER #: 2 LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
KRISTI SHELTON Kristi Shelton

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)														
~~RF1~~ RF2-PT-1	—	—	5/11/99	1100	1	P	NA		X														
RF2-PT-2	—	—	5/11/99	1110																			
RF2-PT-3	—	—	5/11/99	1120																			
RF2-PT-4-99	—	—	5/11/99	1055																			
RF2-PT-4	—	—	5/11/99	1130																			
RF2-PT-5	—	—	5/11/99	1135																			
RF2-PT-6	—	—	5/11/99	1140																			
RF2-PT-7	—	—	5/11/99	1150																			
RF2-PT-8	—	—	5/11/99	1200																			
RF2-PT-9	—	—	5/11/99	1210																			

Comments/Instructions:
(a) Metals include aluminum, antimony, arsenic, barium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, selenium, ~~st~~silver, zinc

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Kristin A Shelton	KRISTIN A SHELTON	Montgomery Watson	5/12/99	0700
RECEIVED BY:				5/13/99	1000
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

MON MERY WATSON

CHAI F CUSTODY RECORD

MW CONTACT PE N:
Ben Holland (916) 921-3563

FED EX #: 8121 6953 ~~4996~~ 5400 COOLER #: ~~2~~ 3b LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
KRISTI SHELTON Kristi Shelton

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)	metals 6010/7000 (b)
40-2-SS-9	—		5/11/99	0850	1	A	NA		X	
40-2-SS-10				0900					X	
40-1-SS-1				0915					X	X
40-1-SS-2				0920						X
40-1-SS-3				0930						X
40-1-SS-3-99				0910						X
40-1-SS-4				0945						X
40-1-SS-5				0955						X
40-1-SS-6				1000						X
40-1-SS-7				1015						X

Comments/Instructions:
(a) Metals include arsenic, cadmium, lead, zinc
(b) metals aluminum, antimony, arsenic, barium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, selenium, silver, zinc

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Kristin A Shelton	KRISTIN A SHELTON	Montgomery Watson	5/12/99	0700
RECEIVED BY:	[illegible]	SACHE CARIBI	APCL	5/14/99	1000
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth
Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic
Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

MON MERY WATSON

CHAI F CUSTODY RECORD

MW CONTACT PE ON:
Ben Holland (916) 921-3563

FED EX #: 8121 6953 ~~4996~~ 5400 COOLER #: ~~2~~ 3b LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
KRISTI SHELTON Kristin Shelton

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)
40-1-SS-8	—	—	5/11/99	1020	1	A	NA		X
40-1-SS-9	—	—		1030					X
40-1-SS-10	—	—		1035					X
RF2-SS-1	—	—		1100					X
RF2-SS-2	—	—		1110					X
RF2-SS-3	—	—		1120					X
RF2-SS-4	—	—		1130					X
RF2-SS-4-99	—	—		1055					X
RF2-SS-5	—	—		1135					X
RF2-SS-6	—	—		1140					X

Comments/Instructions:
(a) Metals include aluminum, antimony, arsenic, barium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, selenium, silver, zinc

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Kristin A Shelton	KRISTIN A SHELTON	Montgomery Watson	5/12/99	0700
RECEIVED BY:	Said Elarib	SAID ELARIB	APCL	5/14/99	[illegible]
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

MON MERY WATSON

CHAI F CUSTODY RECORD

MW CONTACT P ON:
Ben Holland (916) 921-3563

FED EX #: 8121 6953 5400 COOLER #: 3b LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
KRISTI SHELTON Kristi Shelton

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)
RF2-SS-7	—	—	5/11/99	1150	1	A	NA		X
RF2-SS-8	—	—	↓	1200	↓	↓	↓		
RF2-SS-9	—	—		1210					
RF2-SS-10	—	—		1220					

Comments/Instructions:
(a) Metals include aluminum, antimony, arsenic, barium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, selenium, silver, zinc

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Kristi A Shelton	KRISTI A SHELTON	Montgomery Watson	5/12/99	0700
RECEIVED BY:	Said Chu	SAID CHAIM	MWCC	5/14/99	1000
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

MO[illegible] [illegible]MERY WATSON

CHA[illegible] F CUSTODY RECORD

MW CONTACT P[illegible]ON:
Ben Holland (916) 921-3563

FED EX #: 8121-6953-5411 COOLER #: 3A LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
Claudia Patiño [signature]
Kristin Shelton [signature]

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)
40-2-SB-1-2.5	2.0	2.5	5/12/99	0900	1	S	NA	X	X
40-2-SB-1-5.0	4.5	5.0	5/12/99	0915					
40-2-SB-1-10.0	9.5	10.0	5/12/99	0920					
40-2-SB-2-2.5	2.0	2.5	5/12/99	0940					
40-2-SB-2-5.0	4.5	5.0	5/12/99	0955					
40-2-SB-2-10.0	9.5	10.0	5/12/99	1000					
40-2-SB-3-2.5	2.0	2.5	5/12/99	1040					
40-2-SB-3-5.0	4.5	5.0	5/12/99	1054					
40-2-SB-3-10.0	9.5	10.0	5/12/99	1100					
40-2-SB-4-2.5	2.0	2.5	5/12/99	1105					

Comments/Instructions:
(a) Metals include Aluminum, Antimony, Arsenic, Barium, Beryllium, Cadmium, Calcium, Chromium, Cobalt, Copper, Iron, Lead, Magnesium, Manganese, Mercury, Molybdenum, Nickel, Nitrate/Nitrite, Potassium, Selenium, Silver, Sodium, Thallium, Vanadium, Zin

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	[signature]	Claudia Patiño	Montgomery Watson	5/13/99	0700
RECEIVED BY:	[signature]	SAM ELARIB	APCL	5/14/99	1[illegible]
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth
Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic S= Stainless steel sleeve
Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

MON MERY WATSON

CHAI F CUSTODY RECORD

MW CONTACT PL N:
Ben Holland (916) 921-3563

FED EX #: 8121-6953-5411 COOLER #: 3A LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
Claudia Patiño [signature]
Kristin Shelton [signature]

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)	TLC	TCLP
40-2-SB-4-5.0	4.5	5.0	5/12/99	1115	1	S	NA	X	X		
40-2-SB-4-10.0	9.5	10.0	5/12/99	1120							
40-2-SB-5-2.5	2.0	2.5	5/12/99	1010							
40-2-SB-5-5.0	4.5	5.0	5/12/99	1020							
40-2-SB-5-10.0	9.5	10.0	5/12/99	1025							
40-2-SB-1-5-99	98.5	99	5/12/99	0910							
40-2-SB-2-5-QA	4.5	5.0	5/12/99	0955							
40-2-SB-2-10-99	98.5	99	5/12/99	1200				X	X		
40-2-SB-cuttings	—	—	5/12/99	1025						X	
40-2-SB-cuttings	—	—	5/12/99	1025							X

Comments/Instructions:
(a) Metals include Aluminum, Antimony, Arsenic, Barium, Beryllium, Cadmium, Calcium, Chromium, Cobalt, Copper, Iron, Lead, Magnesium, Manganese, Mercury, Molybdenum, Nickel, Nitrate/Nitrite, Potassium, Selenium, Silver, Sodium, Thallium, Vanadium, Zinc

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	[signature]	Claudia Patiño	Montgomery Watson	5/13/99	0700
RECEIVED BY:	[signature]	SAUL CLARISI	APCL	5/14/99	1000
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic S= stainless steel sleeve

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

MONTGOMERY WATSON

CHAIN OF CUSTODY RECORD

MW CONTACT PERSON:
Ben Holland (9 , 921-3563

FED EX #: Courier COOLER #: 4 LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
KRISTI SHELTON Kristin Shelton
Claudia Petrino Claudia Petrino

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)	TCLP - lead	STLC - lead
38-2-SS-CNF-11-1'	0.5	1	5/13/99	1150	1	P	NA		X		
38-2-SS-CNF-12-1'	0.5	1	5/13/99	1155	↓	↓	↓		X		
38-2-SS-CNF-14-1'	0.5	1	5/13/99	1205	↓	↓	↓		X		
38-2-SS-CNF-14	0	0.5	5/13/99	1600	↓	↓	↓		X	X	
38-2-SS-CNF-14	0	0.5	5/13/99	1600	↓	↓	↓				X
38-2-SS-CNF-20	0	0.5	5/13/99	1005	↓	↓	↓		X		
38-2-SS-CNF-22	0	0.5	5/13/99	1015	↓	↓	↓		X		
38-2-SS-CNF-23	0	0.5	5/13/99	1025	↓	↓	↓		X		
38-2-SS-CNF-25	0	0.5	5/13/99	1035	↓	↓	↓		X		
38-2-SS-CNF-27	0	0.5	5/13/99	1550	↓	↓	↓		X	X	

Comments/Instructions:
(a) Metals include Lead
24 hr. Rush TAT

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Krystal A Shelton	KRISTIN A SHELTON	Montgomery Watson	5/13/99	0700
RECEIVED BY:				5/14/99	1100
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

MONT MERY WATSON

CHAIN CUSTODY RECORD

MW CONTACT PE N:
Ben Holland (916) 921-3563

FED EX #: Courier COOLER #: 4 LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
KRISTI SHELTON Kristi Shelton
Claudia Patino Claudia Patino

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)	TCLP - lead	STLC - lead														
38-2-SS-CNF-27	0	0.5	5/13/99	1550	1	P	na				X														
38-2-SS-CNF-28	0	0.5	5/13/99	1048					X																
38-2-SS-CNF-29	0	0.5	5/13/99	1230					X																
38-2-SS-CNF-30	0	0.5	5/13/99	1233					X																
38-2-SS-CNF-33	0	0.5	5/13/99	1246					X																
38-2-SS-CNF-36	0	0.5	5/13/99	1252					X																

Comments/Instructions:
(a) Metals include lead
24 hr TAT

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Kristin A Shelton	Kristin A SHELTON	Montgomery Watson	5/13/99	0700
RECEIVED BY:	[illegible]	ERIC	ERIC	5/13/99	1100
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

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CHAIN CUSTODY RECORD

MW CONTACT PER.
Ben Holland (916) 921-3563

FED EX #: 8121 6953 5385 COOLER #: 5 LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
Claudia Patiño Claudia Patiño
Kristin Shelton Kristin Shelton

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)
38-2-SS-CNF37	Ø	Ø	5/14/99	0835	1	P	NA		X
38-2-SS-CNF41	Ø	Ø	5/14/99	0930					
38-2-SS-CNF42	Ø	Ø	5/14/99	0940					
38-2-SS-CNF43	Ø	Ø	5/14/99	0950					
38-2-SS-CNF45	Ø	Ø	5/14/99	1015					
38-2-SS-CNF47	Ø	Ø	5/14/99	1200					
38-2-SS-CNF49	Ø	Ø	5/14/99	1220					
38-2-SS-CNF53	Ø	Ø	5/14/99	1320					

Comments/Instructions:
(a) Metals include Lead

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Claudia Patiño	Claudia Patiño	Montgomery Watson	5/15/99	0700
RECEIVED BY:	[illegible]	Howard Kenig	APCL	05/17/99	1100
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

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MON MERY WATSON

CHAI F CUSTODY RECORD

MW CONTACT PE ON:
Ben Holland (916) 921-3563

FED EX #: 8121-6953-5374 COOLER #: A LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
Claudia Pabino Claudia Pabino
Kristin Shelton Kristin Shelton

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)
38-2-SS-CNF 64	Ø	Ø	5/14/99	1633	1	P	NA		X
38-2-SS-CNF66	Ø	Ø	5/14/99	1644	1	P	NA		X
38-2-SS-CNF37-1	0.5	1.0	5/15/99	0750	↓	↓	↓		↓
38-2-SS-CNF42-1	0.5	1.0	5/15/99	0810					
38-2-SS-CNF49-1	0.5	1.0	5/15/99	0820					
38-2-SS-CNF74	Ø	Ø	5/15/99	1237					
38-2-SS-CNF28-1	0.5	1.0	5/16/99	1135					
38-2-SS-CNF37-2	1.5	2.0	5/16/99	0853					
38-2-SS-CNF49-2	1.5	2.0	5/16/99	0926					
38-2-SS-~~68~~ 68-CNF68-1	0.5	1.0	5/15/99	1305	↓	↓	↓		↓

Comments/Instructions:
(a) Metals include Lead

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Claudia Pabino	Claudia Pabino	Montgomery Watson	5/18/99	0800
RECEIVED BY:		ERIC Wendel	APCL	5/19/99	1000
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

MC OMERY WATSON

CHA OF CUSTODY RECORD

MW CONTACT I ON:
Ben Holland (916) 921-3563

FED EX #: 8121-6953-5374 COOLER #: A LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
Claudia Patiño Claudia Patiño
Kristin Shelton Kristin Shelton

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)
38-2-SS-CNF50-2	1.5	2.0	5/16/99	0930	1	P	NA		X
38-2-SS-CNF53-2	1.5	2.0	5/16/99	0958	↓	↓	↓		↓
38-2-SS-CNF82	Ø	Ø	5/16/99	0855	↓	↓	↓		↓
38-2-SS-~~Ser~~ CNF84	Ø	Ø	5/16/99	0905	↓	↓	↓		↓
38-2-SS-CNF91	Ø	Ø	5/16/99	0954	↓	↓	↓		↓
38-2-SS-CNF92	Ø	Ø	5/16/99	1000	↓	↓	↓		↓
38-2-SS-CNF101	Ø	Ø	5/17/99	0950	↓	↓	↓		↓

Comments/Instructions:
(a) Metals include Lead

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Claudia Patiño	Claudia Patiño	Montgomery Watson	5/18/99	0800
RECEIVED BY:	[illegible]	ERIC Wendlad	APCL	5/19/99	1000
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

MC OMERY WATSON

CH/ OF CUSTODY RECORD

MW CONTACT I ON:
Ben Holland (916) 921-3563

FED EX #: 8121 6953 5363 COOLER #: A LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
Kristi Shelton Kristi Shelton
Claudia Patino Absent

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)
38-2-SS-CNF20-2'	1.5	2	5/17/99	1040	1	P	NA		X
38-2-SS-CNF84-1'	0.5	1	5/18/99	1010					
38-2-SS-CNF82-1'	0.5	1	5/18/99	0950					
38-2-SS-CNF129	0	0.5	5/18/99	1150					
38-2-SS-CNF133	0	0.5	5/18/99	1210					
38-2-SS-CNF57-3'	2.5	3	5/18/99	1045					
38-2-SS-CNF81-1'	0.5	1	5/18/99	0930					

Comments/Instructions:
(a) Metals include lead

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Kristin Shelton	Kristin Shelton	Montgomery Watson	5/20/99	0800
RECEIVED BY:	[illegible]	HOWARD KUNG	APCC	052199	1200
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

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CHAI F CUSTODY RECORD

MW CONTACT PL ON:
Ben Holland (916) 921-3563

FED EX #: 8121 6953 5320 COOLER #: A LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
Kristi Shelton Kristi Shelton
Claudia Patiño Absent

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)
38-2-SS-CNF126-1	0.5	1	5/19/99	1222	1	P	NA		X
38-2-SS-CNF70-2	1.5	2	5/20/99	0920	↓	↓	↓		↓
38-2-SS-CNF27-3	2.5	3	5/20/99	0945	↓	↓	↓		↓
38-2-SS-CNF77-1	0.5	1	5/19/99	1135	↓	↓	↓		↓
38-2-SS-CNF142	0	0.5	5/19/99	1220	↓	↓	↓		↓
38-2-SS-CNF79-1	0.5	1	5/19/99	1230	↓	↓	↓		↓
38-2-SS-CNF152	0	0.5	5/20/99	0950	↓	↓	↓		↓
38-2-SS-CNF143	0	0.5	5/19/99	1245	↓	↓	↓		↓
38-2-SS-CNF155	0	0.5	5/20/99	1025	↓	↓	↓		↓
38-2-SS-CNF12-5	4.5	5	5/20/99	1100	↓	↓	↓		↓

Comments/Instructions:
(a) Metals include

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Kristin A Shelton	Kristin A Shelton	Montgomery Watson	5/24/99	0800
RECEIVED BY:		ERIC WENDLAND	APCL	5/25/99	1100
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

MO OMERY WATSON

CHA F CUSTODY RECORD

MW CONTACT F ON:
Ben Holland (916) 921-3563

FED EX #: 8121 6953 5320 COOLER #: A LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
Kristi Shelton Kristi Shelton
Claudia Patrio Absent

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)
38-2-SS-CNF176	0	0.5	5/21/99	1102	1	P	NA		X
38-2-SS-CNF203	0	0.5	5/22/99	0828					
38-2-SS-CNF210	0	0.5	5/22/99	0850					
38-2-SS-CNF200	0	0.5	5/22/99	0821					
38-2-SS-CNF196	0	0.5	5/22/99	0815					
38-2-SS-CNF193	0	0.5	5/22/99	0800					
38-2-SS-CNF191	0	0.5	5/21/99	1015					
38-2-SS-CNF188	0	0.5	5/21/99	1030					
38-2-SS-CNF185	0	0.5	5/21/99	1037					
38-2-SS-CNF179	0	0.5	5/21/99	1055					

Comments/Instructions:
(a) Metals include

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Kristin A Shelton	Kristin A Shelton	Montgomery Watson	5/24/99	0800
RECEIVED BY:	[illegible]	ERIC WENDLAND	APCL	5/25/99	1000
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

MC OMERY WATSON

CHA OF CUSTODY RECORD

MW CONTACT I ON:
Ben Holland (916) 921-3563

FED EX #: 8121 6953 5320 COOLER #: A LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
Kristi Shelton Kristi Shelton
Claudia Patiño Absent

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)
38-2-SS-CNF182	0	0.5	5/21/99	1050	1	P	NA		X

Comments/Instructions:
(a) Metals include lead

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Kristi A Shelton	Kristin A Shelton	Montgomery Watson	5/24/99	0800
RECEIVED BY:		ERC Wendland	APCL	5/25/99	1000
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

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CHAIN OF CUSTOD ECORD

Page 1 of 1

US ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT
Environmental Engineering Branch
SPK-ED-E
1325 J Street
Sacramento, California
95814-2922

Project Name: Ft IR-38 (Area 1)
Project Location: Fort Irwin, Ca
Project Coordinator: Curtis Payton
Phone: 916-557- FAX: 916-557-5307
Sampler: Andrea Archer Phone 916-557-7646

Laboratory: Quanterra
Address: 880 Riverside Pkwy
W. Sac, Ca 95605
Contact: Diana Brooks
Phone: 916-373-4362

ANALYSIS REQUESTED ➤

SAMPLE IDENTIFICATION Field	Laboratory	GRAB	COMP	DATE	TIME	6010 Metals	SW7471A (Mercury)							TURN AROUND TIME (DAYS)	MATRIX CODE	NUMBER OF CONTAINERS PLASTIC	GLASS	VOA	SLEEVE	FIELD FILTERED	PRESERVATIVE CODE
38-1-SS-2(-2)		✓		7/16/98	0935	X	X							21	S				1		
38-1-SS-5(-5)		✓		7/16/98	0955	X	X							21	S				1		

COMMENTS/SPECIAL INSTRUCTIONS:
* Fax cooler receipt to Andrea Archer, COE at 916-557-7646 the day samples are received.

CHECKED BY:

PRESERVATIVE CODES:
C = HCl N = HNO_3 S = H_2SO_4

SAMPLE DISPOSAL:
☒ Hold ☐ Dispose ☐ Return
60 days

MATRIX CODES:
W = Water SI = Sludge SP = Solid Product
S = Soil A = Air LP = Liquid Product
Sd = Sediment

SHIPPING:
☐ Fed Ex ☐ Courier ☒ Hand Deliver
Airbill Number:

RELINQUISHED BY	DATE/TIME	RECEIVED BY	DATE/TIME
Andrea L Archer	7/17/98 1000	[illegible]	071798 @ 1000

CESPK FORM 111
1 NOV 97

DISTRIBUTION: WHITE and YELLOW - send to testing laboratory; PINK - retained by originator

0000004

MONT[illegible]MERY WATSON

CHAI[illegible] CUSTODY RECORD

MW CONTACT P[illegible]ON:
Ben Holland (916) 921-3563

FED EX #: _____ COOLER #: _____ LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
Claudia Patino Claudia Patino
~~Erik Hellstrom~~

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)	Lab I.D.
38-2-SS-11	Ø	Ø	5/13/99	0900	1	P	NA		X	FI01-01
38-2-SS-12	Ø	Ø	5/13/99	0905	↓	↓	↓		X	-02
38-2-SS-13	Ø	Ø	5/13/99	0910	↓	↓	↓		X	-03
38-2-SS-14	Ø	Ø	5/13/99	0912	↓	↓	↓		X	-04
38-2-SS-15	Ø	Ø	5/13/99	0915	↓	↓	↓		X	-05
38-2-SS-16	Ø	Ø	5/13/99	0918	↓	↓	↓		X	-06

Comments/Instructions:
(a) Metals include Lead

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Claudia Patino	Claudia Patino	Montgomery Watson	5/13/99	0920
RECEIVED BY:	Douglas J. Honzay	Douglas Honzay	Onsite Env. Labs	5/13/99	0920
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

No 022

MONTGOMERY WATSON

CHAIN OF CUSTODY RECORD

MW CONTACT PERSON:
Ben Holland (916) 921-3563

FED EX #: _____ COOLER #: _____ LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
Claudia Patiño [signature]

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)	Lab I.D.
38-2-SS 17 **	Ø	Ø	5/13/99	0935	1	P	NA		X	FI01-07
38-2-SS-18	Ø	Ø	5/13/99	0940	1	P	NA		X	-08
38-2-SS-19	Ø	Ø	5/13/99	1000	1	P	NA		X	-09
38-2-SS-20*	Ø	Ø	5/13/99	1005	↓	↓	↓		↓	-10
38-2-SS-21	Ø	Ø	5/13/99	1010	↓	↓	↓		↓	-11
38-2-SS 22*	Ø	Ø	5/13/99	1015	↓	↓	↓		↓	-12
38-2-SS 22-99	985	99.1	5/13/99	~~1200~~ 1025	↓	↓	↓		↓	-13

Comments/Instructions:
(a) Metals include Lead

* = confirmation sample ** = split sample (QA)

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Claudia Patiño	Claudia Patiño	Montgomery Watson	5/13/99	1030
RECEIVED BY:	Douglas J Honzay	Doug Honzay	Onsite Env Labs	5/13/99	1030
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

No 024

MONTGOMERY WATSON

CHAIN OF CUSTODY RECORD

MW CONTACT PERSON:
Ben Holland (916) 921-3563

FED EX #:

COOLER #:

LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE: Claudia Patino Claudia Patino

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)	Lab I.D.
38-2-SS 23*	Ø	Ø	5/13/99	1025	1	P	NA		X	FI01-14
38-2-SS 24	Ø	Ø	5/13/99	1030	↓	↓	↓		↓	-15
38-2-SS-25*	Ø	Ø	5/13/99	1035						-16
38-2-SS-26	Ø	Ø	5/13/99	1040						-17
38-2-SS-27	Ø	Ø	5/13/99	1045						-18
38-2-SS-28*	Ø	Ø	5/13/99	1048						-19
38-2-SS-28-99	90.5	99.0	5/13/99	1050	4	P	NA		X	-20

Comments/Instructions:
(a) Metals include

* = confirmation sample

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Claudia Patino	Claudia Patino	Montgomery Watson	5/13/99	1055
RECEIVED BY:	Douglas J. Honzay	Doug Honzay	Onsite Env. Lab	5/13/99	1055
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

No 025

MONT MERY WATSON

CHAI' E CUSTODY RECORD

MW CONTACT P ON:
Ben Holland (916) 921-3563

FED EX #: _____ COOLER #: _____ LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
Claudia Patiño [signature]

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)	Lab I.D
38-2-SS-11-1*	0.5	1.0	5/13/99	1150	1	P	NA		X	FI01-21
38-2-SS-12-1*	0.5	1.0	5/13/99	1155	↓	↓	↓		↓	-22
38-2-SS-13-1	0.5	1.0	5/13/99	1200	↓	↓	↓		↓	-23
38-2-SS-14-1*	0.5	1.0	5/13/99	1205	↓	↓	↓		↓	-24
~~38-2-SS-~~ ∅			↓		↓	↓	↓		↓	
38-2-SS-29	∅	∅	↓	1230	↓	↓	↓		↓	FI01-25
38-2-SS-30*	↓	↓	↓	1233	↓	↓	↓		↓	-26
38-2-SS-31	↓	↓	↓	1238	↓	↓	↓		↓	-27
38-2-SS-32	↓	↓	↓	1241	↓	↓	↓		↓	-28
38-2-SS-33*	↓	↓	↓	1246	↓	↓	↓		↓	-29

Comments/Instructions:
(a) Metals include Lead

* = confirmation sample

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Claudia Patiño	Claudia Patiño	Montgomery Watson	5/13/99	~~12/01~~
RECEIVED BY:	Douglas J. Honzay	Doug Honzay	Onsite Env. Labs	5/13/99	12:55
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

No 023

MONTGOMERY WATSON

CHAIN OF CUSTODY RECORD

MW CONTACT PERSON:
Ben Holland (916) 921-3563

FED EX #:

COOLER #:

LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
Claudia Patino [signature]

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)	Lab ID
38-2-SS-34	Ø	Ø	5/13/99	1248	1	P	NA		X	FI01-30
38-2-SS-35	Ø	Ø	↓	1250	↓	↓	↓		↓	-31
38-2-SS-36 *	Ø	Ø	↓	1252	↓	↓	↓		↓	-32
38-2-SS-33-99	9.85	99.0	5/13/99	1255	1	P	NA		X	-33

Comments/Instructions:
(a) Metals include Lead

* = confirmation sample

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Claudia Patino	Claudia Patino	Montgomery Watson	5/13/99	1255
RECEIVED BY:	Douglas J. Honzay	Doug Honzay	Onsite Env Labs	5/13/99	1255
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

MON' MERY WATSON

CHAI F CUSTODY RECORD

MW CONTACT F SON:
Ben Holland (916) 921-3563

FED EX #: _____ COOLER #: _____ LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
Claudia Patiño (signature)
Kristin Shelton

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)														
38-2-SS-37*	Ø	Ø	5/14/99	0835	L	P	NA		X				F	I	0	2	-	0	1				
38-2-SS-38	↓	↓	↓	0845	↓	↓	↓		↓						↓		-	0	2				
38-2-SS-39				0910													-	0	3				
38-2-SS-40				0920													-	0	4				
38-2-SS-41*				0930													-	0	5				
38-2-SS-42*				0940													-	0	6				
38-2-SS-43*				0950													-	0	7				
38-2-SS-44				1005													-	0	8				
38-2-SS-45*				1015													-	0	9				
38-2-SS-46	↓	↓	↓	1025	↓	↓	↓		↓						↓		-	1	0				

Comments/Instructions:
(a) Metals include Lead

* - confirmation

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Claudia Patiño	Claudia Patiño	Montgomery Watson	5/14/99	1030
RECEIVED BY:	Douglas J. Honzay	Doug Honzay	Onsite Env. Labs	5/14/99	1030
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

MONTGOMERY WATSON

CHAIN OF CUSTODY RECORD

MW CONTACT PERSON:
Ben Holland (916) 921-3563

FED EX #:

COOLER #:

LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
Claudia Patino
Kristin Shelton

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)																
38-2-SS-47 *	Ø	Ø	5/14/99	1200	1	P	NA		X					F	I	O	2	-	1	1					
38-2-SS-48				1210														-	1	2					
38-2-SS-49 *				1200														-	1	3					
38-2-SS-50				1230														-	1	4					
38-2-SS-51				1305														-	1	5					
38-2-SS-52				1315														-	1	6					
38-2-SS-53 *				1320														-	1	7					
38-2-SS-54				1335														-	1	8					
38-2-SS-52-99				1300														-	1	9					

Comments/Instructions:
(a) Metals include Lead

* = confirmation sample

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Claudia Patino	Claudia Patino	Montgomery Watson	5/14/99	1400
RECEIVED BY:	Douglas J. Honzay	Doug Honzay	Onsite Env Labs	5/14/99	1400
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

MONT[illegible]MERY WATSON

CHAI[illegible] CUSTODY RECORD

MW CONTACT P[illegible]ON:
Ben Holland (916) 921-3563

FED EX #: _____ COOLER #: _____ LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)															
3[illegible] 2 [illegible] 35	0	0	[illegible]	1140	1	P	NA		X						F	I	0	2	-	2	0			
38 2 [illegible] 36	0	0	[illegible]	1145															-	2	1			
3[illegible] 2 [illegible] 37	0	0	[illegible]	1150															-	2	2			
3[illegible] 2 [illegible] 38	0	0	[illegible]	1155															-	2	3			

Comments/Instructions:
(a) Metals include [illegible]

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Claudia Patino	Claudia Patino	Montgomery Watson	5/14/99	1400
RECEIVED BY:	Douglas J. Honzay	Doug Honzay	Onsite Env. Lab	5/14/99	1400
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

MON MERY WATSON

CHAI F CUSTODY RECORD

MW CONTACT P ON:
Ben Holland (916) 921-3563

FED EX #:

COOLER #:

LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)															
[illegible]	Ø	Ø	3/14/99	[illegible]	1	P	[illegible]		Y					F	I	0	2	-	2	4				
[illegible]	Ø	Ø	3/14/99	[illegible]														-	2	5				
[illegible]	Ø	Ø	3/14/99	[illegible]														-	2	6				
[illegible]	Ø	Ø	3/14/99	[illegible]														-	2	7				
[illegible]	Ø	Ø	3/14/99	[illegible]														-	2	8				
[illegible]	Ø	Ø	3/14/99	[illegible]														-	2	9				
[illegible]	Ø	Ø	3/14/99	[illegible]														-	3	0				
[illegible]	Ø	Ø	3/14/99	[illegible]														-	3	1				
[illegible]	Ø	Ø	3/14/99	[illegible]														-	3	2				
[illegible]	Ø	Ø	3/14/99	[illegible]														-	3	3				

Comments/Instructions:
(a) Metals include [illegible]

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	[illegible]	[illegible]	Montgomery Watson	3/14/99	1715
RECEIVED BY:	Douglas A. Honzay	Doug Honzay	Onsite Env. Labs	3/14/99	1715
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

No 000

MONTGOMERY WATSON

CHAIN OF CUSTODY RECORD

MW CONTACT PERSON:
Ben Holland (916) 921-3563

FED EX #: _____ COOLER #: _____ LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
[illegible]

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)															
38-2-55-68	Ø	Ø	5/14/99	1639	1	P	DM		X						F	I	0	2	-	3	4			
38-2-55-69	Ø	Ø	5/14/99	1652	↓	↓	↓		↓								↓		-	3	5			
38-2-55-70	Ø	Ø	5/14/99	1655	↓	↓	↓		↓								↓		-	3	6			

Comments/Instructions:
(a) Metals include lead

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	[illegible]	[illegible]	Montgomery Watson	5/14/99	1715
RECEIVED BY:	Douglas J. Honzay	Doug Honzay	Onsite Env. Labs	5/14/99	1715
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

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Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

No 000

MONTGOMERY WATSON

CHAIN OF CUSTODY RECORD

MW CONTACT FOR ON:
Ben Holland (9[illegible]) 921-3563

FED EX #:

COOLER #:

LAB: Applied Physics & Chemistry Laboratory - Onsite

SAMPLER(S) PRINTED NAME AND SIGNATURE
Kevin Sherron Kevin Sullor
Claudia Ramos

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)																
38-2-55-37-1' *	0.5	1	5/15/99	0752	1	P	NA		X							F	I	0	3	-	0	1			
38-2-55-38-1'	0.5	1	5/15/99	0753																-	0	2			
38-2-55-39-1'	0.5	1	5/15/99	0755																-	0	3			
38-2-55-40-1'	0.5	1	5/15/99	0800																-	0	4			
38-2-55-38-1'-99 **	98.5	99	5/15/99	0630																-	0	5			
38-2-55-41-1'	0.5	1	5/15/99	0805																-	0	6			
38-2-55-42-1' *	0.5	1	5/15/99	0810																-	0	7			
38-2-55-43-1'	0.5	1	5/15/99																						
38-2-55-44-1'	0.5	1	5/15/99																						
38-2-55-45-1'	0.5	1	5/15/99																						

Comments/Instructions:
(a) Metals include lead

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Kevin A Sullor	Kevin A Sullor	Montgomery Watson	5/15/99	0900
RECEIVED BY:	Douglas A. Honzay	Doug Honzay	Onsite Env Labs	5/15/99	0900
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

N° 095

MONTGOMERY WATSON

CHAIN OF CUSTODY RECORD

MW CONTACT PERSON:
Ben Holland (916) 921-3563

FED EX #:

COOLER #:

LAB: Applied Physics & Chemistry Laboratory Onsite

SAMPLER(S) PRINTED NAME AND SIGNATURE
[illegible]

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)																
3D 2 55 46-1'49-1' X	0.5	1	5/15/99	0820	1	P	NA		X							E	I	0	3	-	0	8			
3D 2 55 47-1'50-1'	0.5	1		0825																-		9			
3D 2 55 48-1'51-1'	0.5	1		0830																-	1	0			
3D 2 55 49-1'52-1'	0.5	1		0835																-	1	1			
3D 2 55 53-1'	0.5	1		0840																-	1	2			
3D 2 55 54-1'	0.5	1		0845																-	1	3			
3D 2 55 54-1'-99	98.5	99		0850																-	1	4			

Comments/Instructions:
(a) Metals include Lead

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	[illegible]	[illegible]	Montgomery Watson	5/15/99	0900
RECEIVED BY:	Douglas J. Honzay	Doug Honzay	Onsite Env. Labs	5/15/99	0900
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

No 097

MONTGOMERY WATSON

CHAI' F CUSTODY RECORD

MW CONTACT F ON:
Ben Holland (916) 921-3563

FED EX #: _____ COOLER #: _____ LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
Kristin Shelton, Kristin Shelton
Claudia Pedino Claudia Pedino

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)																
38-2-SS 59-1'	0.5	1	5/15/99	1220	1	P	NA		X					F	I	O	3	-	1	5					
38-2-SS 71	0	0.5	5/15/99	1230 1225	1														1	6					
38-2-SS 60-1'	0.5	1		1230															1	7					
38-2-SS 72	0	0.5		1227															1	8					
38-2-SS 60-1-99	98.5	99		1100															1	9					
38-2-SS 61-1'	0.5	1		1233															2	0					
38-2-SS 73	0	0.5		1235															2	1					
38-2-SS 62-1'	0.5	1		1238															2	2					
38-2-SS 74*	0	0.5		1237															2	3					
38-2-SS-30-1'	0.5	1		1240															2	4					

Comments/Instructions:
(a) Metals include lead

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Kristin Shelton	Kristin Shelton	Montgomery Watson	5/15/99	1330
RECEIVED BY:	Douglas J. Honzay	Doug Honzay	Onsite Env Labs	5/15/99	13:30
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

No 096

MONTGOMERY WATSON

CHA[illegible] OF CUSTODY RECORD

MW CONTACT [illegible]SON:
Ben Holland (916) 921-3563

FED EX #: _____ COOLER #: _____ LAB: Applied Physics & Chemistry Laboratory [illegible]

SAMPLER(S) PRINTED NAME AND SIGNATURE
[illegible] Shelton [illegible] Shelton
Claudia Patino Claudia Patino

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)														
38-2-55 65-1'	0.5	1	5/15/99	1250	1	P	[illegible]		X							F	I	0	3	-	2	5	
38-2-55 75	0	0.5		1252																	2	6	
38-2-55 66-1'	0.5	1		1257																	2	7	
38-2-55 76	0	0.5		1255																	2	8	
38-2-55 67-1'	0.5	1		1302																	2	9	
38-2-55 77	0	0.5		1300																	3	0	
38-2-55 68-1'*	0.5	1		1305																	3	1	
38-2-55 78	0	0.5		1307																	3	2	
38-2-55-69-1'	0.5	1		1310																	3	3	
38-2-55-79	0	0.5		1313																	3	4	

Comments/Instructions:
(a) Metals include lead

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Kristin A Shelton	Kristin A Shelton	Montgomery Watson	5/15/99	1330
RECEIVED BY:	Douglas J. Honzay	Doug Honzay	Onsite Env Labs	5/15/99	13:30
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

No 032

MONTGOMERY WATSON

CHAIN OF CUSTODY RECORD

MW CONTACT PERSON:
Ben Holland (916) 921-3563

FED EX #:

COOLER #:

LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
Kevin Shelton
Claudia Robinson

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)															
38 2 55 70-1'	0.5	1	5/15/99	1315	1	P	na		X							F	I	0	3	-	3	5		
38 2 55 70	0	0.5	↓	1318	1	P	na		X									↓		-	3	6		

Comments/Instructions:
(a) Metals include lead

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Kevin Shelton	Kevin Shelton	Montgomery Watson	5/15/99	1330
RECEIVED BY:	Douglas J Honzay	Doug Honzay	Onsite Env Labs	5/15/99	1330
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

MONTGOMERY WATSON

CHAIN OF CUSTODY RECORD

MW CONTACT FOR ON:
Ben Holland (916) 921-3563

FED EX #:

COOLER #:

LAB: Applied Physics & Chemistry Laboratory (Crystal)

SAMPLER(S) PRINTED NAME AND SIGNATURE:
Kristin Shelton [signature]
Claudia Patine [signature]

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)															
38-2-33-21	0	0.5	5/11/99	0850	1	P	N		X				F	I	0	4	-	0	1					
38-2-33-37-21 *	1.5	2	5/11/99	0853													-	0	2					
38-2-33-38-2 *	0	0.5	5/11/99	0855													-	0	3					
38-2-33-38-2	1.5	2	5/11/99	0857													-	0	4					
38-2-33-83	0	0.5	5/11/99	0901													-	0	5					
38-2-33-39-21	1.5	2	5/11/99	0903													-	0	6					
38-2-33-84 **	0	0.5	5/11/99	0905													-	0	7					
38-2-33-40-21	1.5	2	5/11/99	0907													-	0	8					
38-2-33-85	0	0.5	5/11/99	0908													-	0	9					
38-2-33-~~85-79~~ 84-99	98.5	99	5/11/99	0910													-	1	0					

Comments/Instructions:
(a) Metals include lead

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Kristin Shelton	Kristin Shelton	Montgomery Watson	5/11/99	1010
RECEIVED BY:	Douglas J. Honzay	Doug Honzay	Onsite Env Labs	5/11/99	1010
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

No 022

MONT('ERY WATSON

CHAIN CUSTODY RECORD

MW CONTACT PE ON:
Ben Holland (916) 921-3563

FED EX #: _____ COOLER #: _____ LAB: Applied Physics & Chemistry Laboratory Onsite

SAMPLER(S) PRINTED NAME AND SIGNATURE
Kristin Shelton Kristin Shelton
Claudia Pedrino [illegible]

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)														
38-2-55-86	0	0.5	5/16/99	0912	1	P	DA		X					F	I	0	4	-	1	1			
38-2-55-87	0	0.5	5/16/99	0924														-	1	2			
38-2-55-49-21*	1.5	2	5/16/99	0926														-	1	3			
38-2-55-88	0	0.5	5/16/99	0928														-	1	4			
38-2-55-50-21*	1.5	2	5/16/99	0930														-	1	5			
38-2-55-89	0	0.5	5/16/99	0933														-	1	6			
38-2-55-51-~~2~~ 1.5'	1.5	2	5/16/99	0935														-	1	7			
38-2-55-90	0	0.5	5/16/99	0943														-	1	8			
38-2-55-52-~~2~~ 1.5'	1.5	2	5/16/99	0945														-	1	9			
38-2-55-91*	0	0.5	5/16/99	0954														-	2	0			

Comments/Instructions:
(a) Metals include lead

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Kristin Shelton	Kristin Shelton	Montgomery Watson	5/16/99	1010
RECEIVED BY:	Douglas J. Honzay	Doug Honzay	Onsite Env Labs	5/16/99	1010
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

No 002

MONTGOMERY WATSON

CHAIN OF CUSTODY RECORD

MW CONTACT PERSON:
Ben Holland (916) 921-3563

FED EX #:

COOLER #:

LAB: Applied Physics & Chemistry Laboratory Onsite

SAMPLER(S) PRINTED NAME AND SIGNATURE
Kristin Shelton Kristin Shelton
Charlie Atkins Charlie Atkins

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)														
38-2-55-53-21 *	1.5	2	5/16/99	0930	1	P	DA		X						F	I	0	4	-	2	1		
38-2-55-92 **	0	0.5	5/16/99	1000	↓	↓	↓		↓								↓		-	2	2		
38-2-55-52-21	1.5	2	5/16/99	1005	↓	↓	↓		↓										-	2	3		
38-2-55-30-2.99	2.5	99	5/16/99	0910	↓	↓	↓		↓								↓		-	2	4		

Comments/Instructions:
(a) Metals include Lead

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Kristin Shelton	Kristin Shelton	Montgomery Watson	5/16/99	1010
RECEIVED BY:	Douglas J. Honzay	Doug Honzay	Onsite Env Labs	5/16/99	1010
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

No 094

MONTGOMERY WATSON

CHA[illegible] OF CUSTODY RECORD

MW CONTACT [illegible]SON:
Ben Holland (916) 921-3563

FED EX #:

COOLER #:

LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE

[illegible]

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)														
3[illegible] 93	0	0.5	5/16/99	1105	1	P	NA		X					F	I	0	4	-	2	5			
3[illegible] 94	0	0.5		1107														-	2	6			
3[illegible] 95	0	0.5		1109														-	2	7			
3[illegible] 96	0	0.5		1111														-	2	8			
3[illegible] 97	0	0.5		1113														-	2	9			
3[illegible] 98	0	0.5		1115														-	3	0			
3S-[illegible] 99	0	0.5		1118														-	3	1			
3[illegible] 100	0	0.5		1120														-	3	2			
3[illegible] 23-1'	0.5	1		1122														-	3	3			
3[illegible] 24-1'	0.5	1		1125														-	3	4			

Comments/Instructions:
(a) Metals include [illegible]

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	[illegible]	[illegible]	Montgomery Watson	5/16/99	1200
RECEIVED BY:	Douglas J. Honzay	Doug Honzay	Onsite Env Labs	5/16/99	1200
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

No 000

MONTGOMERY WATSON

CHA[illegible] OF CUSTODY RECORD

MW CONTACT [illegible]SON:
Ben Holland (916) 921-3563

FED EX #:

COOLER #:

LAB: Applied Physics & Chemistry Laboratory Onsite

SAMPLER(S) PRINTED NAME AND SIGNATURE,
Kristi Shelton Kristin Shelton
Claudia Patiño Claudia J Patiño

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)														
38-2-SS-25-1'	0.5	1	5/16/99	1128	1	P	M		X					F	I	0	4	-	3	5			
38-2-SS-26-1'	0.5	1		1130														-	3	6			
38-2-SS-27-1'	0.5	1		1133														-	3	7			
38-2-SS-28-1' *	0.5	1		1135														-	3	8			
38-2-SS-11-2'	1.5	2		1140														-	3	9			
38-2-SS-12-2'	1.5	2		1145														-	4	0			
38-2-SS-13-2'	1.5	2		1150														-	4	1			
38-2-SS-14-2'	1.5	2		1155														-	4	2			
38-2-SS-31-1'	0	0.5		1200														-	4	3			
38-2-SS-16-1'	0	0.5		1205														-	4	4			

Comments/Instructions:
(a) Metals include lead

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Kristin Shelton	Kristin Shelton	Montgomery Watson	5/16/99	1200
RECEIVED BY:	Douglas J. Honzay	Doug Honzay	Onsite Env Labs	5/16/99	1200
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

No 080

MONTGOMERY WATSON

CHAIN OF CUSTODY RECORD

MW CONTACT PERSON:
Ben Holland (916) 921-3563

FED EX #: _____ COOLER #: _____ LAB: Applied Physics & Chemistry Laboratory Onsite

SAMPLER(S) PRINTED NAME AND SIGNATURE
Kristin Shelton Kristin Shelton
Claudia Patiño Claudia Patiño

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)														
38-2-33-11-2-99	98.5	99	5/16/99	1100	1	P	DA		X					F	I	0	4	-	4	5			

Comments/Instructions:
(a) Metals include lead

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Kristin A Shelton	Kristin Shelton	Montgomery Watson	5/16/99	1200
RECEIVED BY:	Douglas J. Honzay	Doug Honzay	Onsite Env Labs	5/16/99	1200
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

No 087

MONT[illegible]MERY WATSON

CHAI[illegible] F CUSTODY RECORD

MW CONTACT F[illegible] ON:
Ben Holland (916) 921-3563

FED EX #: _____ COOLER #: _____ LAB: Applied Physics & Chemistry Laboratory Onsite

SAMPLER(S) PRINTED NAME AND SIGNATURE
Kristin Shelton Kristin Shelton
Claudia Patino Claudia Patino

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)														
38-2-SS-101 **	0	0.5	5/17/99	0950	1	P	NA		X					F	I	0	5	-	0	1			
38-2-SS-102	0	0.5	5/17/99	0955														-	0	2			
38-2-SS-103	0	0.5	5/17/99	0958														-	0	3			
38-2-SS-103-99	98.5	99	0715 5/17/99	0700														-	0	4			
38-2-SS-104	0	0.5	1000 5/17/99	1000														-	0	5			
38-2-SS-104-99	98.5	99	0715 5/17/99	0710														-	0	6			
38-2-SS-105	0	0.5	5/17/99	1003														-	0	7			
38-2-SS-105-99	98.5	99		0715														-	0	8			
38-2-SS-106	0	0.5		1005														-	0	9			
38-2-SS-106-99	98.5	99		0720														-	1	0			

Comments/Instructions:
(a) Metals include Lead

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Kristin Shelton	Kristin Shelton	Montgomery Watson	5/17/99	1115
RECEIVED BY:	Douglas J. Honzay	Doug Honzay	Onsite Env. Labs	5/17/99	1115
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

No 090

MONTGOMERY WATSON

CHAIN OF CUSTODY RECORD

MW CONTACT PERSON:
Ben Holland (9..., 921-3563

FED EX #:

COOLER #:

LAB: Applied Physics & Chemistry Laboratory Onsite

SAMPLER(S) PRINTED NAME AND SIGNATURE
Kristi Shelton
Claudia Rubio

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)															
38-2-55-107	0	0.5	5/17/99	1007	1	P	PM		X					F	I	0	5	-	1	1				
38-2-55-107-99	98.5	99		0725														-	1	2				
38-2-55-108	0	0.5		1015														-	1	3				
38-2-55-108-99	98.5	99		0730														-	1	4				
38-2-55-109	0	0.5		1022														-	1	5				
38-2-55-109-99	98.5	99		0735														-	1	6				
38-2-55-110	0	0.5		1027														-	1	7				
38-2-55-110-99	98.5	99																						
38-2-55-111	0	0.5		1035										F	I	0	5	-	1	8				
38-2-55-111-99	98.5	99																						

Comments/Instructions:
(a) Metals include lead

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Kristin Shelton	Kristin Shelton	Montgomery Watson	5/17/99	1115
RECEIVED BY:	Douglas J. Honzay	Doug Honzay	Onsite Env Lab	5/17/99	1115
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

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MONTGOMERY WATSON

CHAIN OF CUSTODY RECORD

MW CONTACT PERSON:
Ben Holland (916) 921-3563

FED EX #: _____ COOLER #: _____ LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
Kristin Shelton, Kristin Shelton
Claudia Patino, Claudia Patino

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)														
38-2-SS-112	0	0.5	5/17/99	1042	1	P	M		X							F	I	0	5	-	1	9	
~~38-2-SS-112-99~~										KTS													
38-2-SS-113	0	0.5		1050												F	I	0	5	-	2	0	
~~38-2-SS-113-99~~										KTS													
38-2-SS-114	0	0.5		1100												F	I	0	5	-	2	1	
38-2-SS-~~115~~-23-2'	1.5	2		1020																-	2	2	
38-2-SS-24-2'	1.5	2		1025																-	2	3	
38-2-SS-25-2'	1.5	2		1030																-	2	4	
38-2-SS-26-2' **	1.5	2		1040																-	2	5	
38-2-SS-27-2'	1.5	2		1045																-	2	6	

Comments/Instructions:
(a) Metals include

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Douglas J. Honzay	Kristin Shelton	Montgomery Watson	5/17/99	1115
RECEIVED BY:	Kristin Shelton	Doug Honzay	Onsite Env Labs	5/17/99	1115
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

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No 086

MONTGOMERY WATSON

CHAIN OF CUSTODY RECORD

MW CONTACT PERSON:
Ben Holland (916) 921-3563

FED EX #: _____ COOLER #: _____ LAB: Applied Physics & Chemistry Laboratory Onsite

SAMPLER(S) PRINTED NAME AND SIGNATURE
Kristin Shelton, Kristin Shelton
Claudia Patiño [signature]

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)														
38-2 SS 28-2'	1.5	.2	5/17/99	1055	1	P	NA		X						F	I	0	5	-	2	7		

Comments/Instructions:
(a) Metals include lead

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Kristin Shelton	Kristin Shelton	Montgomery Watson	5/17/99	1115
RECEIVED BY:	Douglas J. Honzay	Doug Honzay	Onsite Env Lab	5/17/99	1115
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

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MONTGOMERY WATSON

CHAIN OF CUSTODY RECORD

MW CONTACT PERSON:
Ben Holland (916) 921-3563

FED EX #:

COOLER #:

LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
Kristin Shelton
Claudia Palmo

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)														
38 2 55 37 3'	2.5	3	5/18/99	0955	1	P	NA		X					F	I	0	6	-	0	1			
38-2-55 37-3'-99	98.5	99		0900														-	0	2			
38 2 55 81 1' *	0.5	1		0930														-	0	3			
38 2 55 115 *	0	0.5		0935														-	0	4			
38 2 55 38 3'	2.5	3		0940														-	0	5			
38 2 55 116	0	0.5		0945														-	0	6			
38 2 55 82-1' **	0.5	1		0950														-	0	7			
38 2 55 82-1'-99	98.5	99		0710														-	0	8			
38 2 55 117	0	0.5		0955														-	0	9			
38 2 55 83 1'	0.5	1		1000														-	1	0			

Comments/Instructions:
(a) Metals include lead

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Kristin Shelton	Kristin Shelton	Montgomery Watson	5/18/99	1215
RECEIVED BY:	Douglas J. Hanzay	Doug Hanzay	Onsite Env Labs	5/18/99	1215
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

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MONTGOMERY WATSON

CHAIN OF CUSTODY RECORD

MW CONTACT PERSON:
Ben Holland (916) 921-3563

FED EX #:

COOLER #:

LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
Kristin Shelton, Kristin Shelton
Claudia Patino, Claudia Patino

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)																
38-2-35 84-1' *	0.5	1	5/18/99	1010	1	P	NA		X					F	I	0	6	-	1	1					
38-2-35-118	0	0.5	↓	1005	↓	↓	↓		↓							↓		-	1	2					
38-2-35-119	0	0.5		1015														-	1	3					
38-2-35 85-1'	0.5	1		1020														-	1	4					
38-2-35 31-2'	1.5	2		1025														-	1	5					
38-2-35 120	0	0.5		1030														-	1	6					
38-2-35 49-3'	2.5	3		1035														-	1	7					
38-2-35 50-3'	2.5	3		1040														-	1	8					
38-2-35 31-3' *	2.5	3		1045														-	1	9					
38-2-35-121	0	0.5	↓	1050	↓	↓	↓		↓							↓		-	2	0					

Comments/Instructions:
(a) Metals include

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Kristin Shelton	Kristin Shelton	Montgomery Watson	5/18/99	1215
RECEIVED BY:	Douglas J. Honzay	Doug Honzay	Onsite Env Labs	5/18/99	1215
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

N° 037

MONT' MERY WATSON

CHAI' ' CUSTODY RECORD

MW CONTACT P ON:
Ben Holland (916) 921-3563

FED EX #: _____ COOLER #: _____ LAB: Applied Physics & Chemistry Laboratory Onsite

SAMPLER(S) PRINTED NAME AND SIGNATURE
Kristin Shelton Kristin Shelton
Claudia Patiño Claudia Patiño

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)																
38-2-55-89-1'	0.5	1	5/18/99	1055	1	P	DA		X					F	I	0	6	-	2	1					
38-2-55-124	0	0.5		1100														-	2	2					
38-2-55-51-3'-99	98.5	99		0715														-	2	3					
38-2-55-122	0	0.5		1105														-	2	4					
38-2-55-90-1'	0.5	1		1110														-	2	5					
38-2-55-125	0	0.5		1115														-	2	6					
38-2-55-53'-3'	2.5	3		1120														-	2	7					
38-2-55-53-3'-99	98.5	99		0725														-	2	8					
38-2-55-126	0	0.5		1130														-	2	9					
38-2-55-123	0	0.5		1125														-	3	0					

Comments/Instructions:
(a) Metals include lead

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Kristin Shelton	Kristin Shelton	Montgomery Watson	5/18/99	1215
RECEIVED BY:	Douglas J. Honzay	Doug Honzay	Onsite Env. Labs	5/18/99	1215
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

No 020

MONTGOMERY WATSON

CHAIN OF CUSTODY RECORD

MW CONTACT PERSON:
Ben Holland (916) 921-3563

FED EX #:

COOLER #:

LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
Kristin Shelton
Claudia Patino

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)														
38-2-55-121-1	0.5	1	5/18/99	1135	1	P	NA		X				F	I	0	6	-	3	1				
38-2-55-127	0	0.5		1140													-	3	2				
38-2-55-128	0	0.5		1145													-	3	3				
38-2-55-129 *	0	0.5		1150													-	3	4				
38-2-55-130	0	0.5		1155													-	3	5				
38-2-55-131	0	0.5		1200													-	3	6				
38-2-55-132	0	0.5		1205													-	3	7				
38-2-55-133 *	0	0.5		1210													-	3	8				

Comments/Instructions:
(a) Metals include

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Kristin Shelton	Kristin Shelton	Montgomery Watson	5/18/99	1215
RECEIVED BY:	Douglas J. Honzay	Doug Honzay	Onsite Env Labs	5/18/99	1215
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

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No 039

MONTGOMERY WATSON

CHAIN OF CUSTODY RECORD

MW CONTACT FOR ON:
Ben Holland (916) 921-3563

FED EX #:

COOLER #:

LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
Claudia Patino
Kushin Shelton

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)															
38-2-SS-11-3	2.5	3.0	5/19/99	0800	1	P	NA		X					F	I	0	7	-	0	1				
38-2-SS-37-4	3.5	4.0		0805														-	0	2				
38-2-SS-37-4-99	98.5	99.0		0700														-	0	3				
38-2-SS-134	~~133~~	Ø		0815														-	0	4				
38-2-SS-115-1	0.5	1.0		0810														-	0	5				
38-2-SS-12-3	2.5	3.0		0820														-	0	6				
38-2-SS-103-1	0.5	1.0		0825														-	0	7				
38-2-SS-103-1-99	98.5	99.0		0710														-	0	8				
38-2-SS-135	Ø	Ø		0830														-	0	9				

Comments/Instructions:
(a) Metals include Lead

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Claudia Patino	Claudia Patino	Montgomery Watson	5/19/99	0835
RECEIVED BY:	Douglas F. Honzay	Doug Honzay	Onsite Env. Labs	5/19/99	0835
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

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MONTGOMERY WATSON

CHAIN OF CUSTODY RECORD

MW CONTACT F ON:
Ben Holland (9) 921-3563

FED EX #:

COOLER #:

LAB: Applied Physics & Chemistry Laboratory Onsite

SAMPLER(S) PRINTED NAME AND SIGNATURE
Claudia Patino Claudia Patino
Kristin Shelton Kristin Shelton

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)															
38-2-55-136	0	0	5/19/99	0900	1	P	M		X				F	I	C	7	-	1	0					
38-2-55-39-443	2.5	3.0		0905													-	1	1					
38-2-55-102-2	1.5	2.0		0910													-	1	2					
38-2-55-118-1	0.5	1.0		0912													-	1	3					
38-2-55-137	0	0		0915													-	1	4					
38-2-55-105-1	0.5	1.0		0917													-	1	5					
38-2-55-138	0	0		0918													-	1	6					
38-2-55-36-2	1.5	2.0		0920 0921													-	1	7					
38-2-55-75-1	0.5	1.0		0928													-	1	8					
38-2-55-102-1	0.5	1.0		0930													-	1	9					

Comments/Instructions:
(a) Metals include Lead

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Claudia Patino	Claudia Patino	Montgomery Watson	5/19/99	0950
RECEIVED BY:	Douglas J. Honzay	Doug Honzay	Onsite Env. Labs	5/19/99	0950
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

No 041

MONTGOMERY WATSON

CHAIN OF CUSTODY RECORD

MW CONTACT PERSON:
Ben Holland (916) 921-3563

FED EX #: _____ COOLER #: _____ LAB: ~~Applied Physics & Chemistry Laboratory~~ Onsite

SAMPLER(S) PRINTED NAME AND SIGNATURE
Claudia Patino Claudia Patino
Kristin Shelton Kristin Shelton

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)														
38-2-SS-139	Ø	Ø	5/19/99	0932	1	P	NA		X					F	I	0	7	-	2	0			
38-2-SS-140	Ø	Ø		0935														-	2	1			
38-2-SS-77 1**	0.5	1.0		1135														-	2	2			
38-2-SS-67 2	1.5	2.0		1140														-	2	3			
38-2-SS-52 3	2.5	3.0		1145														-	2	4			
38-2-SS-78 1	0.5	1.0		1155														-	2	5			
38-2-SS-126-1 *	0.5	1.0		1220														-	2	6			
38-2-SS-141	Ø	Ø		1225														-	2	7			
38-2-SS-112-1	0.5	1.0		1215														-	2	8			
38-2-SS-147 *	Ø	Ø		1220														-	2	9			

Comments/Instructions:
(a) Metals include Lead

* Contamination ** split (QA)

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Claudia Patino	Claudia Patino	Montgomery Watson	5/19/99	1250
RECEIVED BY:	Douglas J Hanzay	Doug Hanzay	Onsite Env Labs	5/19/99	1250
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

No 042

MONTGOMERY WATSON

CHAIN OF CUSTODY RECORD

MW CONTACT PERSON:
Ben Holland (916) 921-3563

FED EX #: _____ COOLER #: _____ LAB: ~~Applied Physics & Chemistry Laboratory~~ Onsite

SAMPLER(S) PRINTED NAME AND SIGNATURE
Claudia Patiño [signature]
Kristin Shelton [signature]

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)														
38-2-55-116-1	0.5	1.0	5/19/99	0855	1	P	NA		X				F	I	0	7	-	3	0				
38-2-55-116-1-99	98.5	99.0	↓	0715	↓	↓	↓		↓						↓		-	3	1				
38-2-55-79-1 *	0.5	1.0		1230													-	3	2				
38-2-55-125-1	0.5	1.0		1240													-	3	3				
38-2-55-143 *	0	0		1245													-	3	4				
38-2-55-112-1-99	98.5	99.0	↓	0730	↓	↓	↓		↓						↓		-	3	5				
~~38-2-55-137~~ CP																							
~~38-2-55-108-1~~ CP																							
~~38-2-55-105-1~~ CP																							
~~38-2-55-139~~ CP																							

Comments/Instructions:
(a) Metals include Lead

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Claudia Patiño	Claudia Patiño	Montgomery Watson	5/19/99	1250
RECEIVED BY:	Douglas J Honzay	Doug Honzay	Onsite Env. Labs	5/19/99	1250
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

No 044

MONTGOMERY WATSON

CHAIN OF CUSTODY RECORD

MW CONTACT SON:
Ben Holland (916) 921-3563

FED EX #:

COOLER #:

LAB: Applied Physics & Chemistry Laboratory Onsite

SAMPLER(S) PRINTED NAME AND SIGNATURE
Kristin Shelton
Charlie Pedrico

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)															
38 2-55-111-1'	0.5	1	5/19/99	1735	1	P	na		X					F	I	0	7	-	3	6				
38 2-55-145	0	0.5		1745														-	3	7				
38 2-55-12 4'-99	3.5	4		0630														-	3	8				
38 2-12-55-12-4'	3.5	4		1730														-	3	9				
38 2-55-116	0	0.5		1715														-	4	0				
38 2-55-37 3'	4.5	5		1455														-	4	1				
38 2-55-115-2	1.5	2		1525														-	4	2				
38 2-55-73-1'	0.5	1		1520														-	4	3				
38 2-55-144	0	0.5		1515														-	4	4				
38-2-55-54-3'	2.5	3		1755														-	4	5				

Comments/Instructions:
(a) Metals include lead

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Kristin A Shelton	Kristin Shelton	Montgomery Watson	5/19/99	1800
RECEIVED BY:	Douglas J. Honzay	Doug Honzay	Onsite Env. Labs	5/19/99	1800
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

No 045

MON OMERY WATSON

CHA OF CUSTODY RECORD

MW CONTACT SON:
Ben Holland (916) 921-3563

FED EX #:

COOLER #:

LAB: Applied Physics & Chemistry Laboratory

SAMPLER(S) PRINTED NAME AND SIGNATURE
Kristi Shelton Kristi Shelton
Claudia Patino Claudia Patino

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)														
38-2-55-70-2' *	1.5	2	5/20/99	0920	1	P	(N)		X					F	I	O	8	-	0	1			
38-2-55-113-1'	0.5	1		0925														-	0	2			
38-2-55-146	0	0.5		0930														-	0	3			
38-2-55-146-99	0	0.5		0800														-	0	4			
38-2-55-151	0	0.5		0935														-	0	5			
38-2-55-27-3' *	2.5	3		0945														-	0	6			
38-2-55-152 *	0	0.5		0950														-	0	7			
38-2-55-142-1'	0.5	1		0955														-	0	8			
38-2-55-147	0	0.5		1000														-	0	9			
38-2-55-142-1-99	0.5	1		0810														-	1	0			

Comments/Instructions:
(a) Metals include lead

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Kristin A Shelton	Kristin A Shelton	Montgomery Watson	5/20/99	1115
RECEIVED BY:	Douglas J. Honzay	Doug Honzay	Onsite Env Labs	5/20/99	1115
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

No 048

MONTGOMERY WATSON

CHAIN OF CUSTODY RECORD

MW CONTACT PERSON:
Ben Holland (916) 921-3563

FED EX #: _____ COOLER #: _____ LAB: ~~Applied Physics & Chemistry Laboratory~~ Onsite

SAMPLER(S) PRINTED NAME AND SIGNATURE
Kristi Shelton Kristi Shelton
Claudia Patino Claudia Patino

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)														
38-2-55-26-3'	2.5	3	5/20/99	1005	1	P	NA		X				F	I	0	8	-	1	1				
38-2-55-153	0	0.5		1010													-	1	2				
38-2-55-148	0	0.5		1015													-	1	3				
38-2-55-151	0	0.5		1020													-	1	4				
38-2-55-155 *	0	0.5		1025													-	1	5				
38-2-55-156	0	0.5		1030													-	1	6				
38-2-55-49-4'	3.5	4		1035													-	1	7				
38-2-55-49-4-99	3.5	4		0930													-	1	8				
38-2-55-150	0	0.5		1040													-	1	9				
38-2-55-149	0	0.5		1045													-	2	0				

Comments/Instructions:
(a) Metals include Lead

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Kristi Shelton	Kristi Shelton	Montgomery Watson	5/20/99	1115
RECEIVED BY:	Douglas J. Honzay	Doug Honzay	Onsite Env Labs	5/20/99	1115
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

MONTGOMERY WATSON

CHAIN OF CUSTODY RECORD

MW CONTACT PERSON:
Ben Holland (916) 921-3563

FED EX #:

COOLER #:

LAB: ~~Applied Physics & Chemistry Laboratory~~ Onsite

SAMPLER(S) PRINTED NAME AND SIGNATURE
Kristi Shelton Kristi Shelton
Claudia Patiño Claudia Patiño

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)															
38-2-SS-157	0	0.5	5/20/99	1050	1	P	NA		X						F	I	0	8	-	2	1			
38-2-SS-158	0	0.5	↓	1055	↓	↓	↓		↓								↓		-	2	2			
38-2-SS-12-5' *	4.5	5		1100															-	2	3			
38-2-SS-159	0	0.5		1105															-	2	4			
38-2-SS-160	0	0.5		1110															-	2	5			

Comments/Instructions:
(a) Metals include Lead

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Kristi Shelton	Kristi Shelton	Montgomery Watson	5/20/99	1115
RECEIVED BY:	Douglas J. Honzay	Doug Honzay	Onsite Env Labs	5/20/99	1115
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

No 051

MONTGOMERY WATSON

CHAIN OF CUSTODY RECORD

MW CONTACT PERSON:
Ben Holland (916) 921-3563

FED EX #:

COOLER #:

LAB: Applied Physics & Chemistry Laboratory Onsite

SAMPLER(S) PRINTED NAME AND SIGNATURE
Kristin Shelton Kristin Shelton
Claudia Patrick Claudia Patrick

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)	
38 2 55 1601	0	0.5	5/21/99	0810	1	P	NA		X	FI09-01
38 2 55 1602	0	0.5		0815						-02
38 2 55 1603	0	0.5		0820						-03
38 2 55 1604	0	0.5		0825						-04
38 2 55 1603-99	98.5	99		0700						-05
38 2 55 1605	0	0.5		0830						-06
38 2 55 1606	0	0.5		0835						-07
38 2 55 1607	0	0.5		0840						-08
38 2 55 1608	0	0.5		0845						-09
38 2 55 1609	0	0.5		0850						-10

Comments/Instructions:
(a) Metals include Lead

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Kristin Shelton	Kristin Shelton	Montgomery Watson	5/21/99	0930
RECEIVED BY:	Douglas J. Honzay	Doug Honzay	Onsite Env labs	5/21/99	0930
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

No 050

MONTGOMERY WATSON

CHAIN OF CUSTODY RECORD

MW CONTACT PERSON:
Ben Holland (916) 921-3563

FED EX #:

COOLER #:

LAB: Applied Physics & Chemistry Laboratory Onsite

SAMPLER(S) PRINTED NAME AND SIGNATURE
Kristin Shelton Kristin Shelton
Claudia Patino Claudia Patino

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

171

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)															
38 2 SS 171	0	0.5	5/21/99	0855	1	P	NA		X				F	I	0	9	-	1	1					
38 2 SS 172	0	0.5		0900													-	1	2					
38 2 SS 172-99	0	0.5		0910													-	1	3					
38 2 SS 173	0	0.5		0905													-	1	4					
38 2 SS 174	0	0.5		0910													-	1	5					
38 2 SS 170	0	0.5		0850													-	1	6					

Comments/Instructions:
(a) Metals include Lead

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Kristin A Shelton	Kristin A Shelton	Montgomery Watson	5/21/99	0930
RECEIVED BY:	Douglas A. Honzay	Doug Honzay	Onsite Env Labs	5/21/99	0930
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

No 055

MONTGOMERY WATSON

CHAIN OF CUSTODY RECORD

MW CONTACT PERSON:
Ben Holland (916) 921-3563

FED EX #:

COOLER #:

LAB: ~~Applied Physics & Chemistry Laboratory~~ ONS 112

SAMPLER(S) PRINTED NAME AND SIGNATURE
Claudia Patino
Kristin Shelton

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)															
38 2-SS-175	Ø	Ø	5/21/99	~~1005~~ 1105	1	P	NA		X				F	I	0	9	-	1	7					
38 2-SS-176 *	Ø	Ø	5/21/99	~~1010~~ 1102	1	P	NA		X								-	1	8					
38-2-SS-177	Ø	Ø	5/21/99	~~1015~~ 1057	1	P	NA		X								-	1	9					
38-2-SS-178	Ø	Ø	5/21/99	~~1020~~ 1100	1	P	NA		X								-	2	0					
38-2-SS-179 *	Ø	Ø	5/21/99	~~1025~~ 1055	1	P	NA		X								-	2	1					
38-2-SS-180	Ø	Ø	5/21/99	~~1030~~ 1052	1	P	NA		X								-	2	2					
38-2-SS-181	Ø	Ø	5/21/99	~~1035~~ 1046	1	P	NA		X								-	2	3					
38-2-SS-182 *	Ø	Ø	5/21/99	~~1040~~ 1050	1	P	NA		X								-	2	4					
38-2-SS-183	Ø	Ø	5/21/99	1040	1	P	NA		X								-	2	5					
38-2-SS-184	Ø	Ø	5/21/99	1043	1	P	NA		X								-	2	6					

Comments/Instructions:
(a) Metals include Lead

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Claudia Patino	Claudia Patino	Montgomery Watson	5/21/99	1110
RECEIVED BY:	Douglas F. Honzay	Doug Honzay	Onsite Env Labs	5/21/99	1110
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

N° 052

MONTGOMERY WATSON

CHAIN OF CUSTODY RECORD

MW CONTACT PERSON:
Ben Holland (916) 921-3563

FED EX #: _____ COOLER #: _____ LAB: ~~Applied Physics & Chemistry Laboratory~~ Onsite

SAMPLER(S) PRINTED NAME AND SIGNATURE
Claudia Patiño Claudia Patiño
Kristin Shelton Kristin Shelton

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)														
38-2-SS-182-99	Ø	Ø	5/21/99	0745	1	P	1A		X				F	I	0	9	-	2	7				
38-2-SS-185*	Ø	Ø	5/21/99	1037													-	2	8				
38-2-SS-186	Ø	Ø	5/21/99	1039													-	2	9				
38-2-SS-187	Ø	Ø	5/21/99	1033													-	3	0				
38-2-SS-188*	Ø	Ø	5/21/99	1030													-	3	1				
38-2-SS-189	Ø	Ø	5/21/99	1025													-	3	2				
38-2-SS-190	Ø	Ø	5/21/99	1005													-	3	3				
38-2-SS-190-99	Ø	Ø	5/21/99	0730													-	3	4				
38-2-SS-191*	Ø	Ø	5/21/99	1015													-	3	5				
38-2-SS-192	Ø	Ø	5/21/99	1020													-	3	6				

Comments/Instructions:
(a) Metals include Lead

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Claudia Patiño	Claudia Patiño	Montgomery Watson	5/21/99	1110
RECEIVED BY:	Douglas J. Honzay	Doug Honzay	Onsite Env. Labs	5/21/99	1110
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

№ 054

MONTGOMERY WATSON

CHAIN OF CUSTODY RECORD

MW CONTACT PERSON:
Ben Holland (916) 921-3563

FED EX #:

COOLER #:

LAB: ~~Applied Physics & Chemistry Laboratory~~ ONSITE

SAMPLER(S) PRINTED NAME AND SIGNATURE
Claudia Patino
Kristin Holton

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)															
38-2-SS-193 *	0	0.5	5/22/99	0800	1	P	NA		X			F	I	1	0	-	0	1						
38-2-SS-194	0	0.5		0805												-	0	2						
38-2-SS-194-97	98.5	99		0810												-	0	3						
38-2-SS-195	Ø	Ø		0813												-	0	4						
38-2-SS-196 *	Ø	Ø		0815												-	0	5						
38-2-SS-197	Ø	Ø		0817												-	0	6						
38-2-SS-198	Ø	Ø		0823												-	0	7						
38-2-SS-199	Ø	Ø		0819												-	0	8						
38-2-SS-200 *	Ø	Ø		0821												-	0	9						
38-2-SS-201	Ø	Ø		0823												-	1	0						

Comments/Instructions:
(a) Metals include Lead

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Claudia Patino	Claudia Patino	Montgomery Watson	5/22/99	0945
RECEIVED BY:	Douglas J. Honzay	Doug Honzay	Onsite Env Labs	5/22/99	0945
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

MONTGOMERY WATSON

CHAIN OF CUSTODY RECORD

MW CONTACT PERSON:
Ben Holland (916) 921-3563

FED EX #: _____ COOLER #: _____ LAB: ~~Applied Physics & Chemistry Laboratory~~ ONSITE

SAMPLER(S) PRINTED NAME AND SIGNATURE
Claudia Patiño Claudia Patiño
Kristin Shelton Kristin Shelton

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)														
38-2-SS-201-99	Ø	Ø	5/22/99	0745	1	P	NA		X				FI	1	0	-	1	1					
38-2-SS-202	Ø	Ø		0826												-	1	2					
38-2-SS-203 *	Ø	Ø		0829												-	1	3					
38-2-SS-204	Ø	Ø		0838												-	1	4					
38-2-SS-205	Ø	Ø		0840												-	1	5					
38-2-SS-206	Ø	Ø		0842												-	1	6					
38-2-SS-207	Ø	Ø		0844												-	1	7					
38-2-SS-207-99	Ø	Ø		0750												-	1	8					
38-2-SS-208	Ø	Ø		0846												-	1	9					
38-2-SS-209	Ø	Ø		0848												-	2	0					

Comments/Instructions:
(a) Metals include Lead

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	Claudia Patiño	Claudia Patiño	Montgomery Watson	5/22/99	0945
RECEIVED BY:	Douglas J. Honzay	Doug Honzay	Onsite Env Labs	5/22/99	0945
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

MONTGOMERY WATSON

CHAIN OF CUSTODY RECORD

MW CONTACT FOR ON:
Ben Holland (916) 921-3563

FED EX #: _____ COOLER #: _____ LAB: ~~Applied Physics & Chemistry Laboratory~~ ONS IIE

SAMPLER(S) PRINTED NAME AND SIGNATURE
Claudio Patino [signature]
Kristin Shelton [signature]

PROJECT NAME: FTIR-32A, FTIR-38, FTIR-39, and FTIR-40 RI

PROJECT NUMBER: 1212018.371609

ANALYSIS REQUEST

SAMPLE DESCRIPTION	SBD	SED	DATE	TIME	BC	CT	PR	SVOCs 8270	Metals 6010/7000 (a)															
38 2 SS 210 *	Ø	Ø	5/22/99	0850	1	P	MA		X				F	I	1	0	-	2	1					
38 2 SS - 211	Ø	Ø		0900													-	2	2					
38 2 SS 212	Ø	Ø		0905													-	2	3					
38 2 SS 213	Ø	Ø		0910													-	2	4					
38 2 SS 214	Ø	Ø		0915													-	2	5					
38 2 SS 215	Ø	Ø		0920													-	2	6					
38 2 SS 216	Ø	Ø		0925													-	2	7					
38 2 SS 217	Ø	Ø		0930													-	2	8					
38 2 SS 218	Ø	Ø		0935													-	2	9					
38 2 SS - 219	Ø	Ø		0940													-	3	0					

Comments/Instructions:
(a) Metals include Lead

	Signature:	Print Name:	Company Name/Title:	Date:	Time:
RELINQUISHED BY:	[signature]	Claudio Patino	Montgomery Watson	5/22/99	0945
RECEIVED BY:	Douglas for Honzay	Doug Honzay	Onsite Env Labs	5/22/99	0945
RELINQUISHED BY:					
RECEIVED BY:					

For Lab Use Only: Sample Condition Upon Receipt:

Legend
Sample Type Code (SA): From IRPIMS Handbook
SBD: Sample Beginning Depth
SED: Sample Ending Depth

Sampling Matrix Code (MC): From IRPIMS Handbook
Bottle Count (BC): 1,2,3, etc.
Container Type (CT): B = Brass Sleeve, A= Amber Glass, G = Clear Glass, P = Plastic

Preservative (PR): NA = None, A = HNO3, B = H2SO4, C = HCl, D = NaOH

ORIGINAL: Send with sample (sign only in blue or black ink)

COPIES: Retained by Sampler, Sent to Office

No 057

APPENDIX I

DATA VALIDATION REPORTS

DATA VALIDATION REPORT

Project Name:	Fort Irwin DO 37 Sites 32A, 38, 39, 40
Collection Date:	May 10, 1999
Report Date:	June 23, 1999
Matrix:	Soil
Parameters:	Al, As, Cd, Pb, Zn
Validation Level:	Level III
Laboratory:	Applied Chemistry & Physics Laboratory
Laboratory Project ID:	99-3554

SAMPLE IDENTIFICATION

Laboratory Project	Analytical Method	Field Identification	Laboratory Identification
99-3554	EPA 6010A	38-2-PT-1	99-3554-21
99-3554	EPA 6010A	38-2-SS-1	99-3554-2
99-3554	EPA 6010A	40-2-PT-1	99-3554-16
99-3554	EPA 6010A	40-2-PT-2	99-3554-17
99-3554	EPA 6010A	40-2-PT-2-99	99-3554-19
99-3554	EPA 6010A	40-2-PT-3	99-3554-18
99-3554	EPA 6010A	40-2-PT-4	99-3554-22
99-3554	EPA 6010A	40-2-PT-5	99-3554-20
99-3554	EPA 6010A	40-2-SS-1	99-3554-9
99-3554	EPA 6010A	40-2-SS-2	99-3554-10
99-3554	EPA 6010A	40-2-SS-2-99	99-3554-14
99-3554	EPA 6010A	40-2-SS-3	99-3554-11
99-3554	EPA 6010A	40-2-SS-4	99-3554-12
99-3554	EPA 6010A	40-2-SS-5	99-3554-13
99-3554	EPA 6010A	RFI-PT-1	99-3554-15
99-3554	EPA 6010A	RFI-SS-1	99-3554-23

INTRODUCTION

The review follows a modified outline of the USEPA Contract Laboratory Guidelines for Inorganic Data Review (February 1994).

A table summarizing all data qualification is provided at the end of this report.

Raw data were not reviewed for this laboratory project. The review was based on QC data.

Data qualifier definitions:

U	Indicates the compound or analyte was analyzed for but not detected at or above the stated limit.
J	Indicates that the data is estimated.
R	Quality control indicates that the data is not usable.
UJ	Indicates that the compound or analyte was analyzed for but not detected. The sample detection limit is an estimated value.

1. Technical Holding Times

All technical holding time requirements were met.

The chain-of-custodies were reviewed for documentation of cooler temperatures. All cooler temperatures met validation criteria.

2. Calibration

An initial calibration was performed.

The frequency and analysis criteria of the initial verification (ICV) and continuing calibration verification (CCV) were met

3. Blanks

Method blanks were reviewed for each matrix as applicable

Data qualification by the initial, continuing and preparation blanks (ICB/CCB/PBs) was based on the maximum contaminant concentration in the ICB/CCB/PBs in the analysis of each analyte. No contaminant concentrations were found above the reporting limit in the initial, continuing and preparation blanks

4. ICP Interference Check Samples (ICS) Analysis

The frequency of analysis was met.

The criteria for analysis were met.

5. Matrix Spike Analysis

The matrix spike (MS) and matrix spike analyses were reviewed for each matrix as applicable. Percent recoveries (%R) and relative percent differences (RPD) were within QC limits with the following exceptions.

Spike ID (Associated Samples)	Analyte	MS (%R) (Limits)	MSD (%R) (Limits)	RPD (Limits)	Flag
RFI-SS-1 (All samples in laboratory project)	Aluminum	-146 (75-125)	-82 (75-125)	-	No flags

Samples were not qualified because sample concentration exceeded the spiked concentration by greater than four times.

6. Duplicate Sample Analysis

Duplicate (DUP) sample analyses were reviewed for each matrix as applicable.

7. Laboratory Control Samples

Laboratory control samples were reviewed for each matrix as applicable. Percent recoveries were within QC limits.

8. Sample Result Verification

All sample result verification met validation criteria.

9. Overall Assessment of Data

Data flags have been summarized at the end of this report.

10. Field Duplicates

Primary ID (Duplicate ID)	Analyte	Initial Result	Duplicate Result	RPD	Flag
40-2-SS-2 (40-2-SS-2-99)	Arsenic	8.9 mg/kg	10.9 mg/kg	20.2	No Flags
	Cadmium	0.24 mg/kg	0.31 mg/kg	25.4	No Flags
	Lead	13.3 mg/kg	17.2 mg/kg	25.6	No Flags
	Zinc	50.3 mg/kg	70.3 mg/kg	33.2	No Flags
40-2-PT-2 (40-2-PT-2-99)	Arsenic	<0.3 mg/kg	<0.3 mg/kg		
	Cadmium	0.22 mg/kg	0.25 mg/kg	12.8	No Flags
	Lead	0.40 mg/kg	0.35 mg/kg	13.3	No Flags
	Zinc	19.7 mg/kg	21.8 mg/kg	10.1	No Flags

DATA V DATION
SW6010

QC Check	Minimum Frequency	Acceptance Criteria	Flagging Criteria	Comments
Holding times	Each sample	180 days; preserved with nitric acid to PH<2	If HT exceeded, apply J to all non-detect and positive results. If HT grossly exceeded, flag positive results J, and flag all non-detects R.	OK. As, Cd, Pb, Zn, Al, Ba, Co, Cu
Initial calibration	Daily after initial calibration	%R between 90 and 110%	Apply R to all results for specific analyte(s) for all samples associated with the calibration	13:02 pm - OK
Continuing calibration verification	After every 10 samples and at the end of the analysis sequence	All analyte(s) within ±10% of expected value	Apply R to all results for the specific analyte(s) for in all samples since the last acceptable calibration verification	15:01 pm, 15:35 pm, 16:09 pm, 16:43 pm - OK
Blanks		No analytes detected >PQL	If compound is found in blank and not in sample, no action is taken. Any metal detected in the sample, that was also detected in any associated blank, is qualified if the sample concetration is less than 5x's the blank concentration. The CRQL is elevate to the concentration found in the sample. If gross contamination exists, flag affected compounds R.	99M1838-MB-01-ND ICB - Sb-2.3µg/l, Pb 1.4µg/l CCB - (1) Al - 8.7µg/l, Pb 2.0µg/l (2) Pb - 2.6 µg/l (3) Cd - 0.3 µg/l, Pb 1.9 µg/l (4) Cd - 0.3 µg/l, Co - 0.4 µg/l, Cu - 1.6 µg/l No Qualifications.
Interference check solution		Within ±20% of expected value	If the %R>120, do not flag non-detect data, flag positive results J. If %R is between 50 and 79%, flag all results J. If %R<50, flag data R.	OK
Post Digestion Spike Sample		Recovery within 75-125% of expected results.	For results associated with failing post digestion spike, flag all data J.	RFI-SS-1 Al - 205.0% unspiked 107200 mg/L, spiked 11300 mg/L, spike amount 2000 mg/L. Sample concentration exceeds spike concentration by greater than 4X. No action.
Laboratory control sample		Within ±25% of expected value	For specific analyte(s) in all samples in the associated analytical batch; If the LCS %R >125, apply J to all positive results. If the LCS %R between 50 and 79, flag all positive results J and non-detect results R. If the LCS %R <50, flag all results R.	OK

DATA V. DATION
SW6010
(Page 2 of 3)

QC Check	Minimum Frequency	Acceptance Criteria	Flagging Criteria	Comments

DATA ' DATION
SW6010
(Page 3 of 3)

QC Check	Minimum Frequency	Acceptance Criteria	Flagging Criteria	Comments
Duplicate sample		For results >5x CRDL, RPD 20%. For results <5x CRDL, RPD ±CRDL.	For specific analyte(s) in all samples collected from the same site matrix as the parent, apply J if; (1) %R for MS or MSD >UCL or (2) %R for MS or MSD <LCL or (3) MS/MSD RPD >CL.	Cd 0.0452 mg/kg, 0.1397 mg/kg; 102.3% RPD.
Spike sample analysis		Within ±25% of expected value	For specific analyte(s) in all samples in the associated analytical batch; if the LCS %R >125, apply J to all positive results. If the LCS %R between 30 and 74, flag all positive results J and non-detect results R. If the LCS %R <30, flag all results R.	RFI-SS-1 Al MS/MSD - 146%/82%; Unspiked 102 mg/kg, Spiked 5520/5310 mg/Kg. Sample concentration exceeds spike concentration by greater than 4 times. No action.
ICP serial dilution		Recovery within 90-110% of expected results.	For results associated with failing serial dilutions, flag all data J.	
Field duplicates		None	Calculate RPD.	**40-2-SS-2** As: 8.9, 10.9 mg/Kg, Cd: 0.24, 0.31mg/Kg, Pb: 13.3, 17.2 mg/Kg, Zn: 50.3, 70.3 mg/Kg **40-2-PT-2** As: < 0.3, < 0.3 mg/Kg Cd: 0.22, 0.25 mg/Kg Pb: 0.40, 0.35 mg/Kg Zn: 19.7, 21.8 mg/Kg
Overall assessment		Evaluate technical problems not previously addressed.	Professional judgment.	

99-3554 SW6010
(Page 1 of 2)

		38-2-PT-1	38-2-SS-1	40-2-PT-1	40-2-PT-2	40-2-PT-2-99	40-2-PT-3	40-2-PT-4	40-2-PT-5
99-3554 EPA 6010A	Aluminum	129	13500						
99-3554 EPA 6010A	Antimony	0.17 J	< 5.1						
99-3554 EPA 6010A	Arsenic	0.099 J	4.5	< 0.3	< 0.3	< 0.3	< 0.3	0.12 J	< 0.3
99-3554 EPA 6010A	Barium	32.2	161						
99-3554 EPA 6010A	Cadmium			0.1 J	0.22	0.25	0.13 J	0.095 J	0.081 J
99-3554 EPA 6010A	Cobalt	< 0.5	8.3						
99-3554 EPA 6010A	Copper	4.2	16.3						
99-3554 EPA 6010A	Lead	0.63	7.4	0.51	0.4	0.35	0.5	0.43	0.23 J
99-3554 EPA 6010A	Zinc	5.3	40.5	5.7	19.7	21.8	15.4	10.9	16.7

99-3554 SW6010
(Page 2 of 2)

		40-2-SS-1	40-2-SS-2	40-2-SS-2-99	40-2-SS-3	40-2-SS-4	40-2-SS-5	RF1-PT-1	RF1-SS-1
99-3554 EPA 6010A	Aluminum							17.3	5670
99-3554 EPA 6010A	Antimony							< 5	< 5.1
99-3554 EPA 6010A	Arsenic	8.7	8.9	10.9	9.6	9.4	8.4	< 0.3	2.8
99-3554 EPA 6010A	Barium							10.5	122
99-3554 EPA 6010A	Cadmium	0.2 J	0.24	0.31	0.5	0.34	0.15 J		
99-3554 EPA 6010A	Cobalt							< 0.5	5.6
99-3554 EPA 6010A	Copper							1.3	8.3
99-3554 EPA 6010A	Lead	11	13.3	17.2	259	30.1	9.5	0.2 J	8.8
99-3554 EPA 6010A	Zinc	48.1	50.3	70.3	213	74.5	49.8	1.7	21.7

DATA VALIDATION REPORT

Project Name:	Fort Irwin DO 37 Sites 32A, 38, 39, 40
Collection Date:	May 11, 1999
Report Date:	June 24, 1999
Matrix:	Soil
Parameters:	Al, Sb, As, Ba, Cd, Co, Cu, Cr, Mn, Hg, Pb, Ni, Se, Ag, Zn
Validation Level:	Level III
Laboratory:	Applied Chemistry & Physics Laboratory
Laboratory Project ID:	99-3593

SAMPLE IDENTIFICATION

Laboratory Project	Analytical Method	Field Identification	Laboratory Identification
99-3593	EPA 6010A	38-2-PT-1A	99-3593-7
99-3593	EPA 6010A	38-2-PT-2A	99-3593-8
99-3593	EPA 6010A	38-2-PT-3A	99-3593-9
99-3593	EPA 6010A	38-2-PT-3A-99	99-3593-10
99-3593	EPA 6010A	38-2-PT-4	99-3593-1
99-3593	EPA 6010A	38-2-PT-5	99-3593-2
99-3593	EPA 6010A	38-2-PT-6	99-3593-3
99-3593	EPA 6010A	38-2-PT-7	99-3593-4
99-3593	EPA 6010A	38-2-PT-8	99-3593-5
99-3593	EPA 6010A	38-2-PT-9	99-3593-6
99-3593	EPA 6010A	38-2-SS-1A	99-3593-19
99-3593	EPA 6010A	38-2-SS-2	99-3593-11
99-3593	EPA 6010A	38-2-SS-3	99-3593-12
99-3593	EPA 6010A	38-2-SS-3-99	99-3593-20
99-3593	EPA 6010A	38-2-SS-4	99-3593-13
99-3593	EPA 6010A	38-2-SS-5	99-3593-14
99-3593	EPA 6010A	38-2-SS-6	99-3593-15
99-3593	EPA 6010A	38-2-SS-7	99-3593-16
99-3593	EPA 6010A	38-2-SS-8	99-3593-17
99-3593	EPA 6010A	38-2-SS-9	99-3593-18
99-3593	EPA 6010A	40-1-PT-1	99-3593-21
99-3593	EPA 6010A	40-1-PT-10	99-3593-30
99-3593	EPA 6010A	40-1-PT-2	99-3593-22
99-3593	EPA 6010A	40-1-PT-3	99-3593-23
99-3593	EPA 6010A	40-1-PT-3-99	99-3593-31
99-3593	EPA 6010A	40-1-PT-4	99-3593-24
99-3593	EPA 6010A	40-1-PT-5	99-3593-25
99-3593	EPA 6010A	40-1-PT-6	99-3593-26
99-3593	EPA 6010A	40-1-PT-7	99-3593-27
99-3593	EPA 6010A	40-1-PT-8	99-3593-28
99-3593	EPA 6010A	40-1-PT-9	99-3593-29
99-3593	EPA 6010A	40-2-PT-10	99-3593-36
99-3593	EPA 6010A	40-2-PT-6	99-3593-32
99-3593	EPA 6010A	40-2-PT-7	99-3593-33
99-3593	EPA 6010A	40-2-PT-8	99-3593-34
99-3593	EPA 6010A	40-2-PT-9	99-3593-35
99-3593	EPA 6010A	40-2-SS-6	99-3593-37
99-3593	EPA 6010A	40-2-SS-7	99-3593-38
99-3593	EPA 6010A	40-2-SS-8	99-3593-39
99-3593	EPA 6010A	RF1-PT-4A	99-3593-40
99-3593	EPA 6010A	RF1-PT-4A-99	99-3593-41
99-3593	EPA 6010A	RF1-PT-5A	99-3593-42
99-3593	EPA 6010A	RF1-PT-6A	99-3593-43
99-3593	EPA 6010A	RF1-PT-7A	99-3593-44
99-3593	EPA 6010A	RF1-PT-8A	99-3593-45
99-3593	EPA 6010A	RF1-PT-9A	99-3593-46
99-3593	EPA 6010A	RF2-PT-1	99-3593-47

SAMPLE IDENTIFICATION

Laboratory Project	Analytical Method	Field Identification	Laboratory Identification
99-3593	EPA 6010A	RF2-PT-10	99-3593-55
99-3593	EPA 6010A	RF2-PT-2	99-3593-48
99-3593	EPA 6010A	RF2-PT-3	99-3593-49
99-3593	EPA 6010A	RF2-PT-4	99-3593-69
99-3593	EPA 6010A	RF2-PT-4-99	99-3593-56
99-3593	EPA 6010A	RF2-PT-5	99-3593-50
99-3593	EPA 6010A	RF2-PT-6	99-3593-51
99-3593	EPA 6010A	RF2-PT-7	99-3593-52
99-3593	EPA 6010A	RF2-PT-8	99-3593-53
99-3593	EPA 6010A	RF2-PT-9	99-3593-54
99-3593	EPA 6010A	RF1-PT-1A	99-3593-57
99-3593	EPA 6010A	RF1-PT-2A	99-3593-58
99-3593	EPA 6010A	RF1-PT-3A	99-3593-59
99-3593	EPA 6010A	RF1-SS-1A	99-3593-60
99-3593	EPA 6010A	RF1-SS-2A	99-3593-61
99-3593	EPA 6010A	RF1-SS-3A	99-3593-62
99-3593	EPA 6010A	RF1-SS-4A	99-3593-63
99-3593	EPA 6010A	RF1-SS-4A-99	99-3593-64
99-3593	EPA 6010A	RF1-SS-5A	99-3593-65
99-3593	EPA 6010A	RF1-SS-6A	99-3593-66
99-3593	EPA 6010A	RF1-SS-7A	99-3593-70
99-3593	EPA 6010A	RF1-SS-8A	99-3593-67
99-3593	EPA 6010A	RF1-SS-9A	99-3593-68

SAMPLE IDENTIFICATION

Laboratory Project	Analytical Method	Field Identification	Laboratory Identification
99-3593	EPA 7471A	40-1-PT-1	99-3593-21
99-3593	EPA 7471A	40-1-PT-10	99-3593-30
99-3593	EPA 7471A	40-1-PT-2	99-3593-22
99-3593	EPA 7471A	40-1-PT-3	99-3593-23
99-3593	EPA 7471A	40-1-PT-3-99	99-3593-31
99-3593	EPA 7471A	40-1-PT-4	99-3593-24
99-3593	EPA 7471A	40-1-PT-5	99-3593-25
99-3593	EPA 7471A	40-1-PT-6	99-3593-26
99-3593	EPA 7471A	40-1-PT-7	99-3593-27
99-3593	EPA 7471A	40-1-PT-8	99-3593-28
99-3593	EPA 7471A	40-1-PT-9	99-3593-29
99-3593	EPA 7471A	RF2-PT-1	99-3593-47
99-3593	EPA 7471A	RF2-PT-10	99-3593-55
99-3593	EPA 7471A	RF2-PT-2	99-3593-48
99-3593	EPA 7471A	RF2-PT-3	99-3593-49
99-3593	EPA 7471A	RF2-PT-4	99-3593-69
99-3593	EPA 7471A	RF2-PT-4-99	99-3593-56
99-3593	EPA 7471A	RF2-PT-5	99-3593-50
99-3593	EPA 7471A	RF2-PT-6	99-3593-51
99-3593	EPA 7471A	RF2-PT-7	99-3593-52
99-3593	EPA 7471A	RF2-PT-8	99-3593-53
99-3593	EPA 7471A	RF2-PT-9	99-3593-54

INTRODUCTION

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Data qualifier definitions:

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J	Indicates that the data is estimated.
R	Quality control indicates that the data is not usable.
UJ	Indicates that the compound or analyte was analyzed for but not detected. The sample detection limit is an estimated value.

1. Technical Holding Times

All technical holding time requirements were met

The chain-of-custodies were reviewed for documentation of cooler temperatures All cooler temperatures met validation criteria

2. Calibration

An initial calibration was performed.

The frequency and analysis criteria of the initial verification (ICV) and continuing calibration verification (CCV) were met

3. Blanks

Method blanks were reviewed for each matrix as applicable.

Data qualification by the initial, continuing and preparation blanks (ICB/CCB/PBs) was based on the maximum contaminant concentration in the ICB/CCB/PBs in the analysis of each analyte. No contaminant concentrations were found above the reporting limit in the initial, continuing and preparation blanks with the following exceptions:

Blank ID	Analyte	Concentration	Associated Samples
PB (99M1840)	Selenium	0.12 mg/kg	
PB (99M1842)	Selenium	0.13 mg/kg	

Apply "U" flag to all associated sample results for selenium that are less than 5X the method blank concentrations (0 60 mg/Kg and 0 65 mg/Kg, respectively). Associated samples include 40-1-PT-1, 40-1-PT-2, 40-1-PT-3, 40-1-PT-4, 40-1-PT-5, 40-1-PT-6, 40-1-PT-7, 40-1-PT-8, 40-1-PT-9, 40-1-PT-10, and 40-1-PT-3-99.

4. ICP Interference Check Samples (ICS) Analysis

The frequency of analysis was met.

The criteria for analysis were met.

5. Matrix Spike Analysis

The matrix spike (MS) and matrix spike analyses were reviewed for each matrix as applicable. Percent recoveries (%R) and relative percent differences (RPD) were within QC limits with the following exceptions

Spike ID (Associated Samples)	Analyte	MS (%R) (Limits)	MSD (%R) (Limits)	RPD (Limits)	Flag	Associated Samples
40-2-SS-8	Aluminum Manganese Zinc	194 (75-125) -15 (75-125) 0 (75-125)	194 (75-125) -28 (75-125) 67 (75-125)	- -59 (35) 200 (35)	No flag No flag J (detects), R (non-detects)	All project samples from site 40-2

Samples were not qualified because sample concentration exceeded the spiked concentration by greater than four times

6. Duplicate Sample Analysis

Duplicate (DUP) sample analyses were reviewed for each matrix as applicable. The RPD were within QC limits

7. Laboratory Control Samples

Laboratory control samples were reviewed for each matrix as applicable. Percent recoveries were within QC limits

8. Sample Result Verification

All sample result verification met validation criteria.

9. Overall Assessment of Data

Data flags have been summarized at the end of this report.

10. Field Duplicates

Primary ID (Duplicate ID)	Analyte	Initial Result	Duplicate Result	RPD	Flag
38-2-PT-3A (38-2-PT-3A-99)	Aluminum	43.9	108	84.4	No Flags
	Antimony	< 5	< 5	0	No Flags
	Arsenic	< 0.3	< 0.3	0	No Flags
	Barium	4	10.7	91.2	No Flags
	Cobalt	< 0.5	< 0.5	0	No Flags
	Copper	1.6	2.3	35.9	No Flags
	Lead	0.15 J	0.37	0	No Flags
	Zinc	4	4.6	14	No Flags
38-2-SS-3 (38-2-SS-3-99)	Aluminum	26400	41400	44.2	No Flags
	Antimony	1.7 J	1.1 J	42.9	No Flags
	Arsenic	9.3	11.3	19.4	No Flags
	Barium	200	231	14.4	No Flags
	Cobalt	13.2	16.9	24.6	No Flags
	Copper	50.7	81.1	46.1	No Flags
	Lead	174	239	31.5	No Flags
	Zinc	76.5	102	28.6	No Flags
40-1-PT-3 (40-1-PT-3-99)	Aluminum	29.2	24	19.5	No Flags
	Antimony	< 5.0	< 5.0	0	No Flags
	Arsenic	< 0.3	< 0.3	0	No Flags
	Barium	15.8	16.4	3.7	No Flags
	Cadmium	0.048 J	0.05 J	4.1	No Flags
	Chromium	0.82	1.1	29.2	No Flags
	Cobalt	< 0.5	< 0.5	0	No Flags
	Copper	1.8	1.3	32.3	No Flags
	Lead	0.06 J	0.15 J	24.0	No Flags
	Manganese	22.1	5.8	116.8	No Flags
	Mercury	< 0.1	< 0.1	0	No Flags
	Nickel	0.22 J	0.18 J	20	No Flags
	Selenium	0.26 J	0.26 J	0	No Flags
	Silver	< 0.5	< 0.5	0	No Flags
	Zinc	7.1	3.8	60.6	No Flags
RF1-PT-4A (RF1-PT-4A - 99)	Aluminum	287	222	25.5	No Flags
	Antimony	< 5	< 5	0	No Flags
	Arsenic	0.29 J	0.28 J	3.5	No Flags
	Barium	15.2	14.1	7.5	No Flags
	Cobalt	0.2 J	0.18 J	10.5	No Flags
	Copper	2.6	2.4	8	No Flags
	Lead	0.39	0.37	5.3	No Flags
	Zinc	7.7	7.2	6.7	No Flags
RF2-PT-4 (RF2-PT-4-99)	Aluminum	46.1	48	4.0	No Flags
	Antimony	< 5	< 5	0	No Flags
	Arsenic	< 0.3	0.11 J	NC	No Flags
	Barium	30.5	28.3	7.5	No Flags
	Cadmium	< 0.2	< 0.2	0	No Flags
	Chromium	1.3	1.2	8.0	No Flags
	Cobalt	< 0.5	< 0.5	0	No Flags
	Copper	1.6	2	22.2	No Flags
	Lead	0.63	0.26 J	83.1	No Flags
	Manganese	23.7	17.1	32.4	No Flags
	Mercury	< 0.1	< 0.1	0	No Flags
	Nickel	0.33	0.46	32.9	No Flags
	Selenium	0.27 J	0.28 J	3.6	No Flags
	Silver	< 0.5	< 0.5	0	No Flags
	Zinc	3.2	4.2	27	No Flags
RF1-SS-4 (RF1-SS-4-99)	Aluminum	10600	10600	0	No Flags
	Antimony	< 5	0.25 J	NC	No Flags
	Arsenic	3.6	4	10.5	No Flags

Primary ID (Duplicate ID)	Analyte	Initial Result	Duplicate Result	RPD	Flag
RF1-SS-4 (RF1-SS-4-99) (continued)	Barium	124	121	2.4	No Flags
	Cobalt	7.9	8.1	2.5	No Flags
	Copper	12.6	13	3.1	No Flags
	Lead	7.6	7.6	0	No Flags
	Zinc	33.4	34.1	2.1	No Flags

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QC Check	Minimum Frequency	Acceptance Criteria	Flagging Criteria	Comments
Holding times	Each sample	180 days; preserved with nitric acid to PH<2	If HT exceeded, apply J to all non-detect and positive results. If HT grossly exceeded, flag positive results J, and flag all non-detects R.	OK. Al, Sb, As, Ba, Co, Cu, Pb, Zn, Cd, Cr, Mn, Hg, Ni, Se, Ag
Initial calibration	Daily after initial calibration	%R between 90 and 110%	Apply R to all results for specific analyte(s) for all samples associated with the calibration	OK
Continuing calibration verification	After every 10 samples and at the end of the analysis sequence	All analyte(s) within ±10% of expected value	Apply R to all results for the specific analyte(s) for in all samples since the last acceptable calibration verification	8:57am, 9:55am, 10:30am, 11:05am, 11:27am - OK 8:57am, 11:27am, 12:06pm, 12:40pm, 13:15pm, 13:37pm - OK 8:57am, 13:37pm, 14:17pm, 14:51pm, 15:26pm, 15:42pm - OK 8:57am, 15:42pm, 16:18pm, 16:55pm - OK Hg 7:37am, 8:11am, 8:41am, 9:13am, 9:28am - OK
Blanks		No analytes detected >PQL	If compound is found in blank and not in sample, no action is taken. Any metal detected in the sample, that was also detected in any associated blank, is qualified if the sample concetration is less than 5x's the blank concentration. The CRQL is elevate to the concentration found in the sample. If gross contamination exists, flag affected compounds R.	MB - 99M1840-MB-01 Se 0.12mg/kg - 99M1841-MB-01 OK - 99M1842-MB-01 Se 0.13mg/kg 40-1-PT-1 Se 0.42mg/kg 40-1-PT-2 Se 0.30mg/kg 40-1-PT-3 Se 0.26mg/kg 40-1-PT-4 Se 0.18mg/kg 40-1-PT-5 Se 0.51mg/kg 40-1-PT-6 Se 0.33mg/kg 40-1-PT-7 Se 0.32mg/kg 40-1-PT-8 Se 0.21mg/kg 40-1-PT-9 Se 0.34mg/kg 40-1-PT-10 Se 0.38mg/kg 40-1-PT-3-99 Se 0.26mg/kg ICB - OK. CCB (1) Ba 4.0µg/l, Cu 3.7µg/l, Co 1.0µg/l (2) Cu 1.9µg/l (3) As 1.5µg/l, Ba 5.0µg/l, Cu 4.9µg/l (4) Ba 2.0µg/l, Ca 0.6µg/l, Cu 1.3µg/l. ICB - Ag 1.1µg/l CCB (1) Ba 2.0µg/l, Co 0.6µg/l, Cu 1.3µg/l, Mn 0.9µg/l, Ni 0.6µg/l, Ag 0.9µg/l (2) Cu 1.2µg/l, Ag 1.9µg/l (3) As 1.6µg/l, Ba 2.0µg/l, Cr 0.9µg/l, Co 0.6µg/l, Mn 0.7µg/l, Ni 0.7µg/l, Ag 1.6µg/l (4) Ba 1.5µg/l, Continued

QC Check	Minimum Frequency	Acceptance Criteria	Flagging Criteria	Comments
Blanks (continued)				Continue Blanks = Mn 0.7µg/l, Ag 0.9µg/l (5) Mn 0.7µg/l, Ag 1.3µg/l. ICB Ag 1.1µg/l. CCB (1) Mn 0.7µg/l, Ag 1.3µg/l (2) As 1.4µg/l, Ba 2.9µg/l, Cr 1.0µg/l, Co 0.7µg/l, Cu 2.4µg/l, Mn 1.4µg/l, ni 0.7µg/l, Ag 2.7µg/l (3) Ba 1.5µg/l, Co 0.6µg/l, Cu 1.3µg/l, Mn 0.9µg/l, Ni 0.6 µg/l, Ag 1.8µg/l (4) As 1.6µg/l, Cu 1.3µg/l, Mn 0.7µg/l, Ag 1.9µg/l (5) As 2.1µg/l, Cu 1.4µg/l, Mn 1.1µg/l, Ag 1.6µg/l ICB - Ag 1.1µg/l. CCB - (1) As 2.1µg/l, Cu 1.4µg/l, Mn 1.1µg/l, Ag 1.6µg/l (2) As 1.8µg/l, Mn 0.7µg/l, Ag 2.1µg/l (3) Mn 0.7µg/l, ag 1.7 µg/l. Hg (1) ICB - OK. CCB - OK. (2) ICB - OK. CCB-OK. No qualification required due toICBs or CCBs.
Interference check solution		Within ±20% of expected value	If the %R>120, do not flag non-detect data, flag positive results J. If %R is between 50 and 79%, flag all results J. If %R<50, flag data R.	OK
Post Digestion Spike Sample		Recovery within 75-125% of expected results.	For results associated with failing post digestion spike, flag all data J.	**38-2-PT-4** - OK **40-1-PT-3** - OK **RF1-PT-4a-99** - OK **40-2-SS-8** - Al -300%* Mn -64.2%*
Laboratory control sample		Within ±25% of expected value	For specific analyte(s) in all samples in the associated analytical batch; If the LCS %R >125, apply J to all positive results. If the LCS %R between 50 and 79, flag all positive results J and non-detect results R. If the LCS %R <50, flag all results R.	OK
Duplicate sample		For results >5x CRDL, RPD 20%. For results <5x CRDL, RPD ±CRDL.	For specific analyte(s) in all samples collected from the same site matrix as the parent, apply J if; (1) %R for MS or MSD >UCL or (2) %R for MS or MSD <LCL or (3) MS/MSD RPD >CL.	**38-2-PT-4** Pb 36.4%, but <CRDL, no action. **40-1-PT-1** As 200%, but < CRDL, no action. Co 25.2%, but < CRDL, no action. Se 36.5%, but < CRDL, no action. Pb 20.5%, but < CRDL, no action. **40-2-SS-8** As 25.2%, but < CRDL, no action. Ag 200%, but < CRDL, no action. Cu 33.0%, Zn 25.3% (within control limits of 35%). No qualification required. **RF1-PT-4a-99** As 45.2%, but < CRDL, no action.

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QC Check	Minimum Frequency	Acceptance Criteria	Flagging Criteria	Comments
Spike sample analysis		Within ±25% of expected value	For specific analyte(s) in all samples in the associated analytical batch; if the LCS %R >125, apply J to all positive results. If the LCS %R between 30 and 74, flag all positive results J and non-detect results R. If the LCS %R <30, flag all results R.	**40-1-PT-1** - OK **40-2-SS-8** Zn 0%, 67%, RPD 200% Al 194%, 194%, RPD 0% * Mn -15%, -88%, RPD 59% * **RF1-PT-4A-99** - OK * Sample concentration exceeds spiked concentration by greater than 4 times. No action.
ICP serial dilution		Recovery within 90-110% of expected results.	For results associated with failing serial dilutions, flag all data J.	**38-2-PT-4** - As 100%, Co 100%, Pb 100%.No action, initial result <CRDL. **40-1-PT-1** - As 100%, Cd 100%, Co 100%, Pb 100%, Se 100%. No action, initial results <CRDL. **RF1-PT-4a-99** - As 96.1%, Cd 100%, Se 22.3%, Ag 379.9%. No action, initial result < CRDL. Al 14.5%, Ba 12.2%, Cu 25.2%, Pb 15.9%, Mn 12.2%, Ni 11.8%. Apply J flag to associated samples (99-3593-41, 99-3593-43 through 99-3593-61). **40-2-SS-8** - Sb 100%, Ag 259.1%. No action; initial result <CRDL. Cr 12%, Mn 10.9%; Apply J flag to associated samples (99-3593-39, 99-3593-62 through 99-3593-70).

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QC Check	Minimum Frequency	Acceptance Criteria	Flagging Criteria	Comments
Field duplicates		None	Calculate RPD.	**38-2-PT-3A** Al - 84.4%RPD; Ba - 91.2%RPD. **38-2-SS-3** All RPDs OK. **40-1-PT-3** Mn - 116.8%RPD. **RF1-PT-4A** All RPDs OK. **RF2-PT-4** Pb - 83.1%RPD. **RF1-SS-4A** All RPDs OK.
Overall assessment		Evaluate technical problems not previously addressed.	Professional judgment.	

		38-2-PT-1A	38-2-PT-2A	38-2-PT-3A	38-2-PT-3A-99	38-2-PT-4	38-2-PT-5	38-2-PT-6
99-3593 EPA 6010A	Aluminum	83.1	107	43.9	108	122	111	59
99-3593 EPA 6010A	Antimony	< 5	< 5	< 5	< 5	< 5	< 5	< 5
99-3593 EPA 6010A	Arsenic	< 0.3	0.1 J	< 0.3	< 0.3	0.13 J	0.11 J	0.1 J
99-3593 EPA 6010A	Barium	7.6	9.6	4	10.7	4.7	8.2	4.5
99-3593 EPA 6010A	Cadmium							
99-3593 EPA 6010A	Chromium							
99-3593 EPA 6010A	Cobalt	0.15 J	0.16 J	< 0.5	< 0.5	0.12 J	< 0.5	< 0.5
99-3593 EPA 6010A	Copper	2.1	2	1.6	2.3	2.3	2.4	2
99-3593 EPA 6010A	Lead	0.14 J	0.11 J	0.15 J	0.37	0.28 J	0.71	0.1 J
99-3593 EPA 6010A	Manganese							
99-3593 EPA 6010A	Nickel							
99-3593 EPA 6010A	Selenium							
99-3593 EPA 6010A	Silver							
99-3593 EPA 6010A	Zinc	6.9	7.3	4	4.6	6.8	9.5	6
99-3593 EPA 7471A	Mercury							

		38-2-PT-7	38-2-PT-8	38-2-PT-9	38-2-SS-1A	38-2-SS-2	38-2-SS-3	38-2-SS-3-99	38-2-SS-4
99-3593 EPA 6010A	Aluminum	63.8	116	38.4	22700	38000	26400	41400	18400
99-3593 EPA 6010A	Antimony	< 5	< 5	< 5	0.49 J	1.4 J	1.7 J	1.1 J	0.88 J
99-3593 EPA 6010A	Arsenic	0.15 J	< 0.3	< 0.3	9.4	9.2	9.3	11.3	5.5
99-3593 EPA 6010A	Barium	7.2	5.8	15	187	214	200	231	168
99-3593 EPA 6010A	Cadmium								
99-3593 EPA 6010A	Chromium								
99-3593 EPA 6010A	Cobalt	0.24 J	0.12 J	< 0.5	11.8	13.1	13.2	16.9	10
99-3593 EPA 6010A	Copper	4.4	2.5	1.5	45.7	43.6	50.7	81.1	31.7
99-3593 EPA 6010A	Lead	1	0.21 J	0.18 J	58.7	33.4	174	239	53.4
99-3593 EPA 6010A	Manganese								
99-3593 EPA 6010A	Nickel								
99-3593 EPA 6010A	Selenium								
99-3593 EPA 6010A	Silver								
99-3593 EPA 6010A	Zinc	10.8	6.5	6.5	70.8	85.4	76.5	102	52.8
99-3593 EPA 7471A	Mercury								

		38-2-SS-5	38-2-SS-6	38-2-SS-7	38-2-SS-8	38-2-SS-9	40-1-PT-1	40-1-PT-10	40-1-PT-2
99-3593 EPA 6010A	Aluminum	20100	20400	22500	19300	11800	33.6	27.1	30.5
99-3593 EPA 6010A	Antimony	0.74 J	0.85 J	1.4 J	0.62 J	0.63 J	< 5	< 5	< 5
99-3593 EPA 6010A	Arsenic	5.7	5.3	5.3	3.9	4	0.087 J	< 0.3	< 0.3
99-3593 EPA 6010A	Barium	180	155	163	120	152	15.7	21	7.6
99-3593 EPA 6010A	Cadmium						0.072 J	0.06 J	0.69
99-3593 EPA 6010A	Chromium						0.91	0.83	1.6
99-3593 EPA 6010A	Cobalt	9.9	11.5	10.3	8.5	7.8	< 0.5	< 0.5	0.14 J
99-3593 EPA 6010A	Copper	44.3	41.9	54	19.4	17	3.3	1.8	6.5
99-3593 EPA 6010A	Lead	108	67.5	189	17.5	40.6	0.2 J	0.095 J	0.61
99-3593 EPA 6010A	Manganese						6.6	17.4	23.8
99-3593 EPA 6010A	Nickel						0.48	0.2 J	2
99-3593 EPA 6010A	Selenium						0.42 UJ	0.38 UJ	0.3 UJ
99-3593 EPA 6010A	Silver						< 0.5	< 0.5	< 0.5
99-3593 EPA 6010A	Zinc	57.6	62.3	61.2	47.3	37.7	7.4	2.8	53.3
99-3593 EPA 7471A	Mercury						< 0.1	< 0.1	< 0.1

		40-1-PT-3	40-1-PT-3-99	40-1-PT-4	40-1-PT-5	40-1-PT-6	40-1-PT-7	40-1-PT-8	40-1-PT-9
99-3593 EPA 6010A	Aluminum	29.2	24	28.9	40	26.1	32.3	20.2	52.5
99-3593 EPA 6010A	Antimony	< 5	< 5	< 5	< 5	< 5	< 5	0.07 J	< 5
99-3593 EPA 6010A	Arsenic	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
99-3593 EPA 6010A	Barium	15.8	16.4	27.8	14.1	19.5	18	9.7	17.6
99-3593 EPA 6010A	Cadmium	0.048 J	0.05 J	< 0.2	0.36	< 0.2	0.066 J	0.21	< 0.2
99-3593 EPA 6010A	Chromium	0.82	1.1	1.1	1.8	0.8	1.9	1.1	0.53
99-3593 EPA 6010A	Cobalt	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
99-3593 EPA 6010A	Copper	1.8	1.3	1.7	4.6	2	1.6	2.8	2.1
99-3593 EPA 6010A	Lead	0.06 J	0.15 J	0.13 J	0.52	0.087 J	0.18 J	0.3 J	0.26 J
99-3593 EPA 6010A	Manganese	22.1	5.8	9.4	12.8	13.2	27.9	6.5	5.4
99-3593 EPA 6010A	Nickel	0.22 J	0.18 J	0.13 J	0.35	0.13 J	0.15 J	0.59	0.13 J
99-3593 EPA 6010A	Selenium	0.26 UJ	0.26 UJ	0.18 UJ	0.51 U	0.33 UJ	0.32 UJ	0.21 UJ	0.34 UJ
99-3593 EPA 6010A	Silver	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
99-3593 EPA 6010A	Zinc	7.1	3.8	2.4	19.7	3.4	4.3	11	4.8
99-3593 EPA 7471A	Mercury	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1

		40-2-PT-10	40-2-PT-6	40-2-PT-7	40-2-PT-8	40-2-PT-9	40-2-SS-6	40-2-SS-7	40-2-SS-8
99-3593 EPA 6010A	Aluminum								
99-3593 EPA 6010A	Antimony								
99-3593 EPA 6010A	Arsenic	< 0.3	0.15 J	< 0.3	< 0.3	0.12 J	9.5	9.2	8.2
99-3593 EPA 6010A	Barium								
99-3593 EPA 6010A	Cadmium	0.049 J	0.081 J	0.058 J	0.11 J	0.12 J	0.26	0.22	0.27
99-3593 EPA 6010A	Chromium								
99-3593 EPA 6010A	Cobalt								
99-3593 EPA 6010A	Copper								
99-3593 EPA 6010A	Lead	0.14 J	0.28 J	0.13 J	0.17 J	0.29 J	11.9	9.7	13.2
99-3593 EPA 6010A	Manganese								
99-3593 EPA 6010A	Nickel								
99-3593 EPA 6010A	Selenium								
99-3593 EPA 6010A	Silver								
99-3593 EPA 6010A	Zinc	3 J	5.9 J	2.7 J	4.5 J	4.3 J	54.2 J	46.7 J	74.4 J
99-3593 EPA 7471A	Mercury								

		RF1-PT-1A	RF1-PT-2A	RF1-PT-3A	RF1-PT-4A	RF1-PT-4A-99	RF1-PT-5A	RF1-PT-6A	RF1-PT-7A
99-3593 EPA 6010A	Aluminum	169 J	42.8 J	164 J	287	222 J	129	189 J	219 J
99-3593 EPA 6010A	Antimony	0.07 J	< 5	0.086 J	< 5	< 5	< 5	0.071 J	< 5
99-3593 EPA 6010A	Arsenic	0.1 J	< 0.3	0.21 J	0.29 J	0.28 J	0.14 J	0.14 J	0.19 J
99-3593 EPA 6010A	Barium	8.3 J	6.8 J	12.3 J	15.2	14.1 J	12	10.1 J	15.2 J
99-3593 EPA 6010A	Cadmium								
99-3593 EPA 6010A	Chromium								
99-3593 EPA 6010A	Cobalt	0.11 J	< 0.5	0.15 J	0.2 J	0.18 J	< 0.5	0.12 J	0.16 J
99-3593 EPA 6010A	Copper	1.6 J	1.9 J	2.2 J	2.6	2.4 J	1.8	1.9 J	2.2 J
99-3593 EPA 6010A	Lead	0.26 J	0.14 J	0.28 J	0.39	0.37 J	0.77	0.55 J	0.3 J
99-3593 EPA 6010A	Manganese								
99-3593 EPA 6010A	Nickel								
99-3593 EPA 6010A	Selenium								
99-3593 EPA 6010A	Silver								
99-3593 EPA 6010A	Zinc	7	5.7	7.2	7.7	7.2	6.1	6.1	10.3
99-3593 EPA 7471A	Mercury								

		RF1-PT-8A	RF1-PT-9A	RF1-SS-1A	RF1-SS-2A	RF1-SS-3A	RF1-SS-4A	RF1-SS-4A-99	RF1-SS-5A
99-3593 EPA 6010A	Aluminum	187 J	32.1 J	8610 J	7600 J	9670	10600	10600	7710
99-3593 EPA 6010A	Antimony	< 5	< 5	0.35 J	0.3 J	0.34 J	< 5	0.25 J	0.067 J
99-3593 EPA 6010A	Arsenic	0.17 J	< 0.3	3.8	3.3	3.7	3.6	4	3.2
99-3593 EPA 6010A	Barium	22.8 J	4.1 J	119 J	128 J	116	124	121	113
99-3593 EPA 6010A	Cadmium								
99-3593 EPA 6010A	Chromium								
99-3593 EPA 6010A	Cobalt	0.13 J	< 0.5	7	6.8	7.3	7.9	8.1	6.8
99-3593 EPA 6010A	Copper	2.1 J	1.5 J	11.7 J	10.4 J	12.4	12.6	13	11
99-3593 EPA 6010A	Lead	0.31 J	0.22 J	10 J	9.4 J	9.1	7.6	7.6	9.5
99-3593 EPA 6010A	Manganese								
99-3593 EPA 6010A	Nickel								
99-3593 EPA 6010A	Selenium								
99-3593 EPA 6010A	Silver								
99-3593 EPA 6010A	Zinc	6.2	5	30.4	28.1	32.5	33.4	34.1	28
99-3593 EPA 7471A	Mercury								

		RF1-SS-6A	RF1-SS-7A	RF1-SS-8A	RF1-SS-9A	RF2-PT-1	RF2-PT-10	RF2-PT-2	RF2-PT-3
99-3593 EPA 6010A	Aluminum	9980	8170	11600	13000	48.5 J	60.8 J	21.7 J	59.3 J
99-3593 EPA 6010A	Antimony	< 5.1	< 5	0.18 J	< 5.1	0.11 J	< 5	< 5	0.072 J
99-3593 EPA 6010A	Arsenic	3.9	3.6	4.1	3.7	< 0.3	0.11 J	< 0.3	< 0.3
99-3593 EPA 6010A	Barium	127	116	135	125	37 J	25.2 J	19.5 J	24.7 J
99-3593 EPA 6010A	Cadmium					0.072 J	< 0.2	< 0.2	< 0.2
99-3593 EPA 6010A	Chromium					2.3	0.71	0.77	0.87
99-3593 EPA 6010A	Cobalt	7.6	6.7	8.5	8.8	< 0.5	< 0.5	< 0.5	< 0.5
99-3593 EPA 6010A	Copper	12.6	11.2	14.1	16.1	1.8 J	1.7 J	1.4 J	1.5 J
99-3593 EPA 6010A	Lead	8.8	9.1	8.4	6.8	0.2 J	0.23 J	0.12 J	0.19 J
99-3593 EPA 6010A	Manganese					27 J	11.4 J	17.5 J	10.8 J
99-3593 EPA 6010A	Nickel					0.39 J	0.24 J	0.12 J	0.15 J
99-3593 EPA 6010A	Selenium					0.25 J	0.36 J	0.31 J	0.25 J
99-3593 EPA 6010A	Silver					< 0.5	< 0.5	< 0.5	< 0.5
99-3593 EPA 6010A	Zinc	34.8	30	37.8	38.3	4	2.7	2.2	2.3
99-3593 EPA 7471A	Mercury					< 0.1	< 0.1	< 0.1	< 0.1

		RF2-PT-4	RF2-PT-4-99	RF2-PT-5	RF2-PT-6	RF2-PT-7	RF2-PT-8	RF2-PT-9
99-3593 EPA 6010A	Aluminum	46.1	48 J	28.6 J	30.3 J	57.2 J	38 J	36.7 J
99-3593 EPA 6010A	Antimony	< 5	< 5	< 5	< 5	< 5	< 5	< 5
99-3593 EPA 6010A	Arsenic	< 0.3	0.11 J	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
99-3593 EPA 6010A	Barium	30.5	28.3 J	8.2 J	27.7 J	34 J	24.1 J	37.5 J
99-3593 EPA 6010A	Cadmium	< 0.2	< 0.2	< 0.2	< 0.2	0.045 J	< 0.2	< 0.2
99-3593 EPA 6010A	Chromium	1.3 J	1.2	0.91	0.62	1.2	0.91	1.1
99-3593 EPA 6010A	Cobalt	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
99-3593 EPA 6010A	Copper	1.6	2 J	1.1 J	1.5 J	2.8 J	1.3 J	1.9 J
99-3593 EPA 6010A	Lead	0.63	0.26 J	0.11 J	0.059 J	0.28 J	0.15 J	0.11 J
99-3593 EPA 6010A	Manganese	23.7 J	17.1 J	16.1 J	17 J	18.5 J	14.6 J	11.2 J
99-3593 EPA 6010A	Nickel	0.33	0.46 J	0.22 J	0.15 J	0.21 J	0.19 J	0.15 J
99-3593 EPA 6010A	Selenium	0.27 J	0.28 J	0.39 J	0.34 J	0.3 J	0.2 J	0.34 J
99-3593 EPA 6010A	Silver	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
99-3593 EPA 6010A	Zinc	3.2	4.2	1.7	2.5	3.7	3.5	3
99-3593 EPA 7471A	Mercury	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1

DATA VALIDATION REPORT

Project Name:	Fort Irwin DO 37 Sites 32A, 38, 39, 40
Collection Date:	May 13, 1999
Report Date:	June 24, 1999
Matrix:	Soil, TCLP, STLC
Parameters:	Pb
Validation Level:	Level III
Laboratory:	Applied Chemistry & Physics Laboratory
Laboratory Project ID:	99-3606

SAMPLE IDENTIFICATION

Laboratory Project	Analytical Method	Field Identification	Laboratory Identification
99-3606	EPA 6010A	38-2-SS-CNF-11-1'	99-3606-12
99-3606	EPA 6010A	38-2-SS-CNF-12-1'	99-3606-13
99-3606	EPA 6010A	38-2-SS-CNF-14	99-3606-1
99-3606	EPA 6010A	38-2-SS-CNF-14-1'	99-3606-14
99-3606	EPA 6010A	38-2-SS-CNF-20	99-3606-2
99-3606	EPA 6010A	38-2-SS-CNF-22	99-3606-3
99-3606	EPA 6010A	38-2-SS-CNF-23	99-3606-4
99-3606	EPA 6010A	38-2-SS-CNF-25	99-3606-5
99-3606	EPA 6010A	38-2-SS-CNF-27	99-3606-6
99-3606	EPA 6010A	38-2-SS-CNF-28	99-3606-7
99-3606	EPA 6010A	38-2-SS-CNF-29	99-3606-8
99-3606	EPA 6010A	38-2-SS-CNF-30	99-3606-9
99-3606	EPA 6010A	38-2-SS-CNF-33	99-3606-10
99-3606	EPA 6010A	38-2-SS-CNF-36	99-3606-11

INTRODUCTION

The review follows a modified outline of the USEPA Contract Laboratory Guidelines for Inorganic Data Review (February 1994)

A table summarizing all data qualification is provided at the end of this report.

Raw data were not reviewed for this laboratory project The review was based on QC data.

Data qualifier definitions:

U	Indicates the compound or analyte was analyzed for but not detected at or above the stated limit.
J	Indicates that the data is estimated.
R	Quality control indicates that the data is not usable.
UJ	Indicates that the compound or analyte was analyzed for but not detected The sample detection limit is an estimated value.

1. Technical Holding Times

All technical holding time requirements were met.

The chain-of-custodies were reviewed for documentation of cooler temperatures. All cooler temperatures met validation criteria

2. Calibration

An initial calibration was performed.

The frequency and analysis criteria of the initial verification (ICV) and continuing calibration verification (CCV) were met.

3. Blanks

Method blanks were reviewed for each matrix as applicable.

Data qualification by the initial, continuing and preparation blanks (ICB/CCB/PBs) was based on the maximum contaminant concentration in the ICB/CCB/PBs in the analysis of each analyte No contaminant concentrations were found above the reporting limit in the initial, continuing and preparation

4. ICP Interference Check Samples (ICS) Analysis

The frequency of analysis was met.

The criteria for analysis were met.

5. Matrix Spike Analysis

The matrix spike (MS) and matrix spike analyses were reviewed for each matrix as applicable. Percent recoveries (%R) and relative percent differences (RPD) were within QC limits

6. Duplicate Sample Analysis

Duplicate (DUP) sample analyses were reviewed for each matrix as applicable. The RPD were within QC limits

7. Laboratory Control Samples

Laboratory control samples were reviewed for each matrix as applicable. Percent recoveries were within QC limits.

8. Sample Result Verification

All sample result verification met validation criteria.

9. Overall Assessment of Data

Data flags have been summarized at the end of this report

10. Field Duplicates

No field duplicates were identified in this laboratory project.

DATA V .DATION
SW6010

QC Check	Minimum Frequency	Acceptance Criteria	Flagging Criteria	Comments
Holding times	Each sample	180 days; preserved with nitric acid to PH<2	If HT exceeded, apply J to all non-detect and positive results. If HT grossly exceeded, flag positive results J, and flag all non-detects R.	OK
Initial calibration	Daily after initial calibration	%R between 90 and 110%	Apply R to all results for specific analyte(s) for all samples associated with the calibration	OK
Continuing calibration verification	After every 10 samples and at the end of the analysis sequence	All analyte(s) within ±10% of expected value	Apply R to all results for the specific analyte(s) for in all samples since the last acceptable calibration verification	18:26pm, 18:58pm, 19:26pm, 19:48pm, 15:01pm, 15:57pm, 16:19pm, 16:41pm, 17:00pm.
Blanks		No analytes detected >PQL	If compound is found in blank and not in sample, no action is taken. Any metal detected in the sample, that was also detected in any associated blank, is qualified if the sample concetration is less than 5x's the blank concentration. The CRQL is elevate to the concentration found in the sample. If gross contamination exists, flag affected compounds R.	(1) ICB - Pb -7.1ug/l CCB - Pb -10.7, -2.0, 3.6ug/l (2) ICB - Pb -3.1ug/l CCB - Pb -1.5, -3.0, 1.4, 1.1ug/l No qualification required.
Interference check solution		Within ±20% of expected value	If the %R>120, do not flag non-detect data, flag positive results J. If %R is between 50 and 79%, flag all results J. If %R<50, flag data R.	OK
Post Digestion Spike Sample		Recovery within 75-125% of expected results.	For results associated with failing post digestion spike, flag all data J.	38-2-SS-CNF-36 OK 38-2-SS-CNF-23 OK
Laboratory control sample		Within ±25% of expected value	For specific analyte(s) in all samples in the associated analytical batch; If the LCS %R >125, apply J to all positive results. If the LCS %R between 50 and 79, flag all positive results J and non-detect results R. If the LCS %R <50, flag all results R.	OK

DATA V. .DATION
SW6010
(Page 2 of 2)

QC Check	Minimum Frequency	Acceptance Criteria	Flagging Criteria	Comments
Duplicate sample		For results >5x CRDL, RPD 20%. For results <5x CRDL, RPD ±CRDL.	For specific analyte(s) in all samples collected from the same site matrix as the parent, apply M if; (1) %R for MS or MSD >UCL or (2) %R for MS or MSD <LCL or (3) MS/MSD RPD >CL.	38-2-SS-CNF-36 OK 38-2-SS-CNF-23 OK
Spike sample analysis		Within ±25% of expected value	For specific analyte(s) in all samples in the associated analytical batch; if the LCS %R >125, apply J to all positive results. If the LCS %R between 30 and 74, flag all positive results J and non-detect results R. If the LCS %R <30, flag all results R.	38-2-SS-CNF-36 OK
ICP serial dilution		Recovery within 90-110% of expected results.	For results associated with failing serial dilutions, flag all data J.	38-2-SS-CNF-36 41.8% Apply J flag to associated samples (99-3606-2 through 99-3606-12)
Field duplicates		None	Calculate RPD.	None
Overall assessment		Evaluate technical problems not previously addressed.	Professional judgment.	

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(Page 1 of 3)

SDG	Method	Parameter	38-2-SS-CNF-11-1'	38-2-SS-CNF-12-1'	38-2-SS-CNF-14	38-2-SS-CNF-14-1'	38-2-SS-CNF-20	38-2-SS-CNF-22
99-3606	EPA 6010A	Lead	2760 J	3820		210	9.6 J	7.6 J
99-3606	EPA 6010A (soluble)	STLC Lead			22000			
99-3606	EPA 6010A (soluble)	TCLP Lead			124			

99-3606 SW6010
(Page 2 of 3)

SDG	Method	Parameter	38-2-SS-CNF-23	38-2-SS-CNF-25	38-2-SS-CNF-27	38-2-SS-CNF-28	38-2-SS-CNF-29	38-2-SS-CNF-30
99-3606	EPA 6010A	Lead	180 J	524 J		798 J	24.3 J	122 J
99-3606	EPA 6010A (soluble)	STLC Lead			768000			
99-3606	EPA 6010A (soluble)	TCLP Lead			21500			

99-3606 SW6010
(Page 3 of 3)

SDG	Method	Parameter	38-2-SS-CNF-33	38-2-SS-CNF-36
99-3606	EPA 6010A	Lead	10 J	6.1 J
99-3606	EPA 6010A (soluble)	STLC Lead		
99-3606	EPA 6010A (soluble)	TCLP Lead		

DATA VALIDATION REPORT

Project Name:	Fort Irwin DO 37 Sites 32A, 38, 39, 40
Collection Date:	May 11-12, 1999
Report Date:	June 25, 1999
Matrix:	Soil
Parameters:	SVOCs
Validation Level:	Level IV
Laboratory:	Applied Chemistry & Physics Laboratory
Laboratory Project ID:	99-3622

SAMPLE IDENTIFICATION

Laboratory Project	Analytical Method	Field Identification	Laboratory Identification
99-3622	EPA 8270	40-2-SB-1-10.0	99-3622-15
99-3622	EPA 8270	40-2-SB-1-2.5	99-3622-12
99-3622	EPA 8270	40-2-SB-1-5.0	99-3622-14
99-3622	EPA 8270	40-2-SB-1-5-99	99-3622-13
99-3622	EPA 8270	40-2-SB-2-10.0	99-3622-20
99-3622	EPA 8270	40-2-SB-2-10-99	99-3622-19
99-3622	EPA 8270	40-2-SB-2-5.0	99-3622-18
99-3622	EPA 8270	40-2-SB-3-10.0	99-3622-23
99-3622	EPA 8270	40-2-SB-3-2.5	99-3622-21
99-3622	EPA 8270	40-2-SB-3-5.0	99-3622-22
99-3622	EPA 8270	40-2-SB-4-10.0	99-3622-26
99-3622	EPA 8270	40-2-SB-4-2.5	99-3622-24
99-3622	EPA 8270	40-2-SB-4-5.0	99-3622-25
99-3622	EPA 8270	40-2-SB-5-10.0	99-3622-29
99-3622	EPA 8270	40-2-SB-5-2.5	99-3622-27
99-3622	EPA 8270	40-2-SB-5-5.0	99-3622-28

INTRODUCTION

The review follows a modified outline of the USEPA Contract Laboratory Guidelines for Organic Data Review (February 1994).

A table summarizing all data qualification is provided at the end of this report

Raw data were reviewed for this laboratory project The review was based on QC data.

Data qualifier definitions:

U	Indicates the compound or analyte was analyzed for but not detected at or above the stated limit.
J	Indicates that the data is estimated.
R	Quality control indicates that the data is not usable.
UJ	Indicates that the compound or analyte was analyzed for but not detected. The sample detection limit is an estimated value.

1. Technical Holding Times

All technical holding time requirements were met.

The chain-of-custodies were reviewed for documentation of cooler temperatures All cooler temperatures met validation criteria

2. GC/MS Instrument Performance Check

Instrument performance was checked at 12 hour intervals.

All ion abundance requirements were met

3. Initial Calibration

Initial calibration was performed using required standard concentrations.

Percent relative standard deviations (%RSD) were less than or equal to 30.0% for all compoundswith the exception of 2-aminonaphthalene (30.67%) Apply "J" flag to positive results for this compound. Associated samples include 40-2-SB-1-10 0, 40-2-SB-1-2.5, 40-2-SB-1-5 0, 40-2-SB-1-5-99, 40-2-SB-2-10.0, 40-2-SB-2-10-99, 40-2-SB-2-5.0, 40-2-SB-3-10 0, 40-2-SB-3-2.5, 40-2-SB-3-5 0, 40-2-SB-4-10.0, 40-2-SB-4-2.5, 40-2-SB-4-5.0, 40-2-SB-5-10 0, 40-2-SB-5-2.5, and 40-2-SB-5-5 0 No positive results, therefore, no flags applied

Average relative response factors (RRF) for all semivolatile target compounds and system monitoring compounds were greater than or equal to 0.05 as required.

4. Continuing Calibration

Continuing calibration was performed at the required frequencies

All of the continuing calibration percent differences (%D) between the initial calibration RRF and the continuing calibration RRF were less than or equal to 25 0% with the following exceptions

Date	Compound	%D	Associated Samples	Flag
	Benzyl alcohol Benzoic Acid Benzidine	33.6% -25.5% 33 3%	40-2-SB-1-10.0 40-2-SB-1-2.5 40-2-SB-1-5.0 40-2-SB-1-5-99 40-2-SB-2-10 0 40-2-SB-2-10-99 40-2-SB-2-5.0 40-2-SB-3-10.0 40-2-SB-3-2.5 40-2-SB-3-5.0 40-2-SB-4-2.5	J flag (positive results); UJ flag (non-detect results)
	Benzoic Acid 4,6-Dinitro-2-methylphenol	-46 8% -26.0%	40-2-SB-4-5.0 40-2-SB-4-10 0 40-2-SB-5-2 5 40-2-SB-5-5.0 40-2-SB-5-10.0	J flag (positive results); UJ flag (non-detect results)

All of the continuing calibration RRF values were greater than or equal to 0.05.

5. Blanks

Method blanks were reviewed for each matrix as applicable No semivolatile contaminants were found in the method blanks

6. Surrogate Spikes

Surrogates were added to all samples and blanks as required by the method. All surrogate recoveries (%R) were within QC limits.

7. Matrix Spike Analysis

The matrix spike (MS) and matrix spike duplicate (MSD) samples were reviewed for each matrix as applicable. Percent recoveries (%R) and relative percent differences (RPD) were within QC limits.:

8. Laboratory Control Samples

Laboratory control samples were reviewed for each matrix as applicable. Percent recoveries (%R) were within QC limits

9. Regional Quality Assurance and Quality Control

Not applicable.

10. Internal Standards

Internal standard data were not provided and therefore not reviewed

11. Target Compound Identifications

Raw data were reviewed for this laboratory project

12. Compound Quantitation and CRQLs

The QAPP reporting limits were met.

Raw data were reviewed for this laboratory performance.

13. System Performance

Raw data were reviewed for this laboratory project.

14. Overall Assessment

Data flags have been summarized at the end of the report.

15. Field Duplicates

Primary ID (Duplicate ID)	Analyte	Initial Result	Duplicate Result	RPD	Flag
40-2-SB-1-5.0 (40-2-SB-1-5-99)	Bis(2-ethylhexyl) phthalate	245	77 J	104	No Flags
40-2-SB-2-10.0 (40-2-SB-2-10-99)				All RPDs OK	No flags

DATA V DATION
SW8270

QC Check	Minimum Frequency	Acceptance Criteria	Flagging Criteria	Comments
Holding Times	Each sample	extraction 7 days;analyzed 40 days	If HT exceeded, apply J to all non-detect and positive results. If HT grossly exceeded, flag positive results J, and flag all non-detects R.	OK
GC/MS Instrument Performance Check	Prior to initial calibration and calibration verification	Refer to criteria listed in the method	If mass assignment is in error, flag all data R. If ion abundance criteria are not met, professional judgment may be applied to detrmine to what extent the data may be utilized	OK
Initial Calibration	Initial calibration prior to sample analyses	SPCCs average RF≥0.050 and %RSD for RFs for CCCs≤30% and one option below	If the %RSD is greater than 30.0% and the RRF is greater than 0.05, flag positive results J, use professional judgment for non-detected.	5/13/99 10:05:38 2-Aminonaphthalene 30.67%. Calibration exceedance is considered negligible, therefore associated non-detected samples are not flagged.
		option 1 linear-mean RSD for all analytes ≤15% with no individual analyte RSD ≥30%	If the RRF is less than 0.05, flag positive results J, and non-detects R.	
		option 2 linear-least squares regression r≥0.995	See EPA's *National Functional Guidelines* for more in-depth review criteria.	
		option 3 linear-COD≥0.990 (6 points shall be used for second order, 7 points shall be used for third order)		

QC Check	Minimum Frequency	Acceptance Criteria	Flagging Criteria	Comments
Continuing Calibration	Analyzed at the beginning of each 12-hour analysis period following the analysis of instrument performance check.	RRF≥0.050 and %D between initial calibration RF and continuing calibration RF must be within ±25.0% for all target analytes.	If %D is outside ±25.0% and RF≥0.05, flag positive and non-detect results J. If the RF<0.05, flag positive results J and non-detect results R.	Benzyl alcohol 33.6%D; Benzoic acid -25.5%D; Benzidine -33.3%D. Associated Samples: 3622-12, 13, 14, 15, 18 ,19, 19MS, 19MSD, 20, 21, 22, 23, 24. Benzoic acid -46.8%D; 4,6-Dinitro-2-methylphenol -26.0%D; Associated Samples 3622 -25, 26, 27, 28, 29. Apply "J" flag to positive results, and "UJ' to non-detect results.
Blanks	The method blank must be analyzed on each GC/MS system used to analyze that specific group or set of samples.	No contaminants should be found in blanks.	If compound is found in blank and not in sample, no action is taken. Any SV detected in the sample, that was also detected in any associated blank, is qualified if the sample concetration is less than 5x's the blank concentration (10x's for common phthal	99G2752
Surrogate Spikes	Every sample, standard, and method blank.	See method acceptance criteria.	Data are not qualified unless two or more surrogates within the same fraction are out of specification. If two or more surrogates have a recovery that exceeds the UL, flag positive results J. If two or more surrogates that a recovery that is lower than	OK
MS/MSD	One per 20 samples.	Recoveries should be within advisory limits listed in method.	Use professional judgment.	40-2-SB-2-10-99 OK

QC Check	Minimum Frequency	Acceptance Criteria	Flagging Criteria	Comments
Laboratory Control Samples	One per batch	Recoveries should be within advisory limits listed in method.	If LCS exceeds UL, flag positive results J. If the LCS falls below the LL, flag positive results J and non-detect results R. If more than half of the compounds in the LCS are not within the recovery limits, then all associated detected compounds should	OK
Internal Standards		IS area must not vary by more than a factor of two (-50% to +100%) from the associated 12 hour calibration standard.	If IS is outside -50% to +100% area for the associated standard, flag positive results J. Non-detected compounds quantitated using an IS area count greater than 100% should not be qualified. Non-detect compounds using an IS less than 50% are flagged J.	OK
Target Compound Identification		Compound must be within +0.06 TTR of the standard RRT. See method for additional criteria.	Use professional judgment.	OK
Field Duplicates		None	Calculate RPD	**40-2-SB-1-5.0** bis(2-ethylhexyl)phthalate - 104%RPD. **40-2-SB-2-10** All RPDs OK.
CRQLs		Compound quantitation according to the right exquation, and based on the correct internal standard.	Resolve any discrepancies. Use professional judgment.	

QC Check	Minimum Frequency	Acceptance Criteria	Flagging Criteria	Comments
System Performance		Review baseline shifts and chromatogram performance.	Professional judgment.	
Overall Assessment of Data		Evaluate technical problems not previously addressed.	Professional judgment.	

SDG	Method	Parameter	40-2-SB-1-10.0	40-2-SB-1-2.5	40-2-SB-1-5-99	40-2-SB-1-5.0	40-2-SB-2-10-99	40-2-SB-2-10.0	40-2-SB-2-5.0
99-3622	EPA 8270C	1,2,4,5-Tetrachlorobenzene	< 530	< 530	< 520	< 520	< 520	< 530	< 530
99-3622	EPA 8270C	1,2,4-Trichlorobenzene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	1,2-Dichlorobenzene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	1,2-Diphenylhydrazine	< 530	< 530	< 520	< 520	< 520	< 530	< 530
99-3622	EPA 8270C	1,3-Dichlorobenzene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	1,4-Dichlorobenzene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	1-Chloronaphthalene	< 530	< 530	< 520	< 520	< 520	< 530	< 530
99-3622	EPA 8270C	1-Naphthylamine	< 530	< 530	< 520	< 520	< 520	< 530	< 530
99-3622	EPA 8270C	2,3,4,6-Tetrachlorophenol	< 530	< 530	< 520	< 520	< 520	< 530	< 530
99-3622	EPA 8270C	2,4,5-Trichlorophenol	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	2,4,6-Trichlorophenol	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	2,4-Dichlorophenol	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	2,4-Dimethylphenol	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	2,4-Dinitrophenol	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	2,4-Dinitrotoluene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	2,6-Dichlorophenol	< 530	< 530	< 520	< 520	< 520	< 530	< 530
99-3622	EPA 8270C	2,6-Dinitrotoluene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	2-AminoNaphthalene	< 530	< 530	< 520	< 520	< 520	< 530	< 530
99-3622	EPA 8270C	2-ChloroNaphthalene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	2-Chlorophenol	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	2-Methylnaphthalene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	2-Methylphenol	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	2-Nitroaniline	< 290	< 290	< 280	< 280	< 280	< 290	< 280
99-3622	EPA 8270C	2-Nitrophenol	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	2-Picoline	< 1100	< 1100	< 1000	< 1000	< 1000	< 1100	< 1100
99-3622	EPA 8270C	3,3'-Dichlorobenzidine	< 240	< 240	< 240	< 240	< 240	< 240	< 240
99-3622	EPA 8270C	3-Methylcholanthrene	< 530	< 530	< 520	< 520	< 520	< 530	< 530
99-3622	EPA 8270C	3-Nitroaniline	< 2600	< 2600	< 2600	< 2600	< 2600	< 2700	< 2600
99-3622	EPA 8270C	4,6-Dinitro-2-methylphenol	< 300	< 300	< 290	< 290	< 290	< 300	< 290
99-3622	EPA 8270C	4-Aminobiphenyl	< 530	< 530	< 520	< 520	< 520	< 530	< 530

SDG	Method	Parameter	40-2-SB-1-10.0	40-2-SB-1-2.5	40-2-SB-1-5-99	40-2-SB-1-5.0	40-2-SB-2-10-99	40-2-SB-2-10.0	40-2-SB-2-5.0
99-3622	EPA 8270C	4-Bromophenyl phenyl ether	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	4-Chloro-3-methylphenol	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	4-Chloroaniline	< 340	< 340	< 340	< 330	< 340	< 340	< 340
99-3622	EPA 8270C	4-Chlorophenyl phenyl ether	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	4-methylphenol	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	4-Nitroaniline	< 260	< 260	< 260	< 260	< 260	< 270	< 260
99-3622	EPA 8270C	4-Nitrophenol	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	7,12-Dimethylbenz(a)anthracene	< 530	< 530	< 520	< 520	< 520	< 530	< 530
99-3622	EPA 8270C	Acenaphthene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Acenaphthylene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Acetophenone	< 530	< 530	< 520	< 520	< 520	< 530	< 530
99-3622	EPA 8270C	Aniline	< 530	< 530	< 520	< 520	< 520	< 530	< 530
99-3622	EPA 8270C	Anthracene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Benzidine	< 1100 UJ	< 1100 UJ	< 1000 UJ	< 1000 UJ	< 1000 UJ	< 1100 UJ	< 1100 UJ
99-3622	EPA 8270C	Benzo(a)anthracene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Benzo(a)pyrene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Benzo(b)fluoranthene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Benzo(g,h,i)perylene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Benzo(k)fluoranthene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Benzoic acid	< 180 UJ	< 180 UJ	< 180 UJ	< 180 UJ	< 180 UJ	< 180 UJ	< 180 UJ
99-3622	EPA 8270C	Benzyl alcohol	< 180 UJ	< 180 UJ	< 180 UJ	< 180 UJ	< 180 UJ	< 180 UJ	< 180 UJ
99-3622	EPA 8270C	Benzyl butyl phthalate	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	bis (2-Chloroethoxy) methane	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	bis (2-Chloroethyl) ether	< 530	< 530	< 520	< 520	< 520	< 530	< 530
99-3622	EPA 8270C	bis (2-Chloroisopropyl) ether	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	bis (2-Ethylhexyl) phthalate	322	410	77 J	245	< 180	77 J	235
99-3622	EPA 8270C	Chrysene	< 530	< 530	< 520	< 520	< 520	< 530	< 530
99-3622	EPA 8270C	di-n-Butyl phthalate	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	di-n-Octylphthalate	256	333	< 180	205	< 180	57 J	196
99-3622	EPA 8270C	Dibenz(a,h)anthracene	< 180	< 180	< 180	< 180	< 180	< 180	< 180

SDG	Method	Parameter	40-2-SB-1-10.0	40-2-SB-1-2.5	40-2-SB-1-5-99	40-2-SB-1-5.0	40-2-SB-2-10-99	40-2-SB-2-10.0	40-2-SB-2-5.0
99-3622	EPA 8270C	Dibenz(a,j)acridine	< 530	< 530	< 520	< 520	< 520	< 530	< 530
99-3622	EPA 8270C	Dibenzofuran	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Diethyl phthalate	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Dimethyl phthalate	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	DimethylphenylNaphthalene	< 2600	< 2600	< 2600	< 2600	< 2600	< 2700	< 2600
99-3622	EPA 8270C	Diphenylamine	< 530	< 530	< 520	< 520	< 520	< 530	< 530
99-3622	EPA 8270C	Ethyl methanesulfonate	< 530	< 530	< 520	< 520	< 520	< 530	< 530
99-3622	EPA 8270C	Fluoranthene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Fluorene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Hexachlorobenzene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Hexachlorobutadiene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Hexachlorocyclopentadiene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Hexachloroethane	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Indeno(1,2,3-c,d)pyrene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Isophorone	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Methyl methanesulfonate	< 530	< 530	< 520	< 520	< 520	< 530	< 530
99-3622	EPA 8270C	N-Nitroso-di-n-butylamine	< 530	< 530	< 520	< 520	< 520	< 530	< 530
99-3622	EPA 8270C	N-Nitroso-di-n-propylamine	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	N-Nitrosodimethylamine	< 530	< 530	< 520	< 520	< 520	< 530	< 530
99-3622	EPA 8270C	N-Nitrosodiphenylamine	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	N-Nitrosopiperidine	< 530	< 530	< 520	< 520	< 520	< 530	< 530
99-3622	EPA 8270C	Naphthalene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Nitrobenzene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	p-Dimethylaminoazobenzene	< 530	< 530	< 520	< 520	< 520	< 530	< 530
99-3622	EPA 8270C	Pentachlorobenzene	< 2600	< 2600	< 2600	< 2600	< 2600	< 2700	< 2600
99-3622	EPA 8270C	Pentachlorophenol	< 510	< 510	< 500	< 490	< 500	< 510	< 510
99-3622	EPA 8270C	Phenacetin	< 530	< 530	< 520	< 520	< 520	< 530	< 530
99-3622	EPA 8270C	Phenanthrene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Phenol	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Pronamide	< 530	< 530	< 520	< 520	< 520	< 530	< 530

SDG	Method	Parameter	40-2-SB-1-10.0	40-2-SB-1-2.5	40-2-SB-1-5-99	40-2-SB-1-5.0	40-2-SB-2-10-99	40-2-SB-2-10.0	40-2-SB-2-5.0
99-3622	EPA 8270C	Pyrene	< 180	< 180	< 180	< 180	< 180	< 180	< 180

SDG	Method	Parameter	40-2-SB-3-10.0	40-2-SB-3-2.5	40-2-SB-3-5.0	40-2-SB-4-10.0	40-2-SB-4-2.5	40-2-SB-4-5.0	40-2-SB-5-10.0
99-3622	EPA 8270C	1,2,4,5-Tetrachlorobenzene	< 530	< 520	< 520	< 530	< 520	< 530	< 540
99-3622	EPA 8270C	1,2,4-Trichlorobenzene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	1,2-Dichlorobenzene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	1,2-Diphenylhydrazine	< 530	< 520	< 520	< 530	< 520	< 530	< 540
99-3622	EPA 8270C	1,3-Dichlorobenzene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	1,4-Dichlorobenzene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	1-Chloronaphthalene	< 530	< 520	< 520	< 530	< 520	< 530	< 540
99-3622	EPA 8270C	1-Naphthylamine	< 530	< 520	< 520	< 530	< 520	< 530	< 540
99-3622	EPA 8270C	2,3,4,6-Tetrachlorophenol	< 530	< 520	< 520	< 530	< 520	< 530	< 540
99-3622	EPA 8270C	2,4,5-Trichlorophenol	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	2,4,6-Trichlorophenol	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	2,4-Dichlorophenol	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	2,4-Dimethylphenol	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	2,4-Dinitrophenol	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	2,4-Dinitrotoluene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	2,6-Dichlorophenol	< 530	< 520	< 520	< 530	< 520	< 530	< 540
99-3622	EPA 8270C	2,6-Dinitrotoluene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	2-AminoNaphthalene	< 530	< 520	< 520	< 530	< 520	< 530	< 540
99-3622	EPA 8270C	2-ChloroNaphthalene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	2-Chlorophenol	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	2-Methylnaphthalene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	2-Methylphenol	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	2-Nitroaniline	< 280	< 280	< 280	< 280	< 280	< 280	< 290
99-3622	EPA 8270C	2-Nitrophenol	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	2-Picoline	< 1100	< 1000	< 1000	< 1100	< 1000	< 1100	< 1100
99-3622	EPA 8270C	3,3'-Dichlorobenzidine	< 240	< 240	< 240	< 240	< 240	< 240	< 250
99-3622	EPA 8270C	3-Methylcholanthrene	< 530	< 520	< 520	< 530	< 520	< 530	< 540
99-3622	EPA 8270C	3-Nitroaniline	< 2600	< 2600	< 2600	< 2600	< 2600	< 2600	< 2700
99-3622	EPA 8270C	4,6-Dinitro-2-methylphenol	< 290	< 290	< 290	< 290 UJ	< 290	< 290 UJ	< 300 UJ
99-3622	EPA 8270C	4-Aminobiphenyl	< 530	< 520	< 520	< 530	< 520	< 530	< 540

SDG	Method	Parameter	40-2-SB-3-10.0	40-2-SB-3-2.5	40-2-SB-3-5.0	40-2-SB-4-10.0	40-2-SB-4-2.5	40-2-SB-4-5.0	40-2-SB-5-10.0
99-3622	EPA 8270C	4-Bromophenyl phenyl ether	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	4-Chloro-3-methylphenol	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	4-Chloroaniline	< 340	< 330	< 330	< 340	< 330	< 340	< 350
99-3622	EPA 8270C	4-Chlorophenyl phenyl ether	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	4-methylphenol	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	4-Nitroaniline	< 260	< 260	< 260	< 260	< 260	< 260	< 270
99-3622	EPA 8270C	4-Nitrophenol	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	7,12-Dimethylbenz(a)anthracene	< 530	< 520	< 520	< 530	< 520	< 530	< 540
99-3622	EPA 8270C	Acenaphthene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Acenaphthylene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Acetophenone	< 530	< 520	< 520	< 530	< 520	< 530	< 540
99-3622	EPA 8270C	Aniline	< 530	< 520	< 520	< 530	< 520	< 530	< 540
99-3622	EPA 8270C	Anthracene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Benzidine	< 1100 UJ	< 1000 UJ	< 1000 UJ	< 1100	< 1000 UJ	< 1100	< 1100
99-3622	EPA 8270C	Benzo(a)anthracene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Benzo(a)pyrene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Benzo(b)fluoranthene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Benzo(g,h,i)perylene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Benzo(k)fluoranthene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Benzoic acid	< 180 UJ	< 180 UJ	< 180 UJ	< 180 UJ	< 180 UJ	< 180 UJ	< 180 UJ
99-3622	EPA 8270C	Benzyl alcohol	< 180 UJ	< 180 UJ	< 180 UJ	< 180	< 180 UJ	< 180	< 180
99-3622	EPA 8270C	Benzyl butyl phthalate	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	bis (2-Chloroethoxy) methane	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	bis (2-Chloroethyl) ether	< 530	< 520	< 520	< 530	< 520	< 530	< 540
99-3622	EPA 8270C	bis (2-Chloroisopropyl) ether	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	bis (2-Ethylhexyl) phthalate	95 J	< 180	96 J	170 J	< 180	110 J	79 J
99-3622	EPA 8270C	Chrysene	< 530	< 520	< 520	< 530	< 520	< 530	< 540
99-3622	EPA 8270C	di-n-Butyl phthalate	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	di-n-Octylphthalate	< 180	< 180	88 J	< 180	< 180	< 180	71 J
99-3622	EPA 8270C	Dibenz(a,h)anthracene	< 180	< 180	< 180	< 180	< 180	< 180	< 180

SDG	Method	Parameter	40-2-SB-3-10.0	40-2-SB-3-2.5	40-2-SB-3-5.0	40-2-SB-4-10.0	40-2-SB-4-2.5	40-2-SB-4-5.0	40-2-SB-5-10.0
99-3622	EPA 8270C	Dibenz(a,j)acridine	< 530	< 520	< 520	< 530	< 520	< 530	< 540
99-3622	EPA 8270C	Dibenzofuran	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Diethyl phthalate	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Dimethyl phthalate	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	DimethylphenylNaphthalene	< 2600	< 2600	< 2600	< 2600	< 2600	< 2600	< 2700
99-3622	EPA 8270C	Diphenylamine	< 530	< 520	< 520	< 530	< 520	< 530	< 540
99-3622	EPA 8270C	Ethyl methanesulfonate	< 530	< 520	< 520	< 530	< 520	< 530	< 540
99-3622	EPA 8270C	Fluoranthene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Fluorene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Hexachlorobenzene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Hexachlorobutadiene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Hexachlorocyclopentadiene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Hexachloroethane	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Indeno(1,2,3-c,d)pyrene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Isophorone	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Methyl methanesulfonate	< 530	< 520	< 520	< 530	< 520	< 530	< 540
99-3622	EPA 8270C	N-Nitroso-di-n-butylamine	< 530	< 520	< 520	< 530	< 520	< 530	< 540
99-3622	EPA 8270C	N-Nitroso-di-n-propylamine	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	N-Nitrosodimethylamine	< 530	< 520	< 520	< 530	< 520	< 530	< 540
99-3622	EPA 8270C	N-Nitrosodiphenylamine	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	N-Nitrosopiperidine	< 530	< 520	< 520	< 530	< 520	< 530	< 540
99-3622	EPA 8270C	Naphthalene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Nitrobenzene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	p-Dimethylaminoazobenzene	< 530	< 520	< 520	< 530	< 520	< 530	< 540
99-3622	EPA 8270C	Pentachlorobenzene	< 2600	< 2600	< 2600	< 2600	< 2600	< 2600	< 2700
99-3622	EPA 8270C	Pentachlorophenol	< 500	< 500	< 500	< 500	< 500	< 500	< 520
99-3622	EPA 8270C	Phenacetin	< 530	< 520	< 520	< 530	< 520	< 530	< 540
99-3622	EPA 8270C	Phenanthrene	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Phenol	< 180	< 180	< 180	< 180	< 180	< 180	< 180
99-3622	EPA 8270C	Pronamide	< 530	< 520	< 520	< 530	< 520	< 530	< 540

SDG	Method	Parameter	40-2-SB-3-10.0	40-2-SB-3-2.5	40-2-SB-3-5.0	40-2-SB-4-10.0	40-2-SB-4-2.5	40-2-SB-4-5.0	40-2-SB-5-10.0
99-3622	EPA 8270C	Pyrene	< 180	< 180	< 180	< 180	< 180	< 180	< 180

SDG	Method	Parameter	40-2-SB-5-2.5	40-2-SB-5-5.0
99-3622	EPA 8270C	1,2,4,5-Tetrachlorobenzene	< 520	< 520
99-3622	EPA 8270C	1,2,4-Trichlorobenzene	< 180	< 180
99-3622	EPA 8270C	1,2-Dichlorobenzene	< 180	< 180
99-3622	EPA 8270C	1,2-Diphenylhydrazine	< 520	< 520
99-3622	EPA 8270C	1,3-Dichlorobenzene	< 180	< 180
99-3622	EPA 8270C	1,4-Dichlorobenzene	< 180	< 180
99-3622	EPA 8270C	1-Chloronaphthalene	< 520	< 520
99-3622	EPA 8270C	1-Naphthylamine	< 520	< 520
99-3622	EPA 8270C	2,3,4,6-Tetrachlorophenol	< 520	< 520
99-3622	EPA 8270C	2,4,5-Trichlorophenol	< 180	< 180
99-3622	EPA 8270C	2,4,6-Trichlorophenol	< 180	< 180
99-3622	EPA 8270C	2,4-Dichlorophenol	< 180	< 180
99-3622	EPA 8270C	2,4-Dimethylphenol	< 180	< 180
99-3622	EPA 8270C	2,4-Dinitrophenol	< 180	< 180
99-3622	EPA 8270C	2,4-Dinitrotoluene	< 180	< 180
99-3622	EPA 8270C	2,6-Dichlorophenol	< 520	< 520
99-3622	EPA 8270C	2,6-Dinitrotoluene	< 180	< 180
99-3622	EPA 8270C	2-AminoNaphthalene	< 520	< 520
99-3622	EPA 8270C	2-ChloroNaphthalene	< 180	< 180
99-3622	EPA 8270C	2-Chlorophenol	< 180	< 180
99-3622	EPA 8270C	2-Methylnaphthalene	< 180	< 180
99-3622	EPA 8270C	2-Methylphenol	< 180	< 180
99-3622	EPA 8270C	2-Nitroaniline	< 280	< 280
99-3622	EPA 8270C	2-Nitrophenol	< 180	< 180
99-3622	EPA 8270C	2-Picoline	< 1000	< 1000
99-3622	EPA 8270C	3,3'-Dichlorobenzidine	< 240	< 240
99-3622	EPA 8270C	3-Methylcholanthrene	< 520	< 520
99-3622	EPA 8270C	3-Nitroaniline	< 2600	< 2600
99-3622	EPA 8270C	4,6-Dinitro-2-methylphenol	< 290 UJ	< 290 UJ
99-3622	EPA 8270C	4-Aminobiphenyl	< 520	< 520

SDG	Method	Parameter	40-2-SB-5-2.5	40-2-SB-5-5.0
99-3622	EPA 8270C	4-Bromophenyl phenyl ether	< 180	< 180
99-3622	EPA 8270C	4-Chloro-3-methylphenol	< 180	< 180
99-3622	EPA 8270C	4-Chloroaniline	< 330	< 330
99-3622	EPA 8270C	4-Chlorophenyl phenyl ether	< 180	< 180
99-3622	EPA 8270C	4-methylphenol	< 180	< 180
99-3622	EPA 8270C	4-Nitroaniline	< 260	< 260
99-3622	EPA 8270C	4-Nitrophenol	< 180	< 180
99-3622	EPA 8270C	7,12-Dimethylbenz(a)anthracene	< 520	< 520
99-3622	EPA 8270C	Acenaphthene	< 180	< 180
99-3622	EPA 8270C	Acenaphthylene	< 180	< 180
99-3622	EPA 8270C	Acetophenone	< 520	< 520
99-3622	EPA 8270C	Aniline	< 520	< 520
99-3622	EPA 8270C	Anthracene	< 180	< 180
99-3622	EPA 8270C	Benzidine	< 1000	< 1000
99-3622	EPA 8270C	Benzo(a)anthracene	< 180	< 180
99-3622	EPA 8270C	Benzo(a)pyrene	< 180	< 180
99-3622	EPA 8270C	Benzo(b)fluoranthene	< 180	< 180
99-3622	EPA 8270C	Benzo(g,h,i)perylene	< 180	< 180
99-3622	EPA 8270C	Benzo(k)fluoranthene	< 180	< 180
99-3622	EPA 8270C	Benzoic acid	< 180 UJ	< 180 UJ
99-3622	EPA 8270C	Benzyl alcohol	< 180	< 180
99-3622	EPA 8270C	Benzyl butyl phthalate	< 180	< 180
99-3622	EPA 8270C	bis (2-Chloroethoxy) methane	< 180	< 180
99-3622	EPA 8270C	bis (2-Chloroethyl) ether	< 520	< 520
99-3622	EPA 8270C	bis (2-Chloroisopropyl) ether	< 180	< 180
99-3622	EPA 8270C	bis (2-Ethylhexyl) phthalate	140 J	150 J
99-3622	EPA 8270C	Chrysene	< 520	< 520
99-3622	EPA 8270C	di-n-Butyl phthalate	< 180	< 180
99-3622	EPA 8270C	di-n-Octylphthalate	99 J	120 J
99-3622	EPA 8270C	Dibenz(a,h)anthracene	< 180	< 180

SDG	Method	Parameter	40-2-SB-5-2.5	40-2-SB-5-5.0
99-3622	EPA 8270C	Dibenz(a,j)acridine	< 520	< 520
99-3622	EPA 8270C	Dibenzofuran	< 180	< 180
99-3622	EPA 8270C	Diethyl phthalate	< 180	< 180
99-3622	EPA 8270C	Dimethyl phthalate	< 180	< 180
99-3622	EPA 8270C	DimethylphenylNaphthalene	< 2600	< 2600
99-3622	EPA 8270C	Diphenylamine	< 520	< 520
99-3622	EPA 8270C	Ethyl methanesulfonate	< 520	< 520
99-3622	EPA 8270C	Fluoranthene	< 180	< 180
99-3622	EPA 8270C	Fluorene	< 180	< 180
99-3622	EPA 8270C	Hexachlorobenzene	< 180	< 180
99-3622	EPA 8270C	Hexachlorobutadiene	< 180	< 180
99-3622	EPA 8270C	Hexachlorocyclopentadiene	< 180	< 180
99-3622	EPA 8270C	Hexachloroethane	< 180	< 180
99-3622	EPA 8270C	Indeno(1,2,3-c,d)pyrene	< 180	< 180
99-3622	EPA 8270C	Isophorone	< 180	< 180
99-3622	EPA 8270C	Methyl methanesulfonate	< 520	< 520
99-3622	EPA 8270C	N-Nitroso-di-n-butylamine	< 520	< 520
99-3622	EPA 8270C	N-Nitroso-di-n-propylamine	< 180	< 180
99-3622	EPA 8270C	N-Nitrosodimethylamine	< 520	< 520
99-3622	EPA 8270C	N-Nitrosodiphenylamine	< 180	< 180
99-3622	EPA 8270C	N-Nitrosopiperidine	< 520	< 520
99-3622	EPA 8270C	Naphthalene	< 180	< 180
99-3622	EPA 8270C	Nitrobenzene	< 180	< 180
99-3622	EPA 8270C	p-Dimethylaminoazobenzene	< 520	< 520
99-3622	EPA 8270C	Pentachlorobenzene	< 2600	< 2600
99-3622	EPA 8270C	Pentachlorophenol	< 500	< 500
99-3622	EPA 8270C	Phenacetin	< 520	< 520
99-3622	EPA 8270C	Phenanthrene	< 180	< 180
99-3622	EPA 8270C	Phenol	< 180	< 180
99-3622	EPA 8270C	Pronamide	< 520	< 520

SDG	Method	Parameter	40-2-SB-5-2.5	40-2-SB-5-5.0
99-3622	EPA 8270C	Pyrene	< 180	< 180

DATA VALIDATION REPORT

Project Name:	Fort Irwin DO 37 Sites 32A, 38, 39, 40
Collection Date:	May 11-12, 1999
Report Date:	June 25, 1999
Matrix:	Soil
Parameters:	Al,Sb,As,Ba,Cd,Cr,Co,Cu,Pb,Mn,Hg,Ni,Se,Ag,Zn
Validation Level:	Level IV
Laboratory:	Applied Chemistry & Physics Laboratory
Laboratory Project ID:	99-3622

SAMPLE IDENTIFICATION

Laboratory Project	Analytical Method	Field Identification	Laboratory Identification
99-3622	EPA 6010A	40-1-SS-1	99-3622-1
99-3622	EPA 6010A	40-1-SS-10	99-3622-10
99-3622	EPA 6010A	40-1-SS-2	99-3622-2
99-3622	EPA 6010A	40-1-SS-3	99-3622-3
99-3622	EPA 6010A	40-1-SS-3-99	99-3622-11
99-3622	EPA 6010A	40-1-SS-4	99-3622-4
99-3622	EPA 6010A	40-1-SS-5	99-3622-5
99-3622	EPA 6010A	40-1-SS-6	99-3622-6
99-3622	EPA 6010A	40-1-SS-7	99-3622-7
99-3622	EPA 6010A	40-1-SS-8	99-3622-8
99-3622	EPA 6010A	40-1-SS-9	99-3622-9
99-3622	EPA 6010A	40-2-SB-1-10.0	99-3622-15
99-3622	EPA 6010A	40-2-SB-1-2.5	99-3622-12
99-3622	EPA 6010A	40-2-SB-1-5.0	99-3622-14
99-3622	EPA 6010A	40-2-SB-1-5-99	99-3622-13
99-3622	EPA 6010A	40-2-SB-2-10.0	99-3622-20
99-3622	EPA 6010A	40-2-SB-2-10-99	99-3622-19
99-3622	EPA 6010A	40-2-SB-2-5.0	99-3622-18
99-3622	EPA 6010A	40-2-SB-3-10.0	99-3622-23
99-3622	EPA 6010A	40-2-SB-3-2.5	99-3622-21
99-3622	EPA 6010A	40-2-SB-3-5.0	99-3622-22
99-3622	EPA 6010A	40-2-SB-4-10.0	99-3622-26
99-3622	EPA 6010A	40-2-SB-4-2.5	99-3622-24
99-3622	EPA 6010A	40-2-SB-4-5.0	99-3622-25
99-3622	EPA 6010A	40-2-SB-5-10.0	99-3622-29
99-3622	EPA 6010A	40-2-SB-5-2.5	99-3622-27
99-3622	EPA 6010A	40-2-SB-5-5.0	99-3622-28
99-3622	EPA 6010A	40-2-SB-CUTTINGS	99-3622-30
99-3622	EPA 6010A	40-2-SS-10	99-3622-32
99-3622	EPA 6010A	40-2-SS-9	99-3622-31
99-3622	EPA 6010A	RF2-SS-1	99-3622-33
99-3622	EPA 6010A	RF2-SS-10	99-3622-42
99-3622	EPA 6010A	RF2-SS-2	99-3622-34
99-3622	EPA 6010A	RF2-SS-3	99-3622-35
99-3622	EPA 6010A	RF2-SS-4	99-3622-36
99-3622	EPA 6010A	RF2-SS-4-99	99-3622-43
99-3622	EPA 6010A	RF2-SS-5	99-3622-37
99-3622	EPA 6010A	RF2-SS-6	99-3622-38
99-3622	EPA 6010A	RF2-SS-7	99-3622-39
99-3622	EPA 6010A	RF2-SS-8	99-3622-40
99-3622	EPA 6010A	RF2-SS-9	99-3622-41

SAMPLE IDENTIFICATION

Laboratory Project	Analytical Method	Field Identification	Laboratory Identification
99-3622	EPA 7471A	40-1-SS-1	99-3622-1
99-3622	EPA 7471A	40-1-SS-10	99-3622-10
99-3622	EPA 7471A	40-1-SS-2	99-3622-2
99-3622	EPA 7471A	40-1-SS-3	99-3622-3
99-3622	EPA 7471A	40-1-SS-3-99	99-3622-11
99-3622	EPA 7471A	40-1-SS-4	99-3622-4
99-3622	EPA 7471A	40-1-SS-5	99-3622-5
99-3622	EPA 7471A	40-1-SS-6	99-3622-6
99-3622	EPA 7471A	40-1-SS-7	99-3622-7
99-3622	EPA 7471A	40-1-SS-8	99-3622-8
99-3622	EPA 7471A	40-1-SS-9	99-3622-9
99-3622	EPA 7471A	40-2-SB-1-10 0	99-3622-15
99-3622	EPA 7471A	40-2-SB-1-2 5	99-3622-12
99-3622	EPA 7471A	40-2-SB-1-5 0	99-3622-14
99-3622	EPA 7471A	40-2-SB-1-5-99	99-3622-13
99-3622	EPA 7471A	40-2-SB-2-10.0	99-3622-20
99-3622	EPA 7471A	40-2-SB-2-10-99	99-3622-19
99-3622	EPA 7471A	40-2-SB-2-5 0	99-3622-18
99-3622	EPA 7471A	40-2-SB-3-10 0	99-3622-23
99-3622	EPA 7471A	40-2-SB-3-2 5	99-3622-21
99-3622	EPA 7471A	40-2-SB-3-5.0	99-3622-22
99-3622	EPA 7471A	40-2-SB-4-10.0	99-3622-26
99-3622	EPA 7471A	40-2-SB-4-2.5	99-3622-24
99-3622	EPA 7471A	40-2-SB-4-5.0	99-3622-25
99-3622	EPA 7471A	40-2-SB-5-10 0	99-3622-29
99-3622	EPA 7471A	40-2-SB-5-2 5	99-3622-27
99-3622	EPA 7471A	40-2-SB-5-5 0	99-3622-28
99-3622	EPA 7471A	RF2-SS-1	99-3622-33
99-3622	EPA 7471A	RF2-SS-10	99-3622-42
99-3622	EPA 7471A	RF2-SS-2	99-3622-34
99-3622	EPA 7471A	RF2-SS-3	99-3622-35
99-3622	EPA 7471A	RF2-SS-4	99-3622-36
99-3622	EPA 7471A	RF2-SS-4-99	99-3622-43
99-3622	EPA 7471A	RF2-SS-5	99-3622-37
99-3622	EPA 7471A	RF2-SS-6	99-3622-38
99-3622	EPA 7471A	RF2-SS-7	99-3622-39
99-3622	EPA 7471A	RF2-SS-8	99-3622-40
99-3622	EPA 7471A	RF2-SS-9	99-3622-41

INTRODUCTION

The review follows a modified outline of the USEPA Contract Laboratory Guidelines for Inorganic Data Review (February 1994)

A table summarizing all data qualification is provided at the end of this report.

Raw data were reviewed for this laboratory project The review was based on QC data.

Data qualifier definitions:

U	Indicates the compound or analyte was analyzed for but not detected at or above the stated limit.
J	Indicates that the data is estimated.
R	Quality control indicates that the data is not usable.
UJ	Indicates that the compound or analyte was analyzed for but not detected The sample detection limit is an estimated value.

1. Technical Holding Times

All technical holding time requirements were met.

The chain-of-custodies were reviewed for documentation of cooler temperatures All cooler temperatures met validation criteria

2. Calibration

An initial calibration was performed

The frequency and analysis criteria of the initial verification (ICV) and continuing calibration verification (CCV) were met.

3. Blanks

Method blanks were reviewed for each matrix as applicable.

Data qualification by the initial, continuing and preparation blanks (ICB/CCB/PBs) was based on the maximum contaminant concentration in the ICB/CCB/PBs in the analysis of each analyte No contaminant concentrations were found above the reporting limit in the initial, continuing and preparation blanks

4. ICP Interference Check Samples (ICS) Analysis

The frequency of analysis was met

The criteria for analysis were met.

5. Matrix Spike Analysis

The matrix spike (MS) and matrix spike analyses were reviewed for each matrix as applicable. Percent recoveries (%R) and relative percent differences (RPD) were within QC limits

6. Duplicate Sample Analysis

Duplicate (DUP) sample analyses were reviewed for each matrix as applicable. The RPD were within QC limits.

7. Laboratory Control Samples

Laboratory control samples were reviewed for each matrix as applicable Percent recoveries were within QC limits.

8. Sample Result Verification

All sample result verification met validation criteria.

9. Overall Assessment of Data

Data flags have been summarized at the end of this report.

10. Field Duplicates

Primary ID (Duplicate ID)	Analyte	Initial Result	Duplicate Result	RPD	Flag
40-1-SS-3 (40-1-SS-3-99)	Aluminum	12200	11600	5.0	No Flags
	Antimony	< 4.1	< 4.2	0	No Flags
	Arsenic	4.2	3.4	21 1	No Flags
	Barium	156	152	2 6	No Flags
	Cadmium	0.26 J	0.19 J	31.1	No Flags
	Chromium	11.3	11.1	1 8	No Flags
	Cobalt	7 5	7.7	2 6	No Flags
	Copper	18	17 4	3.4	No Flags
	Lead	13	10 2	24 1	No Flags
	Manganese	417	403	3.4	No Flags
	Mercury	0.13	0.1	26.1	No Flags
	Nickel	10.2	10.1	1.0	No Flags
	Selenium	0 98 J	0 42 J	80 0	No Flags
	Silver	2 4	1 5 J	46 2	No Flags
	Zinc	61	53.9	12.4	No Flags
40-2-SB-1-5.0 (40-2-SB-5-99)	Aluminum	10400	11600	10 9	No Flags
	Antimony	< 4.1	< 4 2	0	No Flags
	Arsenic	7.4	11 4	42.6	No Flags
	Barium	113	110	2.7	No Flags
	Beryllium	< 0 82	0 34 J	NC	No Flags
	Cadmium	< 0 41	0.21 J	NC	No Flags
	Calcium	18300	21400	15 6	No Flags
	Chromium	14	13	7 4	No Flags
	Cobalt	6.9	7.7	11 0	No Flags
	Copper	12 7	18 1	35 1	No Flags
	Iron	17600	21900	21 8	No Flags
	Lead	5 5	8 6	44.0	No Flags
	Magnesium	3990	4210	5 4	No Flags
	Manganese	238	250	4.9	No Flags
	Mercury	< 0.1	< 0 1	0	No Flags
	Molybdenum	0.54 J	0 6 J	10 5	No Flags
	Nickel	11.3	14.6	25 5	No Flags
	Potassium	1900	2140	11 9	No Flags
	Selenium	< 2 1	< 2.1	0	No Flags
	Silver	< 2.1	< 2.1	0	No Flags
	Sodium	365	409	11 4	No Flags
	Thallium	< 1 2	< 1 3	0	No Flags
	Vanadium	23 7	29	20 1	No Flags
	Zinc	38.5	47.4	20.7	No Flags
40-2-SB-10.0 (40-2-SB-10-99)	Aluminum	8950	7310	20.2	No Flags
	Antimony	0 32 J	< 4 2	NC	No Flags
	Arsenic	9	8	11.8	No Flags

Primary ID (Duplicate ID)	Analyte	Initial Result	Duplicate Result	RPD	Flag
40-2-SB-10.0 (40-2-SB-10-99) (continued)	Barium	149	173	14 9	No Flags
	Beryllium	0 11 J	0 14 J	24 0	No Flags
	Cadmium	< 0 42	< 0.42	0	No Flags
	Calcium	40300	49800	21 1	No Flags
	Chromium	12.5	8 8	34.7	No Flags
	Cobalt	5 8	5 4	7 1	No Flags
	Copper	10	9.9	1.0	No Flags
	Iron	14400	12000	18 2	No Flags
	Lead	4.7	4 7	0	No Flags
	Magnesium	3750	3410	9 5	No Flags
	Manganese	237	249	4.9	No Flags
	Mercury	< 0 11	< 0.1	0	No Flags
	Molybdenum	< 0.85	< 0 84	0	No Flags
	Nickel	9.7	8.1	18.0	No Flags
	Potassium	1750	1430	20.1	No Flags
	Selenium	< 2.1	0 64 J	NC	No Flags
	Silver	< 2.1	< 2.1	0	No Flags
	Sodium	433	468	7.8	No Flags
	Thallium	< 1 3	< 1.3	0	No Flags
	Vanadium	21	17	21 1	No Flags
	Zinc	30.6	24	24.2	No Flags
RF2-SS-4 (RF2-SS-4-99)	Aluminum	11700	8590	30.7	No Flags
	Antimony	< 4.1	< 4.1	0	No Flags
	Arsenic	7.9	7	12 1	No Flags
	Barium	177	146	19.2	No Flags
	Cadmium	0.19 J	< 0.41	NC	No Flags
	Chromium	11.6	8 2	34 3	No Flags
	Cobalt	7.8	6 3	21.3	No Flags
	Copper	17 8	11 7	41 4	No Flags
	Lead	13 4	8.4	45 9	No Flags
	Manganese	376	324	14 9	No Flags
	Mercury	0.12	0.13	8	No Flags
	Nickel	12	9 5	23.3	No Flags
	Selenium	0 59 J	< 2	NC	No Flags
	Silver	< 2 1	< 2	0	No Flags
	Zinc	52.6	35.9	37.7	No Flags

DATA V .DATION
SW6010

QC Check	Minimum Frequency	Acceptance Criteria	Flagging Criteria	Comments
Holding times	Each sample	180 days; preserved with nitric acid to PH<2	If HT exceeded, apply J to all non-detect and positive results. If HT grossly exceeded, flag positive results J, and flag all non-detects R.	OK
Initial calibration	Daily after initial calibration	%R between 90 and 110%	Apply R to all results for specific analyte(s) for all samples associated with the calibration	OK
Continuing calibration verification	After every 10 samples and at the end of the analysis sequence	All analyte(s) within ±10% of expected value	Apply R to all results for the specific analyte(s) for in all samples since the last acceptable calibration verification	10:35am, 11:44am, 12:20pm, 12:58pm, 13:16pm, 10:35am, 13:16pm, 13:56pm, 14:36pm, 15:08pm, 15:36pm, 16:01pm, 16:25pm, 10:34am, 11:58am, 12:48pm, 13:39pm, 14:29pm,8:54am, 9:38am, 10:08am, 10:42am, 12:56pm, 8:54am, 10:42am, 12:56pm, 13:29pm, 13:58pm, 14:08pm, 10:53am, 11:43am, 14:09pm.
Blanks		No analytes detected >PQL	If compound is found in blank and not in sample, no action is taken. Any metal detected in the sample, that was also detected in any associated blank, is qualified if the sample concetration is less than 5x's the blank concentration. The CRQL is elevate to the concentration found in the sample. If gross contamination exists, flag affected compounds R.	**99M1851** Fe 0.82ug/l, K 18.5ug/l, Tl 0.14ug/l. **99M1852** Fe 0.82ug/l, K 18.5ug/l, Tl 0.14ug/l. **99M1864** OK. ICB: Sb 1.7, K 367.2ug/l. CCB: (1) Cu 4.0, Fe 10.8, Mn 1.2, K 378.8, Se 2.8, Mo 1.2ug/l. (2) Cu 3.3, Fe 17.0, Mn 1.3, K 373.7, Ag -0.7, Tl 1.9, Mo 1.2ug/l. (3) Cu 2.9, Fe 19.7, Mn 1.1, K 373.4, Tl 1.9, Mo 1.3ug/l. (4) Cu 3.1, Fe 19.9, Mn 1.2, K 380.0, Tl 3.3, Mo 1.1ug/l. ICB: Sb 1.7, K 367.2ug/l. CCB: (1) Cu 3.1, Fe 19.9, Mn 1.2, K 380.0, Tl 3.0, Mo 1.3ug/l. (2) Ba 2.4, Cu 4.0, Fe 15.5, Mn 1.0, K 383.9, Tl 3.0, Mo 1.3. (3) Cu 2.7, Fe 19.8, Mn 1.1, K 386.5, Ag -0.6, Tl 3.5, Mo 1.1ug/l. (4) Sb 1.4, Cu 1.8, Fe 29.8, Mn 1.1, K 380.6ug/l. (5) Al -197.6, Ca -204.7, Fe -126.1, Mg -183.3, Mn -0.9, K 249.5, Na 326.5ug/l. (6) Al -73.5, Be 0.1, Co 0.6, Fe -59.2, Mg 56.5, K 294.1, Na 431.0, Tl 2.7, Mo 1.0ug/l. ICB: Sb -2.7, Be 0.1, Mg -5.7, K 86.9ug/l. CCB: (1) Ba 0.5, Be 0.0, Co 0.4, K 87.1, Mo 1.7ug/l. (2) Be 0.0, Co 0.4, Ni 0.5, K 83.7, Na 292.5, Mo 1.3ug/l. (3) Ba 0.6, Be 0.0, Cd 0.3, K 88.5, Tl -2.4, Mo 1.4ug/l. (4) Be 0.1, K 80.7, Mo 0.9ug/l. Hg - OK.
Interference check solution		Within ±20% of expected value	If the %R>120, do not flag non-detect data, flag positive results J. If %R is between 50 and 79%, flag all results J. If %R<50, flag data R.	OK

DATA V. .DATION
SW6010
(Page 2 of 3)

QC Check	Minimum Frequency	Acceptance Criteria	Flagging Criteria	Comments
Post Digestion Spike Sample		Recovery within 75-125% of expected results.	For results associated with failing post digestion spike, flag all data J.	**40-1-SS-1** Al -582.7%R*, Ca 40.2%R*, Fe -2224.3%R*, Mg 6.8%R*, Mn 44.7%R*, K 24.1%R*. **40-2-SB-3-10.0** Al 9.2%R*, Ca 68.3%R*, Fe 2844.1%R*, Mg 67.6%R*, Mn 177.0%R*. * No qualification due to sample concentration exceeding 4X spike concentration.
Laboratory control sample		Within ±25% of expected value	For specific analyte(s) in all samples in the associated analytical batch; If the LCS %R >125, apply J to all positive results. If the LCS %R between 50 and 79, flag all positive results J and non-detect results R. If the LCS %R <50, flag all results R.	OK
Duplicate sample		For results >5x CRDL, RPD 20%. For results <5x CRDL, RPD ±CRDL.	For specific analyte(s) in all samples collected from the same site matrix as the parent, apply M if; (1) %R for MS or MSD >UCL or (2) %R for MS or MSD <LCL or (3) MS/MSD RPD >CL.	**40-1-SS-1** - OK **40-2-SB-3-10.0** - OK
Spike sample analysis		Within ±25% of expected value	For specific analyte(s) in all samples in the associated analytical batch; if the LCS %R >125, apply J to all positive results. If the LCS %R between 30 and 74, flag all positive results J and non-detect results R. If the LCS %R <30, flag all results R.	**40-1-SS-1** Hg OK **40-2-SB-3-10** Hg OK **40-1-SS-1** Al 769, 1060, 197* Mn 63* **40-2-SB-3-10** Al -189, -285, -40*, Ca 48, 38*, Fe 2090, 1900, 196*, Mg 49, 44*, Mn 163, 154 * * No qualification due to sample concentration exceeding 4X spike concentration.
ICP serial dilution		Recovery within 90-110% of expected results.	For results associated with failing serial dilutions, flag all data J.	None

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QC Check	Minimum Frequency	Acceptance Criteria	Flagging Criteria	Comments
Field duplicates		None	Calculate RPD.	**40-1-SS-3** Se - 80.0%RPD **40-2-SB-1-5.0** All RPDs OK. **40-2-SB-10.0** All RPDs OK. **RF2-SS-4** All RPDs OK.
Overall assessment		Evaluate technical problems not previously addressed.	Professional judgment.	

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SDG	Method	Parameter	40-1-SS-1	40-1-SS-10	40-1-SS-2	40-1-SS-3	40-1-SS-3-99	40-1-SS-4
99-3622	EPA 6010A	Aluminum	12400	13300	11500	12200	11600	12300
99-3622	EPA 6010A	Antimony	< 4.2	< 4.1	0.97 J	< 4.1	< 4.2	< 4.1
99-3622	EPA 6010A	Arsenic	5.2	4.9	8.4	4.2	3.4	4.2
99-3622	EPA 6010A	Barium	178	178	205	156	152	154
99-3622	EPA 6010A	Beryllium						
99-3622	EPA 6010A	Cadmium	< 0.42	0.21 J	0.93	0.26 J	0.19 J	< 0.41
99-3622	EPA 6010A	Calcium						
99-3622	EPA 6010A	Chromium	12.1	13.6	13.2	11.3	11.1	10.2
99-3622	EPA 6010A	Cobalt	7.8	8.8	8.2	7.5	7.7	6.9
99-3622	EPA 6010A	Copper	18	16	45.9	18	17.4	13.2
99-3622	EPA 6010A	Iron						
99-3622	EPA 6010A	Lead	10.4	10.4	116	13	10.2	11.2
99-3622	EPA 6010A	Magnesium						
99-3622	EPA 6010A	Manganese	433	505	368	417	403	366
99-3622	EPA 6010A	Molybdenum						
99-3622	EPA 6010A	Nickel	11	11.6	14.1	10.2	10.1	9.2
99-3622	EPA 6010A	Potassium						
99-3622	EPA 6010A	Selenium	0.58 J	0.54 J	< 2.1	0.98 J	0.42 J	0.51 J
99-3622	EPA 6010A	Silver	< 2.1	0.73 J	2.9	2.4	1.5 J	0.83 J
99-3622	EPA 6010A	Sodium						
99-3622	EPA 6010A	Thallium						
99-3622	EPA 6010A	Vanadium						
99-3622	EPA 6010A	Zinc	52.5	54.1	1060	61	53.9	50.9
99-3622	EPA 6010A (soluble)	STLC Aluminum						
99-3622	EPA 6010A (soluble)	STLC Antimony						
99-3622	EPA 6010A (soluble)	STLC Arsenic						
99-3622	EPA 6010A (soluble)	STLC Barium						
99-3622	EPA 6010A (soluble)	STLC Beryllium						
99-3622	EPA 6010A (soluble)	STLC Cadmium						
99-3622	EPA 6010A (soluble)	STLC Calcium						

SDG	Method	Parameter	40-1-SS-1	40-1-SS-10	40-1-SS-2	40-1-SS-3	40-1-SS-3-99	40-1-SS-4
99-3622	EPA 6010A (soluble)	STLC Chromium						
99-3622	EPA 6010A (soluble)	STLC Cobalt						
99-3622	EPA 6010A (soluble)	STLC Copper						
99-3622	EPA 6010A (soluble)	STLC Iron						
99-3622	EPA 6010A (soluble)	STLC Lead						
99-3622	EPA 6010A (soluble)	STLC Magnesium						
99-3622	EPA 6010A (soluble)	STLC Manganese						
99-3622	EPA 6010A (soluble)	STLC Mercury						
99-3622	EPA 6010A (soluble)	STLC Molybdenum						
99-3622	EPA 6010A (soluble)	STLC Nickel						
99-3622	EPA 6010A (soluble)	STLC Potassium						
99-3622	EPA 6010A (soluble)	STLC Selenium						
99-3622	EPA 6010A (soluble)	STLC Silver						
99-3622	EPA 6010A (soluble)	STLC Sodium						
99-3622	EPA 6010A (soluble)	STLC Thallium						
99-3622	EPA 6010A (soluble)	STLC Vanadium						
99-3622	EPA 6010A (soluble)	STLC Zinc						
99-3622	EPA 6010A (soluble)	TCLP Arsenic						
99-3622	EPA 6010A (soluble)	TCLP Barium						
99-3622	EPA 6010A (soluble)	TCLP Cadmium						
99-3622	EPA 6010A (soluble)	TCLP Chromium						
99-3622	EPA 6010A (soluble)	TCLP Lead						
99-3622	EPA 6010A (soluble)	TCLP Mercury						
99-3622	EPA 6010A (soluble)	TCLP Selenium						
99-3622	EPA 6010A (soluble)	TCLP Silver						
99-3622	EPA 7471A	Mercury	0.11	0.11	< 0.1	0.13	0.1	0.11

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SDG	Method	Parameter	40-1-SS-5	40-1-SS-6	40-1-SS-7	40-1-SS-8	40-1-SS-9	40-2-SB-1-10.0
99-3622	EPA 6010A	Aluminum	9600	11300	12700	13600	8770	12300
99-3622	EPA 6010A	Antimony	< 4.1	< 4.1	< 4.1	1.8 J	< 4	0.15 J
99-3622	EPA 6010A	Arsenic	3.8	3.5	5	4.3	2.8	8.7
99-3622	EPA 6010A	Barium	153	144	159	241	131	150
99-3622	EPA 6010A	Beryllium						< 0.84
99-3622	EPA 6010A	Cadmium	0.31 J	< 0.41	0.22 J	3.5	0.21 J	< 0.42
99-3622	EPA 6010A	Calcium						26900
99-3622	EPA 6010A	Chromium	9.1	10.1	12.3	15.3	7.7	16.4
99-3622	EPA 6010A	Cobalt	6.8	6.7	8	7.8	5.4	7.4
99-3622	EPA 6010A	Copper	18.1	14.7	23.8	127	22.9	15.6
99-3622	EPA 6010A	Iron						20400
99-3622	EPA 6010A	Lead	12.5	8.9	12.2	124	7.8	6.7
99-3622	EPA 6010A	Magnesium						4660
99-3622	EPA 6010A	Manganese	401	386	458	468	290	296
99-3622	EPA 6010A	Molybdenum						0.55 J
99-3622	EPA 6010A	Nickel	7.8	8.8	11.3	13	8	12.6
99-3622	EPA 6010A	Potassium						2310
99-3622	EPA 6010A	Selenium	< 2	< 2.1	0.52 J	< 2.1	< 2	< 2.1
99-3622	EPA 6010A	Silver	1.7 J	< 2.1	< 2	41.3	0.92 J	< 2.1
99-3622	EPA 6010A	Sodium						495
99-3622	EPA 6010A	Thallium						< 1.3
99-3622	EPA 6010A	Vanadium						26.4
99-3622	EPA 6010A	Zinc	55.2	43.7	65.6	306	47	41.8
99-3622	EPA 6010A (soluble)	STLC Aluminum						
99-3622	EPA 6010A (soluble)	STLC Antimony						
99-3622	EPA 6010A (soluble)	STLC Arsenic						
99-3622	EPA 6010A (soluble)	STLC Barium						
99-3622	EPA 6010A (soluble)	STLC Beryllium						
99-3622	EPA 6010A (soluble)	STLC Cadmium						
99-3622	EPA 6010A (soluble)	STLC Calcium						

SDG	Method	Parameter	40-1-SS-5	40-1-SS-6	40-1-SS-7	40-1-SS-8	40-1-SS-9	40-2-SB-1-10.0
99-3622	EPA 6010A (soluble)	STLC Chromium						
99-3622	EPA 6010A (soluble)	STLC Cobalt						
99-3622	EPA 6010A (soluble)	STLC Copper						
99-3622	EPA 6010A (soluble)	STLC Iron						
99-3622	EPA 6010A (soluble)	STLC Lead						
99-3622	EPA 6010A (soluble)	STLC Magnesium						
99-3622	EPA 6010A (soluble)	STLC Manganese						
99-3622	EPA 6010A (soluble)	STLC Mercury						
99-3622	EPA 6010A (soluble)	STLC Molybdenum						
99-3622	EPA 6010A (soluble)	STLC Nickel						
99-3622	EPA 6010A (soluble)	STLC Potassium						
99-3622	EPA 6010A (soluble)	STLC Selenium						
99-3622	EPA 6010A (soluble)	STLC Silver						
99-3622	EPA 6010A (soluble)	STLC Sodium						
99-3622	EPA 6010A (soluble)	STLC Thallium						
99-3622	EPA 6010A (soluble)	STLC Vanadium						
99-3622	EPA 6010A (soluble)	STLC Zinc						
99-3622	EPA 6010A (soluble)	TCLP Arsenic						
99-3622	EPA 6010A (soluble)	TCLP Barium						
99-3622	EPA 6010A (soluble)	TCLP Cadmium						
99-3622	EPA 6010A (soluble)	TCLP Chromium						
99-3622	EPA 6010A (soluble)	TCLP Lead						
99-3622	EPA 6010A (soluble)	TCLP Mercury						
99-3622	EPA 6010A (soluble)	TCLP Selenium						
99-3622	EPA 6010A (soluble)	TCLP Silver						
99-3622	EPA 7471A	Mercury	0.11	< 0.1	< 0.1	0.87	< 0.1	< 0.11

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SDG	Method	Parameter	40-2-SB-1-2.5	40-2-SB-1-5-99	40-2-SB-1-5.0	40-2-SB-2-10-99	40-2-SB-2-10.0	40-2-SB-2-5.0
99-3622	EPA 6010A	Aluminum	12600	11600	10400	7310	8950	11900
99-3622	EPA 6010A	Antimony	< 4.2	< 4.2	< 4.1	< 4.2	0.32 J	< 4.2
99-3622	EPA 6010A	Arsenic	10	11.4	7.4	8	9	9.5
99-3622	EPA 6010A	Barium	177	110	113	173	149	169
99-3622	EPA 6010A	Beryllium	0.28 J	0.34 J	< 0.82	0.14 J	0.11 J	0.41 J
99-3622	EPA 6010A	Cadmium	0.22 J	0.21 J	< 0.41	< 0.42	< 0.42	0.18 J
99-3622	EPA 6010A	Calcium	13200	21400	18300	49800	40300	12800
99-3622	EPA 6010A	Chromium	14.8	13	14	8.8	12.5	16.1
99-3622	EPA 6010A	Cobalt	8.7	7.7	6.9	5.4	5.8	7.7
99-3622	EPA 6010A	Copper	19.4	18.1	12.7	9.9	10	17
99-3622	EPA 6010A	Iron	20500	21900	17600	12000	14400	21000
99-3622	EPA 6010A	Lead	11.2	8.6	5.5	4.7	4.7	7.7
99-3622	EPA 6010A	Magnesium	4810	4210	3990	3410	3750	4890
99-3622	EPA 6010A	Manganese	370	250	238	249	237	313
99-3622	EPA 6010A	Molybdenum	0.95	0.6 J	0.54 J	< 0.84	< 0.85	0.46 J
99-3622	EPA 6010A	Nickel	14.8	14.6	11.3	8.1	9.7	13.6
99-3622	EPA 6010A	Potassium	2200	2140	1900	1430	1750	2500
99-3622	EPA 6010A	Selenium	0.84 J	< 2.1	< 2.1	0.64 J	< 2.1	< 2.1
99-3622	EPA 6010A	Silver	< 2.1	< 2.1	< 2.1	< 2.1	< 2.1	< 2.1
99-3622	EPA 6010A	Sodium	205	409	365	468	433	436
99-3622	EPA 6010A	Thallium	< 1.3	< 1.3	< 1.2	< 1.3	< 1.3	< 1.3
99-3622	EPA 6010A	Vanadium	30.9	29	23.7	17	21	31.4
99-3622	EPA 6010A	Zinc	52.6	47.4	38.5	24	30.6	49.2
99-3622	EPA 6010A (soluble)	STLC Aluminum						
99-3622	EPA 6010A (soluble)	STLC Antimony						
99-3622	EPA 6010A (soluble)	STLC Arsenic						
99-3622	EPA 6010A (soluble)	STLC Barium						
99-3622	EPA 6010A (soluble)	STLC Beryllium						
99-3622	EPA 6010A (soluble)	STLC Cadmium						
99-3622	EPA 6010A (soluble)	STLC Calcium						

SDG	Method	Parameter	40-2-SB-1-2.5	40-2-SB-1-5-99	40-2-SB-1-5.0	40-2-SB-2-10-99	40-2-SB-2-10.0	40-2-SB-2-5.0
99-3622	EPA 6010A (soluble)	STLC Chromium						
99-3622	EPA 6010A (soluble)	STLC Cobalt						
99-3622	EPA 6010A (soluble)	STLC Copper						
99-3622	EPA 6010A (soluble)	STLC Iron						
99-3622	EPA 6010A (soluble)	STLC Lead						
99-3622	EPA 6010A (soluble)	STLC Magnesium						
99-3622	EPA 6010A (soluble)	STLC Manganese						
99-3622	EPA 6010A (soluble)	STLC Mercury						
99-3622	EPA 6010A (soluble)	STLC Molybdenum						
99-3622	EPA 6010A (soluble)	STLC Nickel						
99-3622	EPA 6010A (soluble)	STLC Potassium						
99-3622	EPA 6010A (soluble)	STLC Selenium						
99-3622	EPA 6010A (soluble)	STLC Silver						
99-3622	EPA 6010A (soluble)	STLC Sodium						
99-3622	EPA 6010A (soluble)	STLC Thallium						
99-3622	EPA 6010A (soluble)	STLC Vanadium						
99-3622	EPA 6010A (soluble)	STLC Zinc						
99-3622	EPA 6010A (soluble)	TCLP Arsenic						
99-3622	EPA 6010A (soluble)	TCLP Barium						
99-3622	EPA 6010A (soluble)	TCLP Cadmium						
99-3622	EPA 6010A (soluble)	TCLP Chromium						
99-3622	EPA 6010A (soluble)	TCLP Lead						
99-3622	EPA 6010A (soluble)	TCLP Mercury						
99-3622	EPA 6010A (soluble)	TCLP Selenium						
99-3622	EPA 6010A (soluble)	TCLP Silver						
99-3622	EPA 7471A	Mercury	< 0.11	< 0.1	< 0.1	< 0.1	< 0.11	< 0.11

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SDG	Method	Parameter	40-2-SB-3-10.0	40-2-SB-3-2.5	40-2-SB-3-5.0	40-2-SB-4-10.0	40-2-SB-4-2.5	40-2-SB-4-5.0
99-3622	EPA 6010A	Aluminum	10700	10300	9090	10000	10800	11500
99-3622	EPA 6010A	Antimony	0.48 J	< 4.2	< 4.2	< 4.2	< 4.1	< 4.2
99-3622	EPA 6010A	Arsenic	8.6	10	8.3	7.9	9.2	9.1
99-3622	EPA 6010A	Barium	195	170	157	195	132	172
99-3622	EPA 6010A	Beryllium	0.28 J	0.48 J	0.34 J	0.21 J	0.84	0.4 J
99-3622	EPA 6010A	Cadmium	< 0.42	0.22 J	< 0.42	< 0.42	< 0.41	0.21 J
99-3622	EPA 6010A	Calcium	31600	15800	15700	30100	12400	14700
99-3622	EPA 6010A	Chromium	18.6	14	13.2	15.7	10.9	13.9
99-3622	EPA 6010A	Cobalt	6.7	7.5	6.2	6.2	6.6	7.4
99-3622	EPA 6010A	Copper	13.2	16.2	13.2	12.1	13.9	16.3
99-3622	EPA 6010A	Iron	16600	19200	16400	16100	16800	19100
99-3622	EPA 6010A	Lead	6.9	8.3	8	8.1	8.5	8.2
99-3622	EPA 6010A	Magnesium	4200	4260	3680	4090	4550	4940
99-3622	EPA 6010A	Manganese	247	296	260	257	293	324
99-3622	EPA 6010A	Molybdenum	1.2	0.59 J	0.75 J	0.47 J	0.44 J	0.65 J
99-3622	EPA 6010A	Nickel	11.2	14.1	10.7	10.5	11.6	12.7
99-3622	EPA 6010A	Potassium	2010	1850	1750	1850	1850	2220
99-3622	EPA 6010A	Selenium	< 2.1	< 2.1	< 2.1	< 2.1	< 2.1	0.53 J
99-3622	EPA 6010A	Silver	< 2.1	< 2.1	< 2.1	< 2.1	< 2.1	< 2.1
99-3622	EPA 6010A	Sodium	776	330	278	655	646	257
99-3622	EPA 6010A	Thallium	0.65 J	< 1.2	< 1.2	< 1.3	< 1.2	< 1.3
99-3622	EPA 6010A	Vanadium	24.9	27.9	23.9	23.1	25.8	28.6
99-3622	EPA 6010A	Zinc	38.6	51.8	41.4	36.1	46.4	48.7
99-3622	EPA 6010A (soluble)	STLC Aluminum						
99-3622	EPA 6010A (soluble)	STLC Antimony						
99-3622	EPA 6010A (soluble)	STLC Arsenic						
99-3622	EPA 6010A (soluble)	STLC Barium						
99-3622	EPA 6010A (soluble)	STLC Beryllium						
99-3622	EPA 6010A (soluble)	STLC Cadmium						
99-3622	EPA 6010A (soluble)	STLC Calcium						

SDG	Method	Parameter	40-2-SB-3-10.0	40-2-SB-3-2.5	40-2-SB-3-5.0	40-2-SB-4-10.0	40-2-SB-4-2.5	40-2-SB-4-5.0
99-3622	EPA 6010A (soluble)	STLC Chromium						
99-3622	EPA 6010A (soluble)	STLC Cobalt						
99-3622	EPA 6010A (soluble)	STLC Copper						
99-3622	EPA 6010A (soluble)	STLC Iron						
99-3622	EPA 6010A (soluble)	STLC Lead						
99-3622	EPA 6010A (soluble)	STLC Magnesium						
99-3622	EPA 6010A (soluble)	STLC Manganese						
99-3622	EPA 6010A (soluble)	STLC Mercury						
99-3622	EPA 6010A (soluble)	STLC Molybdenum						
99-3622	EPA 6010A (soluble)	STLC Nickel						
99-3622	EPA 6010A (soluble)	STLC Potassium						
99-3622	EPA 6010A (soluble)	STLC Selenium						
99-3622	EPA 6010A (soluble)	STLC Silver						
99-3622	EPA 6010A (soluble)	STLC Sodium						
99-3622	EPA 6010A (soluble)	STLC Thallium						
99-3622	EPA 6010A (soluble)	STLC Vanadium						
99-3622	EPA 6010A (soluble)	STLC Zinc						
99-3622	EPA 6010A (soluble)	TCLP Arsenic						
99-3622	EPA 6010A (soluble)	TCLP Barium						
99-3622	EPA 6010A (soluble)	TCLP Cadmium						
99-3622	EPA 6010A (soluble)	TCLP Chromium						
99-3622	EPA 6010A (soluble)	TCLP Lead						
99-3622	EPA 6010A (soluble)	TCLP Mercury						
99-3622	EPA 6010A (soluble)	TCLP Selenium						
99-3622	EPA 6010A (soluble)	TCLP Silver						
99-3622	EPA 7471A	Mercury	< 0.11	< 0.1	< 0.1	< 0.11	< 0.1	< 0.11

SDG	Method	Parameter	40-2-SB-5-10.0	40-2-SB-5-2.5	40-2-SB-5-5.0	40-2-SB-CUTTINGS	40-2-SS-10
99-3622	EPA 6010A	Aluminum	10800	11300	12400		
99-3622	EPA 6010A	Antimony	< 4.3	0.35 J	< 4.2		
99-3622	EPA 6010A	Arsenic	9	10.5	10.9		9.2
99-3622	EPA 6010A	Barium	187	194	176		
99-3622	EPA 6010A	Beryllium	< 0.86	0.37 J	0.53 J		
99-3622	EPA 6010A	Cadmium	< 0.43	0.27 J	0.37 J		0.26 J
99-3622	EPA 6010A	Calcium	47800	16600	19000		
99-3622	EPA 6010A	Chromium	9.2	16.3	15.6		
99-3622	EPA 6010A	Cobalt	5.9	9.3	8		
99-3622	EPA 6010A	Copper	10	16.9	18.7		
99-3622	EPA 6010A	Iron	13300	19300	21400		
99-3622	EPA 6010A	Lead	5.1	9.7	8.5		10.5
99-3622	EPA 6010A	Magnesium	4830	4890	4710		
99-3622	EPA 6010A	Manganese	252	502	331		
99-3622	EPA 6010A	Molybdenum	0.43 J	0.55 J	0.89		
99-3622	EPA 6010A	Nickel	8.6	14.1	13.7		
99-3622	EPA 6010A	Potassium	2060	2220	2280		
99-3622	EPA 6010A	Selenium	< 2.2	< 2.1	0.52 J		
99-3622	EPA 6010A	Silver	< 2.2	< 2.1	< 2.1		
99-3622	EPA 6010A	Sodium	1530	< 170	493		
99-3622	EPA 6010A	Thallium	< 1.3	< 1.3	< 1.3		
99-3622	EPA 6010A	Vanadium	20.3	30.1	30.7		
99-3622	EPA 6010A	Zinc	31.2	50.7	49.5		53
99-3622	EPA 6010A (soluble)	STLC Aluminum				13100	
99-3622	EPA 6010A (soluble)	STLC Antimony				< 50	
99-3622	EPA 6010A (soluble)	STLC Arsenic				50.9	
99-3622	EPA 6010A (soluble)	STLC Barium				972	
99-3622	EPA 6010A (soluble)	STLC Beryllium				< 5	
99-3622	EPA 6010A (soluble)	STLC Cadmium				< 10	
99-3622	EPA 6010A (soluble)	STLC Calcium				2110000	

SDG	Method	Parameter	40-2-SB-5-10.0	40-2-SB-5-2.5	40-2-SB-5-5.0	40-2-SB-CUTTINGS	40-2-SS-10
99-3622	EPA 6010A (soluble)	STLC Chromium				701	
99-3622	EPA 6010A (soluble)	STLC Cobalt				29.1	
99-3622	EPA 6010A (soluble)	STLC Copper				836	
99-3622	EPA 6010A (soluble)	STLC Iron				10400	
99-3622	EPA 6010A (soluble)	STLC Lead				11.3 J	
99-3622	EPA 6010A (soluble)	STLC Magnesium				7680	
99-3622	EPA 6010A (soluble)	STLC Manganese				327	
99-3622	EPA 6010A (soluble)	STLC Mercury				0.059 J	
99-3622	EPA 6010A (soluble)	STLC Molybdenum				143	
99-3622	EPA 6010A (soluble)	STLC Nickel				91.5	
99-3622	EPA 6010A (soluble)	STLC Potassium				63800	
99-3622	EPA 6010A (soluble)	STLC Selenium				15.6 J	
99-3622	EPA 6010A (soluble)	STLC Silver				< 50	
99-3622	EPA 6010A (soluble)	STLC Sodium				6080000	
99-3622	EPA 6010A (soluble)	STLC Thallium				< 50	
99-3622	EPA 6010A (soluble)	STLC Vanadium				616	
99-3622	EPA 6010A (soluble)	STLC Zinc				122	
99-3622	EPA 6010A (soluble)	TCLP Arsenic				5.4 J	
99-3622	EPA 6010A (soluble)	TCLP Barium				431	
99-3622	EPA 6010A (soluble)	TCLP Cadmium				< 4	
99-3622	EPA 6010A (soluble)	TCLP Chromium				184	
99-3622	EPA 6010A (soluble)	TCLP Lead				< 10	
99-3622	EPA 6010A (soluble)	TCLP Mercury				0.44 J	
99-3622	EPA 6010A (soluble)	TCLP Selenium				< 20	
99-3622	EPA 6010A (soluble)	TCLP Silver				5.1 J	
99-3622	EPA 7471A	Mercury	0.11	0.12	0.11		

SDG	Method	Parameter	40-2-SS-9	RF2-SS-1	RF2-SS-10	RF2-SS-2	RF2-SS-3	RF2-SS-4
99-3622	EPA 6010A	Aluminum		12300	15200	11300	12100	11700
99-3622	EPA 6010A	Antimony		< 4.1	0.65 J	< 4.1	< 4.2	< 4.1
99-3622	EPA 6010A	Arsenic	10	6.6	10.7	6.6	6.6	7.9
99-3622	EPA 6010A	Barium		180	192	140	153	177
99-3622	EPA 6010A	Beryllium						
99-3622	EPA 6010A	Cadmium	0.32 J	< 0.41	< 0.41	< 0.41	< 0.42	0.19 J
99-3622	EPA 6010A	Calcium						
99-3622	EPA 6010A	Chromium		11.2	14.6	11.8	11.7	11.6
99-3622	EPA 6010A	Cobalt		7.5	9.4	7.6	8.1	7.8
99-3622	EPA 6010A	Copper		16	21.6	14.4	16.3	17.8
99-3622	EPA 6010A	Iron						
99-3622	EPA 6010A	Lead	12.4	11	11.6	10.2	9.7	13.4
99-3622	EPA 6010A	Magnesium						
99-3622	EPA 6010A	Manganese		346	422	359	374	376
99-3622	EPA 6010A	Molybdenum						
99-3622	EPA 6010A	Nickel		11.1	16	11	12.8	12
99-3622	EPA 6010A	Potassium						
99-3622	EPA 6010A	Selenium		0.93 J	< 2.1	0.62 J	0.44 J	0.59 J
99-3622	EPA 6010A	Silver		< 2.1	< 2.1	< 2.1	< 2.1	< 2.1
99-3622	EPA 6010A	Sodium						
99-3622	EPA 6010A	Thallium						
99-3622	EPA 6010A	Vanadium						
99-3622	EPA 6010A	Zinc	55.3	45.8	64	42.6	46.7	52.6
99-3622	EPA 6010A (soluble)	STLC Aluminum						
99-3622	EPA 6010A (soluble)	STLC Antimony						
99-3622	EPA 6010A (soluble)	STLC Arsenic						
99-3622	EPA 6010A (soluble)	STLC Barium						
99-3622	EPA 6010A (soluble)	STLC Beryllium						
99-3622	EPA 6010A (soluble)	STLC Cadmium						
99-3622	EPA 6010A (soluble)	STLC Calcium						

SDG	Method	Parameter	40-2-SS-9	RF2-SS-1	RF2-SS-10	RF2-SS-2	RF2-SS-3	RF2-SS-4
99-3622	EPA 6010A (soluble)	STLC Chromium						
99-3622	EPA 6010A (soluble)	STLC Cobalt						
99-3622	EPA 6010A (soluble)	STLC Copper						
99-3622	EPA 6010A (soluble)	STLC Iron						
99-3622	EPA 6010A (soluble)	STLC Lead						
99-3622	EPA 6010A (soluble)	STLC Magnesium						
99-3622	EPA 6010A (soluble)	STLC Manganese						
99-3622	EPA 6010A (soluble)	STLC Mercury						
99-3622	EPA 6010A (soluble)	STLC Molybdenum						
99-3622	EPA 6010A (soluble)	STLC Nickel						
99-3622	EPA 6010A (soluble)	STLC Potassium						
99-3622	EPA 6010A (soluble)	STLC Selenium						
99-3622	EPA 6010A (soluble)	STLC Silver						
99-3622	EPA 6010A (soluble)	STLC Sodium						
99-3622	EPA 6010A (soluble)	STLC Thallium						
99-3622	EPA 6010A (soluble)	STLC Vanadium						
99-3622	EPA 6010A (soluble)	STLC Zinc						
99-3622	EPA 6010A (soluble)	TCLP Arsenic						
99-3622	EPA 6010A (soluble)	TCLP Barium						
99-3622	EPA 6010A (soluble)	TCLP Cadmium						
99-3622	EPA 6010A (soluble)	TCLP Chromium						
99-3622	EPA 6010A (soluble)	TCLP Lead						
99-3622	EPA 6010A (soluble)	TCLP Mercury						
99-3622	EPA 6010A (soluble)	TCLP Selenium						
99-3622	EPA 6010A (soluble)	TCLP Silver						
99-3622	EPA 7471A	Mercury		0.11	0.11	0.13	0.16	0.12

SDG	Method	Parameter	RF2-SS-4-99	RF2-SS-5	RF2-SS-6	RF2-SS-7	RF2-SS-8	RF2-SS-9
99-3622	EPA 6010A	Aluminum	8590	14000	10900	11100	12600	9520
99-3622	EPA 6010A	Antimony	< 4.1	< 4.2	< 4.1	< 4.1	< 4.2	< 4.1
99-3622	EPA 6010A	Arsenic	7	7.3	5.4	6.3	7.8	7.2
99-3622	EPA 6010A	Barium	146	121	151	194	183	150
99-3622	EPA 6010A	Beryllium						
99-3622	EPA 6010A	Cadmium	< 0.41	< 0.42	< 0.41	< 0.41	< 0.42	< 0.41
99-3622	EPA 6010A	Calcium						
99-3622	EPA 6010A	Chromium	8.2	16.2	10.4	10.6	12.1	9.3
99-3622	EPA 6010A	Cobalt	6.3	9.8	7.4	7.2	8.4	6.8
99-3622	EPA 6010A	Copper	11.7	19.1	13.9	15	17.8	13.8
99-3622	EPA 6010A	Iron						
99-3622	EPA 6010A	Lead	8.4	11	9.9	12.7	12	9.7
99-3622	EPA 6010A	Magnesium						
99-3622	EPA 6010A	Manganese	324	378	392	372	383	348
99-3622	EPA 6010A	Molybdenum						
99-3622	EPA 6010A	Nickel	9.5	13.9	10.4	10.8	12.6	9.6
99-3622	EPA 6010A	Potassium						
99-3622	EPA 6010A	Selenium	< 2	< 2.1	0.64 J	< 2	< 2.1	< 2
99-3622	EPA 6010A	Silver	< 2	< 2.1	< 2.1	< 2	< 2.1	< 2
99-3622	EPA 6010A	Sodium						
99-3622	EPA 6010A	Thallium						
99-3622	EPA 6010A	Vanadium						
99-3622	EPA 6010A	Zinc	35.9	53.7	41.2	47.4	54.1	38.4
99-3622	EPA 6010A (soluble)	STLC Aluminum						
99-3622	EPA 6010A (soluble)	STLC Antimony						
99-3622	EPA 6010A (soluble)	STLC Arsenic						
99-3622	EPA 6010A (soluble)	STLC Barium						
99-3622	EPA 6010A (soluble)	STLC Beryllium						
99-3622	EPA 6010A (soluble)	STLC Cadmium						
99-3622	EPA 6010A (soluble)	STLC Calcium						

SDG	Method	Parameter	RF2-SS-4-99	RF2-SS-5	RF2-SS-6	RF2-SS-7	RF2-SS-8	RF2-SS-9
99-3622	EPA 6010A (soluble)	STLC Chromium						
99-3622	EPA 6010A (soluble)	STLC Cobalt						
99-3622	EPA 6010A (soluble)	STLC Copper						
99-3622	EPA 6010A (soluble)	STLC Iron						
99-3622	EPA 6010A (soluble)	STLC Lead						
99-3622	EPA 6010A (soluble)	STLC Magnesium						
99-3622	EPA 6010A (soluble)	STLC Manganese						
99-3622	EPA 6010A (soluble)	STLC Mercury						
99-3622	EPA 6010A (soluble)	STLC Molybdenum						
99-3622	EPA 6010A (soluble)	STLC Nickel						
99-3622	EPA 6010A (soluble)	STLC Potassium						
99-3622	EPA 6010A (soluble)	STLC Selenium						
99-3622	EPA 6010A (soluble)	STLC Silver						
99-3622	EPA 6010A (soluble)	STLC Sodium						
99-3622	EPA 6010A (soluble)	STLC Thallium						
99-3622	EPA 6010A (soluble)	STLC Vanadium						
99-3622	EPA 6010A (soluble)	STLC Zinc						
99-3622	EPA 6010A (soluble)	TCLP Arsenic						
99-3622	EPA 6010A (soluble)	TCLP Barium						
99-3622	EPA 6010A (soluble)	TCLP Cadmium						
99-3622	EPA 6010A (soluble)	TCLP Chromium						
99-3622	EPA 6010A (soluble)	TCLP Lead						
99-3622	EPA 6010A (soluble)	TCLP Mercury						
99-3622	EPA 6010A (soluble)	TCLP Selenium						
99-3622	EPA 6010A (soluble)	TCLP Silver						
99-3622	EPA 7471A	Mercury	0.13	0.11	0.12	0.11	0.12	0.1

DATA VALIDATION REPORT

Project Name:	Fort Irwin DO 37 Sites 32A, 38, 39, 40
Collection Date:	May 11-12, 1999
Report Date:	June 25, 1999
Matrix:	Soil
Parameters:	Nitrate and Nitrite
Validation Level:	Level IV
Laboratory:	Applied Chemistry & Physics Laboratory
Laboratory Project ID:	99-3622

SAMPLE IDENTIFICATION

Laboratory Project	Analytical Method	Field Identification	Laboratory Identification
99-3622	EPA 354.1	40-2-SB-1-10.0	99-3622-15
99-3622	EPA 354.1	40-2-SB-1-2.5	99-3622-12
99-3622	EPA 354.1	40-2-SB-1-5.0	99-3622-14
99-3622	EPA 354.1	40-2-SB-1-5-99	99-3622-13
99-3622	EPA 354.1	40-2-SB-2-10.0	99-3622-20
99-3622	EPA 354.1	40-2-SB-2-10-99	99-3622-19
99-3622	EPA 354.1	40-2-SB-2-5.0	99-3622-18
99-3622	EPA 354.1	40-2-SB-3-10.0	99-3622-23
99-3622	EPA 354.1	40-2-SB-3-2.5	99-3622-21
99-3622	EPA 354.1	40-2-SB-3-5.0	99-3622-22
99-3622	EPA 354.1	40-2-SB-4-10.0	99-3622-26
99-3622	EPA 354.1	40-2-SB-4-2.5	99-3622-24
99-3622	EPA 354.1	40-2-SB-4-5.0	99-3622-25
99-3622	EPA 354.1	40-2-SB-5-10.0	99-3622-29
99-3622	EPA 354.1	40-2-SB-5-2.5	99-3622-27
99-3622	EPA 354.1	40-2-SB-5-5.0	99-3622-28

SAMPLE IDENTIFICATION

Laboratory Project	Analytical Method	Field Identification	Laboratory Identification
99-3622	SM4500NO3D	40-2-SB-1-10.0	99-3622-15
99-3622	SM4500NO3D	40-2-SB-1-2.5	99-3622-12
99-3622	SM4500NO3D	40-2-SB-1-5.0	99-3622-14
99-3622	SM4500NO3D	40-2-SB-1-5-99	99-3622-13
99-3622	SM4500NO3D	40-2-SB-2-10.0	99-3622-20
99-3622	SM4500NO3D	40-2-SB-2-10-99	99-3622-19
99-3622	SM4500NO3D	40-2-SB-2-5.0	99-3622-18
99-3622	SM4500NO3D	40-2-SB-3-10.0	99-3622-23
99-3622	SM4500NO3D	40-2-SB-3-2.5	99-3622-21
99-3622	SM4500NO3D	40-2-SB-3-5.0	99-3622-22
99-3622	SM4500NO3D	40-2-SB-4-10.0	99-3622-26
99-3622	SM4500NO3D	40-2-SB-4-2.5	99-3622-24
99-3622	SM4500NO3D	40-2-SB-4-5.0	99-3622-25
99-3622	SM4500NO3D	40-2-SB-5-10.0	99-3622-29
99-3622	SM4500NO3D	40-2-SB-5-2.5	99-3622-27
99-3622	SM4500NO3D	40-2-SB-5-5.0	99-3622-28

INTRODUCTION

The review follows a modified outline of the USEPA Contract Laboratory Guidelines for Inorganic Data Review (February 1994)

A table summarizing all data qualification is provided at the end of this report.

Raw data were reviewed for this laboratory project. The review was based on QC data.

Data qualifier definitions:

U	Indicates the compound or analyte was analyzed for but not detected at or above the stated limit.
J	Indicates that the data is estimated.
R	Quality control indicates that the data is not usable.
UJ	Indicates that the compound or analyte was analyzed for but not detected. The sample detection limit is an estimated value.

1. Technical Holding Times

All technical holding time requirements were met

The chain-of-custodies were reviewed for documentation of cooler temperatures. All cooler temperatures met validation criteria.

2. Calibration

An initial and continuing calibration was performed.

The frequency and analysis criteria of the initial verification (ICV) and continuing calibration verification (CCV) were met.

3. Blanks

Method blanks were reviewed for each matrix as applicable.

Data qualification by the initial, continuing and preparation blanks (ICB/CCB/PBs) was based on the maximum contaminant concentration in the ICB/CCB/PBs in the analysis of each analyte. No contaminant concentrations were found above the reporting limit in the initial, continuing and preparation blanks.

4. Matrix Spike Analysis

The matrix spike (MS) and matrix spike analyses were reviewed for each matrix as applicable. Percent recoveries (%R) and relative percent differences (RPD) were within QC limits.

5. Duplicate Sample Analysis

Duplicate (DUP) sample analyses were reviewed for each matrix as applicable. The RPD were within QC limits.

6. Laboratory Control Samples

Laboratory control samples were reviewed for each matrix as applicable. Percent recoveries were within QC limits.

7. Sample Result Verification

All sample result verification met validation criteria

8. Overall Assessment of Data

Data flags have been summarized at the end of this report.

9. Field Duplicates

Primary ID (Duplicate ID)	Analyte	Initial Result	Duplicate Result	RPD	Flag
40-2-SB-1-5.0 (40-2-SB-1-5-99)	Nitrate as N Nitrite as N	238 < 0 1	263 < 0 1	10 0	No Flags No Flags
40-2-SB-2-10.0 (40-2-SB-10-99)	Nitrate as N Nitrite as N	141 0.19	134 0.18	5.1 5.4	No Flags No Flags

99-3622 NO2-NO3
(Page 1 of 3)

SDG	Method	Parameter	40-2-SB-1-10.0	40-2-SB-1-2.5	40-2-SB-1-5-99	40-2-SB-1-5.0	40-2-SB-2-10-99	40-2-SB-2-10.0	40-2-SB-2-5.0
99-3622	EPA 354.1	Nitrite as Nitrogen	0.13	0.11	< 0.1	< 0.1	0.18	0.19	0.24
99-3622	SM4500NO3D	Nitrate as Nitrogen	158	13	263	238	134	141	247

99-3622 NO2-NO3
(Page 2 of 3)

SDG	Method	Parameter	40-2-SB-3-10.0	40-2-SB-3-2.5	40-2-SB-3-5.0	40-2-SB-4-10.0	40-2-SB-4-2.5	40-2-SB-4-5.0	40-2-SB-5-10.0
99-3622	EPA 354.1	Nitrite as Nitrogen	0.12	< 0.1	0.11	0.27	0.28	0.2	0.23
99-3622	SM4500NO3D	Nitrate as Nitrogen	13	7	6	33	< 5.2	6	17

99-3622 NO2-NO3
(Page 3 of 3)

SDG	Method	Parameter	40-2-SB-5-2.5	40-2-SB-5-5.0
99-3622	EPA 354.1	Nitrite as Nitrogen	0.24	0.24
99-3622	SM4500NO3D	Nitrate as Nitrogen	6	6

DATA VALIDATION REPORT

Project Name:	Fort Irwin DO 37 Sites 32A, 38, 39, 40
Collection Date:	May 14, 1999
Report Date:	June 24, 1999
Matrix:	Soil
Parameters:	Pb
Validation Level:	Level III
Laboratory:	Applied Chemistry & Physics Laboratory
Laboratory Project ID:	99-3645

INTRODUCTION

The review follows a modified outline of the USEPA Contract Laboratory Guidelines for Inorganic Data Review (February 1994)

A table summarizing all data qualification is provided at the end of this report

Raw data were not reviewed for this laboratory project The review was based on QC data

Data qualifier definitions:

U	Indicates the compound or analyte was analyzed for but not detected at or above the stated limit.
J	Indicates that the data is estimated.
R	Quality control indicates that the data is not usable.
UJ	Indicates that the compound or analyte was analyzed for but not detected. The sample detection limit is an estimated value.

1. Technical Holding Times

All technical holding time requirements were met.

The chain-of-custodies were reviewed for documentation of cooler temperatures. All cooler temperatures met validation criteria

2. Calibration

An initial calibration was performed.

The frequency and analysis criteria of the initial verification (ICV) and continuing calibration verification (CCV) were met.

3. Blanks

Method blanks were reviewed for each matrix as applicable

Data qualification by the initial, continuing and preparation blanks (ICB/CCB/PBs) was based on the maximum contaminant concentration in the ICB/CCB/PBs in the analysis of each analyte. No contaminant concentrations were found above the reporting limit in the initial, continuing and preparation blanks

4. ICP Interference Check Samples (ICS) Analysis

The frequency of analysis was met.

The criteria for analysis were met

5. Matrix Spike Analysis

The matrix spike (MS) and matrix spike analyses were reviewed for each matrix as applicable Percent recoveries (%R) and relative percent differences (RPD) were within QC limits.

6. Duplicate Sample Analysis

Duplicate (DUP) sample analyses were reviewed for each matrix as applicable. The RPD were within QC limits

7. Laboratory Control Samples

Laboratory control samples were reviewed for each matrix as applicable. Percent recoveries were within QC limits

8. Sample Result Verification

All sample result verification met validation criteria

9. Overall Assessment of Data

Data flags have been summarized at the end of this report.

10. Field Duplicates

No field duplicates were identified in this laboratory project.

SAMPLE IDENTIFICATION

Laboratory Project	Analytical Method	Field Identification	Laboratory Identification
99-3645	EPA 6010A	38-2-SS-CNF37	99-3645-1
99-3645	EPA 6010A	38-2-SS-CNF41	99-3645-2
99-3645	EPA 6010A	38-2-SS-CNF42	99-3645-3
99-3645	EPA 6010A	38-2-SS-CNF43	99-3645-4
99-3645	EPA 6010A	38-2-SS-CNF45	99-3645-5
99-3645	EPA 6010A	38-2-SS-CNF47	99-3645-6
99-3645	EPA 6010A	38-2-SS-CNF49	99-3645-7
99-3645	EPA 6010A	38-2-SS-CNF53	99-3645-8

DATA V. .DATION
SW6010
(Page 1 of 4)

QC Check	Minimum Frequency	Acceptance Criteria	Flagging Criteria
Holding times	Each sample	180 days; preserved with nitric acid to PH<2	If HT exceeded, apply J to all non-detect and positive results. If HT grossly exceeded, flag positive results J, and flag all non-detects R.
Initial calibration	Daily after initial calibration	%R between 90 and 110%	Apply R to all results for specific analyte(s) for all samples associated with the calibration
Continuing calibration verification	After every 10 samples and at the end of the analysis sequence	All analyte(s) within ±10% of expected value	Apply R to all results for the specific analyte(s) for in all samples since the last acceptable calibration verification
Blanks		No analytes detected >PQL	If compound is found in blank and not in sample, no action is taken. Any metal detected in the sample, that was also detected in any associated blank, is qualified if the sample concetration is less than 5x's the blank concentration. The CRQL is elevate to the concentration found in the sample. If gross contamination exists, flag affected compounds R.
Interference check solution		Within ±20% of expected value	If the %R>120, do not flag non-detect data, flag positive results J. If %R is between 50 and 79%, flag all results J. If %R<50, flag data R.
Post Digestion Spike Sample		Recovery within 75-125% of expected results.	For results associated with failing post digestion spike, flag all data J.
Laboratory control sample		Within ±25% of expected value	For specific analyte(s) in all samples in the associated analytical batch; If the LCS %R >125, apply J to all positive results. If the LCS %R between 50 and 79, flag all positive results J and non-detect results R. If the LCS %R <50, flag all results R.

DATA V. DATION
SW6010
(Page 2 of 4)

QC Check	Minimum Frequency	Acceptance Criteria	Flagging Criteria
Duplicate sample		For results >5x CRDL, RPD 20%. For results <5x CRDL, RPD ±CRDL.	For specific analyte(s) in all samples collected from the same site matrix as the parent, apply M if; (1) %R for MS or MSD >UCL or (2) %R for MS or MSD <LCL or (3) MS/MSD RPD >CL.
Spike sample analysis		Within ±25% of expected value	For specific analyte(s) in all samples in the associated analytical batch; if the LCS %R >125, apply J to all positive results. If the LCS %R between 30 and 74, flag all positive results J and non-detect results R. If the LCS %R <30, flag all results R.
ICP serial dilution		Recovery within 90-110% of expected results.	For results associated with failing serial dilutions, flag all data J.
Field duplicates		None	Calculate RPD.
Overall assessment		Evaluate technical problems not previously addressed.	Professional judgment.

DATA V DATION
SW6010

Comments

OK

OK

15:01pm, 17:00pm,17:28pm, 17:47pm, 18:10pm.

(1) ICB: Pb -3.1ug/l
CCB: Pb OK, 1.6ug/l, OK, OK.
No qualification required.

OK

None

OK

DATA V. DATION
SW6010

Comments
None
None
None
None
None

SDG	Method	Parameter	38-2-SS-CNF37	38-2-SS-CNF41	38-2-SS-CNF42	38-2-SS-CNF43	38-2-SS-CNF45	38-2-SS-CNF47	38-2-SS-CNF49
99-3645	EPA 6010A	Lead	3390	48.2	83.2	7.9	10.8	9.6	428

SDG	Method	Parameter	38-2-SS-CNF53
99-3645	EPA 6010A	Lead	789

DATA VALIDATION REPORT

Project Name:	Fort Irwin DO 37 Sites 32A, 38, 39, 40
Collection Date:	May 14-17, 1999
Report Date:	June 24, 1999
Matrix:	Soil
Parameters:	Pb
Validation Level:	Level III
Laboratory:	Applied Chemistry & Physics Laboratory
Laboratory Project ID:	99-3686

INTRODUCTION

The review follows a modified outline of the USEPA Contract Laboratory Guidelines for Inorganic Data Review (February 1994)

A table summarizing all data qualification is provided at the end of this report

Raw data were not reviewed for this laboratory project The review was based on QC data.

Data qualifier definitions:

U	Indicates the compound or analyte was analyzed for but not detected at or above the stated limit.
J	Indicates that the data is estimated.
R	Quality control indicates that the data is not usable.
UJ	Indicates that the compound or analyte was analyzed for but not detected. The sample detection limit is an estimated value.

1. Technical Holding Times

All technical holding time requirements were met

The chain-of-custodies were reviewed for documentation of cooler temperatures. All cooler temperatures met validation criteria

2. Calibration

An initial calibration was performed

The frequency and analysis criteria of the initial verification (ICV) and continuing calibration verification (CCV) were met.

3. Blanks

Method blanks were reviewed for each matrix as applicable.

Data qualification by the initial, continuing and preparation blanks (ICB/CCB/PBs) was based on the maximum contaminant concentration in the ICB/CCB/PBs in the analysis of each analyte. No contaminant concentrations were found above the reporting limit in the initial, continuing and preparation.

4. ICP Interference Check Samples (ICS) Analysis

The frequency of analysis was met

The criteria for analysis were met

5. Matrix Spike Analysis

The matrix spike (MS) and matrix spike analyses were reviewed for each matrix as applicable Percent recoveries (%R) and relative percent differences (RPD) were within QC limits

6. Duplicate Sample Analysis

Duplicate (DUP) sample analyses were reviewed for each matrix as applicable The RPD were within QC limits

7. Laboratory Control Samples

Laboratory control samples were reviewed for each matrix as applicable Percent recoveries were within QC limits

8. Sample Result Verification

All sample result verification met validation criteria.

9. Overall Assessment of Data

Data flags have been summarized at the end of this report

10. Field Duplicates

No field duplicates were identified in this laboratory project.

SAMPLE IDENTIFICATION

Laboratory Project	Analytical Method	Field Identification	Laboratory Identification
99-3686	EPA 6010A	38-2-SS-CNF101	99-3686-8
99-3686	EPA 6010A	38-2-SS-CNF28-1	99-3686-9
99-3686	EPA 6010A	38-2-SS-CNF37-1	99-3686-10
99-3686	EPA 6010A	38-2-SS-CNF37-2	99-3686-11
99-3686	EPA 6010A	38-2-SS-CNF42-1	99-3686-12
99-3686	EPA 6010A	38-2-SS-CNF49-1	99-3686-13
99-3686	EPA 6010A	38-2-SS-CNF49-2	99-3686-14
99-3686	EPA 6010A	38-2-SS-CNF50-2	99-3686-15
99-3686	EPA 6010A	38-2-SS-CNF53-2	99-3686-16
99-3686	EPA 6010A	38-2-SS-CNF64	99-3686-1
99-3686	EPA 6010A	38-2-SS-CNF66	99-3686-2
99-3686	EPA 6010A	38-2-SS-CNF68-1	99-3686-17
99-3686	EPA 6010A	38-2-SS-CNF74	99-3686-3
99-3686	EPA 6010A	38-2-SS-CNF82	99-3686-4
99-3686	EPA 6010A	38-2-SS-CNF84	99-3686-5
99-3686	EPA 6010A	38-2-SS-CNF91	99-3686-6
99-3686	EPA 6010A	38-2-SS-CNF92	99-3686-7

DATA VALIDATION
SW6010

QC Check	Minimum Frequency	Acceptance Criteria	Flagging Criteria	Comments
Holding times	Each sample	180 days; preserved with nitric acid to PH<2	If HT exceeded, apply J to all non-detect and positive results. If HT grossly exceeded, flag positive results J, and flag all non-detects R.	OK
Initial calibration	Daily after initial calibration	%R between 90 and 110%	Apply R to all results for specific analyte(s) for all samples associated with the calibration	OK
Continuing calibration verification	After every 10 samples and at the end of the analysis sequence	All analyte(s) within ±10% of expected value	Apply R to all results for the specific analyte(s) for in all samples since the last acceptable calibration verification	16:50pm, 17:28pm, 17:56pm, 18:25pm
Blanks		No analytes detected >PQL	If compound is found in blank and not in sample, no action is taken. Any metal detected in the sample, that was also detected in any associated blank, is qualified if the sample concetration is less than 5x's the blank concentration. The CRQL is elevate to the concentration found in the sample. If gross contamination exists, flag affected compounds R.	(1) ICB 1.7ug/l CCB 2.7ug/l, OK, OK. No qualification required.
Interference check solution		Within ±20% of expected value	If the %R>120, do not flag non-detect data, flag positive results J. If %R is between 50 and 79%, flag all results J. If %R<50, flag data R.	OK
Post Digestion Spike Sample		Recovery within 75-125% of expected results.	For results associated with failing post digestion spike, flag all data J.	38-2-SS-CNF-64 OK
Laboratory control sample		Within ±25% of expected value	For specific analyte(s) in all samples in the associated analytical batch; If the LCS %R >125, apply J to all positive results. If the LCS %R between 50 and 79, flag all positive results J and non-detect results R. If the LCS %R <50, flag all results R.	OK

DATA V. .DATION
SW6010

QC Check	Minimum Frequency	Acceptance Criteria	Flagging Criteria	Comments
Duplicate sample		For results >5x CRDL, RPD 20%. For results <5x CRDL, RPD ±CRDL.	For specific analyte(s) in all samples collected from the same site matrix as the parent, apply M if; (1) %R for MS or MSD >UCL or (2) %R for MS or MSD <LCL or (3) MS/MSD RPD >CL.	38-2-SS-CNF-64 OK
Spike sample analysis		Within ±25% of expected value	For specific analyte(s) in all samples in the associated analytical batch; if the LCS %R >125, apply J to all positive results. If the LCS %R between 30 and 74, flag all positive results J and non-detect results R. If the LCS %R <30, flag all results R.	38-2-SS-CNF-64 OK
ICP serial dilution		Recovery within 90-110% of expected results.	For results associated with failing serial dilutions, flag all data J.	38-2-SS-CNF-64 Pb 13.0%D - Apply J flag to lead for all associated samples (99-3686-1 through 99-3686-17)
Field duplicates		None	Calculate RPD.	
Overall assessment		Evaluate technical problems not previously addressed.	Professional judgment.	

SDG	Method	Parameter	38-2-SS-CNF101	38-2-SS-CNF28-1	38-2-SS-CNF37-1	38-2-SS-CNF37-2	38-2-SS-CNF42-1	38-2-SS-CNF49-1	38-2-SS-CNF49-2
99-3686	EPA 6010A	Lead	10.7 J	1380 J	805 J	156 J	22.4 J	58.8 J	138 J

SDG	Method	Parameter	38-2-SS-CNF50-2	38-2-SS-CNF53-2	38-2-SS-CNF64	38-2-SS-CNF66	38-2-SS-CNF68-1	38-2-SS-CNF74	38-2-SS-CNF82
99-3686	EPA 6010A	Lead	598 J	503 J	16.6 J	112 J	19.9 J	26.6 J	152 J

SDG	Method	Parameter	38-2-SS-CNF84	38-2-SS-CNF91	38-2-SS-CNF92
99-3686	EPA 6010A	Lead	44.3 J	81.5 J	38.1 J

DATA VALIDATION REPORT

Project Name:	Fort Irwin DO 37 Sites 32A, 38, 39, 40
Collection Date:	May 17-18, 1999
Report Date:	June 25, 1999
Matrix:	Soil
Parameters:	Pb
Validation Level:	Level III
Laboratory:	Applied Chemistry & Physics Laboratory
Laboratory Project ID:	99-3755

SAMPLE IDENTIFICATION

Laboratory Project	Analytical Method	Field Identification	Laboratory Identification
99-3755	EPA 6010A	38-2-SS-CNF129	99-3755-1
99-3755	EPA 6010A	38-2-SS-CNF133	99-3755-2
99-3755	EPA 6010A	38-2-SS-CNF26-2'	99-3755-3
99-3755	EPA 6010A	38-2-SS-CNF51-3'	99-3755-4
99-3755	EPA 6010A	38-2-SS-CNF81-1'	99-3755-5
99-3755	EPA 6010A	38-2-SS-CNF82-1'	99-3755-6
99-3755	EPA 6010A	38-2-SS-CNF84-1'	99-3755-7

INTRODUCTION

The review follows a modified outline of the USEPA Contract Laboratory Guidelines for Inorganic Data Review (February 1994)

A table summarizing all data qualification is provided at the end of this report

Raw data were not reviewed for this laboratory project. The review was based on QC data

Data qualifier definitions:

U	Indicates the compound or analyte was analyzed for but not detected at or above the stated limit.
J	Indicates that the data is estimated.
R	Quality control indicates that the data is not usable.
UJ	Indicates that the compound or analyte was analyzed for but not detected. The sample detection limit is an estimated value.

1. Technical Holding Times

All technical holding time requirements were met.

The chain-of-custodies were reviewed for documentation of cooler temperatures All cooler temperatures met validation criteria

2. Calibration

An initial calibration was performed.

The frequency and analysis criteria of the initial verification (ICV) and continuing calibration verification (CCV) were met

3. Blanks

Method blanks were reviewed for each matrix as applicable

Data qualification by the initial, continuing and preparation blanks (ICB/CCB/PBs) was based on the maximum contaminant concentration in the ICB/CCB/PBs in the analysis of each analyte No contaminant concentrations were found above the reporting limit in the initial, continuing and preparation.

4. ICP Interference Check Samples (ICS) Analysis

The frequency of analysis was met.

The criteria for analysis were met

5. Matrix Spike Analysis

The matrix spike (MS) and matrix spike analyses were reviewed for each matrix as applicable Percent recoveries (%R) and relative percent differences (RPD) were within QC limits

6. Duplicate Sample Analysis

Duplicate (DUP) sample analyses were reviewed for each matrix as applicable. The RPD were within QC limits.

7. Laboratory Control Samples

Laboratory control samples were reviewed for each matrix as applicable. Percent recoveries were within QC limits

8. Sample Result Verification

All sample result verification met validation criteria

9. Overall Assessment of Data

Data flags have been summarized at the end of this report

10. Field Duplicates

No field duplicates were identified in this laboratory project

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QC Check	Minimum Frequency	Acceptance Criteria	Flagging Criteria	Comments
Holding times	Each sample	180 days; preserved with nitric acid to PH<2	If HT exceeded, apply J to all non-detect and positive results. If HT grossly exceeded, flag positive results J, and flag all non-detects R.	OK
Initial calibration	Daily after initial calibration	%R between 90 and 110%	Apply R to all results for specific analyte(s) for all samples associated with the calibration	OK
Continuing calibration verification	After every 10 samples and at the end of the analysis sequence	All analyte(s) within ±10% of expected value	Apply R to all results for the specific analyte(s) for in all samples since the last acceptable calibration verification	9:56am, 11:21am, 11:50am, 12:26pm.
Blanks		No analytes detected >PQL	If compound is found in blank and not in sample, no action is taken. Any metal detected in the sample, that was also detected in any associated blank, is qualified if the sample concetration is less than 5x's the blank concentration. The CRQL is elevate to the concentration found in the sample. If gross contamination exists, flag affected compounds R.	(1) ICB: OK CCB: -2.4ug/l, OK, OK. No qualification required.
Interference check solution		Within ±20% of expected value	If the %R>120, do not flag non-detect data, flag positive results J. If %R is between 50 and 79%, flag all results J. If %R<50, flag data R.	OK
Post Digestion Spike Sample	-	Recovery within 75-125% of expected results.	For results associated with failing post digestion spike, flag all data J.	38-2-SS-CNF-129 OK (Soil) Water None
Laboratory control sample		Within ±25% of expected value	For specific analyte(s) in all samples in the associated analytical batch; If the LCS %R >125, apply J to all positive results. If the LCS %R between 50 and 79, flag all positive results J and non-detect results R. If the LCS %R <50, flag all results R.	OK

DATA V DATION
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(Page 2 of 2)

QC Check	Minimum Frequency	Acceptance Criteria	Flagging Criteria	Comments
Duplicate sample		For results >5x CRDL, RPD 20%. For results <5x CRDL, RPD ±CRDL.	For specific analyte(s) in all samples collected from the same site matrix as the parent, apply M if; (1) %R for MS or MSD >UCL or (2) %R for MS or MSD <LCL or (3) MS/MSD RPD >CL.	38-2-SS-CNF-129 OK
Spike sample analysis		Within ±25% of expected value	For specific analyte(s) in all samples in the associated analytical batch; if the LCS %R >125, apply J to all positive results. If the LCS %R between 30 and 74, flag all positive results J and non-detect results R. If the LCS %R <30, flag all results R.	38-2-SS-CNF-129 OK
ICP serial dilution		Recovery within 90-110% of expected results.	For results associated with failing serial dilutions, flag all data J.	
Field duplicates		None	Calculate RPD.	Non field duplicates associated with this SDG.
Overall assessment		Evaluate technical problems not previously addressed.	Professional judgment.	

SDG	Method	Parameter	38-2-SS-CNF129	38-2-SS-CNF133	38-2-SS-CNF26-2'	38-2-SS-CNF51-3'	38-2-SS-CNF81-1'	38-2-SS-CNF82-1'	38-2-SS-CNF84-1'
99-3755	EPA 6010A	Lead	15	11.1	39.7	7.9	13.7	18.6	10

DATA VALIDATION REPORT

Project Name:	Fort Irwin DO 37 Sites 32A, 38, 39, 40
Collection Date:	May 19-22, 1999
Report Date:	June 25, 1999
Matrix:	Soil
Parameters:	Pb
Validation Level:	Level III
Laboratory:	Applied Chemistry & Physics Laboratory
Laboratory Project ID:	99-3802

SAMPLE IDENTIFICATION

Laboratory Project	Analytical Method	Field Identification	Laboratory Identification
99-3802	EPA 6010A	38-2-SS-CNF12-5	99-3802-1
99-3802	EPA 6010A	38-2-SS-CNF126-1	99-3802-21
99-3802	EPA 6010A	38-2-SS-CNF142	99-3802-2
99-3802	EPA 6010A	38-2-SS-CNF143	99-3802-3
99-3802	EPA 6010A	38-2-SS-CNF152	99-3802-4
99-3802	EPA 6010A	38-2-SS-CNF155	99-3802-5
99-3802	EPA 6010A	38-2-SS-CNF176	99-3802-6
99-3802	EPA 6010A	38-2-SS-CNF179	99-3802-7
99-3802	EPA 6010A	38-2-SS-CNF182	99-3802-8
99-3802	EPA 6010A	38-2-SS-CNF185	99-3802-9
99-3802	EPA 6010A	38-2-SS-CNF188	99-3802-10
99-3802	EPA 6010A	38-2-SS-CNF191	99-3802-11
99-3802	EPA 6010A	38-2-SS-CNF193	99-3802-12
99-3802	EPA 6010A	38-2-SS-CNF196	99-3802-13
99-3802	EPA 6010A	38-2-SS-CNF200	99-3802-14
99-3802	EPA 6010A	38-2-SS-CNF203	99-3802-15
99-3802	EPA 6010A	38-2-SS-CNF210	99-3802-16
99-3802	EPA 6010A	38-2-SS-CNF27-1	99-3802-17
99-3802	EPA 6010A	38-2-SS-CNF70-1	99-3802-18
99-3802	EPA 6010A	38-2-SS-CNF77-1	99-3802-19
99-3802	EPA 6010A	38-2-SS-CNF79-1	99-3802-20

INTRODUCTION

The review follows a modified outline of the USEPA Contract Laboratory Guidelines for Inorganic Data Review (February 1994).

A table summarizing all data qualification is provided at the end of this report.

Raw data were not reviewed for this laboratory project. The review was based on QC data

Data qualifier definitions:

U	Indicates the compound or analyte was analyzed for but not detected at or above the stated limit.
J	Indicates that the data is estimated.
R	Quality control indicates that the data is not usable.
UJ	Indicates that the compound or analyte was analyzed for but not detected. The sample detection limit is an estimated value.

1. Technical Holding Times

All technical holding time requirements were met

The chain-of-custodies were reviewed for documentation of cooler temperatures. All cooler temperatures met validation criteria

2. Calibration

An initial calibration was performed.

The frequency and analysis criteria of the initial verification (ICV) and continuing calibration verification (CCV) were met.

3. Blanks

Method blanks were reviewed for each matrix as applicable

Data qualification by the initial, continuing and preparation blanks (ICB/CCB/PBs) was based on the maximum contaminant concentration in the ICB/CCB/PBs in the analysis of each analyte No contaminant concentrations were found above the reporting limit in the initial, continuing and preparation

4. ICP Interference Check Samples (ICS) Analysis

The frequency of analysis was met.

The criteria for analysis were met.

5. Matrix Spike Analysis

The matrix spike (MS) and matrix spike analyses were reviewed for each matrix as applicable. Percent recoveries (%R) and relative percent differences (RPD) were within QC limits

6. Duplicate Sample Analysis

Duplicate (DUP) sample analyses were reviewed for each matrix as applicable The RPD were within QC limits

7. Laboratory Control Samples

Laboratory control samples were reviewed for each matrix as applicable Percent recoveries were within QC limits.

8. Sample Result Verification

All sample result verification met validation criteria

9. Overall Assessment of Data

Data flags have been summarized at the end of this report

10. Field Duplicates

No field duplicates were identified in this laboratory project.

DATA V. DATION
SW6010

QC Check	Minimum Frequency	Acceptance Criteria	Flagging Criteria	Comments
Holding times	Each sample	180 days; preserved with nitric acid to PH<2	If HT exceeded, apply J to all non-detect and positive results. If HT grossly exceeded, flag positive results J, and flag all non-detects R.	OK
Initial calibration	Daily after initial calibration	%R between 90 and 110%	Apply R to all results for specific analyte(s) for all samples associated with the calibration	OK
Continuing calibration verification	After every 10 samples and at the end of the analysis sequence	All analyte(s) within ±10% of expected value	Apply R to all results for the specific analyte(s) for in all samples since the last acceptable calibration verification	13:17pm, 13:54pm, 14:24pm, 14:48pm, 13:17pm, 14:48pm, 15:17pm, 15:39pm, 16:09pm.
Blanks		No analytes detected >PQL	If compound is found in blank and not in sample, no action is taken. Any metal detected in the sample, that was also detected in any associated blank, is qualified if the sample concetration is less than 5x's the blank concentration. The CRQL is elevate to the concentration found in the sample. If gross contamination exists, flag affected compounds R.	(1) ICB: Pb OK. CCB: -2.3, -1.9, -1.4ug/l. (2) ICB: Pb OK CCB: -1.4, 1.6, -1.3, -2.1ug/l. No qualification required.
Interference check solution		Within ±20% of expected value	If the %R>120, do not flag non-detect data, flag positive results J. If %R is between 50 and 79%, flag all results J. If %R<50, flag data R.	OK
Post Digestion Spike Sample		Recovery within 75-125% of expected results.	For results associated with failing post digestion spike, flag all data J.	38-2-SS-CNF-12-5 OK 38-2-SS-CNF-70-1 OK
Laboratory control sample		Within ±25% of expected value	For specific analyte(s) in all samples in the associated analytical batch; If the LCS %R >125, apply J to all positive results. If the LCS %R between 50 and 79, flag all positive results J and non-detect results R. If the LCS %R <50, flag all results R.	OK

DATA V DATION
SW6010

QC Check	Minimum Frequency	Acceptance Criteria	Flagging Criteria	Comments
Duplicate sample		For results >5x CRDL, RPD 20%. For results <5x CRDL, RPD ±CRDL.	For specific analyte(s) in all samples collected from the same site matrix as the parent, apply M if; (1) %R for MS or MSD >UCL or (2) %R for MS or MSD <LCL or (3) MS/MSD RPD >CL.	38-2-SS-CNF-12-5 OK 38-2-SS-CNF-70-1 OK
Spike sample analysis		Within ±25% of expected value	For specific analyte(s) in all samples in the associated analytical batch; if the LCS %R >125, apply J to all positive results. If the LCS %R between 30 and 74, flag all positive results J and non-detect results R. If the LCS %R <30, flag all results R.	38-2-SS-CNF-12-5 OK 38-2-SS-CNF-70-1 OK
ICP serial dilution		Recovery within 90-110% of expected results.	For results associated with failing serial dilutions, flag all data J.	
Field duplicates		None	Calculate RPD.	No field duplicates associated with this SDG.
Overall assessment		Evaluate technical problems not previously addressed.	Professional judgment.	

SDG	Method	Parameter	38-2-SS-CNF12-5	38-2-SS-CNF126-1	38-2-SS-CNF142	38-2-SS-CNF143	38-2-SS-CNF152	38-2-SS-CNF155
99-3802	EPA 6010A	Lead	21.1	11.8	41.5	83.2	56.9	58.6

SDG	Method	Parameter	38-2-SS-CNF176	38-2-SS-CNF179	38-2-SS-CNF182	38-2-SS-CNF185	38-2-SS-CNF188	38-2-SS-CNF191
99-3802	EPA 6010A	Lead	45.4	55.7	23	67.1	39.3	929

SDG	Method	Parameter	38-2-SS-CNF193	38-2-SS-CNF196	38-2-SS-CNF200	38-2-SS-CNF203	38-2-SS-CNF210	38-2-SS-CNF27-1
99-380:	EPA 6010A	Lead	70.3	72.4	75.7	36.4	84.8	70.7

SDG	Method	Parameter	38-2-SS-CNF70-1	38-2-SS-CNF77-1	38-2-SS-CNF79-1
99-380	EPA 6010A	Lead	8.2	5.7	6.8

APPENDIX J

FIELD DUPLICATE AND CONFIRMATION DATA SUMMARY

TABLE J-1

SITES FTIR-38 AND FTIR-40
FIELD DUPLICATE SUMMARY
NATIONAL TRAINING CENTER, FORT IRWIN

Sample Description	Collection Date	Analyte	Units	Sample Result	Field Duplicate Result	RPD (%)
38-2-PT-3A	05/11/99	Aluminum	mg/kg	43.9	108	84.4
		Antimony	mg/kg	< 5	< 5	0
		Arsenic	mg/kg	< 0.3	< 0.3	0
		Barium	mg/kg	4	10.7	91.2
		Cobalt	mg/kg	< 0.5	< 0.5	0
		Copper	mg/kg	1.6	2.3	35.9
		Lead	mg/kg	0.15 J	0.37	0
		Zinc	mg/kg	4	4.6	14.0
38-2-SS-3	05/11/99	Moisture content	%Moisture	9.6	23.3	83.3
		Aluminum	mg/kg	26400	41400	44.2
		Antimony	mg/kg	1.7 J	1.1 J	42.9
		Arsenic	mg/kg	9.3	11.3	19.4
		Barium	mg/kg	200	231	14.4
		Cobalt	mg/kg	13.2	16.9	24.6
		Copper	mg/kg	50.7	81.1	46.1
		Lead	mg/kg	174	239	31.5
		Zinc	mg/kg	76.5	102	28.6
40-1-PT-3	05/11/99	Aluminum	mg/kg	29.2	24	19.5
		Antimony	mg/kg	< 5	< 5	0
		Arsenic	mg/kg	< 0.3	< 0.3	0
		Barium	mg/kg	15.8	16.4	3.7
		Cadmium	mg/kg	0.048 J	0.05 J	4.1
		Chromium	mg/kg	0.82	1.1	29.2
		Cobalt	mg/kg	< 0.5	< 0.5	0
		Copper	mg/kg	1.8	1.3	32.3
		Lead	mg/kg	0.06 J	0.15 J	24.0
		Manganese	mg/kg	22.1	5.8	116.8
		Mercury	mg/kg	< 0.1	< 0.1	0
		Nickel	mg/kg	0.22 J	0.18 J	20.0
		Selenium	mg/kg	0.26 UJ	0.26 UJ	0
		Silver	mg/kg	< 0.5	< 0.5	0
		Zinc	mg/kg	7.1	3.8	60.6
40-1-SS-3	05/11/99	Moisture content	%Moisture	2.2	3.7	50.8
		Aluminum	mg/kg	12200	11600	5.0
		Antimony	mg/kg	< 4.1	< 4.2	0
		Arsenic	mg/kg	4.2	3.4	21.1
		Barium	mg/kg	156	152	2.6

TABLE J-1

SITES FTIR-38 AND FTIR-40
FIELD DUPLICATE SUMMARY
NATIONAL TRAINING CENTER, FORT IRWIN

Sample Description	Collection Date	Analyte	Units	Sample Result	Field Duplicate Result	RPD (%)
40-1-SS-3 (continued)	05/11/99	Cadmium	mg/kg	0.26 J	0.19 J	31.1
		Chromium	mg/kg	11.3	11.1	1.8
		Cobalt	mg/kg	7.5	7.7	2.6
		Copper	mg/kg	18	17.4	3.4
		Lead	mg/kg	13	10.2	24.1
		Manganese	mg/kg	417	403	3.4
		Mercury	mg/kg	0.13	0.1	26.1
		Nickel	mg/kg	10.2	10.1	1.0
		Selenium	mg/kg	0.98 J	0.42 J	80.0
		Silver	mg/kg	2.4	1.5 J	46.2
		Zinc	mg/kg	61	53.9	12.4
40-2-PT-2	05/10/99	Arsenic	mg/kg	< 0.3	< 0.3	0
		Cadmium	mg/kg	0.22	0.25	12.8
		Lead	mg/kg	0.4	0.35	13.3
		Zinc	mg/kg	19.7	21.8	10.1
40-2-SB-1-5.0	05/12/99	Moisture content	%Moisture	3	4.5	40.0
		Nitrate as Nitrogen	mg/kg	238	263	10.0
		Nitrite as Nitrogen	mg/kg	< 0.1	< 0.1	0
		Aluminum	mg/kg	10400	11600	10.9
		Antimony	mg/kg	< 4.1	< 4.2	0
		Arsenic	mg/kg	7.4	11.4	42.6
		Barium	mg/kg	113	110	2.7
		Beryllium	mg/kg	< 0.82	0.34 J	NC
		Cadmium	mg/kg	< 0.41	0.21 J	NC
		Calcium	mg/kg	18300	21400	15.6
		Chromium	mg/kg	14	13	7.4
		Cobalt	mg/kg	6.9	7.7	11.0
		Copper	mg/kg	12.7	18.1	35.1
		Iron	mg/kg	17600	21900	21.8
		Lead	mg/kg	5.5	8.6	44.0
		Magnesium	mg/kg	3990	4210	5.4
		Manganese	mg/kg	238	250	4.9
		Mercury	mg/kg	< 0.1	< 0.1	0
		Molybdenum	mg/kg	0.54 J	0.6 J	10.5
		Nickel	mg/kg	11.3	14.6	25.5
		Potassium	mg/kg	1900	2140	11.9
		Selenium	mg/kg	< 2.1	< 2.1	0
		Silver	mg/kg	< 2.1	< 2.1	0

TABLE J-1

SITES FTIR-38 AND FTIR-40
FIELD DUPLICATE SUMMARY
NATIONAL TRAINING CENTER, FORT IRWIN

Sample Description	Collection Date	Analyte	Units	Sample Result	Field Duplicate Result	RPD (%)
40-2-SB-1-5 0 (continued)	05/12/99	Sodium	mg/kg	365	409	11 4
		Thallium	mg/kg	< 1 2	< 1 3	0
		Vanadium	mg/kg	23 7	29	20 1
		Zinc	mg/kg	38 5	47 4	20 7
		1,2,4,5-Tetrachlorobenzene	µg/kg	< 520	< 520	0
		1,2,4-Trichlorobenzene	µg/kg	< 180	< 180	0
		1,2-Dichlorobenzene	µg/kg	< 180	< 180	0
		1,2-Diphenylhydrazine	µg/kg	< 520	< 520	0
		1,3-Dichlorobenzene	µg/kg	< 180	< 180	0
		1,4-Dichlorobenzene	µg/kg	< 180	< 180	0
		1-Chloronaphthalene	µg/kg	< 520	< 520	0
		1-Naphthylamine	µg/kg	< 520	< 520	0
		2,3,4,6-Tetrachlorophenol	µg/kg	< 520	< 520	0
		2,4,5-Trichlorophenol	µg/kg	< 180	< 180	0
		2,4,6-Trichlorophenol	µg/kg	< 180	< 180	0
		2,4-Dichlorophenol	µg/kg	< 180	< 180	0
		2,4-Dimethylphenol	µg/kg	< 180	< 180	0
		2,4-Dinitrophenol	µg/kg	< 180	< 180	0
		2,4-Dinitrotoluene	µg/kg	< 180	< 180	0
		2,6-Dichlorophenol	µg/kg	< 520	< 520	0
		2,6-Dinitrotoluene	µg/kg	< 180	< 180	0
		2-AminoNaphthalene	µg/kg	< 520	< 520	0
		2-ChloroNaphthalene	µg/kg	< 180	< 180	0
		2-Chlorophenol	µg/kg	< 180	< 180	0
		2-Methylnaphthalene	µg/kg	< 180	< 180	0
		2-Methylphenol	µg/kg	< 180	< 180	0
		2-Nitroaniline	µg/kg	< 280	< 280	0
		2-Nitrophenol	µg/kg	< 180	< 180	0
		2-Picoline	µg/kg	< 1000	< 1000	0
		3,3'-Dichlorobenzidine	µg/kg	< 240	< 240	0
		3-Methylcholanthrene	µg/kg	< 520	< 520	0
		3-Nitroaniline	µg/kg	< 2600	< 2600	0
		4,6-Dinitro-2-methylphenol	µg/kg	< 290	< 290	0
		4-Aminobiphenyl	µg/kg	< 520	< 520	0
		4-Bromophenyl phenyl ether	µg/kg	< 180	< 180	0
		4-Chloro-3-methylphenol	µg/kg	< 180	< 180	0
		4-Chloroaniline	µg/kg	< 330	< 340	0
		4-Chlorophenyl phenyl ether	µg/kg	< 180	< 180	0
		4-methylphenol	µg/kg	< 180	< 180	0
		4-Nitroaniline	µg/kg	< 260	< 260	0

TABLE J-1

SITES FTIR-38 AND FTIR-40
FIELD DUPLICATE SUMMARY
NATIONAL TRAINING CENTER, FORT IRWIN

Sample Description	Collection Date	Analyte	Units	Sample Result	Field Duplicate Result	RPD (%)
40-2-SB-1-5 0 (continued)	05/12/99	4-Nitrophenol	µg/kg	< 180	< 180	0
		7,12-Dimethylbenz(a)anthracene	µg/kg	< 520	< 520	0
		Acenaphthene	µg/kg	< 180	< 180	0
		Acenaphthylene	µg/kg	< 180	< 180	0
		Acetophenone	µg/kg	< 520	< 520	0
		Aniline	µg/kg	< 520	< 520	0
		Anthracene	µg/kg	< 180	< 180	0
		Benzidine	µg/kg	< 1000 UJ	< 1000 UJ	0
		Benzo(a)anthracene	µg/kg	< 180	< 180	0
		Benzo(a)pyrene	µg/kg	< 180	< 180	0
		Benzo(b)fluoranthene	µg/kg	< 180	< 180	0
		Benzo(g,h,i)perylene	µg/kg	< 180	< 180	0
		Benzo(k)fluoranthene	µg/kg	< 180	< 180	0
		Benzoic acid	µg/kg	< 180 UJ	< 180 UJ	0
		Benzyl alcohol	µg/kg	< 180 UJ	< 180 UJ	0
		Benzyl butyl phthalate	µg/kg	< 180	< 180	0
		bis (2-Chloroethoxy) methane	µg/kg	< 180	< 180	0
		bis (2-Chloroethyl) ether	µg/kg	< 520	< 520	0
		bis (2-Chloroisopropyl) ether	µg/kg	< 180	< 180	0
		bis (2-Ethylhexyl) phthalate	µg/kg	245	77 J	104.0
		Chrysene	µg/kg	< 520	< 520	0
		di-n-Butyl phthalate	µg/kg	< 180	< 180	0
		di-n-Octylphthalate	µg/kg	205	< 180	13 0
		Dibenz(a,h)anthracene	µg/kg	< 180	< 180	0
		Dibenz(a,j)acridine	µg/kg	< 520	< 520	0
		Dibenzofuran	µg/kg	< 180	< 180	0
		Diethyl phthalate	µg/kg	< 180	< 180	0
		Dimethyl phthalate	µg/kg	< 180	< 180	0
		DimethylphenylNaphthalene	µg/kg	< 2600	< 2600	0
		Diphenylamine	µg/kg	< 520	< 520	0
		Ethyl methanesulfonate	µg/kg	< 520	< 520	0
		Fluoranthene	µg/kg	< 180	< 180	0
		Fluorene	µg/kg	< 180	< 180	0
		Hexachlorobenzene	µg/kg	< 180	< 180	0
		Hexachlorobutadiene	µg/kg	< 180	< 180	0
		Hexachlorocyclopentadiene	µg/kg	< 180	< 180	0
		Hexachloroethane	µg/kg	< 180	< 180	0
		Indeno(1,2,3-c,d)pyrene	µg/kg	< 180	< 180	0
		Isophorone	µg/kg	< 180	< 180	0
		Methyl methanesulfonate	µg/kg	< 520	< 520	0

TABLE J-1

SITES FTIR-38 AND FTIR-40
FIELD DUPLICATE SUMMARY
NATIONAL TRAINING CENTER, FORT IRWIN

Sample Description	Collection Date	Analyte	Units	Sample Result	Field Duplicate Result	RPD (%)
40-2-SB-1-5.0 (continued)	05/12/99	N-Nitroso-di-n-butylamine	µg/kg	< 520	< 520	0
		N-Nitroso-di-n-propylamine	µg/kg	< 180	< 180	0
		N-Nitrosodimethylamine	µg/kg	< 520	< 520	0
		N-Nitrosodiphenylamine	µg/kg	< 180	< 180	0
		N-Nitrosopiperidine	µg/kg	< 520	< 520	0
		Naphthalene	µg/kg	< 180	< 180	0
		Nitrobenzene	µg/kg	< 180	< 180	0
		p-Dimethylaminoazobenzene	µg/kg	< 520	< 520	0
		Pentachlorobenzene	µg/kg	< 2600	< 2600	0
		Pentachlorophenol	µg/kg	< 490	< 500	0
		Phenacetin	µg/kg	< 520	< 520	0
		Phenanthrene	µg/kg	< 180	< 180	0
		Phenol	µg/kg	< 180	< 180	0
		Pronamide	µg/kg	< 520	< 520	0
		Pyrene	µg/kg	< 180	< 180	0
40-2-SB-2-10.0	05/12/99	Moisture content	%Moisture	5.7	4.6	21.4
		Nitrate as Nitrogen	mg/kg	141	134	5.1
		Nitrite as Nitrogen	mg/kg	0.19	0.18	5.4
		Aluminum	mg/kg	8950	7310	20.2
		Antimony	mg/kg	0.32 J	< 4.2	NC
		Arsenic	mg/kg	9	8	11.8
		Barium	mg/kg	149	173	14.9
		Beryllium	mg/kg	0.11 J	0.14 J	24.0
		Cadmium	mg/kg	< 0.42	< 0.42	0
		Calcium	mg/kg	40300	49800	21.1
		Chromium	mg/kg	12.5	8.8	34.7
		Cobalt	mg/kg	5.8	5.4	7.1
		Copper	mg/kg	10	9.9	1.0
		Iron	mg/kg	14400	12000	18.2
		Lead	mg/kg	4.7	4.7	0.0
		Magnesium	mg/kg	3750	3410	9.5
		Manganese	mg/kg	237	249	4.9
		Mercury	mg/kg	< 0.11	< 0.1	0
		Molybdenum	mg/kg	< 0.85	< 0.84	0
		Nickel	mg/kg	9.7	8.1	18.0
		Potassium	mg/kg	1750	1430	20.1
		Selenium	mg/kg	< 2.1	0.64 J	NC
		Silver	mg/kg	< 2.1	< 2.1	0
		Sodium	mg/kg	433	468	7.8

TABLE J-1

SITES FTIR-38 AND FTIR-40
FIELD DUPLICATE SUMMARY
NATIONAL TRAINING CENTER, FORT IRWIN

Sample Description	Collection Date	Analyte	Units	Sample Result	Field Duplicate Result	RPD (%)
40-2-SB-2-10.0 (continued)	05/12/99	Thallium	mg/kg	< 1.3	< 1.3	0
		Vanadium	mg/kg	21	17	21.1
		Zinc	mg/kg	30.6	24	24.2
		1,2,4,5-Tetrachlorobenzene	µg/kg	< 530	< 520	0
		1,2,4-Trichlorobenzene	µg/kg	< 180	< 180	0
		1,2-Dichlorobenzene	µg/kg	< 180	< 180	0
		1,2-Diphenylhydrazine	µg/kg	< 530	< 520	0
		1,3-Dichlorobenzene	µg/kg	< 180	< 180	0
		1,4-Dichlorobenzene	µg/kg	< 180	< 180	0
		1-Chloronaphthalene	µg/kg	< 530	< 520	0
		1-Naphthylamine	µg/kg	< 530	< 520	0
		2,3,4,6-Tetrachlorophenol	µg/kg	< 530	< 520	0
		2,4,5-Trichlorophenol	µg/kg	< 180	< 180	0
		2,4,6-Trichlorophenol	µg/kg	< 180	< 180	0
		2,4-Dichlorophenol	µg/kg	< 180	< 180	0
		2,4-Dimethylphenol	µg/kg	< 180	< 180	0
		2,4-Dinitrophenol	µg/kg	< 180	< 180	0
		2,4-Dinitrotoluene	µg/kg	< 180	< 180	0
		2,6-Dichlorophenol	µg/kg	< 530	< 520	0
		2,6-Dinitrotoluene	µg/kg	< 180	< 180	0
		2-AminoNaphthalene	µg/kg	< 530	< 520	0
		2-ChloroNaphthalene	µg/kg	< 180	< 180	0
		2-Chlorophenol	µg/kg	< 180	< 180	0
		2-Methylnaphthalene	µg/kg	< 180	< 180	0
		2-Methylphenol	µg/kg	< 180	< 180	0
		2-Nitroaniline	µg/kg	< 290	< 280	0
		2-Nitrophenol	µg/kg	< 180	< 180	0
		2-Picoline	µg/kg	< 1100	< 1000	0
		3,3'-Dichlorobenzidine	µg/kg	< 240	< 240	0
		3-Methylcholanthrene	µg/kg	< 530	< 520	0
		3-Nitroaniline	µg/kg	< 2700	< 2600	0
		4,6-Dinitro-2-methylphenol	µg/kg	< 300	< 290	0
		4-Aminobiphenyl	µg/kg	< 530	< 520	0
		4-Bromophenyl phenyl ether	µg/kg	< 180	< 180	0
		4-Chloro-3-methylphenol	µg/kg	< 180	< 180	0
		4-Chloroaniline	µg/kg	< 340	< 340	0
		4-Chlorophenyl phenyl ether	µg/kg	< 180	< 180	0
		4-methylphenol	µg/kg	< 180	< 180	0
		4-Nitroaniline	µg/kg	< 270	< 260	0
		4-Nitrophenol	µg/kg	< 180	< 180	0

TABLE J-1

SITES FTIR-38 AND FTIR-40
FIELD DUPLICATE SUMMARY
NATIONAL TRAINING CENTER, FORT IRWIN

Sample Description	Collection Date	Analyte	Units	Sample Result	Field Duplicate Result	RPD (%)
40-2-SB-2-10 0 (continued)	05/12/99	7,12-Dimethylbenz(a)anthracene	µg/kg	< 530	< 520	0
		Acenaphthene	µg/kg	< 180	< 180	0
		Acenaphthylene	µg/kg	< 180	< 180	0
		Acetophenone	µg/kg	< 530	< 520	0
		Aniline	µg/kg	< 530	< 520	0
		Anthracene	µg/kg	< 180	< 180	0
		Benzidine	µg/kg	< 1100 UJ	< 1000 UJ	0
		Benzo(a)anthracene	µg/kg	< 180	< 180	0
		Benzo(a)pyrene	µg/kg	< 180	< 180	0
		Benzo(b)fluoranthene	µg/kg	< 180	< 180	0
		Benzo(g,h,i)perylene	µg/kg	< 180	< 180	0
		Benzo(k)fluoranthene	µg/kg	< 180	< 180	0
		Benzoic acid	µg/kg	< 180 UJ	< 180 UJ	0
		Benzyl alcohol	µg/kg	< 180 UJ	< 180 UJ	0
		Benzyl butyl phthalate	µg/kg	< 180	< 180	0
		bis (2-Chloroethoxy) methane	µg/kg	< 180	< 180	0
		bis (2-Chloroethyl) ether	µg/kg	< 530	< 520	0
		bis (2-Chloroisopropyl) ether	µg/kg	< 180	< 180	0
		bis (2-Ethylhexyl) phthalate	µg/kg	77 J	< 180	NC
		Chrysene	µg/kg	< 530	< 520	0
		di-n-Butyl phthalate	µg/kg	< 180	< 180	0
		di-n-Octylphthalate	µg/kg	57 J	< 180	NC
		Dibenz(a,h)anthracene	µg/kg	< 180	< 180	0
		Dibenz(a,j)acridine	µg/kg	< 530	< 520	0
		Dibenzofuran	µg/kg	< 180	< 180	0
		Diethyl phthalate	µg/kg	< 180	< 180	0
		Dimethyl phthalate	µg/kg	< 180	< 180	0
		DimethylphenylNaphthalene	µg/kg	< 2700	< 2600	0
		Diphenylamine	µg/kg	< 530	< 520	0
		Ethyl methanesulfonate	µg/kg	< 530	< 520	0
		Fluoranthene	µg/kg	< 180	< 180	0
		Fluorene	µg/kg	< 180	< 180	0
		Hexachlorobenzene	µg/kg	< 180	< 180	0
		Hexachlorobutadiene	µg/kg	< 180	< 180	0
		Hexachlorocyclopentadiene	µg/kg	< 180	< 180	0
		Hexachloroethane	µg/kg	< 180	< 180	0
		Indeno(1,2,3-c,d)pyrene	µg/kg	< 180	< 180	0
		Isophorone	µg/kg	< 180	< 180	0
		Methyl methanesulfonate	µg/kg	< 530	< 520	0
		N-Nitroso-di-n-butylamine	µg/kg	< 530	< 520	0

TABLE J-1

SITES FTIR-38 AND FTIR-40
FIELD DUPLICATE SUMMARY
NATIONAL TRAINING CENTER, FORT IRWIN

Sample Description	Collection Date	Analyte	Units	Sample Result	Field Duplicate Result	RPD (%)
40-2-SB-2-10 0 (continued)	05/12/99	N-Nitroso-di-n-propylamine	µg/kg	< 180	< 180	0
		N-Nitrosodimethylamine	µg/kg	< 530	< 520	0
		N-Nitrosodiphenylamine	µg/kg	< 180	< 180	0
		N-Nitrosopiperidine	µg/kg	< 530	< 520	0
		Naphthalene	µg/kg	< 180	< 180	0
		Nitrobenzene	µg/kg	< 180	< 180	0
		p-Dimethylaminoazobenzene	µg/kg	< 530	< 520	0
		Pentachlorobenzene	µg/kg	< 2700	< 2600	0
		Pentachlorophenol	µg/kg	< 510	< 500	0
		Phenacetin	µg/kg	< 530	< 520	0
		Phenanthrene	µg/kg	< 180	< 180	0
		Phenol	µg/kg	< 180	< 180	0
		Pronamide	µg/kg	< 530	< 520	0
		Pyrene	µg/kg	< 180	< 180	0
40-2-SS-2	05/10/99	Moisture content	%Moisture	2	1.7	16 2
		Arsenic	mg/kg	8.9	10 9	20 2
		Cadmium	mg/kg	0 24	0 31	25.5
		Lead	mg/kg	13 3	17.2	25 6
		Zinc	mg/kg	50.3	70.3	33 2
RF1-PT-4A	05/11/99	Aluminum	mg/kg	287	222 J	25.5
		Antimony	mg/kg	< 5	< 5	0
		Arsenic	mg/kg	0.29 J	0.28 J	3 5
		Barium	mg/kg	15 2	14 1 J	7.5
		Cobalt	mg/kg	0 2 J	0 18 J	10 5
		Copper	mg/kg	2.6	2.4 J	8.0
		Lead	mg/kg	0 39	0 37 J	5.3
		Zinc	mg/kg	7 7	7.2	6 7
RF1-SS-4A	05/11/99	Moisture content	%Moisture	0.9	1 4	43.5
		Aluminum	mg/kg	10600	10600	0.0
		Antimony	mg/kg	< 5	0 25 J	NC
		Arsenic	mg/kg	3.6	4	10.5
		Barium	mg/kg	124	121	2 4
		Cobalt	mg/kg	7.9	8.1	2.5
		Copper	mg/kg	12 6	13	3 1
		Lead	mg/kg	7 6	7.6	0
		Zinc	mg/kg	33.4	34.1	2.1

TABLE J-1

SITES FTIR-38 AND FTIR-40
FIELD DUPLICATE SUMMARY
NATIONAL TRAINING CENTER, FORT IRWIN

Sample Description	Collection Date	Analyte	Units	Sample Result	Field Duplicate Result	RPD (%)
RF2-PT-4	05/11/99	Aluminum	mg/kg	46.1	48 J	4.0
		Antimony	mg/kg	< 5	< 5	0
		Arsenic	mg/kg	< 0.3	0.11 J	NC
		Barium	mg/kg	30.5	28.3 J	7 5
		Cadmium	mg/kg	< 0.2	< 0.2	0
		Chromium	mg/kg	1.3	1.2	8.0
		Cobalt	mg/kg	< 0.5	< 0 5	0
		Copper	mg/kg	1.6	2 J	22.2
		Lead	mg/kg	0.63	0.26 J	83.1
		Manganese	mg/kg	23 7	17 1 J	32.4
		Mercury	mg/kg	< 0 1	< 0 1	0
		Nickel	mg/kg	0 33	0.46 J	32.9
		Selenium	mg/kg	0 27 J	0.28 J	3.6
		Silver	mg/kg	< 0.5	< 0 5	0
		Zinc	mg/kg	3 2	4 2	27.0
RF2-SS-4	05/11/99	Moisture content	%Moisture	3 3	1 7	64.0
		Aluminum	mg/kg	11700	8590	30 7
		Antimony	mg/kg	< 4.1	< 4.1	0
		Arsenic	mg/kg	7 9	7	12 1
		Barium	mg/kg	177	146	19.2
		Cadmium	mg/kg	0 19 J	< 0.41	NC
		Chromium	mg/kg	11.6	8.2	34.3
		Cobalt	mg/kg	7.8	6.3	21 3
		Copper	mg/kg	17 8	11 7	41.4
		Lead	mg/kg	13 4	8.4	45.9
		Manganese	mg/kg	376	324	14.9
		Mercury	mg/kg	0 12	0.13	8.0
		Nickel	mg/kg	12	9 5	23.3
		Selenium	mg/kg	0.59 J	< 2	NC
		Silver	mg/kg	< 2.1	< 2	0
		Zinc	mg/kg	52.6	35.9	37 7

J - Result is an estimate
NC - Not Calculated
mg/Kg -milligrams per kilogram
µg/Kg - micrograms per kilogram
RPD - Relative Percent Diffference

APPENDIX L

TOXICOLOGY PROFILES

ALUMINUM
(CAS RN 39148-24-8)

Aluminum is a silver-white, flexible metal and is nature's third most abundant element, making up 8 percent of the earth's crust. It is always found combined with other elements such as ores. Aluminum is highly reactive. Many foods contain aluminum. Normal human intake from food alone is approximately 10 mg/day. Estimated total daily ingestion from all sources is 20 mg/day.

Absorption/Distribution/Metabolism/Excretion

The absorption of aluminum in humans and animals is low by any route of exposure. The absorption of aluminum following oral exposure is, to some extent, dependent on its chemical form. Gupta et al. (1986) showed that oral absorption was 27 percent in rats following a single dose of 8.1 mg aluminum/kg as aluminum chloride. Following oral exposures, trivalent aluminum (Al^{+3}) is absorbed to a minor extent and taken up or transferred into the intestinal mucosa, lungs, plasma, bone, and cells of various organs. The maximum intestinal absorption of Al^{+3} in adult humans is estimated at 2 μg/day. Approximately 0.1 percent-0.5 percent of the normal Al^{+3} in food (less than 20 mg) is absorbed (Ganrot, 1986).

Once absorbed, approximately one-half of the total body burden of aluminum is distributed in the skeleton, and one-fourth to the lungs. Animal evidence suggests that following oral exposures aluminum accumulates in the brain, especially the hippocampus. This distribution may play an important pathogenic role in aluminum neurotoxicity (Santos et al., 1987). Aluminum also distributes to the bone, muscle, and kidneys; and there is limited animal evidence that aluminum may distribute to the milk of lactating mothers and cross the placenta to accumulate in the fetus (Cranmer et al., 1986; Yokel and McNamara, 1985). Once in the blood, Al^{+3} ions are believed to be present almost exclusively in the plasma.

Since aluminum is an element, it is not metabolized like other, more complex, chemicals. It is always found attached to other chemicals. These affinities, however, may change within the body.

Approximately 0.09 percent and 96 percent of human aluminum intake, per day is cleared through the urine and feces, respectively. This result was obtained by Greger and Baier (1983) in experiments of exposure to 1.71 mg Al/kg/day as aluminum lactate in addition to 0.07 mg Al/kg/day in basal diet for 20 days.

Target Organ Toxicity

The USEPA Region 9 has established a chronic oral RfD for aluminum of 1.0 mg/kg-day, and an inhalation RfD of 1.4×10^{-3} mg/kg-day (USEPA, 2000).

Human Toxicity. There is little evidence that aluminum is toxic by the oral route. However, aluminum has been known to cause deaths in humans. Specifically, aluminum phosphide (a grain fumigant), is the only life-threatening aluminum compound and has been associated with deaths due to overdose (Chopra et al., 1986; Khosla et al., 1988). The toxicity of this compound is due to the phosphine, however, and not the aluminum.

Patients on dialysis are subject to two syndromes that may be associated with aluminum -- dialysis encephalopathy (characterized by progressive dementia) and renal osteodystrophy (characterized by increased fractures). Patients on long-term hemodialysis for chronic kidney failure often acquire musculo-skeletal effects characterized by bone softening resulting in increased spontaneous fractures and pain (King et al., 1981; Mayn et al., 1985; Willis and Savory, 1989). In these situations, aluminum may be given in high doses (orally) to control excesses in phosphates, or provided intravenously in the dialysis fluid. Patients who have been on renal dialysis can also develop neurodegenerative diseases. These diseases are characterized by altered speech, personality changes, seizures, and motor dysfunction. Aluminum is not actually known to cause either of these syndromes.

A 1989 study in England and Wales (Martyn et al., 1989) indicated that increased aluminum content in the drinking water may be associated with increased incidence of Alzheimer's disease, a neurodegenerative disease that can lead to death. Much of this scientific evidence seems to suggest a relationship between brain aluminum concentrations and Alzheimer's disease, but the casual link between aluminum exposure and this disease is tenuous. It is noted, however, that

patients who have Alzheimer's disease may be more vulnerable to the effects of aluminum than other people (Shore and Wyatt, 1983).

Epidemiological studies on many factory workers exposed to aluminum via inhalation revealed an increase in deaths from some types of cancer. Because these workers were also exposed to highly carcinogenic polycyclic aromatic hydrocarbons and tobacco smoke, these increases may not necessarily be attributed to aluminum exposure. Also noted was the workers' lower than expected total mortality rate, as compared to the general population (Gibbs and Horowitz, 1979; Milham, 1979; Mur et al., 1987; Rockette and Arena, 1983; Theriault et al., 1984).

Several case studies show that some aluminum workers develop lung fibrosis when exposed to aluminum dusts. However, it is not clear that the aluminum caused the fibrosis; it is likely that the dust had irritant properties.

Animal Toxicity. Of experiments performed on animals, none have shown death from inhalation exposure to aluminum, even from up to 1,000 mg/m^3 for an acute 4-hour exposure. Few studies have reviewed respiratory effects in animals after inhalation. Exposure of rats, guinea pigs, and hamsters to aluminum chlorohydrate or aluminum oxide produced proliferations of macrophages in the alveolar walls as well as granulomatous reactions characterized by giant vacuoled macrophages. In some cases, the responses were accompanied by pneumonia.

Aluminum is fatal to laboratory animals only in very high doses. An LD_{50} of 261/mg aluminum/kg for rats has been reported for aluminum nitrate (Llobet et al., 1987a). An LD_{50} of 770 mg aluminum/kg for mice has been reported for the chloride form (Ondreicka et al., 1966).

Developmental and Reproductive Toxicity

The only human data on developmental effects comes from infants with renal failure. Progressive encephalopathy was observed among children with severe renal disease who had received oral doses of aluminum-containing phosphate binders for 4 to 12 months (Finberg et al., 1986). Studies indicate that only certain children are affected.

The effects of aluminum on the development of laboratory animals is controversial Decreases in pup growth and neurological development were observed in some studies, while others did not show these effects Several studies using aluminum chloride or aluminum hydroxide have shown that aluminum does not affect fetal, neurobehavioral, skeletal, or visceral development abnormalities, while other studies have shown decreased body weights or delays in neurobehavioral development It is unclear whether these effects are permanent and toxicologically significant, or whether they disappear as the animal matures.

No studies were located regarding reproductive effects in humans after oral exposure. Studies with laboratory animals appear to substantiate the idea that exposure to aluminum compounds does not result in adverse reproductive effects (in rats)

Genotoxicity

The genotoxic and subcellular effects of aluminum on DNA in neurons and other cells may partially explain some of the possible neurotoxic effects. These effects include binding to DNA phosphate and bases, altering sister chromatid exchange, and decreasing cell division Data from in vivo exposures of mice to aluminum chloride also indicate that this compound is clastogenic. Wedrychowski et al. (1986) supported this data by in vitro studies showing that aluminum chloride causes cross-linking of chromosomal proteins and DNA in Sprague-Dawley rats. Crapper-McLachlan (1989) demonstrated that aluminum can interact with DNA in the formation of neurofibrillary tangles in the brain which are associated with Alzheimer's disease

Carcinogenicity

Aluminum is not known to cause cancer in humans There is some indication that workers in the aluminum industry have had a higher than expected incidence of cancer; however, evidence suggests that may be due to other potent carcinogens to which they are also exposed (such as tobacco smoke and polycyclic aromatic hydrocarbons). Slope factors and unit risks have not been developed.

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ANTIMONY
(CAS RN 7440-36-0)

Antimony is a silvery-white metal of medium hardness that breaks easily. Small amounts of antimony are found in the earth's crust. Antimony enters the environment during mining and processing of its ores and in the production of antimony metal, alloys, antimony oxide, and combinations of antimony with other substances. Small amounts are also released by incinerators, coal-burning power plants, and metal smelting and refining. Most antimony ends up in the soil or sediment where it attaches strongly to particles that contain iron, manganese, or aluminum; therefore it cannot be easily released to affect health. Some antimony may be taken up by plants and animals

Absorption/Distribution/Metabolism/Excretion

Studies have shown that antimony is only partially absorbed from the GI tract upon ingestion. The major sites of accumulation in animals following oral exposure (exclusive of the GI tract) are the liver, kidney, bone, lung, spleen, and thyroid. Estimates of absorption in animals from the GI tract, for antimony tartrate and antimony trichloride compounds, range from 2 percent to 7 percent (Felicetti et al., 1974; Gerber et al., 1982; cited in ATSDR, 1991). The authors of the ATSDR (1991) toxicological profile suggest that absorption of trivalent antimony salts in humans is probably less than 10 percent. The International Commission on Radiological Protection (ICRP, 1981; cited in ATSDR, 1991) has recommended 10 percent (for antimony tartrate) and 1 percent (all other forms) as reference values for GI absorption.

There is no definitive evidence that antimony is absorbed through the lungs upon inhalation. Absorption from the respiratory tract is a function of particle size. Particles of 0.7 or 0.3 μm size have been shown to be relatively insoluble in the lung and according to Thomas et al. (1973; cited in ATSDR, 1991) are slowly absorbed over several weeks.

Like many metals, antimony does not undergo catabolism within the body. Increased levels of urinary antimony have been noted in workers exposed to antimony trioxide (Cooper et al., 1968;

Ludersdorf et al., 1987; cited in ATSDR, 1991). Antimony is excreted via the urine and feces of animals. Studies indicate that the urine/feces ratio depends on the chemical form.

Occupational exposures to antimony trioxide and/or pentoxide dust (at 8.87 mg antimony/m^3 or greater) have resulted in antimony pneumoconiosis. Changes in pulmonary function were also observed in workers exposed to airborne antimony (Cooper et al., 1968; Potkonjak and Pavlovich, 1983; Renes, 1953; cited in ATSDR, 1991). Chronic bronchitis, chronic emphysema, inactive tuberculosis, pleural adhesions, and irritation (including chronic coughing and wheezing) have also been observed (Potkonjak and Pavlovich, 1983; cited in ATSDR, 1991). In a study by Briseger et al (1954; cited in ATSDR, 1991) workers occupationally exposed to 2.15 mg antimony/m^3 as antimony trisulfide were observed for 8 months to 2 years. Increased blood pressure (greater than 150/90) and altered EKG readings were noted. GI disorders (abdominal pain, diarrhea, vomiting, and ulcers) have also been noted following repeated prolonged exposure to airborne antimony in the trichloride, trisulfide, or oxide forms. A causal relationship to antimony exposure has not been definitely established as workers were exposed to a variety of other agents in addition to antimony and exposures may have been via ingestion as well as inhalation.

Acute Toxicity

Dunn (1928; cited in ATSDR, 1991) observed workers who drank an average of 10 ounces of lemonade contaminated with potassium antimony tartrate (equivalent to 0.53 antimony/kg for a 70 kg man). Shortly after ingestion, workers began to vomit.

Ocular conjunctivitis and dermatosis (observed more during periods of high temperature) have been reported following contact of the skin and/or eyes to airborne antimony (Potkonjak and Pavlovich, 1983; Renes, 1953; Stevenson, 1965).

The end result was death for guinea pigs exposed via inhalation to 37.9 mg antimony /m^3 as antimony trioxide dust for 52 to 125 days (Dernehl et al., 1945; cited in ATSDR, 1991) or guinea pigs and rats exposed to 1,395 mg antimony/m^3 as stibine gas for 30 minutes (Price et al., 1979; cited in ATSDR, 1991).

Death was observed in rabbits following a single dermal application of antimony oxides at a level of 1,584 mg antimony/kg or greater (Industrial Bio-Test Laboratories, 1972; Myers et al., 1978; cited in ATSDR 1991). The cause of death was not reported. Edema was noted in rabbits in the area where an antimony trioxide patch (6,685 mg antimony/kg) was applied for 1 day (Myers et al., 1978; cited in ATSDR, 1991).

Target Organ Toxicity

The USEPA has established a chronic oral RfD for antimony of 4.0×10^{-4} mg/kg-day (USEPA, 2000). Derivation of this value was based on a study in which rats (50 male and 50 female) were administered 5 mg/L (ppm) potassium antimony tartrate in water (Schroeder et al., 1970; cited in IRIS, April 2001). Growth rates of the treated rats were not affected; however both sexes had a survival rate of 106 and 107 fewer days (male and females, respectively) than did controls. Cholesterol levels were altered (increase and decrease) in both sexes, and non-fasting blood glucose levels and mean heart weight were decreased in the males. A dose level of 0.35 mg/kg-day was established as the effective exposure level from this study. An uncertainty factor of 1,000 was applied to this value. Low confidence is placed on the RfD because only one animal species was used, only one dose level was used, no threshold dose was determined, and gross pathology and histopathology were not well described.

Exposure of humans to antimony via inhalation or orally has been shown to result in pneumoconiosis, altered EKG readings, increased blood pressure, abdominal distress, ulcers, dermatosis and ocular irritation. Similar effects have been reported in animals following similar exposures. These effects are described in more detail below.

It is of interest to note that antimony has long been recognized as having beneficial effects as well as toxic effects. For example, it is currently used to treat two parasitic diseases, schistosomiasis and leishmaniasis.

Neurotoxicity. Muscle weakness, difficulty in moving, and abnormal gait have been observed in animals following oral and dermal exposure to antimony (Fleming 1982; Myers et al. 1978 cited in ATSDR 1991). Decreased motor efficiency and dystonic torsion of the limbs were observed

in mine receiving intraperitoneal injections of potassium antimony (Mansour and Reese 1965; cited in ATSDR 1991). Degenerative changes in the anterior horn cells of the lumbar cord, edema with hydropic degeneration in the sciatic nerve, and swelling of the myoneural junction have also been observed in mice. According to the ATSDR (1991), since neurological effects have been routinely detected in animals, neurotoxic effects are also likely to occur in humans.

Hepatotoxicity. Parenchymatous degeneration has been observed in rats and guinea pigs exposed to airborne antimony (Brieger et al. 1954; Dernehl et al. 1945; cited in ATSDR 1991); and, swelling of the hepatic cords has been observed in rats orally exposed to antimony (Hiraoka 1986; cited in ATSDR 1991). No hepatic effects have been observed in humans.

GI toxicity. Historically, antimony has been known for its emetic properties. Vomiting, diarrhea, gastric discomfort, and ulcers have been reported in humans following inhalation or oral exposure to antimony. Amounts as low as 0.529 mg antimony/kg have resulted in vomiting.

Respiratory System Toxicity. A variety of respiratory effects have been noted in animals following exposure to antimony. In a 1989 study conducted by Bio/dynamics (cited in ATSDR, 1991), a dose-related increase in the number of alveolar/intralveolar macrophages was observed in rats exposed to 0.046 mg antimony/m^3 as antimony trioxide for 13 weeks or more. A number of the macrophages had returned to normal in those rats exposed for 1 year by six months after cessation of exposure. More severe respiratory effects, such as interstitial fibrosis and lipoid pneumonia, have been observed in rats exposed to antimony trisulfide or antimony trioxide for a period of 1 year (Gross et al., 1952; Groth et al., 1986; Watt, 1980, 1983; Wong et al., 1979; cited in ATSDR, 1991). These effects were noted at exposure levels between 1.6 and 83.6 mg antimony/m^3.

Cardiotoxicity. Degenerative changes in the myocardium and related EKG abnormalities were noted in a variety of animal species upon exposure to antimony trisulfide dust (Brieger et al., 1954; cited in ATSDR, 1991). In addition, parenchymatous and fatty degeneration of the liver was observed in rabbits exposed to 19.94 mg antimony /m^3 as antimony trisulfide for 5 days. Dernehl et al. (1945; cited in ATSDR, 1991) observed similar effects in guinea pigs exposed to

37.9 mg antimony/m^3 as antimony trioxide for 30 weeks. Marmo et al. (1987; cited in ATSDR, 1991) exposed rats (pre- and postnatally, or postnatally alone) to 0.0748 mg antimony/kg/day as antimony trichloride. The authors noted that the exposure affected the development of some cardiovascular reflexes important for regulating systemic arterial blood pressure.

Developmental Toxicity

No studies regarding developmental effects in humans after oral exposure to antimony were available. However, pre- and postnatal or postnatal exposure only impaired the development of cardiovascular reflexes important to regulating systemic arterial blood pressure in laboratory animals (ATSDR, 1991).

Reproductive Toxicity

Women occupationally exposed to a mixture of antimony trioxide, antimony pentasulfide, and metallic antimony at an antimony metallurgical plant experienced an increased incidence of spontaneous abortions (compared to a control group) (Belyaeva, 1967; cited in ATSDR, 1991). Disturbances in menstrual cycles were also observed.

Genotoxicity

Positive results for chromosome breakage in human leukocytes were found in in vitro studies conducted by Paton and Allison (1972; cited in ATSDR, 1991). Positive results have also been found for DNA damage, viral transformation, and chromosomal aberrations. However, because of the limited in vitro genotoxicity data and the lack of in vitro tests, the genotoxicity of antimony in humans cannot be determined.

Carcinogenicity

Inhalation exposure to antimony trioxide or antimony trisulfide produced lung tumors in rats (Groth et al., 1986; Watt, 1983; Wong et al., 1979; cited in ATSDR, 1991). In 1980 and 1983 studies conducted by Watt, exposure of animals to antimony trioxide (aerosol particle size of 0.44 μm) resulted in cancer. A 1989 study (Bio/dynamics; cited in ATSDR, 1991), using antimony trioxide at a particle size of 3.8 μm did not result in cancer. The carcinogenicity of inhaled antimony is probably related to its deposition in the respiratory tract. The lung

carcinogenicity of inhaled antimony may not predict carcinogenic potential of other routes of exposure. Antimony has not produced cancer in rats or mice exposed orally (Kanisawa and Schroeder, 1969; Schroeder et al., 1968, 1970; cited in ATSDR, 1991).

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ARSENIC

(CAS RN 7440-38-2)

Arsenic is a naturally occurring element in the earth's crust usually found combined with one or more other elements. It is especially prevalent in ores that contain copper or lead. When combined with oxygen, chlorine, or sulfur it is referred to as inorganic arsenic, and when combined with carbon and hydrogen it is referred to as organic arsenic. This is an important distinction since inorganic forms are more prevalent in the environment than organic forms, and because inorganic forms are more toxic than organic forms. Both forms are released to the environment by human activities such as fossil fuel consumption, pesticide use and copper smelting, and via natural processes such as volcanic emissions, weathering of arsenic-containing minerals and ores, and forest fires (ATSDR, 1992). Soil usually contains about 5,000 μg/kg arsenic; food contains about 20 to 140 μg/kg; waste contains about 2 μg/L; and air contains about 0.02 to 0.10 $\mu g/m^3$.

Absorption/Distribution/Metabolism/Excretion

Water soluble inorganic arsenic compounds are substantially absorbed (more than 90 percent) from the GI tract of humans and laboratory animals. Estimates of absorption following oral exposure of humans to water soluble, inorganic arsenic compounds range from 54 to 95 percent (Bettley and O'Shea, 1975; cited in ATSDR, 1992). Less water soluble forms are absorbed to a smaller degree. For example, only 30 to 40 percent of an oral dose of arsenic trioxide, which has limited water solubility, is absorbed by laboratory animals (Marafante and Vahter, 1987; cited in ATSDR, 1992). Water soluble, inorganic arsenic compounds are also rapidly and substantially absorbed via inhalation in both animals and humans. Studies have indicated that 75 to 85 percent of deposited arsenic is absorbed from the lungs within 4 days (Holland et al., 1959 cited in ATSDR, 1992). Less soluble arsenic compounds (e.g., lead arsenate, gallium arsenide) are less completely absorbed (about 55 percent of an administered dose absorbed in 3 days) (Marafante and Vahter, 1987; cited in ATSDR, 1992). There is little quantitative information on the dermal absorption of arsenic compounds in humans or in animals. However, one study has indicated that arsenic initially binds to the skin and is then slowly taken up into blood (Dutkiewicz, 1977; cited in ATSDR, 1992).

Once absorbed, arsenic is rapidly cleared from the blood in humans and animals (except in rats where it is bound to red blood cells) and distributed to the liver, kidney, lung, spleen, aorta, skin, hair and upper GI tract (Rhodes and Sanders, 1985; Liebscher and Smith, 1968; cited in ATSDR, 1992). These tissues are then cleared rapidly except for skin and hair, where arsenic tends to accumulate. Most absorbed arsenic is metabolized in the liver to methylated products and excreted in the urine (ATSDR, 1992). Since methyl derivatives of arsenic appear to be less toxic than inorganic arsenic, and since methylation results in less tissue retention of inorganic arsenic, methylation is viewed as a detoxification process.

Acute Toxicity

Oral doses of about 50 to 300 mg inorganic arsenic may be fatal to adults, and subchronic oral exposure to about 3 mg/day can be fatal to infants exposed via contaminated milk. On the basis of these observations, the minimum acute and subacute oral lethal dose in humans is estimated to be about 1 to 3 mg/kg/day (ATSDR, 1992). Inhalation or dermal exposure has not been associated with acute lethality in humans.

Acute or subacute oral exposures to high nonlethal, oral doses of arsenic ranging from about 0.04 to 3 mg/kg/day via drinking water or other types of ingestion (e.g., herbal preparation) produces a range of GI signs, with nausea, vomiting, and thirst being common. Very high oral doses may also produce acute encephalopathy (any degenerative disease of the brain), and injury to the liver consisting of necrosis (cell death) and fatty infiltration.

Animals are less sensitive to the toxic effects of arsenic than are humans. For example, reported lethal doses in animals (10 to 300 mg/kg) are significantly higher than lethal doses reported in humans (0.6 to 2 mg/kg).

Target Organ Toxicity

The USEPA has published a chronic oral RfD of 3 0 x 10^{-4} mg/kg-day for arsenic (IRIS, 2001). This value is based on observations of keratosis, hyperpigmentation, and possible vascular complications in humans exposed to arsenic in their drinking water. The purpose of the UF of 3 associated with this RfD is to account for the lack of data to preclude reproductive toxicity as a critical effect and to account for some uncertainty over whether the NOAEL of the critical study accounts for all senstive individuals. It should be noted that there was not a clear consensus among the Agency scientists on this RfD. risk managers should realize the flexibility afforded them in making regulatory decisions when uncertainty and lack of clear consensus are taken into account.

Developmental Toxicity

There is only suggestive evidence that exposure to arsenic results in developmental toxicity in humans (ATSDR, 1992). Studies in animals, however, do support the view that arsenic is a developmental toxicant, causing reduced birth weight, a variety of fetal malformations (both skeletal and soft tissue), and increased fetal mortality. These effects have been noted following inhalation exposure of mice (Nagymajtenyi et al. 1985), oral exposure of mice and hamsters (Baxley et al., 1981; Hood and Harrison, 1982; Hood et al., 1978; cited in ATSDR 1992), and intraperitoneal or intravenous injection of rats, mice, and hamsters (Beaudoin, 1974; Carpenter, 1987; Ferm and Carpenter, 1968; Ferm et al., 1971; Hanlong and Ferm, 1986c; Hood and Bishop, 1972; Mason et al., 1989; Willhite, 1981; cited in ATSDR, 1992). However, in all these cases the doses required to cause effects were high and often resulted in significant maternal toxicity or even lethality. It thus appears that although inorganic arsenic is a developmental toxicant, the developing fetus is not especially susceptible, and teratogenicity or fetotoxicity are unlikely to be of concern except at doses that are also toxic to the pregnant female (ATSDR, 1992).

Genotoxicity

The results of tests for genotoxicity of arsenic are mixed, but in general the inorganic arsenicals appear to be either inactive or weak mutagens (Jacobson-Kram and Montalbano, 1985; cited in ATSDR, 1992) that are able to produce chromosomal effects (aberrations, sister chromatid

exchange) in most systems. Studies of humans have detected higher than average incidence of chromosomal aberrations in peripheral lymphocytes, both after inhalation exposure (Beckman et al., 1977; Nordenson et al., 1978; cited in ATSDR, 1992) and oral exposure (Burgdorf et al., 1977; Nordenson et al. 1979; cited in ATSDR, 1992)

Cardiotoxicity. Chronic oral exposure to arsenic is also associated with cardiological and vascular effects Injury and abnormal function of cardiac tissue have been reported in children ingesting water containing as little as 0.6 to 0.8 mg/L arsenic. Peripheral vascular disease leading to gangrene of the toes and feet ("Blackfoot disease") has been reported in a Taiwanese population ingesting drinking water containing 0.4 to 0.6 mg/L arsenic (Chen et al., 1988b; Chi and Blackwell, 1968; Tseng et al., 1968; cited in ATSDR, 1992). Similar peripheral vascular lesions have been reported in vintners exposed to arsenical pesticides, in persons in Chili consuming water containing about 0.8 mg/L arsenic, and in patients from a region in Mexico where arsenic toxicity is endemic (ATSDR, 1992) (It should be noted that some investigators have questioned the role of arsenic in Blackfoot disease and have suggested that the causative factor may be a fluorescent arsenic-containing compound of unknown structure which is present in water where "Blackfoot disease" is endemic.)

Carcinogenicity

There is evidence that chronic oral exposure to elevated levels of arsenic increases the risk of skin cancer in humans The largest study of arsenic-induced skin cancer has been described by Tseng (1968 cited in ATSDR, 1992). This study focused on a large population in Taiwan where arsenic levels in deep wells used for drinking water ranged from 0.001 to 1.82 mg/L, with average levels of around 0.4 to 0.6 mg/L Based on examination of over 40,000 exposed people the excess skin cancer rate was found to be 10.6/1000 (or about 1×10^{-2}). On the basis of these and other (Wv et al., 1989; Zaldiver, 1974; cited in ATSDR, 1992) the EPA cautions that the design of this study limits its usefulness in risk estimation Arsenic-induced skin cancer has also been attributed to water supplies in Chile, Argentina and Mexico (Borgono and Greiber, 1972; Bergoglio, 1964; Cebrian et al. 1983; cited in ATSDR, 1992).

The USEPA has concluded that the Tseng (1977) study is the most appropriate basis for the derivation of an oral unit risk and slope factor for arsenic, although because of its study design considerable uncertainty in dose response should be recognized. Based on this study, a unit risk of 5.0 x 10^{-5} $(ug/L)^{-1}$ has been published (IRIS, 2001). The associated oral slope factor is calculated to be 1.5 $(mg/kg\text{-}day)^{-1}$. IRIS (2001) notes that a recent memorandum by the Administrator of the USEPA, while recommending that the above slope factor be adopted, also notes that the "uncertainties associated with ingested inorganic arsenic are such that estimates could be modified downwards as much as an order of magnitude, relative to risk estimates associated with most other carcinogens. In such instances, the management document must clearly articulate this fact and state the factors that influenced such a decision." (This seems to imply that a unit risk of 5.0 x 10^{-6} for arsenic may be appropriate, and that an associated slope factor of 1.5 x 10^{-1} $(mg/kg\text{-}day)^{-1}$ may be acceptable.)

The ATSDR toxicological profile for arsenic notes that several types of internal tumors have also been associated with oral arsenic exposure (ATSDR, 1992). For example, hepatic angiosarcoma, a rare tumor in the general population, occurs at increased frequency in persons exposed to Fowler's solution (potassium arsenite), or to arsenical pesticides. Also, exposure to arsenic through ingestion of water containing 0.4 to 1.1 mg/L arsenic has been associated with increased occurrence of bladder, lung and liver cancer. Limited observations suggest arsenic might be associated with several other types of cancer as well, including cancer of the mammary gland, cancer of the lymphatic tissues, leukemia, and renal adenocarcinoma (Kasper et al., 1984; Lender et al., 1975; Regelson et al., 1968, Roth, 1957; Sommers and McManus, 1953; Chen et al., 1985, 1986, 1988a, 1988b, 1988c; Chiang et al., 1988; Wu et al., 1989; cited in ATSDR, 1992).

Chronic Toxicity

Chronic exposure to arsenic via inhalation results in an elevated risk of lung cancer in humans. Studies of smelter workers in the United States, Sweden, and Japan have all found an association between occupational arsenic exposure and lung cancer mortality (Enterline and Marsh, 1982; Lee-Feldstein, 1983; Axelson et al., 1978; Tokudome and Kuratsune, 1976; Rencher et al., 1977; cited in ATSDR, 1992). Studies of pesticide manufacturing workers, of arsenical pesticide applicators, and of a population located near a pesticide manufacturing plant have also revealed

an excess of lung cancer deaths among exposed persons (Ott et al., 1974; Mabuchi et al., 1979; Matanoski et al., 1981; Roth, 1958; cited in ATSDR, 1992).

The EPA has derived geometric means of unit risks from different data sets obtained from workers occupationally exposed at two different smelters in the United States. The final estimate of an inhalation unit risk is the geometric mean of these two values and is 4.3×10^{-3} $(\mu g/m^3)^{-1}$ from which an inhalation slope factor of 1.5×10^{1} $(mg/kg/day)^{-1}$ has been derived (IRIS, 2001)

It is interesting to note that in laboratory animals oral exposure to arsenic does not result in cancer; and, there is only suggestive evidence that exposure to arsenic via inhalation induces lung cancer.

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U S. Environmental Protection Agency (USEPA) Region 9. Region 9 PRGs Table 2000 Update. November 1, 2000.

BARIUM

(CAS RN 7440-39-3)

Barium is a yellowish-white, slightly lustrous metal with a body-centered cubic structure (Merck, 1983; cited in HSDB, 2001). It is used in paints, soap, paper, and rubber, and in the manufacture of ceramics and glass (Doull, et al., 1986; cited in HSDB, 2001). It is also used as a component in various proprietary nodularizing and deoxidizing alloys, in the manufacture of alloys for such products as nickel barium parts used in ignition equipment for automobiles, and in the manufacture of lithopone and television picture tubes (Venugopal, et al., 1978; cited in HSDB, 2001). Barium is soluble in alcohol but insoluble in benzene; it has a boiling point of 1640°C and a melting point of 725°C (Weast, 1989; cited in HSDB, 2001). Naturally occurring barium is a mixture of seven stable isotopes; thirteen other radioactive isotopes are known to exist (Weast, 1989; cited in HSDB, 2001).

Absorption/Distribution/Metabolism/Excretion

Absorption of barium following inhalation exposure by humans has not been widely studied; however, results of studies with experimental animals suggest that the rate and extent of absorption of barium from the respiratory tract depends on the exposure level, and the solubility of the particular form of barium that was administered (ATSDR, 1991). As with other metals, barium is probably very poorly absorbed from the GI tract; the International Commission for Radiation Protection (ICRP) estimates that the GI absorption of barium is less than 5% (ICRP, 1973; cited in ATSDR, 1991). Barium is not lexpected to cross intact skin because of the high polarity of the forms in which it is most commonly encountered (ATSDR, 1991); therefore, dermal absorption of barium is not likely.

Studies in humans indicate that barium distributes predominantly to the skeleton and teeth. The route of exposure is presumed to be mostly oral (ATSDR, 1991). Barium occurs mostly in the bones and teeth of humans. Very little is found in blood plasma or soft tissues; but, when it is detected in the organs, it is found in the eyes, lungs, skin, and adipose tissue in humans (Schroeder et al., 1972, as cited in ATSDR, 1991).

Since barium is an element, it is not metabolized in the body, but it may be metabolically transported or incorporated into complexes or tissues (ATSDR, 1991).

Barium taken by mouth is poorly absorbed, therefore, most of the dose is excreted in the feces (Tipton et al., 1966; cited in ATSDR, 1991). Dogs that received barium by gavage excreted most of the dose within a few days and less then 3% of the initial body burden remained in the body after two weeks (Cuddihy and Griffith, 1972; cited in ATSDR, 1991).

Acute Toxicity

No studies were available regarding death in humans or animals after inhalation or dermal exposure to barium. However, mortality has been reported to occur in a number of cases where humans have been acutely exposed to barium through accidental or intentional ingestion (ATSDR, 1991). These observations are supported by findings from acute studies with rodents that indicate barium is toxic by the oral route (Borzelleca et al., 1988; cited in ATSDR, 1991). Reduced life span also has been observed in chronic oral studies with mice. These results from human case studies and acute and chronic studies with rodents suggest that humans who are exposed orally to high levels of barium may be at increased risk for mortality (ATSDR, 1991).

Target Organ Toxicity

Barium has been associated with a number of adverse health effects in both humans and experimental animals. Both human and animal evidence suggests that the cardiovascular system may be one of the primary targets of barium toxicity (ATSDR, 1991).

The USEPA has calculated an oral RfD of 7.0×10^{-2} mg/kg-day based on increased blood pressure observed in subchronic to chronic human drinking water studies (IRIS, 2001) The UF of 3 is used to account for sensitive individuals The USEPA has also calculated an inhalation RfD of 1.4×10^{-4} mg/kg-day for barium (IRIS, 2001).

Respiratory Effects. Benign pneumoconiosis has been observed in workers exposed occupationally by inhalation to barium (Doig et al., 1976; cited in ATSDR, 1991). Acute intravasation of barium sulfate into the circulatory system of an adult female following a barium

enema caused the compound to be deposited in blood cells throughout the body, including the lungs, and resulted in respiratory failure (Cove et al., 1974; cited in ATSDR, 1991).

Developmental Toxicity

Results of a study which evaluated the correlation between barium concentrations in drinking water and human congenital malformation rates of the CNS indicated there was no correlation. However, another study suggested that exposure to barium may potentially be associated with adverse developmental effects. Reduced survival, underdevelopment, lowered body weight, decreased ability of the peripheral nervous system, and various blood disorders were reportedly noted in the offspring of rats following inhalation to barium for an intermediate exposure period. In the same study, increased mortality, increased leukocyte count, disturbances in liver function, and increased urinary excretion of hippuric acid were noted in the offspring of rats treated orally to barium during conception and pregnancy (Tarasenko et al., 1977; cited in ATSDR, 1991).

Reproductive Toxicity

There are no studies regarding the reproductive effects of barium in humans (ATSDR, 1991). However, two animal studies have provided limited information suggesting that humans exposed to barium may be at increased risk for developing reproductive effects. Decreased ovary weight and decreased ovary/brain weight ratio have been noted in rats following acute oral exposure to barium. Intermediate inhalation exposure to barium has been associated in rats in one limited study with disturbances in spermatogenesis, shortened estrous cycle, and alterations in the morphological structure of the ovaries and testes (Tarasenko et al., 1980; cited in ATSDR, 1991).

Genotoxicity

Available data relating to the genotoxic effects of barium are derived from in vitro studies only; there were no available data regarding the genotoxicity of barium in vivo. A single recombination assay in which Bacillus subtilis was exposed to barium was negative for mutagenicity. Results of a test evaluating the fidelity of DNA synthesis in an avian myeloblastosis virus DNA polymerase system indicate that barium did not affect the accuracy of DNA replication (Nishioka, 1975; cited in ATSDR, 1991).

Carcinogenicity

Two chronic oral studies which examined the incidence of tumors in rats and mice exposed to barium acetate in drinking water for lifetime were negative for carcinogenicity; however, they were inadequate for evaluating carcinogenic effects because insufficient numbers of animals were used, a complete histological examination was not performed, and only one exposure dose was evaluated (Schroeder and Mitchener 1975; cited in ATSDR, 1991) Precancerous lesions were reported in one study in which a woman was treated on the cervix with a barium chloride solution; however, the relevance of this limited observation cannot be determined because only one subject was treated and because the vehicle solution was not specified (Ayre, 1966; cited in ATSDR, 1991). Barium has not been evaluated by the USEPA for human carcinogenic potential (IRIS, 2001)

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CADMIUM
(CAS RN 7440-43-9)

Cadmium occurs naturally in the earth's crust, and low levels of cadmium are found in most waters. It is most often encountered in combination with other elements such as oxygen, chlorine, or sulfur. The largest anthropogenic source of cadmium in the general environment is the burning of fossil fuels (such as coal or oil) or the incineration of municipal waste materials. It may also escape into the air from zinc, lead, or copper smelters. Smoke from cigarettes also contains cadmium and most people who smoke have about twice as much cadmium in their bodies as nonsmokers.

Absorption/Distribution/Metabolism/Excretion

Cadmium is poorly absorbed from the GI tract. An average of only 3 to 6 percent of an oral dose of cadmium chloride has been reported to be retained by humans, with individual values ranging from about 1 to 7 percent. In animals, 0.5 to about 3 percent of an oral dose is retained.

Absorption via inhalation is considerably greater than via ingestion, although this is limited to cadmium adsorbed to particulates of 0.1 mm or smaller which tend to be deposited in alveoli. For example, about 60 to 70 percent of a dose of cadmium instilled in rat lungs has been reported to be absorbed. No direct measurements of alveolar absorption in humans are available, but calculations based on the increased body burden in smokers compared to that in nonsmokers suggest that respiratory absorption in man is probably about 30 to 60 percent. Small quantities of cadmium may also be absorbed through the skin.

Once absorbed, cadmium is widely distributed in the body with the major portion going to the liver and to the renal cortex of the kidney, where it accumulates. Cadmium is not known to undergo any direct metabolic conversions. It does, however, induce increased synthesis of the protein metallothionen, to which it is bound. When present in plasma the cadmium-metallothionen complex is readily diffusible and filterable at the glomerulus and is effectively reabsorbed from the glomerular filtrate. This process effectively prevents efficient excretion of cadmium in the urine and contributes to the accumulation of cadmium in the kidney and liver.

Acute Toxicity

Acute oral exposure to 1,500 to 8,900 mg (20 to 130 mg/kg) cadmium or acute inhalation exposure to 40 to 50 mg/m^3 cadmium for 1 hour or to 9 mg/m^3 cadmium for 5 hours has been reported to cause death in humans High oral exposures result in severe irritation of the GI tract including vomiting, diarrhea and abdominal pain The concentration of cadmium in water that will induce vomiting is approximately 15 mg/L. High inhalation exposures are intensely irritating to respiratory tissues. Typical acute respiratory effects include severe tracheobronchitis (inflammation of the trachea and bronchi), pneumonitis (inflammation of the lung), and pulmonary edema (retention of fluid in the lung).

Acute oral LD_{50} values for cadmium in laboratory animals range from 50 to 350 mg/kg. Acute inhalation LD_{50} values range from 500 to 15,000 mg/m^3-minute

Acute parenteral exposure of male rats to 2.2 mg/kg cadmium has resulted in marked necrosis and atrophy of the testes. Very large acute oral doses (100 mg/kg) have also been reported to cause similar testicular damage. Acute injections of cadmium also result in massive ovarian hemorrhage in female rats given subcutaneous injections of 2.3 to 4.6 mg/kg. Similar effects have been observed in mice. Hemorrhage and necrosis of the placenta of rats has also been observed following subcutaneous injection of 4.5 mg/kg cadmium on days 17 to 21 of gestation.

Target Organ Toxicity

The most commonly observed effects associated with chronic cadmium exposure are related to the accumulation of cadmium in the kidney, which occurs regardless of the route of exposure. It has been estimated that when accumulation of cadmium in the renal cortex reaches 200 μg/L wet weight renal cortex, the types of renal dysfunction described below will result.

Cadmium is unusual in relation to most of the substances for which an oral RfD has been determined in that a vast quantity of both human and animal toxicity data are available The RfD is based on the highest level of cadmium in the human renal cortex not associated with significant proteinuria, which is 200 μg cadmium/gm wet weight human renal cortex. A toxicokinetic model was used to determine the level of chronic oral exposure that would result in

this level of cadmium accumulation in the kidney (USEPA, 1985; cited in ATSDR, 1989). Assuming that 2.5 percent of cadmium in food and 5 percent of cadmium in water is absorbed, and that 0.01 percent of the body burden of cadmium is eliminated each day, the model estimates that a daily dose of 0.005 mg/kg-day cadmium in water, or 0.01 mg/kg-day cadmium in food would result in a concentration of 200 μg Cd/gm wet weight renal cortex. These values are thus considered No Observed Adverse Effect Levels (NOAELs). When these values are adjusted to account for the possibility that some humans may be especially sensitive to cadmium-induced renal disease they become 0.0005 mg/kg-day for water and 0.001 mg/kg-day for food.

The USEPA has derived an oral RfD of 0.0005 mg/kg-day for cadmium in water and 0.001 mg/kg-day for cadmium in food based on the occurrence of proteinuria in humans (IRIS, 2001). The USEPA has not yet derived an inhalation RfC or RfD.

Renal Toxicity. Proximal tubular damage in the kidney as indicated by the presence of $beta_2$-microglobulin (microglobulinuria), lysozyme, ribonuclease, immunoglobulin light chains and retinol-binding protein in the urine occurs in workers exposed to cadmium via inhalation. This may be accompanied by depressed tubular reabsorption of other solutes, as well, such as enzymes, amino acids, glucose, calcium and inorganic phosphate. Microglobulinuria has also been reported in males in cadmium-polluted areas of Japan and Belgium.

These effects typically occur only after relatively long exposures to cadmium, or if cadmium levels have been acutely elevated. Following acute exposures, the relatively slow development of toxicity may represent the time required for cadmium to be redistributed in the body and the time required to reach a critical level in the renal cortex. Several estimates have indicated that chronic exposures to 200 to 352 μg/day (about 0.003 to 0.005 mg/kg-day) cadmium over a period of 45 to 50 years would result in a critical level of cadmium in the renal cortex, and subsequent tubular proteinuria in at least 10 percent of an exposed population. A dose of 50 μg/day (about 0.0007 mg/kg-day) was estimated to cause tubular proteinuria in about 1 percent of an exposed population after 45 years. Via inhalation, it has been estimated that 10 percent of a worker population exposed to a concentration of 50 mg/m^3 would develop proteinuria in 10 years and that 1 percent would be affected at an exposure level of 16 $\mu g/m^3$. Exposures to 2.2 and 0.7

$\mu g/m^3$ cadmium for 50 years would result in similar renal dysfunction in 10 percent and 1 percent of the exposed population, respectively

The renal response to cadmium exposure in laboratory animals appears to be similar to humans. In cadmium exposed rabbits, enzymuria occurred when the cadmium level in renal cortex reached 117 μg/L (dose not provided); aminoaciduria was observed at about 200 μg/L; and, low molecular weight proteinuria occurred when the renal cortex cadmium concentration was about 300 μg/L.

Musculo-Sketetal Toxicity. Painful bone disorders, including osteomalacia (softening of the bones), osteoporosis (bone thinning) and spontaneous bone fracture, have been observed in some humans chronically exposed to high levels of cadmium. These symptoms have been most thoroughly studied in postmenopausal women living in a cadmium-contaminated area in Japan where the affliction is called Itai-Itai disease. Osteomalacia has also been observed in some occupationally exposed workers. These effects on bone are generally considered to be indirect, arising as a consequence of cadmium-induced renal disease. (It should be noted that the role of cadmium as a direct cause of Itai-Itai disease is disputed. Some investigators argue that a nutritional deficiency plays the most important role and that cadmium exposure may simply enhance the incidence or severity of the disease through its effects on the kidney.)

Hematotoxicity. Some other effects reported to be associated with chronic occupational cadmium exposure are lowered hemoglobin concentrations and decreased packed cell volumes, and malabsorption of iron and various other solutes. Dyspnea (difficult breathing), emphysema, decreased forced vital capacity, and increased mortality from respiratory disease have also been reported among populations chronically exposed to cadmium via inhalation. A positive correlation between increased mean renal cadmium concentrations in humans and the incidence of death from hypertensive disease has been reported by several laboratories. However, the incidence of hypertension is not known to be increased in human populations known to have been exposed to cadmium. A link between cadmium and hypertensive disease is therefore not certain.

Long-term oral cadmium administration has also been associated with anemia in mice and rats, and with increased passive avoidance behavior and neurobehavioral changes in rats.

Hepatotoxicity. Chronic oral exposure of rabbits to about 13 μg/kg/day cadmium in their drinking water, and of rats to 17 mg/L cadmium has been associated with structural changes in the liver. Changes in carbohydrate and ATP metabolism in the livers of rats have been reported following exposure to 25 ppm cadmium in their food.

Cardiotoxicity. A number of studies indicate that function of both the heart and the vascular system of laboratory animals may be impaired by cadmium exposure. Characteristic effects in the heart include decreased speed and strength of contractions. The effects in vascular smooth muscle may be either vasodilation or vasoconstriction, depending on conditions. Chronic exposure of rats to about 0.5 mg/kg-day cadmium in their drinking water resulted in small but significant increases in average systolic blood pressure. Changes were also observed in electrocardiograms of exposed rats. This hypertensive effect appears to be biphasic, reaching a maximum effect at doses around 0.1 mg/kg-day, but having no effect at exposure levels of 5 to 10 mg/kg-day.

Respiratory System Toxicity. Emphysema in rabbits and pulmonary fibrotic lesions in rats have been observed following chronic inhalation exposure to cadmium. Decreased calcium content in bone accompanied by marked rental tubular injury and increased urinary excretion of calcium have also been reported to follow chronic cadmium exposure of rats via inhalation.

Immunotoxicity. Relatively low doses of cadmium have been reported to alter the immune response in experimental animals. For example, decreased levels of spleen plaque-forming cells have been observed in mice exposed to 0.6 mg/kg-day for 10 weeks. Mice exposed to 5 to 50 mg/L cadmium in drinking water for 3 weeks exhibited immune suppression. Cadmium concentrations in the renal cortex of affected mice in these experiments was only 0.3 to 6.0 μg/L, which is considerably lower than the suggested critical level of cadmium in human renal cortex (200 μg/L) associated with toxicity.

Developmental and Reproductive Toxicity

As noted above acute parenteral exposure of rats to 2.2 mg/g or acute exposure to high oral doses, results in marked necrosis and atrophy of the testes. Single injections of 2.3 to 4.3 mg/kg cadmium to female rats or mice causes massive ovarian hemorrhage. Other reproductive effects include severely depressed testosterone levels and no viable sperm in male rats injected with doses of 1.8 mg/kg of cadmium chloride 14 days previously. Similarly, a marked reduction in sperm count of male rats injected with 1 mg/kg of cadmium chloride 15 days previously has been reported, although no decrease in fertility was observed until the dose reached 5 mg/kg.

Single injections (intravenous or subcutaneous) of high doses of cadmium during gestation result in teratogenicity and increased fetal mortality in hamsters (effective dose: 2 mg/kg) and mice (effective dose: 0.63 mg/kg). When exposure is via ingestion (about 10 to 15 mg/kg-day) the most common finding is decreased weight of offspring, usually without significant teratogenic or developmental effects. Congenital tail malformation was observed in a three generation study of rats exposed to 10 mg/L of cadmium chloride in drinking water (about 1 mg/kg-day) and sirenomelia (fused legs) was observed in offspring of rats dosed by gavage with cadmium chloride (40 mg/kg) on days 7 to 16 of gestation. Impaired neurobehavioral development in rats has been reported following exposure of female rats via gavage (0.4 or 4.0 mg/kg, given for 5 weeks preceding and continuing through gestation), via drinking water (60 mg/L given during gestation), or via inhalation (0.02 or 0.16 mg/m^3, for 5 months preceding and continuing through gestation.

Exposure to airborne concentrations of 0.2 to 0.6 mg/m^3 during gestation results in a reduction of both maternal and fetal weight gain but no significant teratogenicity. Similarly, decreased pup weight and elevated perinatal mortality was observed in rats exposed to cadmium by inhalation to 3 mg/m^3, but no teratogenic or developmental effects were noted.

It should be noted that cadmium has not been observed to cause teratogenic or other developmental or reproductive effects in exposed humans.

Genotoxicity

Available data suggest that cadmium is mutagenic in mammalian cell culture assay systems. It is also mutagenic in both the mouse lymphoma assay and the Chinese hamster cell assay.

Conflicting results have been reported for chromosomal aberration studies using human lymphocytes from exposed workers, and using human and animal cell lines treated with cadmium in vitro. Chromosomal aberrations have been reported in hamster cells treated with cadmium sulfate or cadmium chloride and in human lymphocytes treated with cadmium acetate and cadmium sulfide. However, human lymphocytes treated with cadmium chloride in vitro showed no chromosomal aberrations. Lymphocytes taken from humans with above average cadmium exposure have produced both positive and negative responses.

Carcinogenicity

Epidemiological studies in humans exposed to cadmium provide limited evidence that inhaled cadmium is a human lung carcinogen. Thun et al. (1985; cited in ATSDR, 1989) reported that mortality from respiratory cancer tended to increase in a dose-dependent fashion in workers with cumulative levels of less than 585, between 585 -2,920 and greater than 2,920 mg cadmium/m^3-days, although the increase was statistically significant only in the high dose group. These exposures correspond to time-weighted daily average levels of 168, 727 and 2,522 $\mu g/m^3$ cadmium, respectively. This observation is complicated by the fact that workers may have been exposed to other carcinogenic chemicals, including arsenic; and, exposure levels to both cadmium and arsenic were higher in previous years than in more recent years. Although some researchers have concluded that the observed excess in lung cancer is more likely to be due to arsenic than cadmium exposure (White 1985, Lamm 1987 cited in ATSDR, 1989), Thun et al. (1985) considered possible confounding by arsenic and concluded that arsenic exposure could not explain the observed excess in lung cancer.

An excess lung cancer risk has also been observed in three other studies but the EPA has concluded interpretation of the results of these studies is compromised by the presence of other carcinogens (arsenic, smoking) in the exposure, or by a small study population (Varner 1983; Sorahan and Waterhouse 1983; Armstrong and Kazantzis, 1983 cited in ATSDR, 1989).

Four studies of workers exposed to cadmium dust or fumes have provided evidence of a statistically significant association with prostate cancer (Kipling and Waterhouse, 1967; Lemen et al., 1976; Holden, 1980; Sorahan and Waterhouse, 1983 cited in ATSDR, 1989), but the total number of cases was small in each study.

Studies in animals have demonstrated that chronic inhalation exposure to cadmium chloride is associated with increased frequency of lung tumors. Takenaka et al. (1983 cited in ATSDR, 1989) exposed rats to aerosols of cadmium chloride at concentrations of 0, 12.5, 25 or 50 $\mu g/m^3$ for 18 months and observed a dose related increase in primary lung carcinoma frequency of 0, 15, 53 and 71 percent respectively. Mammary tumors in female rats, and tumors at multiple sites in male rats have been reported to follow intrathecal instillation of cadmium oxide (Sanders and Mahaffey, 1984 cited in ATSDR, 1989).

The USEPA has calculated unit risk values of lung cancer associated with lifetime exposure to a concentration of 1 $\mu g/m^3$ from both animal data (Takenaka et al., 1983 cited in ATSDR, 1989) and human data (Thun et al., 1985 cited in ATSDR, 1989). The resulting unit risk values based on animal and human data are 9.2×10^{-2} and 1.8×10^{-3} respectively. The California EPA (Cal EPA) has established an inhalation slope factor of 1.5×10^{1} $(mg/kg\text{-}day)^{-1}$ (Cal EPA, 1992). A unit risk of 1.8×10^{-3} $(ug/m^3)^{-1}$ has also been published by the USEPA (IRIS, 2001), with a corresponding inhalation slope factor of 6.3 $(mg/kg\text{-}day)^{-1}$.

There is no evidence to suggest cadmium is carcinogenic to either animals or humans via oral exposure.

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CHROMIUM

(CAS RN [Cr^3] 16065-83-1; [Cr^6] 18540-29-9)

Chromium III, or +3, is a naturally occurring element found in soil, volcanic dust, and gases. It is considered to be an essential nutrient involved in the maintenance of normal glucose metabolism, cholesterol, and fat in humans. A minimum human daily ingestion of 50 to 100 μ g/day (0.0007 to 0.003 mg/kg/day) has been estimated to be safe and adequate. The only toxic effect associated with chromium III reported to occur in humans is sensitization (an allergic reaction) following occupational dermal exposure.

Most known toxic effects of chromium have been attributed to chromium VI, or +6, which is not naturally occurring. It is produced and released to the environment primarily as a result of industrial processes involving the use of chromium containing pigments, in metal finishing and in wood treatment. Chromium 0, or metallic chromium, is less prevalent in the environment than either III or VI and is not well characterized in terms of levels of exposure or potential health effects.

Chromium has been known to enter the environment as a result of chromium hide processing. In this process, large amounts of chromium oxide (Cr_2O_3) and chromium sulfate ($Cr2(S04))^3$ are used, discharged into the wastewater, and subsequently enter any existing surface impoundments.

Absorption/Distribution/Metabolism/Excretion

Absorption of chromium from the GI tract is relatively low and depends on its valence state. Less than 1 and 11 percent of oral doses of chromium III and VI, respectively, are absorbed by humans. GI absorption in animals appears to be slightly higher. Values of up to 3 percent for chromium III and up to 25 percent for chromium VI have been reported. Occupational studies demonstrating chromium in urine, serum, and blood cells indicate that both chromium III and VI are absorbed through the lungs in humans, although the percentage absorbed is unknown. Animal studies indicate that 5 to 30 percent of administered chromium III is absorbed through the lungs, while 53 to 85 percent of administered chromium VI is. Chromium VI and III are only minimally absorbed through either animal or human skin.

Following absorption, chromium is distributed primarily to lungs and kidneys with additional distribution to the liver, bladder, spleen, bone and heart. Chromium III is excreted in the urine. Chromium VI appears to be readily reduced to Chromium III in the liver and lung and then excreted in the urine. There is no indication that significant oxidation of chromium III to chromium VI occurs in vivo.

Acute Toxicity

Chromium VI is irritating, and short-term high level exposure can result in adverse effects at the site of contact such as: ulcers of the skin following dermal contact, irritation of the nasal mucosa and perforation of the nasal septum following inhalation of 0.01 to 0.024 mg/m^3 chromium VI; and, irritation of the GI tract following ingestion. Acute oral exposure to about 2 g chromate (chromium VI) has been reported to result in tubular necrosis (cell death) of the kidney, diffuse necrosis in the liver and subsequent death. Acute oral exposure to 5 g or more of chromate compounds results in GI bleeding, and massive fluid loss prior to death as a result of cardiovascular shock

Acute dermal exposure to high levels of chromium VI through the application of antiscabies ointment has also been reported to result in renal tubular necrosis with subsequent uremia (presence of urinary constituents in blood resulting from decreased urination). At lower concentrations, chromium VI compounds are sensitizers and commonly cause allergic dermatitis in printers, cement workers, metal factory workers, painters and leather tanners.

The most commonly observed adverse effects associated with intermediate or chronic exposure to chromium VI in humans occur via inhalation. Ulcerated or perforated nasal mucosa occurs in workers exposed to chromium VI at concentrations ranging from 0.06 to 0.72 mg/m^3. Slight, transient decreases in lung function have also been observed in chrome plating workers exposed to 2 to 20 $\mu g/m^3$ chromic (VI) acid for about 2.5 years (median). Nasal ulcerations and perforations were also observed in these workers. Occupational exposures to an average of 6 $\mu g/m^3$ chromium VI have resulted in renal tubular damage as indicated by increased beta2-microglobulin excretion in the urine. (This is a small molecule normally reabsorbed in the proximal renal tubules of the kidneys.)

Long-term exposure of workers to airborne chromium has also been associated with lung cancer. Although it is not clear which form of chromium is responsible for this effect, only compounds of chromium VI have been found to cause cancer in animal studies. Thus, the EPA considers chromium VI to be a known human carcinogen when inhaled, as described below

Chronic dermal exposure of humans to either chromium III or chromium VI can result in sensitization; however, reactions to chromium VI are more common. Inhalation exposure of workers to chromium compounds may also result in sensitization. Because the development of hypersensitivity is highly variable between individuals, it has not been possible to estimate a minimal effective dose for this effect.

Target Organ Toxicity

In rats the oral LD_{50} for chromium ranges from 17 to 22 mg/kg for chromium VI and from 422 to 2,369 mg/kg for chromium III. Toxic effects prior to death include pulmonary distension, fluid distension of the GI tract, erosion and discoloration of the GI mucosa, cyanosis, and gastric ulcers. In rabbits a dermal LD_{50} for chromium VI ranging from 397 to 677 mg/kg has been reported. Signs of toxicity included dermal necrosis, and corrosion, diarrhea and dermal edema and erythema. Acute dermal exposures have also been shown to result in sensitization in guinea pigs. The LC_{50} (concentration in air resulting in death is 50 percent of exposed animals) in rats for chromium VI is 33 to 65 mg/m^3 Signs of toxicity prior to death are respiratory distress and irritation.

Inhalation exposure to either chromium VI or III compounds at concentrations of 0.2 to 0.9 mg/m^3 has been reported to result in depression of some indices of immune system function in rats or rabbits (e.g., inhibition of macrophage phagocytic activity), whereas exposure to chromium VI at concentrations less than or equal to 0.1 mg/m^3 chromium results in immune system stimulation (e.g., increased phagocytic activity of macrophages).

Chromium VI is a respiratory tract irritant in animals at higher levels of exposure When inhaled, it results in nasal perforation and granulomata (tumors) of the lungs in rabbits, rats, and guinea pigs exposed to 3 to 4 mg/m^3 CrO_3 (about 4 mg/m^3 chromium VI) 5 hours/day, 4

days/week for a lifetime. Necrosis, atrophy (a wasting away) and hyperplasia of the bronchial epithelium, and alveolar proteinosis (accumulation of protein) have been observed in mice exposed to 13 mg/m^3 $CaCrO_4$ (about 4 mg/m^3 chromium VI) 5 hours/day, 5 days/week for 6 months to life

Other studies in animals have demonstrated that: (1) hypoactivity occurs in rats provided drinking water with 0.7 g/L chromium VI for 28 days; (2) kidney damage occurs in rats treated subcutaneously with 20 mg/kg chromium VI or intraperitoneally with 2 mg/kg chromium VI or III; and (3) hepatic damage occurs in rabbits and rats treated intraperitoneally with 2 mg/kg/day chromium III or VI.

The highest no-observed-adverse-effect-level (NOAEL) following oral exposure to chromium VI is 25 mg/L (ppm) drinking water (equivalent to 2.5 mg/kg/day) in rats (Mackenzie et al., 1958). In this study, groups of 21 rats were dosed with potassium chromate (K_2CrO_4) in the drinking water for 1 year and examined for body weights, clinical blood chemistry, and gross and microscopic pathology. No effect of treatment on these parameters was observed. The 2.5 mg/kg-day dose is the basis for a chronic oral RfD for chromium VI as calculated by the USEPA (IRIS, 2001). When this value is adjusted to account for the possibilities that: 1) humans may be more sensitive than rats to the toxic effects of chromium; 2) some members of the human population may be especially susceptible to the toxic effects of chromium; and, 3) toxic effects may result from a lower dose of chromium if it were administered for a lifetime, it becomes 3.0 x 10^{-3} (mg/kg-day), which is the oral RfD for chromium VI (IRIS, 2001). The UF of 300 is included due to the following: a factor of 10 for interhuman variability, a factor of 10 for interspecies variability, and a factor of 3 to compensate for the less-than-lifetime exposure duration of the principal study.

The USEPA considers that confidence in this RfD is low because the critical study used only 21 exposed rats and examined only a small number of parameters. Moreover, no dose demonstrating certain toxicity was observed in this study or in any other studies. It is possible that other toxic effects could have occurred but remained unobserved; or, that even higher doses could have been administered without resulting in adverse effects. Other studies reviewed by the

EPA indicating a dose-response relationship are also of low quality. Finally, possible teratogenic or reproductive effects of oral exposure to chromium VI have not been evaluated.

The highest NOAEL following oral exposure to chromium III is 1,468 mg/kg/day. Groups of 60 male and female rats exposed to this dose for 2 years exhibited no effects on survival, body weight, blood, and urine clinical chemistry values, or on gross and microscopic appearance of organs and tissues (Ivankovic and Preussmann, 1975). This dose is the basis for the chronic oral RfD for chromium III as calculated by EPA (IRIS, 2000). When this value is adjusted to account for the possibilities that: 1) humans may be more sensitive than rats to the toxic effects of chromium; 2) some members of the human population may be especially susceptible to the toxic effects of chromium; and, 3) the critical study failed to identify adverse effects that were actually present, it becomes 1.5 mg/kg-day, which is the oral RfD for chromium III. The UF of 100 associated with this value is based on a factor of 10 each for interhuman and interspecies variability.

The USEPA considers that confidence in this RfD is low because explicit detail on study protocol and results in the critical study were not provided; and, because no dose demonstrating toxicity was observed in this or in any other studies. The true NOAEL could therefore be considerably higher than that observed in the critical study.

Developmental and Reproductive Toxicity

Increased fetal death and an increase in external abnormalities were observed in hamsters treated by intravenous injection with CrO_3 (chromium VI) on a single day of gestation. Fetal weight depression and an increase in external abnormalities has been reported in mice treated intraperitoneally with 15.24 mg/kg CrO_3 chromium III on gestation day 8.

Adverse reproductive effects have been reported in mice given a single intraperitoneal injection of 20 mg/kg potassium dichromate (chromium VI) or 21 injections of 2 mg/kg potassium dichromate. Testicular effects have been reported in rabbits injected intraperitoneally with 2 mg/kg/day chromium III nitrate or potassium dichromate VI for 3 to 6 weeks.

Genotoxicity

Chromosomal aberrations have been demonstrated in blood lymphocytes of some workers exposed to chromium VI but not in others. Tests of chromium VI for gene mutation, chromosome aberrations, and cell transformation in in vitro nonhuman assays have been consistently positive. Results are consistently negative for chromium III except at very high concentrations or in cells with phagocytic activity. Chromium VI is therefore considered to be a more active genotoxin than chromium III.

Carcinogenicity

Epidemiologic studies of chromate production facilities in the United States (Machle and Gregorius, 1948; Brinton et al., 1952; Mancuso and Hueper, 1951; Mancuso, 1975; Baetjer, 1950; Taylor, 1966; Enterline, 1974; Hayes et al., 1979; Hill and Ferguson, 1979), Great Britain (Bidstrup, 1951; Bidstrup and Case, 1956; Alderson et al , 1981), Japan (Watanabe and Fukuchi, 1975; Ohsaki et al., 1978; Sano and Mitohara, 1978; Satoh et al., 1981), and West Germany (Korallus et al., 1982; Bittersohl, 1971) have established an association between chromium exposure and lung cancer. Studies of workers in the chrome pigment industry have also found an association between occupational chromium exposure (predominantly chromium VI) and lung cancer (Langard and Norseth, 1975; Davies 1978, 1979; Frentzel-Beyme, 1983).

Animal studies support the notion that chromium VI (and not chromium III) is a carcinogen. An increase in lung tumors in mice exposed to 13 mg/m^3 calcium chromate (4.3 mg/m^3 chromium VI) 5 hrs/day, 5 days/week for life and in rats exposed to sodium dichromate (0.1 mg/m^3 chromium VI) continuously for 18 months has been reported (Nettesheim et al. 1971, Glaser et al. 1986). Cancer has also resulted when chromium VI is instilled or implanted into the lungs of rats (Steinhoff et al. 1986 a, b; Laskin et al 1970; Levy and Martin 1983; Levy et al. 1986, Levy and Venitt, 1975). Cancer has also resulted in a variety of tumors in laboratory tests when chromium VI was injected at sites other than lungs (IRIS, 2001). Exposure of laboratory animals to chromium III or chromium (0) metal has not resulted in cancer.

The USEPA has classified chromium VI as a Class A, known human carcinogen, by inhalation The key epidemiological study used for quantitative risk assessment is by Mancuso (1975), who

found a dose-related increase in lung cancer death rates in chromate production workers exposed to chromium at 1 to 8 mg/m^3-year total chromium. Using these data and a dose-response model that is linear at low doses, USEPA derived a unit risk estimate of 1.2E-02 $(ug/m^3)^{-1}$ for exposure to air containing 1 $\mu g/m^3$ chromium VI (IRIS 2001). This value results in an inhalation slope factor of 2.9×10^2 $(mg/kg\text{-}day)^{-1}$.

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COBALT

(CAS RN 7440-48-4)

Cobalt is essential as a component of vitamin B_{12} required for the production of red blood cells and prevention of pernicious anemia. Cobalt is a relatively rare metal produced as a byproduct or coproduct of the refining of other mined metals such as copper and nickel. It is used in high-temperature alloys and in permanent magnets. Its salts are useful in paint driers, as catalysts, and in the production of numerous pigments (Goyer, 1986).

Inhalation is a potential route of exposure occurring most commonly when material containing cobalt powders are handled manually, or where cobalt materials are subjected to grinding. Dermal exposure to cobalt can occur in any operation where these materials are handled manually, or where solutions containing cobalt are present.

Absorption/Distribution/Metabolism/Excretion

In a study using radioactive cobalt administered orally or intravenously it was found that cobalt does not accumulate in tissues, suggesting that absorption and retention is poor (Browning, 1969, as cited in HSDB, 2001). Cobalt is stored in intestinal mucosa and subsequently lost through normal desquamation of epithelium (Venugopal, 1978; cited in HSDB, 2001).

Acute Toxicity

Acute, high oral or parenteral doses of cobalt in humans and animals induced myocardial degeneration, often leading to mortality, erythropoiesis, enlarged thyroid, and in animals, renal tubular degeneration (Elinder and Friberg, 1986). Chronic ingestion from the consumption of beer containing high concentrations of cobalt has been associated with a condition called "beer-drinkers cardiomyopathy," which includes polycythemia, goiter, and marked myocardial degeneration and mortality. The therapeutic use of 0.16 to 0.32 mg/kg-day Co in anemic anephric dialysis patients for 12 to 32 weeks induced a significant but reversible rise in blood hemoglobin (HEAST, 1995).

Occupational (inhalation and dermal) exposure has been associated with allergic dermatitis, chronic interstitial pneumonitis, reversibly impaired lung function, occupational asthma, and myocardial effects (Goyer, 1986). Cobalt has been determined to be the etiologic factor in hard metal disease, the syndrome of respiratory symptoms and pneumoconiosis associated with inhalation exposure to dusts containing tungsten carbide with cobalt powder as a binder (Elinder and Friberg, 1986). The lowest occupational air concentration of cobalt associated with hard metal disease was 0.003 Co/m^3 (Sprince et al., 1988). It should be noted that the workers were also exposed to tungsten and sometimes to titanium, tantalum, and niobium (Elinder and Friberg, 1986). Similar lung effects have been seen in animals exposed to cobalt by inhalation.

Target Organ Toxicity

Important target organs in orally exposed humans are the heart, erythrocyte, and thyroid. Target organs for occupational exposure are the skin, lungs, and heart. The National Center for Environmental Assessment (NCEA) has established an oral reference dose (RfD) of 6.0×10^{-2} mg/kg-day for cobalt.

Carcinogenicity

No studies were located regarding the carcinogenicity of cobalt in humans.

Single and repeated subcutaneous or intramuscular injection of cobalt powder and salts to rats may cause sarcomas at the site of injection (Gilman, 1962, cited in Casarett and Doull, 1986; Venupogal, 1978, Friberg 1986, and Seiler 1988; cited in HSDB, 2001). It must be noted that there is little evidence of carcinogenicity from any other route of exposure.

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COPPER

(CAS RN 7440-50-8)

Copper is a reddish metal that occurs naturally in rock, soil, water, sediment, and air. Its average concentration in the earthís crust is about 50 parts per million. It is insoluble in hot and cold water but soluble in nitric acid or hot sulfuric acid (Weast, 1983; as cited in HSDB, 2001). Copper also occurs naturally in plants and animals. It is an essential element for all known living organisms including humans and other animals (ATSDR, 1990). Copper can be easily molded or shaped. Its reddish color is most commonly seen in the United States penny, electrical wiring, and some water pipes (ATSDR, 1990). Copper is used as a metal for electrical and electronic products (e.g., wire), building construction (e.g., plumbing pipes), industrial machinery, and equipment. In the transportation industry it is used in automobiles (HSDB, 2001). Copper has a boiling point of 2595°C, and a melting point of 1083°C (The Merck Index, 1983; cited in HSDB, 2001).

Absorption/Distribution/Metabolism/Excretion

Copper oxide was observed in alveolar capillaries three hours after rats were exposed to a welding dust aerosol generated from pure copper wires (Batsura, 1969; cited in ATSDR, 1990). Copper is absorbed in the stomach and small intestine. The site of maximal copper absorption is not known for humans, but it is assumed to be the stomach and upper intestine because of the rapid appearance of ^{64}Cu in the plasma after oral administration (Bearn and Kunkel, 1955; cited in ATSDR, 1990)

Copper is absorbed from the GI tract as ionic copper, or is bound to amino acids (Crampton et al., 1965; cited in ATSDR, 1990). Numerous factors may affect copper absorption. These factors include: (1) competition with other metals, including zinc and cadmium (Davies and Campbell, 1977; cited in ATSDR, 1990); (2) the amount of copper in the stomach (Farrer and Mistilis, 1967; cited in ATSDR, 1990); (3) certain dietary components; and (4) form of copper. The absorption of copper appears to be inversely related to the amount of copper in the GI tract (Strickland et al., 1972; cited in ATSDR, 1990).

Absorbed copper loosely binds to plasma albumin and amino acids in the portal blood, and is taken to the liver (Marceau et al., 1970; cited in ATSDR, 1990). In the liver, copper is incorporated into ceruloplasmin and released into the plasma. Radioactive copper does not accumulate in extrahepatic organs until after the emergence of ceruloplasmin-^{64}Cu, suggesting that ceruloplasmin is a copper donor for the tissues (Owen, 1965; cited in ATSDR, 1990).

The metabolism of copper consists mainly of its transfer to and from various organic ligands, most notably sulfhydryls and imidazole groups on amino acids and proteins. Several specific binding proteins for copper have been identified that are important in the uptake, storage, and release of copper from tissues. In the liver and other tissues, copper is stored bound to metallothionein and amino acids and in association with copper-dependent enzymes. Several studies have shown that copper exposure induces metallothionein synthesis (Mercer et al., 1981; cited in ATSDR, 1990).

Bile is the major pathway for the excretion of copper. After the oral administration of radioactive copper as copper acetate in healthy humans, 72% was excreted in the feces (Bush et al., 1955; cited in ATSDR, 1990). Normally, 0.5 - 3.0 percent of daily copper intake is excreted into the urine (Cartwright and Wintrobe, 1964; cited in ATSDR, 1990). Biliary excretion of copper does not increase proportionally with dosage, suggesting that the hepatobiliary transport of copper is saturable (Gregus and Klaassen, 1986; cited in ATSDR, 1990). Thus, at high copper intakes, urinary copper excretion increases (Gitlan et al., 1960; cited in ATSDR, 1990).

Acute Toxicity

The only significant example of copper toxicity in humans is Wilsonís disease (Hepatolenticular degeneration), an autosomal recessive disorder that affects normal copper homeostasis. The disease is characterized by excessive retention of hepatic copper, decreased concentration of plasma ceruloplasmin, impaired biliary copper excretion, and hypercupruria. The systemic manifestations of Wilsonís disease are hepatic and renal lesions and hemolytic anemia (Schroeder et al., 1966; cited in ATSDR, 1990).

There are several reports of humans dying as a result of copper poisoning. Most of these involve the ingestion of large amounts of copper. Chuttani et al. (1965; cited in ATSDR, 1990) attributed these deaths to extensive hepatic centrilobular necrosis. Deaths in animals given >250 mg Cu/kg/day in the diet have also been attributed to extensive hepatic centrilobular necrosis.

Target Organ Toxicity

The primary toxicological effects of consuming high levels of copper in humans is GI irritation, manifested as vomiting, nausea, diarrhea, and anorexia. Centrilobular necrosis of the liver and necrosis and sloughing of tubular cells in the kidney have been observed in individuals dying from copper poisoning (Chuttani et al., 1965; cited in ATSDR, 1990).

The USEPA has listed a drinking water standard for copper of 1.3 mg/L (HEAST, 1997) from which an oral RfD of 3.7 x 10^{-2} mg/kg-day can be derived.

Immunological Effects. Dermal exposure to copper results in contact allergic dermatitis in some individuals (Barranco, 1972; cited in ATSDR, 1990). Inhalation studies in mice confirm the finding of impaired immune function after exposure to copper (Drummond et al., 1986; cited in ATSDR, 1990).

Neurological Effects. Neurological effects have not been observed in healthy humans exposed to high levels of copper in drinking water. However, a clinical manifestation of Wilson's disease is CNS degenerative changes. Symptoms include poor coordination, psychological impairment, tremor, disturbed gait, and rigidity (Strickland and Leu, 1975; cited in ATSDR, 1990). Although neurotoxicity has not been observed in animals exposed to high levels of copper, increased concentration of copper in the brain has been observed in rats given high levels of copper orally or intraperitoneally (DeVries et al., 1986; cited in ATSDR, 1990).

Developmental Toxicity

Increased fetal mortality and developmental abnormalities have been observed in mice, mink, and hamsters either injected with copper or fed a diet high in copper (Aulerich et al., 1982; cited in ATSDR, 1990). Developmental effects have been observed in minks administered doses 50 times lower than those given to mice and hamsters. Furthermore, distinct developmental effects in minks have resulted from dietary levels of copper that were well below the levels that would have been expected to cause maternal toxicity. Although developmental effects have not been reported in humans, there is a possibility that there may be an increased incidence of spontaneous abortion and miscarriage in women exposed to high levels of copper (ATSDR, 1990).

Reproductive Toxicity

Although reproductive performance was not adversely affected in minks fed a diet high in copper (Aulerich et al., 1982; cited in ATSDR, 1990), the insertion of copper wires into the vas deferens or uterus prior to conception or at gestational day 3 resulted in decreased fertility or decreased number of implantation sites in monkeys, rats, hamsters, and rabbits (Chang and Tatum, 1970; cited in ATSDR, 1990).

Genotoxicity

Several in vitro studies have examined genotoxic effects of copper in nonhuman systems. The results of tests using prokaryotic organisms are equivocal. However, positive results have been observed in vitro and in vivo in mammalian systems. At low levels (0.01 - 0.1 mM Cu as copper sulfate), DNA strand breaks were not observed in rat hepatocytes; however strand breaks did occur at high concentrations (0.04 mM Cu as copper sulfate) (Sina et al., 1983, as cited in ATSDR, 1990). Although there are no data on the mutagenicity of copper in humans, in vivo studies and mammalian system in vitro studies suggest that copper is a potential human mutagen.

Carcinogenicity

An elevated incidence of cancer has not been observed in humans or animals exposed to copper via inhalation, oral, or dermal routes of exposure. The USEPA classifies copper as a Class D carcinogen (not classified) based on the fact that there are no human data, inadequate animal data from assays of copper compounds, and equivocal mutagenicity data (IRIS, 2001).

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LEAD

(CAS RN 7439-92-1)

Lead is a naturally occurring bluish-grey metal found in small amounts in the earth's crust. It is found in plants and animals, air, drinking water, rivers, lakes, oceans, dust, and soil. Lead remains in soil for many years. Mixed ores or recycled scrap are the source of lead to industry. Its main use is in the manufacture of storage batteries followed by production of chemicals including paints, gasoline additives, various metal products, and ammunition.

The largest source of lead in air is from vehicle exhaust. Other sources include emissions from iron and steel production, smelting operations, municipal waste incinerators, and lead-acid-battery manufacturers. Lead is also present in tobacco smoke. The main sources of lead released to water are lead plumbing and solder in buildings; lead-containing dust and soil carried into water by rain and wind; and wastewater from industries using lead.

Exposure to lead may occur via breathing air, drinking water, and eating soil or foods that contain lead. Another source, for children, is from swallowing non-food items such as chips of lead-containing paint (i.e., pica).

Absorption/Distribution/Metabolism/Excretion

The rate and degree of lead absorption are largely related to its solubility in body tissues and fluids, among other factors. Upon inhalation, some fraction of inhaled airborne and orally ingested lead is deposited in the respiratory tract. The rate of deposition in adult humans is approximately 30 percent to 50 percent. Upon deposition in the lower respiratory tract, all chemical forms of lead are almost completely absorbed. Approximately 20 percent of inhaled lead was absorbed within 1 hour, and 70 percent was absorbed within 10 hours in humans breathing lead-containing engine exhausts or lead oxide and lead nitrate aerosols at 2 to 10 $\mu g/m^3$ lead (Chamberlain et al., 1978; cited in ATSDR, 1986). Inhaled lead is absorbed extensively and rapidly in animals as well. Morgan and Holmes (1978; cited in ATSDR, 1986) estimated absorption rates of 50 percent within 1 hour and 98 percent within 7 days in adult rats breathing the equivalent of 6 mg/m^3 lead.

The primary site of lead absorption in children is the GI tract (approximately 50 percent) upon oral exposure, compared to 8 percent in adults (Hammond, 1982; cited in ATSDR, 1986) or 15 percent (Chamberlain et al., 1978; cited in ATSDR, 1986). Absorption may be as high as 45 percent in fasting adults (Chamberlain et al., 1978; cited in ATSDR, 1986). GI absorption in children (from nonfood sources) is estimated to be approximately 30 percent from dirt/dust and 17 percent from paint chips (Drill et al., 1979; cited in ATSDR, 1986). Absorption values are similar in animals (i.e., 1 percent to 15 percent in adults). The extent of GI absorption is age dependent (i.e., younger animals absorb 40 to 50 times more lead via the diet than do adults). GI absorption is enhanced by milk products, low calcium and vitamin D levels, fasting, or iron deficiencies. Dermal absorption is much less significant due to a greatly reduced dermal absorption rate. In humans, approximately 0 percent to 0.3 percent absorption has been measured (ATSDR, 1986).

Once in the body, lead is dispersed primarily to the bone, blood, and soft tissue pools regardless of the route of absorption. The half-life of lead in blood is approximately 36 days, in soft-tissue is 40 days and in bone is 10^4 days. Greater than 99 percent of blood lead is associated with the red blood cells. Over 50 percent of this blood pool is bound to hemoglobin, with lesser amounts bound to other proteins. Fetal hemoglobin has a greater affinity for lead than does adult hemoglobin. The biological half-life of lead in the blood of 2 year-old children is approximately 10 months.

In human adults approximately 95 percent of the total lead body burden is present in the bones. In children, this value is 73 percent. Bone lead levels increase with age. In most soft tissue, lead does not appear to accumulate as a function of age in humans over 20 years old.

Any dietary lead not absorbed by the GI tract is eliminated in the feces of both humans and animals. Rosen (1985; cited in ATSDR, 1986) demonstrated that 50 percent to 60 percent of the absorbed fraction of lead was excreted on a short-term basis. Chamberlain et al. (1978; cited in ATSDR, 1986) found this half-life to be 19 days. Infants have been shown to retain 34 percent of the total amount of absorbed lead whereas adults demonstrate a 1 percent retention rate. In animals (rats) initial excretion occurs in the urine followed by greater excretion in the feces. In

rats excretion occurs in two phases. The initial phase half-life is 21 hours followed by a slower 280 hour second phase (Morgan et al., 1977; cited in ATSDR, 1986).

Acute Toxicity

Human Toxicity. Mortality for workers was studied by Cooper et al. (1986; cited in ATSDR, 1986) in a cohort study of employees at lead-producing facilities. Two cohorts, all of whom had been employed for at least 1 year during 1946 through 1970 were studied for mortality from 1947 through 1980. Mean blood lead levels were 63 μg/dL for 1,326 of the 4,519 battery workers and 80 μg/dL for 537 of 2,300 lead production workers from 1947 through 1972. The number of observed deaths of both groups was significantly greater (P less than 0.01) than expected. Increased mortality resulted in a large part from malignant neoplasms; chronic renal disease; and "ill-defined" causes

In children, lead intoxication leading to encephalopathy and death may result from oral exposure. The range of blood lead levels associated with encephalopathy is approximately 90 to 700 or 800 μg/dL and the range associated with death is approximately 125 to 750 μg/dL. The mortality rate of untreated lead encephalopathy (a severe neurological effect) in children was estimated by the USEPA to be 65 percent prior to the introduction of chelation therapy. Shortly after therapy is started, mortality decreases for 25 to 33 percent. An absence of signs or symptoms has been observed in some children at blood lead levels of 60 to 300 μg/dL. Acute lead poisoning symptoms other than signs of encephalopathy have been observed at blood lead levels of approximately 60 to 450 μg/dL. Rummo (1974; cited in ATSDR, 1986) and Rummo et al. (1979; cited in ATSDR, 1986) observed hyperactivity and a decrease of 16 IQ points on the McCarthy General Cognitive Index (GCI) among children who previously had encephalopathy and whose mean blood lead levels at the time of encephalopathy were 88 μg/dL.

Lead interferes with heme biosynthesis by altering the activity of several key enzymes. A marked interference results in a reduction of the hemoglobin concentration in blood. Decreased hemoglobin production, coupled with an increase in erythrocyte destruction, results in anemia.

In adults, early symptoms of lead encephalopathy may develop within weeks of initial exposure These symptoms include dullness, irritability, poor attention span, headache, muscular tremor, loss of memory, and hallucinations. The condition may then worsen to delirium, convulsions, paralysis, coma, and death. Severe lead encephalopathy is not observed except at blood lead levels well in excess of 120 μg/dL (Kehoe, 1961a, b, c; cited in ATSDR, 1986). Smith et al. (1938; cited in ATSDR, 1986) suggested that acute lead poisoning in adults can occur at blood lead levels of approximately 100 μg/dL. Increased central and peripheral nervous system and GI symptoms were noted in 25 lead workers with maximum blood lead levels of 50 to 69 μg/dL (Haenninen et al., 1979; cited in ATSDR, 1986). Decreases in nerve conduction velocity have been observed in workers with blood lead levels of 30 to 48 μg/dL (Seppalainen et al., 1983; cited in ATSDR, 1986). Robinson et al (1985; cited in ATSDR, 1986) cited evidence of a lead-related decrease in hearing acuity of children at maximum blood lead levels of 6.2 to 56.0 μg/dL. Lead neuropathy in children may be associated with the incidence of sickle cell disease in children.

Evidence from occupational, clinical, and general population studies indicates that lead affects the cardiovascular system in humans, resulting in cardiac lesions, electrocardiographic abnormalities, and increases in blood pressure. Renal toxicity (early or acute nephropathy) has also been associated with lead exposure but appears to be reversible. Chronic lead nephropathy associated with blood lead levels of 40 to greater than 100 μg/dL is irreversible.

Animal Toxicity. High rates of mortality were observed in rats exposed to tetramethyl lead (organic lead) for 7 h/day, 5 days/week at 63 mg/m^3 for 10 days, 49 mg/m^3 for 18 days, and 22 mg/m^3 for 35 days (Davis et al., 1963; cited in ATSDR, 1986). Several studies in animals also indicate that the effects of lead on heme synthesis occur in many tissues. The formation of heme-containing cytochromes is inhibited in animals treated intraperitoneally or orally with lead compounds. Impairment of heme synthesis results in disruption of a variety of important physiological processes including reduced hemoglobin synthesis, reduction of hemoproteins, renal endocrine effects, and hepatic effects

Studies in animals have shown delays in reflex development in rats during early postnatal life at greater than 59 µg/dL (Kishi et al., 1983; cited in ATSDR, 1986). Decreased visual acuity in young rats have been observed in several studies at mean blood lead levels of 65 µg/dL. Blood lead levels as low as 15 to 20 µg/dL were associated with slower learning and higher rates of inappropriate responses (Cory - Slechta et al., 1985; and Schlipkoter and Winneke, 1980; cited in ATSDR, 1986).

Exposure of male rats had an effect on cardiovascular function at levels of 50 ppm lead. Lead acetate was given in drinking water for 160 days with results of markedly increased blood pressure (182/138) as compared to 129/98 in controls (Iannaccone et al , 1981; cited in ATSDR, 1986). The mean blood lead level in the treated group was 38.4 µg/dL.

Animal studies provide evidence of nephropathy similar to that in humans, particularly after acute exposures. Lead appears to affect vitamin D metabolism in renal tubule cells such that circulating levels of the vitamin D hormone, 1,25 - dihydroxyvitamin D, are reduced (Smith et al., 1981; cited in ATSDR, 1986). High calcium diets protected against this effect. In vitro studies with rat pituitary cells showed that lead inhibited the thyrotropin-releasing hormone (TRH) and stimulated release of thyrotropin-stimulating hormone (TSH) in a dose-related manner (Huseman et al., 1987; cited in ATSDR, 1986). This supports the conclusions drawn from human data.

Developmental and Reproductive Toxicity

The USEPA (IRIS, 2001) has concluded, based on a review of several studies, that a definitive association between prenatal lead exposure in humans and the occurrence of congenital anomalies has not been demonstrated. Various studies have reported decreased birth weights, still births, and placental weight. However, as noted by USEPA (IRIS, 2001), the majority of these studies did not account for possible confounding variables (i.e., socioeconomic status and concurrent exposures). Therefore, the above conclusion has been made. It has been noted, however, that gestational age may be reduced as prenatal lead exposure increases, even at blood lead levels below 15 µg/dL. Several studies have indicated negative correlations between maternal or cord blood lead levels and gestational age.

In one prospective study of the effects of pre- and postnatal lead exposure on child development McMichael et al. (1986; cited in ATSDR, 1986) studied 831 pregnant women and followed 774 pregnancies to completion in a lead smelter town. Blood lead levels were significantly higher in women who lived in the town compared to those residing outside the town (11.2 μg/dL versus 7.5 μg/dL). No association between lead exposure and congenital anomalies was noted when factors such as smoking and alcohol consumption were reviewed. Also observed was a greater incidence of low-birth weight (less than 2,500 g at gestational age greater than or equal to 37 weeks) in the town. More miscarriages and stillbirths occurred in the Port Pirie mothers compared to others. Neurobehavioral development, therefore, appears to be deleteriously affected by prenatal lead exposures. Transplacental transfer of lead in humans has been demonstrated in a number of studies. Fetal uptake of lead occurs by the 12th week of development and increases throughout development (Barltrop, 1969, and Horiuchi et al., 1959; cited in ATSDR, 1986). Highest lead levels were measured in fetal bone, kidney, and liver tissue and lesser amounts in the brain and heart.

Teratogenicity studies in rats and mice provide no evidence that lead compounds (acetate or nitrate) are teratogenic when exposure occurs by natural routes. Intravenous or intraperitoneal injection of lead compounds into pregnant rats, mice or hamsters, however, has produced malformations in several studies. There are indications, as well, that lead accumulates in the placenta in times of fetal stress.

Severe occupational exposure (primarily via inhalation) to lead has been shown to be associated with a high likelihood of spontaneous abortions. The USEPA (IRIS, 2001) has concluded that reproduction effects on the sperm or testes of men chronically exposed at blood lead levels of 40 to 50 μg/dL may occur. Lancranjan et al. (1975; cited in ATSDR, 1986) studied 150 men with long-term lead exposure, categorized as follows: lead-poisoned (mean blood lead level 74.5 μg/dL); moderately poisoned (mean: 52.8 μg/dL); slightly poisoned (mean: 41 μg/dL); or physiologically poisoned (mean: 23 μg/dL). The lead-poisoned and moderately exposed groups had decreases in fertility. The effects were thought to be directly on the testes.

Chowdhury et al. (1984) found testicular atrophy and cellular degeneration in male rats given lead acetate in drinking water at 1 g/L (1,000 ppm) for 60 days. Blood lead levels averaged 142.6 μg/dL.

Genotoxicity

Results of in vitro studies with human lymphocyte cultures performed with lead acetate have been nearly divided between positive and negative. Results of in vivo studies are also contradictory, although the weight of evidence does suggest that lead has an effect on chromosomes. The status of calcium nutrition may be important in the expression of lead-induced clastogenicity in both in vitro and in vivo tests. Studies in mice (DeKnudt and Gerber, 1979; cited in ATSDR, 1986) and monkeys (DeKnudt et al., 1977; cited in ATSDR, 1986) indicated that calcium deficiency may enhance the genotoxicity of lead.

Carcinogenicity

The USEPA (IRIS, 2001) has concluded that current human data are inadequate to refute or demonstrate the potential carcinogenicity of lead exposure to humans. Animal data, however, were deemed sufficient (particularly soluble lead salts).

An extensive series of reports of a large number of workers at six domestic lead production plants (smelter and recycling plants) and ten battery plants exists. Increased incidences of total malignant neoplasms were observed for both categories of lead workers. In a more recent evaluation of a more select subset from the original study increases in total malignancies in both groups of workers attributed to digestive and respiratory cancers was reported (Cooper and Gaffey, 1975, and Cooper, 1976; cited in ATSDR, 1986.

The most comprehensive set of studies of carcinogenicity resulting from oral exposure to lead was performed by Azar et al. (1973; cited in ATSDR, 1986). Lead acetate was given to rats at 0, 10, 50, 100, 500, 1,000, or 2,000 ppm lead in the diet for 2 years. Fifty rats per sex were exposed. After the study was in progress, groups of 20 rats per sex were also fed 0, 1,000 or 2,000 ppm lead in diet. Blood lead levels measured at 24 months were 12.7, 11.0, 18.5, 35.2 and 77.8 μg/dL in the 0-, 10-, 50-, 100-, and 500- ppm groups. Levels of 16.4, 98.6, and 98.4 μg/dL

were observed in the 0-, 1,000-, and 2,000- ppm groups. Renal tumors occurred in 5/50 male rats at 500 ppm, in 10/20 males at 1,000 ppm, and in 16/20 males and 7/20 females at 2,000 ppm.

The USEPA (IRIS, 2001) has classified lead as Class B2, Probable Human Carcinogen However, the agency is currently reviewing both the toxicity and carcinogenicity of lead for further evidence. Cancer slope factors and unit risk factors are not available

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Integrated Risk Information System (IRIS) U.S. Environmental Protection Agency (USEPA). April, 2001.

MANGANESE

(CAS RN 7439-96-5)

Manganese is a naturally occurring substance found in many types of rock. Pure manganese is a silver-colored metal that is not naturally occurring, but occurs combined with other chemicals such as oxygen, sulfur, and chlorine. Some manganese compounds can dissolve in water, and low levels of these compounds are naturally present in lakes, streams, and the ocean. Rocks containing high levels of manganese compounds are mined for use in the production of manganese metal. This metal is mixed with iron to make steel.

Absorption/Distribution/Metabolism/Excretion

A significant fraction of manganese particles inhaled are initially deposited in the lungs and then transported via mucociliary transport to the GI tract. Thus, manganese may be absorbed both in the lungs and the GI tract. The amount absorbed across the human GI tract is typically 3 to 5 percent (Davidsson et al., 1988, 1989; Mena et al., 1969; cited in ATSDR, 1991). Low iron levels apparently lead to increased manganese absorption. GIuptake in animals following oral exposure is similar, with uptake estimated at 2.5 to 5.5 percent in rats (Pollack et al., 1965; cited in ATSDR, 1991). Several studies in animals indicate that GI absorption may vary with age. Rehnberg et al. (1980, 1981; cited in ATSDR, 1991) noted that rats exposed to manganese tetroxide showed larger increases in tissue levels in neonatal rats (ages 1 to 15 days) than in older rats.

In humans, most tissue concentrations of manganese range from 0.1 and 1 μg per gram wet weight, with highest levels observed in the liver, pancreas, and kidneys, and lowest levels in bone and fat (Sumino et al., 1975; Tipton and Cook, 1963; cited in ATSDR, 1991). Levels in animal tissue are similar. Studies in animals indicate that upon oral exposure, an increase in manganese levels was observed in all tissues; however, the magnitude of the increase diminishes over time (Kristensson et al., 1986; Rehnberg et al., 1980, 1981, 1982; cited in ATSDR, 1991)

Excretion of manganese in humans and animals is primarily through the feces. Humans who inhaled manganese as manganese tetroxide or manganese chloride excreted approximately 60

percent of the material deposited in the lungs in the feces within 4 days (Mena et al., 1969; cited in ATSDR, 1991).

Acute Toxicity

Human Toxicity. Inhalation of particulate manganese compounds leads to an inflammatory response in the lungs. Damage to lung tissue is usually not extensive, but may include local areas of edema, fibrosis, or emphysema (Suzuki et al., 1978; Davies, 1946; Shiotsuka, 1984; Zaidi et al., 1973; cited in ATSDR, 1991). Symptoms and signs of lung irritation and injury may include cough, bronchitis, and minor reductions of lung function. The EPA notes that an inflammatory response of this type is not unique to manganese-containing particles, but it is characteristic of nearly all inhalable particulate matter. An increased prevalence of infectious lung disease, pneumonia in particular, has been noted in workers with chronic occupational exposure to manganese dust and in residents near a ferromanganese factory (Davies, 1946; WHO, 1987; cited in ATSDR, 1991).

The USEPA has published an oral RfD of 2.4 x 10^{-2} mg/kg-day for manganese in food (IRIS, 2001). The UF is 1, and the RfD is based on CNS effects from chronic human ingestion. WHO (1973; as cited in ATSDR, 1991) reported no adverse effects in humans upon consumption of 8 to 9 mg Mn/day associated with daily diets. Evaluation of standard diets from the United States, England, and Holland revealed average daily intakes of 2.3 to 8.8 mg Mn/day (Schroeder et al., 1966; as cited in ATSDR, 1991). This study suggested that higher levels may be achieved from a normal diet (especially a vegetarian diet). Schroeder et al. reported a chronic human NOAEL of 11.5 mg Mn/day as safe. And finally, the National Research Council (NRC, 1989; as cited in ATSDR, 1991) determined an "adequate and safe" intake of manganese to be 2 to 5 mg/day for adults.

The USEPA has published an inhalation RfC of 5.0E-05 mg/m^3 (IRIS, 2001) which yields an inhalation RfD of 1.4 x 10^{-5} mg/kg-day for manganese. The RfC is based on impairment of neurobehavioral function and has a UF of 1000. This UF results from a factor of 10 for sensitive individuals; 10 for use of a LOAEL; and 10 for the less-than-chronic periods of exposure, lack of

developmental data, and potential unquantified differences in toxicity of various forms of manganese.

Animal Toxicity. Inhalation of particulate manganese compounds also leads to an inflammatory response in animal lungs. Increased susceptibility to lung infection by bacterial pathogens following inhalation of manganese dusts has been confirmed in several acute animal studies (Adkins et al., 1980; Maigetter et al., 1976; cited in ATSDR, 1991).

Most acute toxicity studies indicate that manganese compounds have low oral acute toxicity. Upon daily oral exposure of 930 mg/kg-day, significant mortality in rats was not observed until after 16 months of exposure (Hejtmancik et al., 1987a; cited in ATSDR, 1991). Chronic exposure of mice to 810 mg/kg-day did not cause increased mortality within 24 months (Hejtmancik et al., 1987b; cited in ATSDR, 1991). Gianutsos and Murray (1982 cited in ATSDR, 1991) administered oral doses of manganese (as manganese chloride) to laboratory animals as high as 2,300 mg/kg-day for six months without observing lethality.

Developmental and Reproductive Toxicity

The effects of manganese on fetal development in humans have not been investigated thoroughly. The incidence of stillbirths and malformations has been studied in an Australian population living on an island where high environmental levels of manganese existed (Kilburn, 1987; cited in ATSDR, 1991). However, because the study population was small and data from a suitable control group was lacking, it is not possible to judge if the incidence of abnormalities was higher than average.

The number of children born to occupationally exposed males may be lower than average (Lauwreys et al., 1985; cited in ATSDR, 1991), and decreased libido and impotence are frequently observed in male workers exposed to high levels of manganese dusts in the work place (Emara et al., 1971; Mena et al., 1967; Rodier, 1955; cited in ATSDR, 1991). Young male rats and mice exposed orally to manganese experienced delayed growth and maturation of the testes and other reproductive tissues (Gray and Laskey, 1980; cited in ATSDR, 1991). Information on reproductive effects in females is very limited. One study indicated, however,

that female rats exposed to manganese oxide by inhalation for 18 weeks had an increased number of pups per litter (ATSDR, 1991)

Genotoxicity

Results of manganese genotoxicity in vitro have been mixed, while those from in vivo tests have been negative. Errors in the fidelity of DNA replication have been noted in vitro as Mn^{+2} can substitute for the magnesium ion (Mg^{+2}) in DNA polymerase (El-Deiry et al., 1984; cited in ATSDR, 1991)

Carcinogenicity

Information on the carcinogenic potential of manganese is limited. The USEPA has designated manganese as a Class D component (IRIS, 2001). In rats, males exposed to 86, 290, or 930 mg/kg-day manganese (as manganese sulfate) had an increased incidence of pancreatic cell adenomas and carcinomas (Hejtmancik et al., 1987a; cited in ATSDR, 1991). However, it should be noted that the incidence was low and was not dose-responsive. It should be noted further that this tumor type only appeared in one female (in the mid-dose group) and that no increases in tumor frequency were detected in other tissues.

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MERCURY

(CAS RN 7439-97-6)

Mercury is a transition metal and, in its elemental state, occurs at room temperature as a liquid. It is commonly produced as a byproduct of gold mining and is produced from mining operations. It is commonly used in thermometers, barometers and other pressure-sensing devices and in electrical components. World production of mercury exceeds 6.5 million kilograms annually.

Adsorption/Distribution/Metabolism/Excretion

Mercury occurs naturally in the environment and is distributed throughout the world. It occurs in three valence states; as a metal and various inorganic and organic complexes. It is discharged into the environment in the form of gaseous emissions, various salts in industrial processes, and is capable of bioaccumulation into terrestrial and aquatic food chains. A saturated atmosphere of elemental mercury can contain up to 18 mg/m^3 and it can exist in the monoatomic state as a vapor. Inorganic mercury (Hg^{+1} and Hg^{+2}) readily forms complexes with organics, especially sulfhydryl groups and can form salts with organic and inorganic acids. Organic mercury consists of primarily methyl, ethyl, phenyl and alkoxyalkyl mercury compounds in the form of organic and inorganic acid salts. The compounds readily bioaccumulate due to their lipophilic nature and can interact with biologically significant ligands. These compounds are capable of passing placental barriers.

Acute Toxicity

Acute human exposure to high concentrations of mercury vapor results in loss of respiratory function and death due to pulmonary tissue necrosis and edema (Teng and Brennan, 1959). Organic mercury exposure involving diethylmercury at concentrations up to 1 mg/m^3 for up to four months resulted in death with major tissue damage being in the gastrointestinal tract. Acute inhalation exposure of mercury vapor and organic mercury to experimental animals results in death due to pulmonary edema.

Inhalation of metallic mercury vapor results in systemic toxicity to humans and experimental animals. The effects are dose related such that at low levels, the central nervous system and

kidney are target organs while at higher doses, the respiratory tract, cardiovascular and gastrointestinal organs are targeted. Respiratory effects in humans and rodents include pulmonary edema, lobar pneumonia, desquamation of bronchiolar epithelium, necrosis and death (Ashe et al., 1953). Cardiovascular effects include initial increase in blood pressure followed by degeneration and myocardial necrosis. Gastrointestinal effects include nausea, vomiting, gingivitis, mercurial stomatitis and necrosis of the intestinal mucosa (Lillis, 1985). Renal effects include proteinuria, hematuria, degeneration of the convoluted tubules and death (Campbell, 1948). Creatine excretion increased in exposed individuals with increasing dose suggesting that this marker might be a useful gauge for the level of mercury exposure (Buch et al., 1980). In rodents, renal tubular epithelium degeneration is noted at moderate doses (3 mg/m^3) (Kishi et al., 1978). Based on these studies, a level of from 1 to 3 mg/m^3 resulted in a lowest-observable-adverse-effects-level (LOAEL).

Target Organ Toxicity

The central nervous system is a major target organ for elemental mercury exposure. Elemental mercury rapidly passes the blood-brain barrier and can exert toxicity based on conversion to inorganic forms and interaction with sulfhydryl groups in the neuronal tissue. Acute exposure results in excitability, tremors, decreased motor and muscular function, headache, visual disturbances, ataxia, dysarthria and, with severe exposure, paralysis and death (Cassarett and Doull, 1986; Hanninen, 1982) Chronic exposure to elemental mercury results in tremors, loss of short-term memory, decreased psychomotor skill and general neurological dysfunction that becomes irreversible after prolonged exposure (Fawer et al., 1983). Elevated urinary excretion of mercury generally correlates with neurological symptoms. Due to the cumulative nature of mercury intoxication, a chronic inhalation MRL of 0.00026 mg/m^3 has been suggested for a long-term exposure level of atmospheric mercury.

Developmental Toxicity

Rodent exposure to metallic mercury results in neurological and behavioral effects similar to those manifested in humans, although rodents appear less sensitive than humans to mercury inhalation (Armstrong, 1963; Ganser and Kirschner, 1985).

Investigations in humans following prenatal exposure to mercury suggests increased spontaneous abortion and menstrual disturbances. Due to the rapid absorption of mercury via inhalation, transfer of mercury from maternal blood to maternal milk can result in neonatal exposure to mercury (Cassarett and Doull, 1986).

Elemental mercury vapor caused increased fetal toxicity in rodents. The number of resorptions and fetal mortality increased with treatment groups. Rats exposed to doses of 0.5 mg/m^3 during days 10 to 15 of gestation resulted in increased resorptions and increased skeletal malformations (Steffek et al., 1987). Based on rodent and human data, mercury exposure during mid to late pregnancy could result in developmental and/or reproductive toxicity.

Genotoxicity

Genotoxic effects of elemental and inorganic mercury via inhalation include elevated chromosomal abnormalities in lymphocytes. Conflicting reports indicate the potential for development of both chromosomal aberrations and aneuploidy in humans. Bone marrow chromosomal aberrations have been demonstrated in mice exposed to organic mercury vapors. Short-term mutagenicity assays in various cultured cells indicate a lack if direct mutagenic activity of mercury or mercury salts.

Carcinogenicity

Based on fairly extensive human epidemiological investigations, there is no correlation between occupational mercury exposure and increased tumor burden. There is no experimental animal data or bioassays that indicated that the various forms of mercury could enhance tumor development in rodents. Based on these data, the U.S. Environmental Protection Agency (USEPA) has classified mercury as a Class D compound and has not developed cancer potency values for mercury (IRIS, 2001).

Chronic Toxicity

Chronic exposure to elemental mercury vapor results in prolonged neurological symptoms which include tremors, loss of memory, decreased psychomotor skill and neurological dysfunction (Fawer et al , 1983) Increased urinary excretion of mercury and the development of proteinuria indicate chronic mercury intoxication as does the elevated creatine excretion (Ganser and Kirschner, 1985). The USEPA (IRIS) database lists a chronic inhalation reference dose (RfC) of 3 0 x 10^{-4} mg/m^3 for elemental mercury. A UF value of 1000 was applied The IRIS database also lists a chronic oral reference dose (RfD) for mercuric chloride ($HgCl_2$) of 3 0 x 10^{-4} mg/kg-day (IRIS, 2001), which is also used as the oral reference dose for 'mercury and compounds' in the USEPA Region 9 PRG tables (USEPA, 2000).

Toxicokinetics

Absorption is high for inhalation of elemental mercury vapor, but low for ingestion of elemental mercury. Oral absorption of inorganic mercury may range from 2 to 38 percent, and is nearly complete for organic mercury. Mercury accumulates primarily in the kidney. Elemental and organic mercury can also be transferred through the blood-brain barrier and the placenta because of their high lipophilicity. Inorganic mercury compounds can reach most organs, but accumulation in the brain and fetus is reduced because of their low lipophilicity Following exposure to elemental mercury, excretion occurs via the urine, feces, and expired air. Following exposure to inorganic mercury, excretion occurs via the urine and feces. Organic mercury compounds are excreted primarily in the inorganic form via the urine and feces (ATSDR, 1988)

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MOLYBDENUM
(CAS RN 7439-98-7)

Molybdenum is a nutritionally essential trace metal in humans that is used as a cofactor for the enzymes xanthine oxidase and aldehyde oxidase. In plants it is necessary for fixing of atmospheric nitrogen by bacteria at the start of protein synthesis. Hence, it is ubiquitous in food. The average daily human intake of molybdenum in food is approximately 350 µg (Goyer, 1986; cited in Casarett and Doull, 1991).

The most important source of molybdenum is molybdenite (MoS_2). Industrial uses of this metal include the manufacture of high-temperature resistant steel alloys for use in gas turbines and jet aircraft engines, and the production of catalysts, lubricants, and dyes.

Absorption/Distribution/Metabolism/Excretion

Molybdenum from soluble compounds is readily absorbed from the GI or respiratory tracts (Friberg and Lener, 1986). Estimates of GI absorption in humans average around 50 percent, with a range of 38 to 72 percent observed in young women, and 77 percent reported for school children. The form of oxidation state of molybdenum used in these studies was not specified. Estimates of GI absorption in laboratory animals have ranged from 40 to 85 percent for hexavalent molybdenum.

Inhalation uptake studies with guinea pigs showed that molybdenum disulfide was essentially unabsorbed, but that hexavalent molybdenum was absorbed to an appreciable (unquantified) extent (Friberg and Lener, 1986). Absorbed molybdenum was distributed primarily to the kidneys, and bone in several animal models (Friberg and Lener, 1986). Molybdenum appears to accumulate in the liver, cartilage of the long bones, and skin. In humans and most animal models, the kidneys are the principal organs of excretion. The excretion of molybdenum is affected by the level of copper and sulfate in the diet.

Chronic Toxicity

Chronic molybdenum poisoning in livestock has resulted from a molybdenum-copper imbalance and is characterized by anemia, GI disturbances, bone disorders, and growth depression (Friberg and Lener, 1986). In laboratory animals, excess molybdenum has induced effects in the liver, kidneys, and spleen. Gout-like symptoms were observed in humans living in a high molybdenum, low-copper area. A few cases of pneumoconiosis were reported in occupationally exposed workers.

The USEPA (IRIS, 2001) has derived a provisional chronic oral RfD of 5.0 x 10^{-3} mg/kg-day, based on a LOAEL in humans exposed to high levels in water and diet, and on an uncertainty factor of 30. The critical effect associated with the oral RfD is increased uric acid levels. The UF of 30 results from a factor of 3 for sensitive human populations and a factor of 10 for use of a LOAEL rather than a NOAEL. Target organs for molybdenum toxicity include the erythrocyte, joints, liver, and kidneys

Carcinogenicity

No studies were located regarding the human carcinogenicity of molybdenum.

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NICKEL

(CAS RN 7440-02-0)

Nickel is a naturally occurring silvery metal that is found in the earth's crust in the form of various nickel minerals Nickel is primarily used in the manufacture of various steels and alloys and in electroplating.

Exposure of the general population may occur via breathing air, ingesting drinking water and food that contain nickel compounds, and skin contact with a variety of products. The single largest source of nickel to the atmosphere is from fuel oil combustion. Sources of nickel in water and soil include storm water runoff, soil amended with municipal sewage sludge, wastewater from municipal sewage treatment plants, and ground water near landfill sites.

Absorption/Distribution/Metabolism/Excretion

Very little nickel may be absorbed from the respiratory tract of humans as indicated by Kalliomaki et al. (1981). The results of this study indicated that urinary nickel increased very little even as the nickel content of inhaled fumes reached up to 30 $\mu g/m^3$ in steel welders. It is noted that greater absorption occurs in soluble nickel compounds. The half-life of nickel clearance from the nasal mucosa is estimated at 3.5 years. Absorption of nickel compounds in animals following inhalation is dependent on the deposition of particles in the lungs. Wehner and Craig (1972) found that 45 days after exposure of rats to nickel oxide (particle size of 1.0 to 2.5 μm), approximately half was still present in the lungs.

Human studies reviewed by USEPA (1986) indicate that 1 to 10 percent of dietary (orally administered) nickel is gastrointestinally absorbed. Studies in rats, dogs, and mice reveal the same percentages of absorption following oral exposure to nickel, nickel sulfate hexahydrate, or nickel chloride.

Several studies indicate that nickel can penetrate human skin. Norgaard (1955) used aqueous solutions of nickel sulfate to find that 55 to 77 percent of the nickel applied to occluded skin was absorbed; most absorbed during the first 24 hours following application. It is also evidenced that

nickel ions from a chloride solution pass through the skin about 50 times faster than ions from sulfate solutions. Lloyd (1980) demonstrated that approximately 1 hour following nickel (II) application to shaved guinea pigs skin, nickel had accumulated in keratinaceous areas and in hair sacs. Nickel metal does not readily penetrate the skin.

Once inside the body following inhalation exposure, nickel is distributed primarily to the lungs. Studies in laboratory animals also indicate concentrations in the spleen, bone, and kidneys. In human and rabbit blood, nickel is found in serum as ultrafilterable nickel, albumin-bound nickel, and in a metalloprotein. Nickel levels in serum were noted to increase in volunteers at 5.6 mg nickel as nickel sulfate (Christensen and Lagesson, 1981). The half-life of nickel in the serum was 11 hours. Following oral exposure to mice, nickel localized in the kidneys, lungs, and CNS (Oskarsson and Tjalve, 1979). Whanger (1973) found that as the amount of nickel in rat diets increased, the nickel content of the kidney, liver, heart, and testis also increased. Whanger observed the highest levels in the rat kidneys.

Once absorbed, nickel binds to albumin, L-histidine, and 2-macroglobulin in human serum. Binding in animals is similar. Increased levels of serum nickel have been reported in cases of acute myocardial infraction. Serum nickel levels are also elevated in acute stroke and extensive burn injury patients.

Regardless of the route of exposure, absorbed nickel is excreted in the urine in both animals and humans. Unabsorbed nickel is excreted in the feces. Nickel is also excreted in the hair and sweat following oral exposure.

Acute Toxicity

Human Toxicity. The lung is the primary target for nickel in humans following inhalation exposure. Human inhalation exposure to nickel refinery dust that contains nickel subsulfide is associated with lung cancer. Asthma, an allergic response, has been observed in nickel-plating workers exposed to nickel sulfate, welders exposed to nickel sulfate, and welders exposed to nickel oxides. Anosmia, septal perforation, chromic rhinitis, and sinusitis have been reported at

high concentration exposures in nickel-plating workers (USEPA, 1986). Specific dose-response data for respiratory effects are not available.

Animal Toxicity. Animal studies, which have found increased susceptibility to pulmonary infections probably due secondarily to the effect of nickel on the immune system, indicate that this effect may be of concern for humans

Exposure of mice and rats to nickel sulfate hexahydrate at concentrations of 0, 0.7, 1.6, 3.3, 6.7, or 13.5 mg/m^3 nickel for 6 hours per day for 12 days produced respiratory effects at all exposures (Benson et al., 1988). A short-term inhalation study studied rats exposed to nickel chloride (109 μg/m^3 nickel) for 12 hours per day, 6 days per week for at least 2 weeks (Bingham et al., 1972). Exposure resulted in marked accumulations of macrophages in alveolar spaces. This study can be considered key for short-term exposure because the concentrations are lower than those examined in other short-term inhalation studies. In a chronic inhalation study conducted by Takenaka et al. (1985), rats were exposed by inhalation to nickel oxide produced by the pyrolysis of nickel acetate at 0, 60 or 200 μg/m^3 nickel. Exposures ran for 23 hours per day, 7 days per week, for up to 31 months Results of this investigation showed that every rat exposed exhibited characteristics in the lung similar to those of alveolar proteinosis. Two rats sacrificed at 31 months had also developed focal septal fibrosis. This study is a key study as it examined lower exposure concentrations of nickel than did other chronic studies

Lung lesions were also found in dogs fed nickel in the diet at levels of 0, 100, 1,000, or 2,500 ppm for a period of 2 years (Ambrose et al., 1976). It was noted, however that lung lesions are relatively common in dogs and therefore the resulting observation may not be nickel-related.

An oral RfD of 2.0 x 10^{-2} mg/kg-day is presented in IRIS (2001) This value is based on decreased body and organ weights of rats in a chronic oral study. The UF of 300 is derived from a factor of 10 for interspecies extrapolation, 10 for sensitive populations, and 3 for inadequacies in the reproductive studies.

Developmental and Reproductive Toxicity

The inhibition of prolaction release by nickel (II) that may affect interactions between the hypothalamus and the pituitary gland needed to maintain pregnancy was demonstrated by LaBella et al. (1973a, b). A number of studies indicate effects on the fertility in males. Jaquet and Mayence (1982) mated untreated female mice with male mice given nickel nitrate injections at 40 or 56 mg/kg. Doses of 40 mg/kg showed no effect on the fertilization capability of the spermatozoa or the ability of the fertilized eggs to cleave. At 56 mg/kg a significant proportion of the eggs was not fertilized. These results suggest an effect on spermatogenesis.

Genotoxicity

The compounds that have been tested in genotoxicity studies are predominantly soluble nickel chloride and nickel sulfate.

Tests for chromosome aberrations and sister chromatid exchange (SCE) in cultured human lymphocytes or human epithelia cells exposed to nickel sulfate and nickel sulfide consistently produce positive results. Studies on the in vitro genotoxicity of mammalian cells for DNA damage, SCE, chromosome aberrations, and cell transformation have been positive. Negative results have been consistently obtained for in vivo tests of chromosome aberrations, micronuclei formations, and dominant lethality in mice and rats. Nickel does, however, appear to be toxic to male germ cells in vivo, resulting in reduced fertility (Jaquet and Mayence, 1982).

Carcinogenicity

Several epidemiological studies conducted prior to 1975 indicated an increased risk of pulmonary and nasal cavity cancers among nickel refinery workers. The most common types of respiratory cancers include epidermoid, anaplastic, and pleomorphic carcinomas. The results of the following studies have been used by the USEPA in developing a unit risk slope for nickel.

Disease risks of workers were studied by Enterline and Marsh (1982). Exposures varied from 5 mg/m^3 nickel for refinery workers to 0.01 to 0.75 mg/m^3 nickel for other workers. An excess risk of nasal sinus cancer was noted in the refinery workers. An overall excess of lung cancer was not noted.

A 1977 mortality study of 937 nickel refinery workers by Doll et al. identified 145 lung and 56 nasal cancer cases. Nearly all nasal sinus cancers were found in workers who began work prior to the use of respiratory protection.

Chovil et al (1981) studied a cohort of 495 sinter workers. The expected cases and deaths of lung cancer were reported as 6.38 and 4.25, respectively. Numbers observed by this study were 54 cases and 37 deaths.

Magnus et al. (1980) studied a cohort of 2,247 refinery workers who had been employed in the industry for at least 3 years. Risks of nasal cancer were increased in all job categories examined, with the highest observed in roasting/smelting workers. An excess risk of laryngeal cancer was also observed (highest risk seen in electrolysis workers). An assessment of the combined effects of smoking and nickel exposure to the risk of lung cancer led the authors to state that the effects are likely to be additive.

A long-term inhalation study of nickel subsulfide in rats, conducted by Ottolenghi et al. 1974, reportedly is the most relevant animal study to human exposure. The study showed an increase in hyperplastic and neoplastic changes in the lungs for both males and female rats.

From available data in humans, the USEPA has estimated that lifetime exposure to 1 microgram of nickel refinery dust per cubic meter of air would result in 2,400 additional cases of cancer in a population of 10,000,000 people. Lifetime exposure to 1 microgram of nickel subsulfide per cubic meter of air would result in 4,800 additional cancer cases in a population of 10,000,000 people. (The major sources of both of these nickel compounds are nickel refineries; there are no operating refineries in the United States.)

Based on human epidemiological data, the USEPA has classified nickel refinery dust from pyrometallurgical sulfide nickel matte refineries as a Group A carcinogen (a known human carcinogen). An inhalation unit risk of 2.4×10^{-4} $(\mu g/m^3)^{-1}$ has been established (IRIS, 2001). An inhalation slope factor of 8.4×10^{-1} $(mg/kg\text{-}day)^{-1}$ has also been established (HEAST, 1997).

It is noted that the above unit risk should not be used if air concentrations exceed 40 $\mu g/m^2$, since above this value the slope factor may differ from that stated.

The data from the 1974 Ottolenghi et al. study and in vitro studies, along with the fact that nickel subsulfide is a major component of nickel refinery dust, are sufficient for the USEPA to classify nickel subsulfide as a Group A carcinogen as well. An inhalation unit risk of 4.8 x 10^{-4} $(\mu g/m^3)^{-1}$ has been established (IRIS, 2001). An inhalation slope factor of 1.7 $(mg/kg\text{-}day)^{-1}$ has also been established (HEAST, 1997). It should be noted, however, that the cited unit risk should not be used if the air concentration exceeds 20 $\mu g/m^3$, since above this concentration the slope factor may differ from that stated.

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PHTHALATES

Di-n-octyl phthalate (DOP), bis (2-ethyl hexyl), phthalate (BEHP), and di-n-butyl phthalate (DBP), are members of the phthalate and phthalate esters family. Because of the lack of compound-specific information and the similarity of toxicity of the group of compounds, the general toxicity of the family of compounds with specific examples of various phthalate compounds will be presented.

Phthalate esters are used as plasticizers in almost every product category. They are used in construction, household products, toys, packaging, apparel, and medical products (Klaassen, et al., 1986).

Phthalates do not dissolve easily in water nor do they evaporate easily. However small amounts can enter the air as a gas. Phthalates once in the air generally break down within a few days. In soil, phthalates are broken down by the bacteria present which can take anywhere from a day up to a month depending on what types of bacteria are present and the temperature of the soil (Johnson, et al., 1977).

Phthalates appear to have relatively low toxicity. What animal data are available indicate that it takes consumption of large amounts to produce adverse effects, which are primarily reproductive.

Acute Effects

Acute lethality studies in animals indicate low acute toxicity of DOP, BEHP, and DBP. Study findings as observed by Smith (1953), Hardin, et al. (1987), and White, et al. (1983) include single lethal doses of 8000 mg/kg up to more than 20,000 mg/kg.

Systemic Effects

An oral reference dose (RfD) of 2.0 x 10^{-2} mg/kg-day for BEHP based on no observed effects on relative liver weight is reported by the USEPA (IRIS, 2001). An oral RfD of 1.0 x 10^{-1} mg/kg-day is reported by the USEPA for DBP. The BEHP value is derived from a study conducted by Carpenter, et al. (1953) in which rats and guinea pigs were exposed to BEHP at 20-195 g/kg-day. A lowest-observed-adverse-effects level (LOAEL) was identified and converted to 19 mg/kg-day of BEHP.

Carcinogenic Effects

Sittig (1985) reports that no studies on the carcinogenic potential of DOP are available. BEHP however has been classified as B2 (probable human carcinogen), by the USEPA on the basis of dose related increases in liver tumor responses in rats and mice, both male and female (IRIS, 2001; HEAST, 1995). One group of 100 rats and one of 100 mice each were fed 0, 6000, and 12,000 ppm BEHP for 103 weeks. The increase in hepatocellular carcinoma and combined incidence of carcinoma and adenoma were significant (NTP, 1982). These findings are supported by data by Ganning, et al. (1984) that has shown BEHP to be a potent inducer of hepatic peroxisomal enzyme activity. The oral slope factor for BEHP is 1.4 x 10^{-2} $(mg/kg\text{-}day)^{-1}$ which is equivalent to an oral carcinogenic unit risk of 4 x 10^{-7} $(\mu g/l)^{-1}$ (IRIS, 2001).

Teratogenicity, Embryotoxicity, And Reproductive Effects

Intraperitoneal injection of DOP in pregnant rats has caused teratogenic effects, increased resorptions and fetal toxicity (USEPA, 1980). DBP has been shown to be toxic to the fetus (IRIS, 2001). BEHP has been observed to be fetotoxic and teratogenic also (Shiot and Nishimura, 1982)

The phthalates have also been associated with reproductive effects including seminiferous tubule damage and testicular damage (Shiota and Nichimura, 1982; Singhe, 1972; IRIS, 2001).

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POLYCYCLIC AROMATIC HYDROCARBONS

Polycyclic aromatic hydrocarbons (PAHs) are formed during the incomplete combustion of organic substances (e.g., coal, oil, gas, garbage). There are over 100 PAHs; among the most common are: acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene. The toxicity information available on PAHs is limited. Therefore, the potential health effects of "unknown" PAHs are inferred from those listed above. PAHs are generally found in the environment as mixtures of 2 or more compounds. Most PAHs are not readily soluble in water. Some easily volatilize into air; generally, PAHs will persist in the environment for months to years. PAHs are found throughout the environment. Background levels are 0.02 to 1.2 mg/m^3 (rural) to 0.15 to 19.3 mg/m^3 (urban) and 4 to 24 ng/L, for air and water respectively.

PAHs can be classified according to the electron density associated with the molecule as alternate or non-alternate. This distinction is toxicologically significant because the two classes appear to behave differently, particularly with respect to how the molecule is metabolized.

Absorption/Distribution/Metabolism/Excretion

PAHs appear to be readily bioavailable following inhalation exposure. Absorption of PAHs following inhalation has been inferred from the presence of urinary metabolites of PAHs in humans following exposure (Becher and Bjorseth, 1983; cited in ATSDR, 1990). However, the dose-uptake relationship was not linear over the exposure concentration range, probably due to incomplete availability of the PAHs adsorbed to airborne particulate matter. Studies in animals suggest that clearance of PAHs from the lung is the product of direct absorption into the blood stream and clearance by mucociliary action and subsequent ingestion. The size of the particles to which the PAHs are adsorbed will influence the relative degree of absorption into the blood stream from the lungs (Sun et al., 1982; Cresia et al., 1976; cited in ATSDR, 1990). Benzo(a)pyrene was not bioavailable following direct nasal instillation in hamsters, monkeys, or dogs; local mucosal absorption and metabolism were predominant (Dahl et al., 1985 and Petridou-Fischer et al., 1988; cited in ATSDR, 1990).

The oral bioavailability of PAHs is variable Benzo(a)pyrene could not be detected in human feces following ingestion of broiled meat containing benzo(a)pyrene; blood levels did not appear to have been measured (Hecht et al., 1979; cited in ATSDR, 1990) Many of the animal studies only evaluated recovery of the administered dose in the feces and failed to measure blood or urine levels; therefore, a direct indication of bioavailability was not determined In two studies, benzo(a)pyrene and benzo(a)anthracene were detected in the liver, lung, kidney, blood, and brain; however, no quantitative data were given (Yamazaki et al., 1987; Modica et al., 1982; cited in ATSDR, 1990).

PAHs are absorbed through the skin of both humans and animals. PAHs could be detected in the blood following application of crude coal tar to the skin of humans (Storer et al., 1984; cited in ATSDR, 1990). Three percent of an applied dose of ^{14}C-benzo(a)pyrene permeated human skin in vitro (Kao et al., 1985; cited in ATSDR, 1990). In mice, 93 percent of a dermally applied dose of ^{14}C-benzo(a)pyrene was recovered in the feces after 7 days, indicating that only about 7 percent was absorbed (Sanders et al., 1986; cited in ATSDR, 1990). Fifty-three percent of a dermally applied dose of ^{14}C-anthracene was recovered in the urine, feces, and tissues of rats over a 6 day period (Yang et al., 1986; cited in ATSDR, 1990) A number of other PAHs were absorbed following dermal exposure, but the amount absorbed is not linear with dose, suggesting saturation of an uptake process (Sanders et al., 1986; cited in ATSDR, 1990).

The distribution of PAHs in humans is unknown. In animals, benzo(a)pyrene has been predominant PAH studied. PAHs were more widely distributed following oral exposure than inhalation exposure; and, distribution was limited following dermal exposure Typically, the highest distribution was to the lung, liver, kidney, and GI tract (Weyand and Bevan 1986, 1987, 19888; Schnizlein et al., 1987; Sun et al., 1982; Bartosek et al., 1984; Daniel et al., 1967; cited in ATSDR, 1990). Concentrations of PAHs were detected in the fetus following oral administration to the dam. However, the differences in fetal concentration appeared to reflect differences in GI uptake in the dam and not ability to permeate the placenta (Shendrikova and Aleksandrov, 1974 cited; in ATSDR, 1990). The majority of radioactivity was recovered in the lipid fraction of the tissues (Yamazaki et al., 1987; cited in ATSDR, 1990).

PAH metabolism has been studied extensively in vivo (animals) and in vitro (human and animal cells) (ATSDR, 1990). In general, metabolism transforms lipophilic PAHs into more water-soluble, excretable compounds. Because of the structural similarities among PAHs, benzo(a)pyrene has been used as a model for PAH metabolism. Benzo(a)pyrene is metabolized by the microsomal enzyme, aryl hydrocarbon hydroxylase (AHH). This enzyme is inducible in some species. The inducibility of this enzyme has been shown to be associated with increased survival time (Robinson et al. 1975; cited in ATSDR, 1990) PAHs also induce aldehyde dehydrogenase (ADH) activity with a variable potency that has been correlated with carcinogenic potency (Torronen et al., 1981; cited in ATSDR, 1990). Some PAHs are also able to induce carboxylesterase activity (Nousiainen et al., 1984; cited in ATSDR, 1990). Epoxide hydrolase metabolism of PAHs may lead to epoxide formation, increasing the likelihood for carcinogenic effects in organs with this enzyme activity (Moore et al., 1982; cited in ATSDR, 1990). There is some evidence to suggest that formation of bay-region diol epoxides are not the reactive intermediates associated with the tumorigenic effect of benzo(b)fluoranthene and other non-alternate PAHs (Amin et al., 1982, 1985; cited in ATSDR, 1990)

Studies on the elimination of PAHs are limited. However, PAHs and their metabolites have been recovered in variable amounts in the urine, feces, and/or bile after oral, dermal, or inhalation exposure (ATSDR, 1990). Following intravenous administration of ^{3}H-benzo(a)pyrene, the overall elimination was fit to a triexponential model; the final elimination half-life was 178 minutes (Weyand and Bevan, 1986; cited in ATSDR, 1990)

Acute Toxicity

A single exposure to PAHs has been associated with a number of toxic effects, including initiation of carcinogenicity (see 'Target Organ Toxicity' and 'Carcinoenicity' sections for details). The acute lethal toxicity of PAHs ranges from 250 mg/kg for the most potent to 700 mg/kg for the least potent. However, most exposure situations will involve a mixture of PAHs; and, it is not possible to tell whether the acute lethal toxicity for a mixture will lie somewhere in between these values or whether toxicity will be additive. In addition, these data were obtained following parenteral administration, a step which by-passes metabolism in the liver; therefore, their relevance to human exposure is questionable.

Target Organ Toxicity

Pyrene (CASN 129-00-0). The USEPA has established an oral reference dose (RfD) of 3.0 x 10^{-2} mg/kg-d based on administration of 0, 75, 125, or 250 mg/kg/day pyrene by oral intubation to mice for 13 weeks (IRIS, 2001). Minimal to mild nephropathy (renal tubular pathology and decreased kidney weights) was observed; the dose relationship was moderate. The UF was 3,000 due to species variability and lack of additional toxicity studies. The overall confidence in the RfD is low due to gaps in the database.

Fluoranthene (CASN 206-44-0). The USEPA has established an oral RfD of 4.0 x 10^{-2} mg/kg-day based on gavage administration of 0, 125, 250, or 500 mg/kg/day fluoranthene to mice for 13 weeks (IRIS, 2001) The mid and high dose mice exhibited nephropathy, a dose-dependent increase in liver enzymes and weights, and increased salivation. The UF was 3,000 due to species variability, the use of a subchronic study, and lack of additional toxicity data. The overall confidence in the RfD is low due to gaps in the database.

Acenaphthene (CASN 83-32-9). The USEPA has established an oral RfD of 6.0 x 10^{-2} mg/kg-day for acenaphthene (IRIS, 2001) based on hepatotoxicity during an oral subchronic study on mice The UF of 3,000 was due to species variability, use of a subchronic study, lack of adequate data in a second species, and lack of reproductive/developmental data.

Anthracene (CASN 120-12-7). The USEPA has established an oral RfD of 3.0 x 10^{-1} mg/kg-day for anthracene (IRIS, 2001) based on no observed effects in a subchronic study on mice. The UF of 3,000 was due to species variability, use of a subchronic study, lack of adequate data in a second species, and lack of reproductive/developmental data.

Naphthalene (CASN 91-20-3). The USEPA has established an oral RfD of 2.0 x 10^{-2} mg/kg-day for naphthalene (IRIS, 2000) based on no observed effects in a subchronic study on rats. The UF of 3,000 was due to species variability, use of a subchronic study, lack of adequate data in a second species, and lack of reproductive/developmental data.

GI Toxicity. Carboxylesterase activity of the intestinal mucosa was decreased in rats following intragastric administration of 50 or 150 mg/kg-day benzo(a)anthracene or benzo(a)pyrene for 4 days; enzyme activity was increased following oral exposure to 100 mg/kg-day of anthracene or phenanthrene (Nousiainen et al., 1984; cited in ATSDR, 1990).

Hematological Toxicity. Bone marrow depression (aplastic anemia and pancytopenia) leading to death was observed in mice whose AHH enzyme was not inducible following oral administration of 120 mg benzo(a)pyrene/kg-day for 180 days (Robinison et al., 1975; cited in ATSDR, 1990).

Hepatic Toxicity. A number of hepatic effects (enzyme and foci induction, liver regeneration, and increased weights) have been observed in animals administered PAHs. These effects are not life-threatening but may precede the onset of more serious effects. A single intragastric administration of 200 mg/kg of benzo(a)pyrene, benzo(a)anthracene, or dibenz(a,h)anthracene induced the formation of preneoplastic hepatocytes in a promotion/initiation bioassay in partially hepatectomized rats fed 2-acetylaminofluorene (Tsuda and Farber, 1980; cited in ATSDR, 1990). PAHs stimulate liver regeneration in partially hepatectomized rats following administration in the diet for 10 days. Non-carcinogenic PAHs required higher doses (Gershbein, 1975; cited in ATSDR, 1990).

Dermal Toxicity. Dermal exposure to benzo(a)pyrene in humans was associated with epidermal changes indicative of neoplastic proliferation, chronic dermatitis and hyperkeratosis, or exacerbation of pre-existing skin lesions (Cottini and Mazzone, 1939; USEPA, 1988 cited in ATSDR, 1990). Topical application of PAHs have been associated with adverse effects in animals including skin cancer, effects on sebaceous glands, increased number of skin melanocytes, dermal inflammation, allergic contact hypersensitivity, and photosensitization (Bock and Mund, 1958; Iwata et al , 1981; Klemme et al., 1987; Old et al., 1963; and Forbes et al., 1976; cited in ATSDR, 1990).

Immunotoxicity. Immunotoxic effects have been observed following dermal and parenteral administration in animals PAHs that are carcinogenic are also immunosuppressive with the

same rank order of potency (ATSDR, 1990). Effects observed have included inhibition of T-cell dependent and independent antibody production and inhibition of lymphocyte mediated immunity (Blanton et al., 1986; Lyte and Bick, 1985; Whit and Holsapple, 1984; Wojdani et al., 1984; cited in ATSDR, 1990).

Developmental Toxicity

There is no information on the developmental effects of exposure to PAHs in humans (ATSDR, 1990)

In animals, in utero exposure to benzo(a)pyrene (10, 40, or 160 mg/kg-day orally during gestation) was associated with reduced mean postnatal pup weight and increased incidence of sterility associated with alterations in gonadal morphology and germ-cell development in male mice (Mackenzie and Angevine, 1981; cited in ATSDR, 1990). An observed increased incidence of stillborns, resorptions, and malformations following dietary administration of 120 mg benzo(a)pyrene/kg-day to the dam was associated with the metabolic responsiveness of the offspring and the dams (Legraverend et al., 1984; cited in ATSDR, 1990). Parental administration of a number of PAHs has been associated with a number of developmental effects: stillbirths, increased fetal resorptions, malformations, adverse gonadal histology, and decreased fetal survival. The implications of the results obtained following parenteral administration, which by-passes first-pass metabolism of the liver, to human exposure are that adverse effects on the fetus are possible.

Reproductive Toxicity

There is no information on the effect of PAH on reproduction in humans (ATSDR, 1990).

Benzo(a)pyrene decreased the percentage of pregnant females at parturition in pregnant CD-1 mice (Mackenzie and Angevine, 1981; cited in ATSDR, 1990) and reduced the incidence of pregnancy in rats (Rigdon and Rennels, 1964; cited in ATSDR), but it had no effect on fertility of Swiss mice (Rigdon and Neal, 1965; cited in ATSDR, 1990). Increased resorptions and decreased number of corpora lutea, uterine weights, and fetal survival were observed following parenteral administration of benzo(a)pyrene (Swartz and Mattison, 1985; Bui et al., 1986; cited in ATSDR, 1990). The implications of the results obtained following parenteral administration, which by-passes first-pass metabolism of the liver, to human exposure are that adverse effects on reproduction are possible.

Genotoxicity

A number of PAHs have been tested in numerous in vitro and in vivo genotoxicity studies (ATSDR, 1990). In general, several PAHs demonstrated genotoxic potential that required metabolic activation Benzo(a)pyrene produced several genotoxic effects: DNA binding/damage, sister chromatic exchange, chromosomal aberration, cell transformation; effects were observed in bacterial and mammalian (both somatic and germ) cells. DNA damage was also observed in human cells Acenaphthene, acenaphthylene, or fluorene were negative for genotoxic effects and anthracene, phenanthrene, and pyrene where negative in all but one in vitro test.

Carcinogenicity

Epidemiologic studies of humans exposed to coke-oven and roofing-tar emissions and cigarette smoke have demonstrated an increase in mortality due to lung cancer (Lloyd, 1971; Mazumdar et al., 1975; Redmond et al., 1976; Hammond et al., 1976; cited in ATSDR, 1990). Skin tumors have been reported among individuals exposed to mixtures containing PAHs: scrotal cancer among chimney sweeps and skin cancer following exposure to shade oils (Pott, 1775; Purde and Etlin, 1980; cited in ATSDR, 1990). While these mixtures contain PAHs they also contain a

number of other potentially carcinogenic chemicals, tumor promoters, initiators, and co-carcinogens. This concomitant exposure prevents making a direct causal relationship to PAHs

Inhalation, oral, and dermal exposure to PAHs have been associated with carcinogenic effects in animals (ATSDR, 1990). These studies suggest that the site of tumor induction is influenced by the route of administration. Following inhalation exposure an increased incidence of respiratory tract tumors was observed. Benign and malignant tumors, adenomas, papillomas, neoplasms, and carcinomas of the lung, alimentary tract (particularly the forestomach), and mammary glands were observed following ingestion of benzo(a)pyrene, benzo(a)anthracene and dibenz(a,h)anthracene by rodents. A dose-responsive increase in the incidence of forestomach papillomas and carcinomas was observed in mice following dietary administration of 33.3 mg benzo(a)pyrene/kg/day for 30 to 197 days (Neal and Rigdon, 1967; cited in ATSDR, 1990). While the relevance of forestomach tumors in rodents to human cancer is debatable and not all PAHs are associated with a carcinogenic or genotoxic effect, the overall evidence suggests exposures to PAHs are associated with an increased risk of cancer.

Benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, dibenz(a,h)anthracene, chrysene, and indeno(1,2,3-cd)pyrene have been demonstrated to induce skin tumors in mice following dermal exposure (ATSDR, 1990). Benzo(a)pyrene, in particular, is a potent experimental skin carcinogen. It is often used as a positive control in carcinogenesis bioassays. The dose-response relationship of benzo(a)pyrene and skin tumors has been investigated in a number of studies (Cavalieri et al., 1988; Shubik and Porta, 1957; Bingham and Falk, 1969; Wynder and Hoffman, 1959; Warshawsky and Barkley, 1987; cited in ATSDR, 1990). Benzo(a)pyrene has been demonstrated to induce malignant skin tumor at exposures as low as 0.0054 mg/kg-day; however, the solvent and strain of mouse tested will influence the tumorigenic dose (Bingham and Falk, 1969; Warshawsky and Barkley, 1987; cited in ATSDR, 1990). The latency of tumor production by benzo(a)pyrene may also be affected by the schedule of administration because of the ability of this PAH to induce the enzyme responsible for its metabolism (Slaga and diGiovanni, 1984; Weibel, 1980; cited in ATSDR, 1990).

Pyrene (CASN 129-00-0). Mice administered intraperitoneal injections of pyrene on days 1, 8, and 15 of age did not demonstrate a treatment-related increase in tumor incidence (Wislocki et al., 1986; cited in IRIS, 2001). Pyrene was not positive or inconclusive in mouse skin-painting assays (Badger et al., 1940; Horton and Christian, 1974; Van Duuren and Goldschmidt, 1976; Salaman and Roe, 1956; Scribner, 1973; cited in IRIS, 2001). Subcutaneous injection of pyrene did not produce tumors in Jackson A mice (Shear and Leiter, 1941 cited in IRIS, 2001). The EPA has classified pyrene as a Class D carcinogen; not classifiable as to human carcinogenicity due to no human data and inadequate data from animal bioassays.

Benzo(a)pyrene (CASN 50-32-8). There are multiple animal studies demonstrating increased incidence of carcinogenic effects following oral, intratracheal, inhalation, and dermal administration of benzo(a)pyrene. Benzo(a)pyrene has been shown to be an initiator and a complete carcinogen following dermal application (IARC, 1973; cited in IRIS, 2001). A dose-responsive increase in squamous cell papillomas and carcinomas of the forestomach was observed following oral administration of 1 to 250 ppm benzo(a)pyrene to rats and hamsters for 197 days (Rigdon and Neal, 1966, 1969; cited in IRIS, 2001). The incidences of respiratory tract and upper digestive tract tumors were increased following intratracheal instillation or inhalation of benzo(a)pyrene by guinea pigs, hamsters, and rats (USEPA, 1991; cited in IRIS, 2001). Inhalation exposure of hamsters to benzo(a)pyrene at 9.5 mg/m^3-day for 10 weeks was associated with development of tumors of the nasal cavity, larynx, trachea, and pharynx. At the next highest dose, 45 mg/m^3-day, neoplasms were also observed in the upper digestive tract. The lowest dosed (2.2 mg/m^3-day) animals did not develop tumors (Thyssen et al., 1981; cited in IRIS, 2001). Intraperitoneal and subcutaneous injection of benzo(a)pyrene is associated with injection site tumors (USEPA, 1991; cited in IRIS, 2001). Based on no human data and sufficient animal data benzo(a)pyrene is classified, B2; probable human carcinogen. The USEPA has calculated an oral slope factor of 7.3 (mg/kg-day)$^{-1}$, and a corresponding drinking water unit risk of 2.1 x 10^{-4} (ug/L)$^{-1}$ (IRIS, 2001). Cal EPA has established an oral slope factor of 1.2 x 10^{+1} (mg/kg-day)$^{-1}$, and an inhalation slope factor of 3.9 (mg/kg-day)$^{-1}$ (Cal EPA, 1994). The inhalation slope factor corresponds to a unit risk value of 1.1 x 10^{-3} (ug/m^3)$^{-1}$ (Cal EPA, 1994)

Benzo(k)fluoranthene (CASN 207-08-9). In a lifetime study in female rats, lung implants of 0.65, 3.4, or 17 mg/kg benzo(k)fluoranthene exhibited a dose-related increase in the incidence of epidermoid carcinomas in the lung and thorax. Equivocal incidences of lung adenomas and hepatic adenomas and hepatomas were reported in mice administered intraperitoneal injections of 120 μg benzo(k)fluoranthene/mouse on days 1, 8, and 15 of age (LaVoie et al., 1987; cited in IRIS, 2001). Benzo(k)fluoranthene was positive in mouse skin-painting assays (Van Duuren et al., 1966; LaVoie et al., 1982; Amin et al., 1985; cited in IRIS, 2001). Based on these data, USEPA has classified benzo(k)fluoranthene as B2, "probable" human carcinogen. Using a potency equivalency factor (PEF) of 0.1, the benzo(a)pyrene inhalation slope factor of 3.9 $(mg/kg\text{-}day)^{-1}$, and the oral slope factor of $1.2 \times 10^{+1}$ $(mg/kg\text{-}day)^{-1}$, Cal EPA has established an inhalation slope factor of 3.9×10^{-1} $(mg/kg\text{-}day)^{-1}$, and an oral slope factor of 1.2 $(mg/kg\text{-}day)^{-1}$ for benzo(k)fluoranthene (Cal EPA, 1994).

Indeno(1,2,3-cd)pyrene (CASN 193-39-5). The USEPA has classified indeno(1,2,3-cd)pyrene as a B2 probable human carcinogen (IRIS, 2001). Using a PEF of 0.1, the benzo(a)pyrene inhalation slope factor of 3.9 $(mg/kg\text{-}day)^{-1}$, and the oral slope factor of $1.2 \times 10^{+1}$, Cal EPA has established an inhalation slope factor of 3.9×10^{-1} $(mg/kg\text{-}day)^{-1}$, and an oral slope factor of 1.2 $(mg/kg\text{-}day)^{-1}$ for indeno(1,2,3-cd)pyrene (Cal EPA, 1994).

Benzo(b)fluoranthene (CASN 205-99-2). In a lifetime study in female rats, lung implants of 0.4, 1.2, or 4.1 mg/kg benzo(b)fluoranthene exhibited a dose-related increase in the incidence of epidermoid carcinomas and pleomorphic sarcoma in the lung and thorax. Equivocal incidences of lung adenomas and hepatic adenomas and hepatomas were reported in mice administered intraperitoneal injections of 126 μg benzo(b)fluoranthene/mouse on days 1, 8, and 15 of age (LaVoie et al., 1987; cited in IRIS, 2001). Injection site sarcomas were observed in mice administered subcutaneous injections of benzo(b)fluoranthene (2.6 mg total dose) over 2 months (Lacassagne et al., 1963; cited in ATSDR, 1990). Benzo(b)fluoranthene was positive for complete carcinogenesis and initiation in mouse skin-painting assays (Wynder and Hoffmann, 1959; LaVoie et al., 1982; Amin et al., 1985; cited in IRIS, 2001). Based on these data, USEPA has classified benzo(k)fluoranthene as B2, "probable" human carcinogen. Using a PEF of 0.1, the benzo(a)pyrene inhalation slope factor of 3.9 $(mg/kg\text{-}day)^{-1}$, and the oral slope factor of 1.2 x

10^{+1} (mg/kg-day)$^{-1}$, Cal EPA has established an inhalation slope factor of 3.9 x 10^{-1} (mg/kg-day)$^{-1}$, and an oral slope factor of 1.2 (mg/kg-day)$^{-1}$ for benzo(b)fluoranthene (Cal EPA, 1994).

Dibenz(a,h)anthracene (CASN 53-70-3). The USEPA has calculated an oral slope factor of 7.3 (mg/kg-day)$^{-1}$ for dibenz(a,h)anthracene, based on its relative toxicity to benzo(a)pyrene. Dibenz(a,h)anthracene has been classified as a B2 probable human carcinogen Cal EPA has established an oral and inhalation slope factor of 4.1 (mg/kg-day)$^{-1}$ (Cal EPA, 1994). The inhalation slope factor corresponds to a unit risk value of 1.2 x 10^{-3} (ug/m^3)$^{-1}$ (Cal EPA, 1994).

Acenaphthylene (CASN 208-96-8). Dermal application of acenaphthylene (0.25 percent) did not cause tumor development in a lifetime study in mice (Cook, 1932). While no control was used in this study, other PAHs tested did result in skin tumor formation. The USEPA has classified acenaphthylene as a Class D carcinogen; not classifiable as to human carcinogenicity (IRIS, 2001).

Anthracene (CASN 120-12-7). EPA has listed anthracene as a Class D carcinogen; not classifiable as to human carcinogenicity due to lack of human data and inadequate animal bioassay data (IRIS, 2001).

Phenanthrene (CASN 85-01-8). Two skin painting assays were negative for complete carcinogenic activity; 1 out of 5 mouse skin painting assays was positive for initiation (IRIS, 2001). Tumorigenic activity was not detected following intraperitoneal injection of phenanthrene (0.25 mg total dose) on days 1, 8, and 15 after birth (Buening et al., 1979; cited in IRIS, 2001). A single subcutaneous injection of 40 µg phenanthrene in albino mice was not overtly tumorigenic (Grant and Roe, 1963; cited in IRIS, 2001). No tumors were reported in mice receiving a single subcutaneous injection of 5 mg phenanthrene (Steiner, 1955; cited in IRIS, 2001). The USEPA has classified phenanthrene as a Class D carcinogen; not classifiable as to human carcinogenicity

Benzo(a)anthracene (CASN 56-55-3). Increased incidence of pulmonary tumors and hepatomas was observed in mice following oral gavage with 500 mg benzo(a)anthracene/kg/day

3 times/week for 5 weeks (Klein, 1963; cited in IRIS, 2001). A single gavage dose of 0.5 mg benzo(a)anthracene was not tumorigenic, while multiple gavage treatments (8 or 16 over 16 months) resulted in forestomach papillomas (Bock and King, 1959; cited in IRIS, 2001). Following intraperitoneal injection of benzo(a)anthracene on days 1, 8, and 15 of age (638 μg/mouse total dose) the incidence of liver adenomas or carcinomas was increased in treated male mice, while the incidence of pulmonary adenomas or carcinomas was increased in treated females (Wislocki et al., 1986; IRIS, 2001). Benzo(a)anthracene was positive as a complete carcinogen and as an initiator in mouse skin painting bioassays (IARC, 1973 cited; in IRIS, 2001). Injection site sarcomas were observed following subcutaneous or intramuscular injection of benzo(a)anthracene (Steiner and Falk, 1951; Steiner and Edgecomb, 1952; Klein, 1952; cited in IRIS, 2001). The USEPA has classified benzo(a)anthracene as a B2, "probable" human carcinogen. Using a PEF of 0.1, the benzo(a)pyrene inhalation slope factor of 3.9 $(mg/kg\text{-}day)^{-1}$, and the oral slope factor of $1.2 \times 10^{+1}$ $(mg/kg\text{-}day)^{-1}$, Cal EPA has established an inhalation slope factor of 3.9×10^{-1} $(mg/kg\text{-}day)^{-1}$, and an oral slope factor of 1.2 $(mg/kg/day)^{-1}$ for benzo(a)anthracene (Cal EPA, 1994).

Naphthalene (CASN 91-20-3). No treatment-related tumors developed in rats fed a diet supplemented with 360 mg naphthalene/kg-day (total dose administered was 10 g/rat) (Schmahl, 1955; cited in IRIS, 2001). Pulmonary tumors developed in mice following inhalation exposure to 0, 10, or 30 ppm naphthalene for 6 hours/day, 5 days/week for 6 months; no dose-response was observed (Adkins et al., 1986; cited in IRIS, 2001). The number of gamma-glutamyl transpeptidase positive foci, an early neoplastic indicator, was not increased following single gavage administration of 100 mg naphthalene/kg (Tsuda et al., 1980; cited in IRIS, 2001). No carcinogenic responses were observed in rats after intraperitoneal injection of 20 mg naphthalene/kg once a week for 40 weeks (Schmahl, 1955; cited in IRIS). Naphthalene was negative as a complete carcinogen or initiator in mouse skin-painting assays (Kennaway, 1930; Schmelts et al., 1978; cited in IRIS, 2001). The USEPA has classified naphthalene as a Class D carcinogen

Benzo(g,h,i)perylene (CASN 191-24-2). Benzo(g,h,i)perylene was negative as a complete carcinogen or an initiator in mouse skin painting assays (IRIS, 2001). Rats with

benzo(g,h,i)perylene lung implants did not develop increased incidence of epidermoid carcinomas in the lung or thorax (Deutsch-Wenzel et al., 1983). Mice injected subcutaneously with 0.1, 1, or 10 mg benzo(g,h,i)perylene once every 2 weeks for 20 weeks did not develop tumors (Muller, 1968; cited in IRIS, 2001). The USEPA has classified benzo(g,h,i)perylene as a Class D carcinogen.

Chrysene (CASN 218-01-9). Chrysene tested positive as a complete carcinogen and an initiator in mouse skin painting studies (IRIS, 2001). The incidence of liver adenomas or carcinomas and lung adenomas was increased in male, but not female, mice administered intraperitoneal injections of chrysene on days 1, 8, and 15 of age (total dose was 160 or 640 μg/mouse) (Wislocki et al., 1986; cited in IRIS, 2001). Intraperitoneal injection of chrysene on days 1, 8, and 15 of birth resulted in increased incidence of hepatic tumors in treated male mice and not treated females (Chang et al., 1983). Using a PEF of 0.01, the benzo(a)pyrene inhalation slope factor of 3.9 $(mg/kg\text{-}day)^{-1}$, and the oral slope factor of $1.2 \times 10^{+1}$ $(mg/kg\text{-}day)^{-1}$, Cal EPA has established an inhalation slope factor of 3.9×10^{-2} $(mg/kg\text{-}day)^{-1}$, and an oral slope factor of 1.2×10^{-1} $(mg/kg\text{-}day)^{-1}$ for chrysene (Cal EPA, 1994).

Fluoranthene (CASN 206-44-0). Fluoranthene was consistently negative as a complete carcinogen in mouse skin painting studies (IRIS, 2001). The USEPA has classified fluoranthene as a Class D carcinogen

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SELENIUM

(CAS RN 7782-49-2)

Selenium toxicity depends on total body levels since its deficiency and excess result in several disorders (ASTDR, 1989). The nature of the toxicity does not appear to correlate with the oxidation state of selenium but absorption and bio-availability depend on the form of selenium (i.e., organic or inorganic).

Acute Toxicity

Low body and tissue levels of selenium result in diminished glutathione peroxidase enzyme activity in whole blood and erythrocytes which adversely effects the protection of cells from oxidation damage (Valentine et. al, 1988). Depressed selenium levels result in at least two chronic, non-cancerous, metabolic diseases: Keshan disease and Kashin-Beck disease (Yang et. al, 1988). Keshan disease manifests its symptoms by increased necrosis of the myocardial muscle, while Kashin-Beck disease results in degeneration, atrophy, and necrosis of cartilage Low selenium intake in other instances results in increased cardiomyopathy resulting in increased cardiovascular deaths in man (Oster et. al, 1983; Salonen et. al, 1982).

Excessive body levels of selenium manifest their symptoms as increased garlic breath, increased skin rashes, dental carie increase, brittle and discolored nails, hair loss and increased nervous system disorders (Kilness and Hochberg, 1977; Yang et. al, 1983). Severe selenosis can result in chronic nervous system degeneration and depression

In rodent species, oral ingestion of selenium and selenium salts produce acute toxicity to mice, rats, guinea pigs, and rabbits (ASTDR, 1989). Nonlethal doses of selenium sulfide or selenium disulfide result in pulmonary edema and respiratory congestion (Carter, 1966; Koppel et. at, 1986). Ingestion of high levels of selenacious plants results in respiratory failure in livestock (NAS, 1976).

Severe gastrointestinal distress, abdominal cramping and fluid imbalance result from acute dosage with selenium salt in humans (Koppel, 1986) Livestock suffering from "blind staggers"

exhibit severe gastrointestinal distress and upon necropsy, pronounced gastrointestinal necrosis (Shamberger, 1986). Gastrointestinal disorders in rodents fed grains high in selenium resulted in NOAELs of 0.5 mg/kg/day (ASTDR, 1989).

Chronic Toxicity

In chronic exposure settings with mice, myocardial amyloidosis of the heart was observed but the significance of this finding is unclear. Oral dosage of mice and rats with selenium salts results in myocardial hyperemia, hemorrhage, and degeneration, and pericardial edema (Schroeder and Mitchener, 1972).

Limited investigations in humans suggest that hepatic effects occur following chronic ingestion of selenium compounds. Abnormal liver function (serum bilirubin and alkaline phosphatase activity) has been demonstrated in one patient (Civil and MacDonald, 1978).

Hepatic congestion in ruminants and rodents have been noted (Hopper et. al, 1985; Palmer and Olsen, 1974). Chronic exposure to selenium compounds in rodents also results in depressed liver weight and eventually cirrhosis (NOAEL 0 68 mg/kg/day) (Harr et.al, 1967).

Selenium intoxication has resulted in effects on other organ systems in rodents and humans. Renal effects such as nephritis and severe interstitial nephritis and any lordosis have been noted following oral ingestion of selenium compounds (Harr et. al, 1967). Oral ingestion of selenium has been associated with delayed eye lid development in mice (Ostadalova and Babicky, 1980).

The USEPA (IRIS) lists a chronic oral reference dose (RfD) of 5.0×10^{-3} (mg/kg-day) (IRIS, 2001).

Developmental Toxicity

There have been no investigations demonstrating that selenium or selenacious containing plants induce developmental anomalies in humans (ASTDR, 1989). Selenium does not induce terata in rodent species under very stringent conditions (Barlow and Sullivan, 1982). Avian species appear to be highly susceptible to selenium induced terata (Palmer et. at, 1973). Selenium ingestion elicits decreased fetal body weights in rats and mice and impairs fertility and conception rates in rodents (Chowdhury and Venkatakrishna-Ghatt, 1983). Selenium also decreases fecundacy in swine (Wahlstrom and Olson, 1959). Recent investigations in primates indicate that selenium does not induce fetal malformations under continuous dosing prior to conception through parturition (Tarental et al, in press).

Genotoxocity

Selenium by itself has not been shown mutagenic in bacterial or mammalian cell mutagenesis assays (ASTDR, 1989). In fact, the presence of selenium in the mutation assays as a media supplement or as an adjunct to the S9 metabolic activation system decrease mutegenic activity of known mutagens (Gairola and Chow, 1982).

Carcinogenicity

Carcinogenicity data in rodents for dietary selenium present conflicting results. Early reports indicate that sodium selenate or selenacious plant material enhanced hepatic tumor incidence in rodents (Volgarev and Tscherkes, 1967; Schroder and Mitchener 1971a). Later reports indicate that dietary selenium inhibits spontaneous tumor development or chemically induced (N-2-fluorenylacetamide) tumors (Harr et.al, 1967). Selenium and selenium containing plants do not enhance the development of tumors in humans (ASTDR, 1989). In fact, in areas where high indigenous selenium occurs in the diet, tumor rates for tongue, esophagus, stomach, intestine, rectum, liver, pancreas, lung and bladder are significantly lower in males and females than in low selenium exposure diets (Shamberger et al., 1976). The possible mechanism may relate to effects on glutathione peroxidase levels (Valentine et al, 1988).

Selenium sulfide is the only compound known to consistently increase tumor incidence in the form of hepatocellular carcinomas and alveolar/bronchiolar carcinomas in rats and mice (NTP,

1980). Selenium sulfide is only used in topical pharmaceutical preparations and not taken orally. Lastly, in 1975, IARC concluded from the literature that selenium in the forms of selenite, selenate, and organic forms was non-carcinogenic to rodents and humans and is not considered to be a carcinogen.

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TOTAL PETROLEUM HYDROCARBONS (TPH)

Petroleum hydrocarbons encompass numerous compounds of varying carbon chain length and arrangement. Within the group of hydrocarbons, individual compounds can be further characterized as belonging to a specific fraction on the basis of boiling point.

The compounds with fewest carbon and highest potential for volatilization include natural gas and some gasoline constituents. Benzene, toluene, ethylbenzene, and xylene (BTEX) are in this fraction. Benzene is a known human carcinogen based on occupational epidemiology. Inhalation is the primary route of exposure and the blood cells the target organ. Leukemia is the resulting disease. Other members of this group have not demonstrated this carcinogenic potential but have been shown to cause adverse effects in the central nervous system and liver.

The middle distillate fraction includes compounds with six or more carbons. Many are used as solvents, thinners, and varnishes. Inhalation of members with this fraction can cause increased respiration, cyanosis and pulmonary edema. The heaviest petroleum fraction includes fuel oils and kerosene. These molecules contain eight or more carbons. These compounds have relatively low to moderate toxicity. Ingestion cause central nervous system depression and gastrointestinal irritation. Dermal exposure can lead to dermatitis

The polycyclic aromatic hydrocarbons (PAHs) consist of compounds where three or more benzene rings are joined. Benzo(a)pyrene is considered the most toxic of this group because of its association with cancer in animals and human occupational studies. It is postulated that metabolism renders these compounds more toxic. Therefore, the structure of the metabolite influences toxicity.

ZINC

(CAS RN 7440-66-6)

Metallic zinc and various zinc salts are used extensively in the metal plating industry. Zinc is used in galvanizing, electroplating, dry cells, alloying, soldering fluxes, smoke generators, and zinc oxide is used as a pigment for paints and cosmetics. The toxicity of zinc depends on the particular form and salt of zinc and on the route of administration. Zinc is an essential nutrient and is found in a number of metalloenzymes including carbonic anhydrase, carboxypeptidase, alcohol dehydrodgenase, lactic dehydrogenase and alkaline phosphatase (Klaassen et al., 1986).

Zinc salts are used therapeutically as topical astringents, antiseptics, and emetics. Zinc undecylenate is commonly used in athlete's foot preparations and zinc pyridinethione is a common ingredient in antidandruff shampoos. Zinc is often used as a carrier salt for insulin preparations and bactericides.

Acute Effects

Acute exposure to zinc salts via ingestion results in nausea and gastrointestinal irritation. The most common form of acute zinc intoxication is in the inhalation of metal fumes. Zinc fume intoxication results in ocular, mucous membrane, and dermal irritation, malaise, fatigue, headache, blurred vision, and muscle cramping with pulmonary edema at very high concentrations. Upper respiratory tract irritation and sore throat are common symptoms of fume exposures. Acute, lethal exposure results in severe pulmonary edema followed by cyanosis, coma and death (Proctor, 1989).

Chronic Effects

In brass foundry workers, zinc oxide was found to produce zinc fume fevers due to inhalation of fumes during manufacturing processes. Clinical recovery is usually complete in 24 to 48 hours. Chronic exposure to fumes has not shown adverse effects (NIOSH, 1986). Chronic exposure often results in bronchial pneumonia.

A fine salt of strong mineral acids can be corrosive to the skin and irritating to the gastrointestinal tract. However, the use of zinc oxide in many topical dermatologic preparations has demonstrated a low potential for skin irritation. An occupational dermatitis "Oxidepox" was reported in alloy workers exposed to zinc oxide particulates (ATSDR, 1989). It was concluded that zinc oxide particulates and lack of personal hygiene contributed to the minor eruptions. These were reversible with the institution of good hygiene practices (Clayton, 1981).

Gastrointestinal disturbances with peptic-ulcer-like symptoms have been supported in workers employed for years in brass foundries (Clayton, 1981). Clinically latent liver dysfunction has been reported in workers exposed to high levels of zinc oxide. Evidence of peptic ulcers was felt to be indicative of gastrointestinal tract damage (NIOSH, 1986)

The USEPA has derived a chronic oral reference dose (RfD) of 3.0×10^{-1} mg/kg-day for zinc (IRIS, 2001).

Zinc is a nutritionally essential metal and deficiency results in several health consequences. Excessive exposure to zinc is relatively uncommon and requires very heavy exposure.

Carcinogenic And Other Health Effects

There are no reports of zinc or zinc salts possessing carcinogenic activity. Zinc has been reported to inhibit tumor initiation but the mechanism is unknown. Zinc is cytotoxic to cells in culture and can cause chromosomal abnormalities to mammalian cells in culture.

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APPENDIX M

HUMAN HEALTH RISK ASSESSMENT CALCULATIONS

TABLE M-1

CANCER RISK CALCULATIONS FOR HYPOTHETICAL FUTURE RESIDENTS
SITE FTIR-38 AREA 1 - SURFACE SOILS
NATIONAL TRAINING CENTER, FORT IRWIN

Constituent	Soil Concentration[a] (mg/kg)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	VOC Inhalation Dose (mg/kg-d)	Dust Inhalation Dose (mg/kg-d)	Cancer Slope Factor (mg/kg-d)$^{-1}$			Pathway-Specific Cancer Risk				Chemical-Specific Risk
						Oral	Dermal	Inhalation	Ingestion	Dermal	VOC Inhalation	Dust Inhalation	
Inorganics													
Arsenic	15.5	2.43E-05	2.3E-06	Inc	1.7E-09	1.5E+00	1.5E+00	1.5E+01	3.6E-05	3.4E-06	Inc	2.6E-08	4.0E-05
Beryllium	1.7	2.66E-06	8.4E-08	Inc	1.9E-10	na	na	8.4E+00	0.0E+00	0.0E+00	Inc	1.6E-09	1.6E-09
Cadmium	1.1	1.72E-06	5.4E-09	Inc	1.2E-10	na	na	6.3E+00	0.0E+00	0.0E+00	Inc	7.8E-10	7.8E-10
Chromium	29.9	4.68E-05	1.5E-06	Inc	3.4E-09	na	na	4.2E+01	0.0E+00	0.0E+00	Inc	1.4E-07	1.4E-07
												ILCR:	**4.0E-05**

Notes:

[a] Based on the maximum or 95 percent upper confidence limit (95% UCL) on the mean concentration detected at the site.

1) Doses and cancer risks shown only for carcinogenic chemicals with available toxicity values.
2) Absorbed doses were calculated for dermal contact with the medium, and intakes were calculated for ingestion or inhalation of a medium
3) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor.

ILCR	Incremental lifetime cancer risk.
Inc	Incomplete pathway.
mg/kg	Milligrams per kilogram.
mg/kg-d	Milligrams per kilogram per day.
na	Not available.

TABLE M-2

NONCANCER HAZARD CALCULATIONS FOR A HYPOTHETICAL FUTURE RESIDENT
SITE FTIR-38 AREA 1 - SURFACE SOILS
NATIONAL TRAINING CENTER, FORT IRWIN

Constituent	Soil Concentration[a] (mg/kg)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	VOC Inhalation Dose (mg/kg-d)	Dust Inhalation Dose (mg/kg-d)	Reference Dose (mg/kg-d)			Pathway-Specific Noncancer HI				Chemical-Specific HI
						Oral	Dermal	Inhalation	Ingestion	Dermal	VOC Inhalation	Dust Inhalation	
Inorganics													
Aluminum	30,900	1.13E-01	3.6E-03	Inc	8.1E-06	1.0E+00	1.0E+00	1.4E-03	1.1E-01	3.6E-03	Inc	5.8E-03	1.2E-01
Arsenic	15.5	5.66E-05	5.4E-06	Inc	4.1E-09	3.0E-04	3.0E-04	3.0E-04	1.9E-01	1.8E-02	Inc	1.4E-05	2.1E-01
Barium	244	8.91E-04	2.8E-05	Inc	6.4E-08	7.0E-02	7.0E-02	1.4E-04	1.3E-02	4.0E-04	Inc	4.6E-04	1.4E-02
Beryllium	1.7	6.21E-06	2.0E-07	Inc	4.5E-10	2.0E-03	2.0E-03	5.7E-06	3.1E-03	9.8E-05	Inc	7.8E-05	3.3E-03
Cadmium	1.1	4.02E-06	1.3E-08	Inc	2.9E-10	5.0E-04	5.0E-04	5.0E-04	8.0E-03	2.5E-05	Inc	5.8E-07	8.1E-03
Chromium	29.9	1.09E-04	3.4E-06	Inc	7.9E-09	1.5E+00	1.5E+00	na	7.3E-05	2.3E-06	Inc	0.0E+00	7.5E-05
Cobalt	15.9	5.81E-05	1.8E-06	Inc	4.2E-09	6.0E-02	6.0E-02	6.0E-02	9.7E-04	3.1E-05	Inc	7.0E-08	1.0E-03
Copper	79.8	2.92E-04	9.2E-06	Inc	2.1E-08	3.7E-02	3.7E-02	3.7E-02	7.9E-03	2.5E-04	Inc	5.7E-07	8.1E-03
Manganese	765	2.79E-03	8.8E-05	Inc	2.0E-07	2.4E-02	2.4E-02	1.4E-05	1.2E-01	3.7E-03	Inc	1.4E-02	1.3E-01
Molybdenum	5.5	2.01E-05	6.3E-07	Inc	1.4E-09	5.0E-03	5.0E-03	5.0E-03	4.0E-03	1.3E-04	Inc	2.9E-07	4.1E-03
Zinc	177	6.47E-04	2.0E-05	Inc	4.7E-08	3.0E-01	3.0E-01	3.0E-01	2.2E-03	6.8E-05	Inc	1.6E-07	2.2E-03
												Total HI:	0.50

Notes:

[a] Based on the maximum or 95 percent upper confidence limit (95% UCL) on the mean concentration detected at the site.

1) Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

2) Absorbed doses were calculated for dermal contact with the medium, and intakes were calculated for ingestion or inhalation of a medium

3) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HI = Exposure Dose/Reference dose.

HI — Hazard index.
Inc — Incomplete pathway.
mg/kg — Milligrams per kilogram.
mg/kd-d — Milligrams per kilogram per day.

TABLE M-3

CANCER RISK CALCULATIONS FOR A FUTURE INDUSTRIAL WORKER
SITE FTIR-38 AREA 1 - SURFACE SOILS
NATIONAL TRAINING CENTER, FORT IRWIN

Constituent	Soil Concentration[a] (mg/kg)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	VOC Inhalation Dose (mg/kg-d)	Dust Inhalation Dose (mg/kg-d)	Cancer Slope Factor (mg/kg-d)$^{-1}$			Pathway-Specific Cancer Risk				Chemical-Specific Risk
						Oral	Dermal	Inhalation	Ingestion	Dermal	VOC Inhalation	Dust Inhalation	
Inorganics													
Arsenic	15.5	2.71E-06	1.1E-06	Inc	1.4E-08	1.5E+00	1.5E+00	1.5E+01	4.1E-06	1.6E-06	Inc	2.2E-07	5.9E-06
Beryllium	1.7	2.97E-07	3.9E-08	Inc	1.6E-09	na	na	8.4E+00	0.0E+00	0.0E+00	Inc	1.3E-08	1.3E-08
Cadmium	1.1	1.92E-07	2.5E-09	Inc	1.0E-09	na	na	6.3E+00	0.0E+00	0.0E+00	Inc	6.4E-09	6.4E-09
Chromium	29.9	5.22E-06	6.9E-07	Inc	2.8E-08	na	na	4.2E+01	0.0E+00	0.0E+00	Inc	1.2E-06	1.2E-06
												ILCR:	7.1E-06

Notes:

[a] Based on the maximum or 95 percent upper confidence limit (95% UCL) on the mean concentration detected at the site.

1) Doses and cancer risks shown only for carcinogenic chemicals with available toxicity values.
2) Absorbed doses were calculated for dermal contact with the medium, and intakes were calculated for ingestion or inhalation of a medium
3) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor.

ILCR	Incremental lifetime cancer risk.
Inc	Incomplete pathway.
mg/kg	Milligrams per kilogram.
mg/kg-d	Milligrams per kilogram per day.
na	Not available.

TABLE M-4

NONCANCER HAZARD CALCULATIONS FOR A FUTURE INDUSTRIAL WORKER
SITE FTIR-38 AREA 1 - SURFACE SOILS
NATIONAL TRAINING CENTER, FORT IRWIN

Constituent	Soil Concentration[a] (mg/kg)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	VOC Inhalation Dose (mg/kg-d)	Dust Inhalation Dose (mg/kg-d)	Reference Dose (mg/kg-d)			Pathway-Specific Noncancer HI				Chemical-Specific HI
						Oral	Dermal	Inhalation	Ingestion	Dermal	VOC Inhalation	Dust Inhalation	
Inorganics													
Aluminum	30,900	1.51E-02	2.0E-03	Inc	7.9E-05	1.0E+00	1.0E+00	1.4E-03	1.5E-02	2.0E-03	Inc	5.7E-02	7.4E-02
Arsenic	15.5	7.58E-06	3.0E-06	Inc	4.0E-08	3.0E-04	3.0E-04	3.0E-04	2.5E-02	1.0E-02	Inc	1.3E-04	3.5E-02
Barium	244	1.19E-04	1.6E-05	Inc	6.3E-07	7.0E-02	7.0E-02	1.4E-04	1.7E-03	2.3E-04	Inc	4.5E-03	6.4E-03
Beryllium	1.7	8.32E-07	1.1E-07	Inc	4.4E-09	2.0E-03	2.0E-03	5.7E-06	4.2E-04	5.5E-05	Inc	7.6E-04	1.2E-03
Cadmium	1.1	5.38E-07	7.1E-09	Inc	2.8E-09	5.0E-04	5.0E-04	5.0E-04	1.1E-03	1.4E-05	Inc	5.6E-06	1.1E-03
Chromium	29.9	1.46E-05	1.9E-06	Inc	7.7E-08	1.5E+00	1.5E+00	na	9.8E-06	1.3E-06	Inc	0.0E+00	1.1E-05
Cobalt	15.9	7.78E-06	1.0E-06	Inc	4.1E-08	6.0E-02	6.0E-02	6.0E-02	1.3E-04	1.7E-05	Inc	6.8E-07	1.5E-04
Copper	79.8	3.90E-05	5.2E-06	Inc	2.0E-07	3.7E-02	3.7E-02	3.7E-02	1.1E-03	1.4E-04	Inc	5.5E-06	1.2E-03
Manganese	765	3.74E-04	4.9E-05	Inc	2.0E-06	2.4E-02	2.4E-02	1.4E-05	1.6E-02	2.1E-03	Inc	1.4E-01	1.6E-01
Molybdenum	5.5	2.69E-06	3.6E-07	Inc	1.4E-08	5.0E-03	5.0E-03	5.0E-03	5.4E-04	7.1E-05	Inc	2.8E-06	6.1E-04
Zinc	177	8.66E-05	1.1E-05	Inc	4.5E-07	3.0E-01	3.0E-01	3.0E-01	2.9E-04	3.8E-05	Inc	1.5E-06	3.3E-04
												Total HI:	**0.28**

Notes:

[a] Based on the maximum or 95 percent upper confidence limit (95% UCL) on the mean concentration detected at the site.

1) Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

2) Absorbed doses were calculated for dermal contact with the medium, and intakes were calculated for ingestion or inhalation of a medium

3) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HI = Exposure Dose/Reference dose.

HI	Hazard index.
Inc	Incomplete pathway.
mg/kg	Milligrams per kilogram.
mg/kd-d	Milligrams per kilogram per day.

TABLE M-5

CANCER RISK CALCULATIONS FOR HYPOTHETICAL FUTURE RESIDENTS
SITE FTIR-38 AREA 1 - SUBSURFACE SOILS
NATIONAL TRAINING CENTER, FORT IRWIN

Constituent	Soil Concentration[a] (mg/kg)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	VOC Inhalation Dose (mg/kg-d)	Dust Inhalation Dose (mg/kg-d)	Cancer Slope Factor (mg/kg-d)$^{-1}$			Pathway-Specific Cancer Risk				Chemical-Specific Risk
						Oral	Dermal	Inhalation	Ingestion	Dermal	VOC Inhalation	Dust Inhalation	
Inorganics													
Beryllium	1.6	2.50E-06	7.9E-08	Inc	1.8E-10	na	na	8.4E+00	0.0E+00	0.0E+00	Inc	1.5E-09	1.5E-09
Chromium	33.5	5.24E-05	1.7E-06	Inc	3.8E-09	na	na	4.2E+01	0.0E+00	0.0E+00	Inc	1.6E-07	1.6E-07
												ILCR:	1.6E-07

Notes:

[a] Based on the maximum or 95 percent upper confidence limit (95% UCL) on the mean concentration detected at the site.

1) Doses and cancer risks shown only for carcinogenic chemicals with available toxicity values.
2) Absorbed doses were calculated for dermal contact with the medium, and intakes were calculated for ingestion or inhalation of a medium
3) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor.

ILCR	Incremental lifetime cancer risk.
Inc	Incomplete pathway.
mg/kg	Milligrams per kilogram.
mg/kg-d	Milligrams per kilogram per day.
na	Not available.

TABLE M-6

NONCANCER HAZARD CALCULATIONS FOR A HYPOTHETICAL FUTURE RESIDENT
SITE FTIR-38 AREA 1 - SUBSURFACE SOILS
NATIONAL TRAINING CENTER, FORT IRWIN

Constituent	Soil Concentration[a] (mg/kg)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	VOC Inhalation Dose (mg/kg-d)	Dust Inhalation Dose (mg/kg-d)	Reference Dose (mg/kg-d)			Pathway-Specific Noncancer HI				Chemical-Specific HI
						Oral	Dermal	Inhalation	Ingestion	Dermal	VOC Inhalation	Dust Inhalation	
Inorganics													
Aluminum	30,000	1.10E-01	3.5E-03	Inc	7.9E-06	1.0E+00	1.0E+00	1.4E-03	1.1E-01	3.5E-03	Inc	5.6E-03	1.2E-01
Barium	198	7.23E-04	2.3E-05	Inc	5.2E-08	7.0E-02	7.0E-02	1.4E-04	1.0E-02	3.3E-04	Inc	3.7E-04	1.1E-02
Beryllium	1.6	5.84E-06	1.8E-07	Inc	4.2E-10	2.0E-03	2.0E-03	5.7E-06	2.9E-03	9.2E-05	Inc	7.4E-05	3.1E-03
Chromium	33.5	1.22E-04	3.9E-06	Inc	8.8E-09	1.5E+00	1.5E+00	na	8.2E-05	2.6E-06	Inc	0.0E+00	8.4E-05
Cobalt	14.1	5.15E-05	1.6E-06	Inc	3.7E-09	6.0E-02	6.0E-02	6.0E-02	8.6E-04	2.7E-05	Inc	6.2E-08	8.9E-04
Copper	49.9	1.82E-04	5.8E-06	Inc	1.3E-08	3.7E-02	3.7E-02	3.7E-02	4.9E-03	1.6E-04	Inc	3.5E-07	5.1E-03
Manganese	801	2.93E-03	9.2E-05	Inc	2.1E-07	2.4E-02	2.4E-02	1.4E-05	1.2E-01	3.8E-03	Inc	1.5E-02	1.4E-01
Vanadium	421	1.54E-03	4.9E-05	Inc	1.1E-07	7.0E-03	7.0E-03	7.0E-03	2.2E-01	6.9E-03	Inc	1.6E-05	2.3E-01
Zinc	215	7.85E-04	2.5E-05	Inc	5.7E-08	3.0E-01	3.0E-01	3.0E-01	2.6E-03	8.3E-05	Inc	1.9E-07	2.7E-03
												Total HI:	**0.51**

Notes:

[a] Based on the maximum or 95 percent upper confidence limit (95% UCL) on the mean concentration detected at the site.

1) Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

2) Absorbed doses were calculated for dermal contact with the medium, and intakes were calculated for ingestion or inhalation of a medium

3) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HI = Exposure Dose/Reference dose.

HI	Hazard index.
Inc	Incomplete pathway.
mg/kg	Milligrams per kilogram.
mg/kd-d	Milligrams per kilogram per day.

TABLE M-7

CANCER RISK CALCULATIONS FOR A FUTURE INDUSTRIAL WORKER
SITE FTIR-38 AREA 1 - SUBSURFACE SOILS
NATIONAL TRAINING CENTER, FORT IRWIN

Constituent	Soil Concentration[a] (mg/kg)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	VOC Inhalation Dose (mg/kg-d)	Dust Inhalation Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$			Pathway-Specific Cancer Risk				Chemical-Specific Risk
						Oral	Dermal	Inhalation	Ingestion	Dermal	VOC Inhalation	Dust Inhalation	
Inorganics													
Beryllium	1.6	2.80E-07	3.7E-08	Inc	1.5E-09	na	na	8.4E+00	0.0E+00	0.0E+00	Inc	1.2E-08	1.2E-08
Chromium	33.5	5.85E-06	7.7E-07	Inc	3.1E-08	na	na	4.2E+01	0.0E+00	0.0E+00	Inc	1.3E-06	1.3E-06
												ILCR:	1.3E-06

Notes:

[a] Based on the maximum or 95 percent upper confidence limit (95% UCL) on the mean concentration detected at the site.

1) Doses and cancer risks shown only for carcinogenic chemicals with available toxicity values.
2) Absorbed doses were calculated for dermal contact with the medium, and intakes were calculated for ingestion or inhalation of a medium
3) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor.

ILCR	Incremental lifetime cancer risk.
Inc	Incomplete pathway.
mg/kg	Milligrams per kilogram.
mg/kg-d	Milligrams per kilogram per day.
na	Not available.

TABLE M-8

NONCANCER HAZARD CALCULATIONS FOR A FUTURE INDUSTRIAL WORKER
SITE FTIR-38 AREA 1 - SUBSURFACE SOILS
NATIONAL TRAINING CENTER, FORT IRWIN

Constituent	Soil Concentration[a] (mg/kg)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	VOC Inhalation Dose (mg/kg-d)	Dust Inhalation Dose (mg/kg-d)	Reference Dose (mg/kg-d)			Pathway-Specific Noncancer HI				Chemical-Specific HI
						Oral	Dermal	Inhalation	Ingestion	Dermal	VOC Inhalation	Dust Inhalation	
Inorganics													
Aluminum	30,000	1.47E-02	1.9E-03	Inc	7.7E-05	1.0E+00	1.0E+00	1.4E-03	1.5E-02	1.9E-03	Inc	5.5E-02	7.2E-02
Barium	198	9.69E-05	1.3E-05	Inc	5.1E-07	7.0E-02	7.0E-02	1.4E-04	1.4E-03	1.8E-04	Inc	3.6E-03	5.2E-03
Beryllium	1.6	7.83E-07	1.0E-07	Inc	4.1E-09	2.0E-03	2.0E-03	5.7E-06	3.9E-04	5.2E-05	Inc	7.2E-04	1.2E-03
Chromium	33.5	1.64E-05	2.2E-06	Inc	8.6E-08	1.5E+00	1.5E+00	na	1.1E-05	1.4E-06	Inc	0.0E+00	1.2E-05
Cobalt	14.1	6.90E-06	9.1E-07	Inc	3.6E-08	6.0E-02	6.0E-02	6.0E-02	1.1E-04	1.5E-05	Inc	6.0E-07	1.3E-04
Copper	49.9	2.44E-05	3.2E-06	Inc	1.3E-07	3.7E-02	3.7E-02	3.7E-02	6.6E-04	8.7E-05	Inc	3.5E-06	7.5E-04
Manganese	801	3.92E-04	5.2E-05	Inc	2.1E-06	2.4E-02	2.4E-02	1.4E-05	1.6E-02	2.2E-03	Inc	1.5E-01	1.7E-01
Vanadium	421	2.06E-04	2.7E-05	Inc	1.1E-06	7.0E-03	7.0E-03	7.0E-03	2.9E-02	3.9E-03	Inc	1.5E-04	3.3E-02
Zinc	215	1.05E-04	1.4E-05	Inc	5.5E-07	3.0E-01	3.0E-01	3.0E-01	3.5E-04	4.6E-05	Inc	1.8E-06	4.0E-04
												Total HI:	0.28

Notes:

[a] Based on the maximum or 95 percent upper confidence limit (95% UCL) on the mean concentration detected at the site.

1) Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

2) Absorbed doses were calculated for dermal contact with the medium, and intakes were calculated for ingestion or inhalation of a medium

3) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HI = Exposure Dose/Reference dose.

HI — Hazard index.
Inc — Incomplete pathway.
mg/kg — Milligrams per kilogram.
mg/kd-d — Milligrams per kilogram per day.

TABLE M-9

CANCER RISK CALCULATIONS FOR HYPOTHETICAL FUTURE RESIDENTS
SITE FTIR-38 AREA 2 - SURFACE SOILS
NATIONAL TRAINING CENTER, FORT IRWIN

Constituent	Soil Concentration[a] (mg/kg)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	VOC Inhalation Dose (mg/kg-d)	Dust Inhalation Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$			Pathway-Specific Cancer Risk				Chemical-Specific Risk
						Oral	Dermal	Inhalation	Ingestion	Dermal	VOC Inhalation	Dust Inhalation	
Inorganics													
Arsenic	8.6	1.35E-05	1.3E-06	Inc	9.7E-10	1.5E+00	1.5E+00	1.5E+01	2.0E-05	1.9E-06	Inc	1.5E-08	2.2E-05
Beryllium	0.92	1.44E-06	4.5E-08	Inc	1.0E-10	na	na	8.4E+00	0.0E+00	0.0E+00	Inc	8.7E-10	8.7E-10
												ILCR:	2.2E-05

Notes:

[a] Based on the maximum or 95 percent upper confidence limit (95% UCL) on the mean concentration detected at the site.

1) Doses and cancer risks shown only for carcinogenic chemicals with available toxicity values.

2) Absorbed doses were calculated for dermal contact with the medium, and intakes were calculated for ingestion or inhalation of a medium

3) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor.

ILCR	Incremental lifetime cancer risk.
Inc	Incomplete pathway.
mg/kg	Milligrams per kilogram.
mg/kg-d	Milligrams per kilogram per day.
na	Not available.

TABLE M-10

NONCANCER HAZARD CALCULATIONS FOR A HYPOTHETICAL FUTURE RESIDENT
SITE FTIR-38 AREA 2 - SURFACE SOILS
NATIONAL TRAINING CENTER, FORT IRWIN

Constituent	Soil Concentration[a] (mg/kg)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	VOC Inhalation Dose (mg/kg-d)	Dust Inhalation Dose (mg/kg-d)	Reference Dose (mg/kg-d)			Pathway-Specific Noncancer HI				Chemical-Specific HI
						Oral	Dermal	Inhalation	Ingestion	Dermal	VOC Inhalation	Dust Inhalation	
Inorganics													
Aluminum	22,051	8.06E-02	2.5E-03	Inc	5.8E-06	1.0E+00	1.0E+00	1.4E-03	8.1E-02	2.5E-03	Inc	4.1E-03	8.7E-02
Antimony	5.5	2.01E-05	6.3E-07	Inc	1.4E-09	4.0E-04	4.0E-04	4.0E+00	5.0E-02	1.6E-03	Inc	3.6E-10	5.2E-02
Arsenic	8.6	3.14E-05	3.0E-06	Inc	2.3E-09	3.0E-04	3.0E-04	3.0E-04	1.0E-01	9.9E-03	Inc	7.5E-06	1.1E-01
Barium	184	6.72E-04	2.1E-05	Inc	4.8E-08	7.0E-02	7.0E-02	1.4E-04	9.6E-03	3.0E-04	Inc	3.5E-04	1.0E-02
Beryllium	0.92	3.36E-06	1.1E-07	Inc	2.4E-10	2.0E-03	2.0E-03	5.7E-06	1.7E-03	5.3E-05	Inc	4.2E-05	1.8E-03
Cobalt	12.2	4.46E-05	1.4E-06	Inc	3.2E-09	6.0E-02	6.0E-02	6.0E-02	7.4E-04	2.3E-05	Inc	5.3E-08	7.7E-04
Copper	230	8.40E-04	2.7E-05	Inc	6.0E-08	3.7E-02	3.7E-02	3.7E-02	2.3E-02	7.2E-04	Inc	1.6E-06	2.3E-02
Manganese	654	2.39E-03	7.5E-05	Inc	1.7E-07	2.4E-02	2.4E-02	1.4E-05	1.0E-01	3.1E-03	Inc	1.2E-02	1.1E-01
Molybdenum	3.5	1.28E-05	4.0E-07	Inc	9.2E-10	5.0E-03	5.0E-03	5.0E-03	2.6E-03	8.1E-05	Inc	1.8E-07	2.6E-03
Selenium	0.80	2.92E-06	9.2E-08	Inc	2.1E-10	5.0E-03	5.0E-03	5.0E-03	5.8E-04	1.8E-05	Inc	4.2E-08	6.0E-04
Zinc	102	3.73E-04	1.2E-05	Inc	2.7E-08	3.0E-01	3.0E-01	3.0E-01	1.2E-03	3.9E-05	Inc	8.9E-08	1.3E-03
												Total HI:	0.41

Notes:

[a] Based on the maximum or 95 percent upper confidence limit (95% UCL) on the mean concentration detected at the site.

1) Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.
2) Absorbed doses were calculated for dermal contact with the medium, and intakes were calculated for ingestion or inhalation of a medium
3) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HI = Exposure Dose/Reference dose.

HI Hazard index.
Inc Incomplete pathway.
mg/kg Milligrams per kilogram.
mg/kd-d Milligrams per kilogram per day.

TABLE M-11

CANCER RISK CALCULATIONS FOR A FUTURE INDUSTRIAL WORKER
SITE FTIR-38 AREA 2 - SURFACE SOILS
NATIONAL TRAINING CENTER, FORT IRWIN

Constituent	Soil Concentration[a] (mg/kg)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	VOC Inhalation Dose (mg/kg-d)	Dust Inhalation Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$			Pathway-Specific Cancer Risk				Chemical-Specific Risk
						Oral	Dermal	Inhalation	Ingestion	Dermal	VOC Inhalation	Dust Inhalation	
Inorganics													
Arsenic	8.6	1.50E-06	6.0E-07	Inc	7.9E-09	1.5E+00	1.5E+00	1.5E+01	2.3E-06	8.9E-07	Inc	1.2E-07	3.3E-06
Beryllium	0.92	1.61E-07	2.1E-08	Inc	8.4E-10	na	na	8.4E+00	0.0E+00	0.0E+00	Inc	7.1E-09	7.1E-09
												ILCR:	3.3E-06

Notes:

[a] Based on the maximum or 95 percent upper confidence limit (95% UCL) on the mean concentration detected at the site.

1) Doses and cancer risks shown only for carcinogenic chemicals with available toxicity values.
2) Absorbed doses were calculated for dermal contact with the medium, and intakes were calculated for ingestion or inhalation of a medium
3) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor.

ILCR	Incremental lifetime cancer risk.
Inc	Incomplete pathway.
mg/kg	Milligrams per kilogram.
mg/kg-d	Milligrams per kilogram per day.
na	Not available.

TABLE M-12

NONCANCER HAZARD CALCULATIONS FOR A FUTURE INDUSTRIAL WORKER
SITE FTIR-38 AREA 2 - SURFACE SOILS
NATIONAL TRAINING CENTER, FORT IRWIN

Constituent	Soil Concentration[a] (mg/kg)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	VOC Inhalation Dose (mg/kg-d)	Dust Inhalation Dose (mg/kg-d)	Reference Dose (mg/kg-d)			Pathway-Specific Noncancer HI				Chemical-Specific HI
						Oral	Dermal	Inhalation	Ingestion	Dermal	VOC Inhalation	Dust Inhalation	
Inorganics													
Aluminum	22,051	1.08E-02	1.4E-03	Inc	1.1E-04	1.0E+00	1.0E+00	1.4E-03	1.1E-02	1.4E-03	Inc	7.7E-02	8.9E-02
Antimony	5.5	2.69E-06	3.6E-07	Inc	2.7E-08	4.0E-04	4.0E-04	4.0E+00	6.7E-03	8.9E-04	Inc	6.7E-09	7.6E-03
Arsenic	8.6	4.21E-06	1.7E-06	Inc	4.2E-08	3.0E-04	3.0E-04	3.0E-04	1.4E-02	5.6E-03	Inc	1.4E-04	2.0E-02
Barium	184	9.00E-05	1.2E-05	Inc	9.0E-07	7.0E-02	7.0E-02	1.4E-04	1.3E-03	1.7E-04	Inc	6.4E-03	7.9E-03
Beryllium	0.92	4.50E-07	5.9E-08	Inc	4.5E-09	2.0E-03	2.0E-03	5.7E-06	2.3E-04	3.0E-05	Inc	7.9E-04	1.0E-03
Cobalt	12.2	5.97E-06	7.9E-07	Inc	6.0E-08	6.0E-02	6.0E-02	6.0E-02	9.9E-05	1.3E-05	Inc	9.9E-07	1.1E-04
Copper	230	1.13E-04	1.5E-05	Inc	1.1E-06	3.7E-02	3.7E-02	3.7E-02	3.0E-03	4.0E-04	Inc	3.0E-05	3.5E-03
Manganese	654	3.20E-04	4.2E-05	Inc	3.2E-06	2.4E-02	2.4E-02	1.4E-05	1.3E-02	1.8E-03	Inc	2.3E-01	2.4E-01
Molybdenum	3.5	1.71E-06	2.3E-07	Inc	1.7E-08	5.0E-03	5.0E-03	5.0E-03	3.4E-04	4.5E-05	Inc	3.4E-06	3.9E-04
Selenium	0.80	3.91E-07	5.2E-08	Inc	3.9E-09	5.0E-03	5.0E-03	5.0E-03	7.8E-05	1.0E-05	Inc	7.8E-07	8.9E-05
Zinc	102	4.99E-05	6.6E-06	Inc	5.0E-07	3.0E-01	3.0E-01	3.0E-01	1.7E-04	2.2E-05	Inc	1.7E-06	1.9E-04
												Total HI:	0.37

Notes:

[a] Based on the maximum or 95 percent upper confidence limit (95% UCL) on the mean concentration detected at the site.

1) Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

2) Absorbed doses were calculated for dermal contact with the medium, and intakes were calculated for ingestion or inhalation of a medium

3) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HI = Exposure Dose/Reference dose.

HI Hazard index.
Inc Incomplete pathway.
mg/kg Milligrams per kilogram.
mg/kd-d Milligrams per kilogram per day.

TABLE M-13

CANCER RISK CALCULATIONS FOR HYPOTHETICAL FUTURE RESIDENTS
SITE FTIR-40 AREA 1.1 - SURFACE SOILS
NATIONAL TRAINING CENTER, FORT IRWIN

Constituent	Soil Concentration[a] (mg/kg)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	VOC Inhalation Dose (mg/kg-d)	Dust Inhalation Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$			Pathway-Specific Cancer Risk				Chemical-Specific Risk
						Oral	Dermal	Inhalation	Ingestion	Dermal	VOC Inhalation	Dust Inhalation	
Inorganics													
Arsenic	10.3	1.61E-05	1.5E-06	Inc	1.2E-09	1.5E+00	1.5E+00	1.5E+01	2.4E-05	2.3E-06	Inc	1.7E-08	2.6E-05
Cadmium	53.9	8.44E-05	2.7E-07	Inc	6.1E-09	na	na	6.3E+00	0.0E+00	0.0E+00	Inc	3.8E-08	3.8E-08
Chromium	31.9	4.99E-05	1.6E-06	Inc	3.6E-09	na	na	4.2E+01	0.0E+00	0.0E+00	Inc	1.5E-07	1.5E-07
												ILCR:	2.7E-05

Notes:

[a] Based on the maximum or 95 percent upper confidence limit (95% UCL) on the mean concentration detected at the site.

1) Doses and cancer risks shown only for carcinogenic chemicals with available toxicity values.
2) Absorbed doses were calculated for dermal contact with the medium, and intakes were calculated for ingestion or inhalation of a medium
3) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor.

ILCR	Incremental lifetime cancer risk.
Inc	Incomplete pathway.
mg/kg	Milligrams per kilogram.
mg/kg-d	Milligrams per kilogram per day.
na	Not available.

TABLE M-14

NONCANCER HAZARD CALCULATIONS FOR A HYPOTHETICAL FUTURE RESIDENT
SITE FTIR-40 AREA 1.1 - SURFACE SOILS
NATIONAL TRAINING CENTER, FORT IRWIN

Constituent	Soil Concentration[a] (mg/kg)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	VOC Inhalation Dose (mg/kg-d)	Dust Inhalation Dose (mg/kg-d)	Reference Dose (mg/kg-d)			Pathway-Specific Noncancer HI				Chemical-Specific HI
						Oral	Dermal	Inhalation	Ingestion	Dermal	VOC Inhalation	Dust Inhalation	
Inorganics													
Aluminum	19,202	7.01E-02	2.2E-03	Inc	5.0E-06	1.0E+00	1.0E+00	1.4E-03	7.0E-02	2.2E-03	Inc	3.6E-03	7.6E-02
Antimony	36.1	1.32E-04	4.2E-06	Inc	9.5E-09	4.0E-04	4.0E-04	4.0E+00	3.3E-01	1.0E-02	Inc	2.4E-09	3.4E-01
Arsenic	10.3	3.76E-05	3.6E-06	Inc	2.7E-09	3.0E-04	3.0E-04	3.0E-04	1.3E-01	1.2E-02	Inc	9.0E-06	1.4E-01
Barium	405	1.48E-03	4.7E-05	Inc	1.1E-07	7.0E-02	7.0E-02	1.4E-04	2.1E-02	6.7E-04	Inc	7.6E-04	2.3E-02
Cadmium	53.9	1.97E-04	6.2E-07	Inc	1.4E-08	5.0E-04	5.0E-04	5.0E-04	3.9E-01	1.2E-03	Inc	2.8E-05	4.0E-01
Chromium	31.9	1.17E-04	3.7E-06	Inc	8.4E-09	1.5E+00	1.5E+00	na	7.8E-05	2.5E-06	Inc	0.0E+00	8.0E-05
Cobalt	10.6	3.87E-05	1.2E-06	Inc	2.8E-09	6.0E-02	6.0E-02	6.0E-02	6.5E-04	2.0E-05	Inc	4.6E-08	6.7E-04
Copper	12,069	4.41E-02	1.4E-03	Inc	3.2E-06	3.7E-02	3.7E-02	3.7E-02	1.2E+00	3.8E-02	Inc	8.6E-05	1.2E+00
Manganese	714	2.61E-03	8.2E-05	Inc	1.9E-07	2.4E-02	2.4E-02	1.4E-05	1.1E-01	3.4E-03	Inc	1.3E-02	1.3E-01
Mercury	1.9	6.94E-06	2.2E-07	Inc	5.0E-10	3.0E-04	3.0E-04	3.0E-04	2.3E-02	7.3E-04	Inc	1.7E-06	2.4E-02
Molybdenum	11.4	4.16E-05	1.3E-06	Inc	3.0E-09	5.0E-03	5.0E-03	5.0E-03	8.3E-03	2.6E-04	Inc	6.0E-07	8.6E-03
Nickel	32.6	1.19E-04	3.8E-06	Inc	8.6E-09	2.0E-02	2.0E-02	2.0E-02	6.0E-03	1.9E-04	Inc	4.3E-07	6.1E-03
Selenium	0.94	3.43E-06	1.1E-07	Inc	2.5E-10	5.0E-03	5.0E-03	5.0E-03	6.9E-04	2.2E-05	Inc	4.9E-08	7.1E-04
Silver	74.0	2.70E-04	8.5E-06	Inc	1.9E-08	5.0E-03	5.0E-03	5.0E-03	5.4E-02	1.7E-03	Inc	3.9E-06	5.6E-02
Zinc	8,740	3.19E-02	1.0E-03	Inc	2.3E-06	3.0E-01	3.0E-01	3.0E-01	1.1E-01	3.4E-03	Inc	7.7E-06	1.1E-01
Organic Compounds													
2,4,6-Trinitrotoluene	0.90	3.29E-06	1.0E-06	Inc	2.4E-10	5.0E-04	5.0E-04	5.0E-04	6.6E-03	2.1E-03	Inc	4.7E-07	8.7E-03
												Total HI:	**2.5E+00**

Notes:

[a] Based on the maximum or 95 percent upper confidence limit (95% UCL) on the mean concentration detected at the site.

1) Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

2) Absorbed doses were calculated for dermal contact with the medium, and intakes were calculated for ingestion or inhalation of a medium

3) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HI = Exposure Dose/Reference dose.

HI Hazard index.
Inc Incomplete pathway.
mg/kg Milligrams per kilogram.
mg/kd-d Milligrams per kilogram per day.

TABLE M-15

CANCER RISK CALCULATIONS FOR A FUTURE INDUSTRIAL WORKER
SITE FTIR-40 AREA 1.1 - SURFACE SOILS
NATIONAL TRAINING CENTER, FORT IRWIN

Constituent	Soil Concentration[a] (mg/kg)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	VOC Inhalation Dose (mg/kg-d)	Dust Inhalation Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$			Pathway-Specific Cancer Risk				Chemical-Specific Risk
						Oral	Dermal	Inhalation	Ingestion	Dermal	VOC Inhalation	Dust Inhalation	
Inorganics													
Arsenic	10.3	1.80E-06	7.1E-07	Inc	9.4E-09	1.5E+00	1.5E+00	1.5E+01	2.7E-06	1.1E-06	Inc	1.4E-07	3.9E-06
Cadmium	53.9	9.42E-06	1.2E-07	Inc	4.9E-08	na	na	6.3E+00	0.0E+00	0.0E+00	Inc	3.1E-07	3.1E-07
Chromium	31.9	5.57E-06	7.4E-07	Inc	2.9E-08	na	na	4.2E+01	0.0E+00	0.0E+00	Inc	1.2E-06	1.2E-06
												ILCR:	5.4E-06

Notes:

[a] Based on the maximum or 95 percent upper confidence limit (95% UCL) on the mean concentration detected at the site.

1) Doses and cancer risks shown only for carcinogenic chemicals with available toxicity values.
2) Absorbed doses were calculated for dermal contact with the medium, and intakes were calculated for ingestion or inhalation of a medium
3) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor.

ILCR Incremental lifetime cancer risk.
Inc Incomplete pathway.
mg/kg Milligrams per kilogram.
mg/kg-d Milligrams per kilogram per day.
na Not available.

TABLE M-16

NONCANCER HAZARD CALCULATIONS FOR A FUTURE INDUSTRIAL WORKER
SITE FTIR-40 AREA 1.1 - SURFACE SOILS
NATIONAL TRAINING CENTER, FORT IRWIN

Constituent	Soil Concentration[a] (mg/kg)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	VOC Inhalation Dose (mg/kg-d)	Dust Inhalation Dose (mg/kg-d)	Reference Dose (mg/kg-d)			Pathway-Specific Noncancer HI				Chemical-Specific HI
						Oral	Dermal	Inhalation	Ingestion	Dermal	VOC Inhalation	Dust Inhalation	
Inorganics													
Aluminum	19,202	9.39E-03	1.2E-03	Inc	3.0E-05	1.0E+00	1.0E+00	1.4E-03	9.4E-03	1.2E-03	Inc	2.1E-02	3.2E-02
Antimony	36.1	1.77E-05	2.3E-06	Inc	5.6E-08	4.0E-04	4.0E-04	4.0E+00	4.4E-02	5.8E-03	Inc	1.4E-08	5.0E-02
Arsenic	10.3	5.04E-06	2.0E-06	Inc	1.6E-08	3.0E-04	3.0E-04	3.0E-04	1.7E-02	6.7E-03	Inc	5.4E-05	2.4E-02
Barium	405	1.98E-04	2.6E-05	Inc	6.3E-07	7.0E-02	7.0E-02	1.4E-04	2.8E-03	3.7E-04	Inc	4.5E-03	7.7E-03
Cadmium	53.9	2.64E-05	3.5E-07	Inc	8.4E-08	5.0E-04	5.0E-04	5.0E-04	5.3E-02	7.0E-04	Inc	1.7E-04	5.4E-02
Chromium	31.9	1.56E-05	2.1E-06	Inc	5.0E-08	1.5E+00	1.5E+00	na	1.0E-05	1.4E-06	Inc	0.0E+00	1.2E-05
Cobalt	10.6	5.19E-06	6.8E-07	Inc	1.7E-08	6.0E-02	6.0E-02	6.0E-02	8.6E-05	1.1E-05	Inc	2.8E-07	9.8E-05
Copper	12,069	5.90E-03	7.8E-04	Inc	1.9E-05	3.7E-02	3.7E-02	3.7E-02	1.6E-01	2.1E-02	Inc	5.1E-04	1.8E-01
Manganese	714	3.49E-04	4.6E-05	Inc	1.1E-06	2.4E-02	2.4E-02	1.4E-05	1.5E-02	1.9E-03	Inc	8.0E-02	9.6E-02
Mercury	1.9	9.30E-07	1.2E-07	Inc	3.0E-09	3.0E-04	3.0E-04	3.0E-04	3.1E-03	4.1E-04	Inc	9.9E-06	3.5E-03
Molybdenum	11.4	5.58E-06	7.4E-07	Inc	1.8E-08	5.0E-03	5.0E-03	5.0E-03	1.1E-03	1.5E-04	Inc	3.6E-06	1.3E-03
Nickel	32.6	1.59E-05	2.1E-06	Inc	5.1E-08	2.0E-02	2.0E-02	2.0E-02	8.0E-04	1.1E-04	Inc	2.5E-06	9.1E-04
Selenium	0.94	4.60E-07	6.1E-08	Inc	1.5E-09	5.0E-03	5.0E-03	5.0E-03	9.2E-05	1.2E-05	Inc	2.9E-07	1.0E-04
Silver	74.0	3.62E-05	4.8E-06	Inc	1.2E-07	5.0E-03	5.0E-03	5.0E-03	7.2E-03	9.6E-04	Inc	2.3E-05	8.2E-03
Zinc	8,740	4.28E-03	5.6E-04	Inc	1.4E-05	3.0E-01	3.0E-01	3.0E-01	1.4E-02	1.9E-03	Inc	4.6E-05	1.6E-02
Organic Compounds													
2,4,6-Trinitrotoluene	0.90	4.40E-07	5.8E-07	Inc	1.4E-09	5.0E-04	5.0E-04	5.0E-04	8.8E-04	1.2E-03	Inc	2.8E-06	2.0E-03
												Total HI:	**0.48**

Notes:

[a] Based on the maximum or 95 percent upper confidence limit (95% UCL) on the mean concentration detected at the site.

1) Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

2) Absorbed doses were calculated for dermal contact with the medium, and intakes were calculated for ingestion or inhalation of a medium

3) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HI = Exposure Dose/Reference dose.

HI — Hazard index.
Inc — Incomplete pathway.
mg/kg — Milligrams per kilogram.
mg/kd-d — Milligrams per kilogram per day.

TABLE M-17

CANCER RISK CALCULATIONS FOR HYPOTHETICAL FUTURE RESIDENTS
SITE FTIR-40 AREA 1.1 - SUBSURFACE SOILS
NATIONAL TRAINING CENTER, FORT IRWIN

Constituent	Soil Concentration[a] (mg/kg)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	VOC Inhalation Dose (mg/kg-d)	Dust Inhalation Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$			Pathway-Specific Cancer Risk				Chemical-Specific Risk
						Oral	Dermal	Inhalation	Ingestion	Dermal	VOC Inhalation	Dust Inhalation	
Inorganics													
Arsenic	9.6	1.50E-05	1.4E-06	Inc	1.1E-09	1.5E+00	1.5E+00	1.5E+01	2.3E-05	2.1E-06	Inc	1.6E-08	2.5E-05
Cadmium	5.9	9.24E-06	2.9E-08	Inc	6.6E-10	na	na	6.3E+00	0.0E+00	0.0E+00	Inc	4.2E-09	4.2E-09
												ILCR:	2.5E-05

Notes:

[a] Based on the maximum or 95 percent upper confidence limit (95% UCL) on the mean concentration detected at the site.

1) Doses and cancer risks shown only for carcinogenic chemicals with available toxicity values.
2) Absorbed doses were calculated for dermal contact with the medium, and intakes were calculated for ingestion or inhalation of a medium
3) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor.

ILCR	Incremental lifetime cancer risk.
Inc	Incomplete pathway.
mg/kg	Milligrams per kilogram.
mg/kg-d	Milligrams per kilogram per day.
na	Not available.

TABLE M-18

NONCANCER HAZARD CALCULATIONS FOR A HYPOTHETICAL FUTURE RESIDENT
SITE FTIR-40 AREA 1.1 - SUBSURFACE SOILS
NATIONAL TRAINING CENTER, FORT IRWIN

Constituent	Soil Concentration[a] (mg/kg)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	VOC Inhalation Dose (mg/kg-d)	Dust Inhalation Dose (mg/kg-d)	Reference Dose (mg/kg-d)			Pathway-Specific Noncancer HI				Chemical-Specific HI
						Oral	Dermal	Inhalation	Ingestion	Dermal	VOC Inhalation	Dust Inhalation	
Inorganics													
Arsenic	9.6	3.51E-05	3.3E-06	Inc	2.5E-09	3.0E-04	3.0E-04	3.0E-04	1.2E-01	1.1E-02	Inc	8.4E-06	1.3E-01
Barium	251	9.17E-04	2.9E-05	Inc	6.6E-08	7.0E-02	7.0E-02	1.4E-04	1.3E-02	4.1E-04	Inc	4.7E-04	1.4E-02
Cadmium	5.9	2.16E-05	6.8E-08	Inc	1.6E-09	5.0E-04	5.0E-04	5.0E-04	4.3E-02	1.4E-04	Inc	3.1E-06	4.3E-02
Copper	222	8.11E-04	2.6E-05	Inc	5.8E-08	3.7E-02	3.7E-02	3.7E-02	2.2E-02	6.9E-04	Inc	1.6E-06	2.3E-02
Manganese	532	1.94E-03	6.1E-05	Inc	1.4E-07	2.4E-02	2.4E-02	1.4E-05	8.1E-02	2.6E-03	Inc	1.0E-02	9.4E-02
Mercury	0.21	7.67E-07	2.4E-08	Inc	5.5E-11	3.0E-04	3.0E-04	3.0E-04	2.6E-03	8.1E-05	Inc	1.8E-07	2.6E-03
Selenium	0.75	2.74E-06	8.6E-08	Inc	2.0E-10	5.0E-03	5.0E-03	5.0E-03	5.5E-04	1.7E-05	Inc	3.9E-08	5.7E-04
Silver	9.9	3.62E-05	1.1E-06	Inc	2.6E-09	5.0E-03	5.0E-03	5.0E-03	7.2E-03	2.3E-04	Inc	5.2E-07	7.5E-03
Zinc	761	2.78E-03	8.8E-05	Inc	2.0E-07	3.0E-01	3.0E-01	3.0E-01	9.3E-03	2.9E-04	Inc	6.7E-07	9.6E-03
												Total HI:	0.32

Notes:

[a] Based on the maximum or 95 percent upper confidence limit (95% UCL) on the mean concentration detected at the site.

1) Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

2) Absorbed doses were calculated for dermal contact with the medium, and intakes were calculated for ingestion or inhalation of a medium

3) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HI = Exposure Dose/Reference dose.

HI Hazard index.
Inc Incomplete pathway.
mg/kg Milligrams per kilogram.
mg/kd-d Milligrams per kilogram per day.

TABLE M-19

CANCER RISK CALCULATIONS FOR A FUTURE INDUSTRIAL WORKER
SITE FTIR-40 AREA 1.1 - SUBSURFACE SOILS
NATIONAL TRAINING CENTER, FORT IRWIN

Constituent	Soil Concentration[a] (mg/kg)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	VOC Inhalation Dose (mg/kg-d)	Dust Inhalation Dose (mg/kg-d)	Cancer Slope Factor (mg/kg-d)$^{-1}$			Pathway-Specific Cancer Risk				Chemical-Specific Risk
						Oral	Dermal	Inhalation	Ingestion	Dermal	VOC Inhalation	Dust Inhalation	
Inorganics													
Arsenic	9.6	1.68E-06	6.6E-07	Inc	8.8E-09	1.5E+00	1.5E+00	1.5E+01	2.5E-06	1.0E-06	Inc	1.3E-07	3.6E-06
Cadmium	5.9	1.03E-06	1.4E-08	Inc	5.4E-09	na	na	6.3E+00	0.0E+00	0.0E+00	Inc	3.4E-08	3.4E-08
												ILCR:	3.7E-06

Notes:

[a] Based on the maximum or 95 percent upper confidence limit (95% UCL) on the mean concentration detected at the site.

1) Doses and cancer risks shown only for carcinogenic chemicals with available toxicity values.
2) Absorbed doses were calculated for dermal contact with the medium, and intakes were calculated for ingestion or inhalation of a medium
3) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor.

ILCR	Incremental lifetime cancer risk.
Inc	Incomplete pathway.
mg/kg	Milligrams per kilogram.
mg/kg-d	Milligrams per kilogram per day.
na	Not available.

TABLE M-20

NONCANCER HAZARD CALCULATIONS FOR A FUTURE INDUSTRIAL WORKER
SITE FTIR-40 AREA 1.1 - SUBSURFACE SOILS
NATIONAL TRAINING CENTER, FORT IRWIN

Constituent	Soil Concentration[a] (mg/kg)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	VOC Inhalation Dose (mg/kg-d)	Dust Inhalation Dose (mg/kg-d)	Reference Dose (mg/kg-d)			Pathway-Specific Noncancer HI				Chemical-Specific HI
						Oral	Dermal	Inhalation	Ingestion	Dermal	VOC Inhalation	Dust Inhalation	
Inorganics													
Arsenic	9.6	4.70E-06	1.9E-06	Inc	2.5E-08	3.0E-04	3.0E-04	3.0E-04	1.6E-02	6.2E-03	Inc	8.2E-05	2.2E-02
Barium	251	1.23E-04	1.6E-05	Inc	6.4E-07	7.0E-02	7.0E-02	1.4E-04	1.8E-03	2.3E-04	Inc	4.6E-03	6.6E-03
Cadmium	5.9	2.89E-06	3.8E-08	Inc	1.5E-08	5.0E-04	5.0E-04	5.0E-04	5.8E-03	7.6E-05	Inc	3.0E-05	5.9E-03
Copper	222	1.09E-04	1.4E-05	Inc	5.7E-07	3.7E-02	3.7E-02	3.7E-02	2.9E-03	3.9E-04	Inc	1.5E-05	3.3E-03
Manganese	532	2.60E-04	3.4E-05	Inc	1.4E-06	2.4E-02	2.4E-02	1.4E-05	1.1E-02	1.4E-03	Inc	9.7E-02	1.1E-01
Mercury	0.21	1.03E-07	1.4E-08	Inc	5.4E-10	3.0E-04	3.0E-04	3.0E-04	3.4E-04	4.5E-05	Inc	1.8E-06	3.9E-04
Selenium	0.75	3.67E-07	4.8E-08	Inc	1.9E-09	5.0E-03	5.0E-03	5.0E-03	7.3E-05	9.7E-06	Inc	3.8E-07	8.3E-05
Silver	9.9	4.84E-06	6.4E-07	Inc	2.5E-08	5.0E-03	5.0E-03	5.0E-03	9.7E-04	1.3E-04	Inc	5.1E-06	1.1E-03
Zinc	761	3.72E-04	4.9E-05	Inc	2.0E-06	3.0E-01	3.0E-01	3.0E-01	1.2E-03	1.6E-04	Inc	6.5E-06	1.4E-03
												Total HI:	0.15

Notes:

[a] Based on the maximum or 95 percent upper confidence limit (95% UCL) on the mean concentration detected at the site.

1) Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

2) Absorbed doses were calculated for dermal contact with the medium, and intakes were calculated for ingestion or inhalation of a medium

3) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HI = Exposure Dose/Reference dose.

HI Hazard index.
Inc Incomplete pathway.
mg/kg Milligrams per kilogram.
mg/kd-d Milligrams per kilogram per day.

TABLE M-21

CANCER RISK CALCULATIONS FOR HYPOTHETICAL FUTURE RESIDENTS
SITE FTIR-40 AREA 2 - SURFACE SOILS
NATIONAL TRAINING CENTER, FORT IRWIN

Constituent	Soil Concentration[a] (mg/kg)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	VOC Inhalation Dose (mg/kg-d)	Dust Inhalation Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$			Pathway-Specific Cancer Risk				Chemical-Specific Risk
						Oral	Dermal	Inhalation	Ingestion	Dermal	VOC Inhalation	Dust Inhalation	
Inorganics													
Arsenic	9.8	1.53E-05	1.5E-06	Inc	1.1E-09	1.5E+00	1.5E+00	1.5E+01	2.3E-05	2.2E-06	Inc	1.7E-08	2.5E-05
Cadmium	0.35	5.48E-07	1.7E-09	Inc	3.9E-11	na	na	6.3E+00	0.0E+00	0.0E+00	Inc	2.5E-10	2.5E-10
												ILCR:	2.5E-05

Notes:

[a] Based on the maximum or 95 percent upper confidence limit (95% UCL) on the mean concentration detected at the site.

1) Doses and cancer risks shown only for carcinogenic chemicals with available toxicity values.
2) Absorbed doses were calculated for dermal contact with the medium, and intakes were calculated for ingestion or inhalation of a medium
3) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor.

ILCR	Incremental lifetime cancer risk.
Inc	Incomplete pathway.
mg/kg	Milligrams per kilogram.
mg/kg-d	Milligrams per kilogram per day.
na	Not available.

TABLE M-22

NONCANCER HAZARD CALCULATIONS FOR A HYPOTHETICAL FUTURE RESIDENT
SITE FTIR-40 AREA 2 - SURFACE SOILS
NATIONAL TRAINING CENTER, FORT IRWIN

Constituent	Soil Concentration[a] (mg/kg)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	VOC Inhalation Dose (mg/kg-d)	Dust Inhalation Dose (mg/kg-d)	Reference Dose (mg/kg-d)			Pathway-Specific Noncancer HI				Chemical-Specific HI
						Oral	Dermal	Inhalation	Ingestion	Dermal	VOC Inhalation	Dust Inhalation	
Inorganics													
Arsenic	9.8	3.58E-05	3.4E-06	Inc	2.6E-09	3.0E-04	3.0E-04	3.0E-04	1.2E-01	1.1E-02	Inc	8.6E-06	1.3E-01
Cadmium	0.35	1.28E-06	4.0E-09	Inc	9.2E-11	5.0E-04	5.0E-04	5.0E-04	2.6E-03	8.1E-06	Inc	1.8E-07	2.6E-03
Zinc	101	3.69E-04	1.2E-05	Inc	2.7E-08	3.0E-01	3.0E-01	3.0E-01	1.2E-03	3.9E-05	Inc	8.9E-08	1.3E-03
												Total HI:	0.13

Notes:

[a] Based on the maximum or 95 percent upper confidence limit (95% UCL) on the mean concentration detected at the site.

1) Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.
2) Absorbed doses were calculated for dermal contact with the medium, and intakes were calculated for ingestion or inhalation of a medium
3) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HI = Exposure Dose/Reference dose.

HI Hazard index.
Inc Incomplete pathway.
mg/kg Milligrams per kilogram.
mg/kd-d Milligrams per kilogram per day.

TABLE M-23

CANCER RISK CALCULATIONS FOR A FUTURE INDUSTRIAL WORKER
SITE FTIR-40 AREA 2 - SURFACE SOILS
NATIONAL TRAINING CENTER, FORT IRWIN

Constituent	Soil Concentration[a] (mg/kg)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	VOC Inhalation Dose (mg/kg-d)	Dust Inhalation Dose (mg/kg-d)	Cancer Slope Factor (mg/kg-d)$^{-1}$			Pathway-Specific Cancer Risk				Chemical-Specific Risk
						Oral	Dermal	Inhalation	Ingestion	Dermal	VOC Inhalation	Dust Inhalation	
Inorganics													
Arsenic	9.8	3.42E-06	6.8E-07	Inc	9.0E-09	1.5E+00	1.5E+00	1.5E+01	5.1E-06	1.0E-06	Inc	1.3E-07	6.3E-06
Cadmium	0.35	1.22E-07	8.1E-10	Inc	3.2E-10	na	na	6.3E+00	0.0E+00	0.0E+00	Inc	2.0E-09	2.0E-09
												ILCR:	6.3E-06

Notes:

[a] Based on the maximum or 95 percent upper confidence limit (95% UCL) on the mean concentration detected at the site.

1) Doses and cancer risks shown only for carcinogenic chemicals with available toxicity values.
2) Absorbed doses were calculated for dermal contact with the medium, and intakes were calculated for ingestion or inhalation of a medium
3) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor.

ILCR	Incremental lifetime cancer risk.
Inc	Incomplete pathway.
mg/kg	Milligrams per kilogram.
mg/kg-d	Milligrams per kilogram per day.
na	Not available.

TABLE M-24

NONCANCER HAZARD CALCULATIONS FOR A FUTURE INDUSTRIAL WORKER
SITE FTIR-40 AREA 2 - SURFACE SOILS
NATIONAL TRAINING CENTER, FORT IRWIN

Constituent	Soil Concentration[a] (mg/kg)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	VOC Inhalation Dose (mg/kg-d)	Dust Inhalation Dose (mg/kg-d)	Reference Dose (mg/kg-d)			Pathway-Specific Noncancer HI				Chemical-Specific HI
						Oral	Dermal	Inhalation	Ingestion	Dermal	VOC Inhalation	Dust Inhalation	
Inorganics													
Arsenic	9.8	4.79E-06	1.9E-06	Inc	2.5E-08	3.0E-04	3.0E-04	3.0E-04	1.6E-02	6.3E-03	Inc	8.4E-05	0.02
Cadmium	0.35	1.71E-07	2.3E-09	Inc	9.0E-10	5.0E-04	5.0E-04	5.0E-04	3.4E-04	4.5E-06	Inc	1.8E-06	0.0003
Zinc	101	4.94E-05	6.5E-06	Inc	2.6E-07	3.0E-01	3.0E-01	3.0E-01	1.6E-04	2.2E-05	Inc	8.6E-07	0.0002
												Total HI:	0.02

Notes:

[a] Based on the maximum or 95 percent upper confidence limit (95% UCL) on the mean concentration detected at the site.

1) Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

2) Absorbed doses were calculated for dermal contact with the medium, and intakes were calculated for ingestion or inhalation of a medium

3) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HI = Exposure Dose/Reference dose.

HI Hazard index.
Inc Incomplete pathway.
mg/kg Milligrams per kilogram.
mg/kd-d Milligrams per kilogram per day.

TABLE M-25

CANCER RISK CALCULATIONS FOR HYPOTHETICAL FUTURE RESIDENTS
SITE FTIR-40 AREA 2 - SUBSURFACE SOILS
NATIONAL TRAINING CENTER, FORT IRWIN

Constituent	Soil Concentration[a] (mg/kg)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	VOC Inhalation Dose (mg/kg-d)	Dust Inhalation Dose (mg/kg-d)	Cancer Slope Factor (mg/kg-d)$^{-1}$			Pathway-Specific Cancer Risk				Chemical-Specific Risk
						Oral	Dermal	Inhalation	Ingestion	Dermal	VOC Inhalation	Dust Inhalation	
Inorganics													
Arsenic	10.8	1.69E-05	1.6E-06	Inc	1.2E-09	1.5E+00	1.5E+00	1.5E+01	2.5E-05	2.4E-06	Inc	1.8E-08	2.8E-05
Cadmium	0.80	1.25E-06	4.0E-09	Inc	9.0E-11	na	na	6.3E+00	0.0E+00	0.0E+00	Inc	5.7E-10	5.7E-10
Organic Compounds													
Benzo(a)anthracene	0.125	1.96E-07	9.3E-08	Inc	1.4E-11	7.3E-01	7.3E-01	3.1E-01	1.4E-07	6.8E-08	Inc	4.4E-12	2.1E-07
Benzo(a)pyrene	0.125	1.96E-07	9.3E-08	Inc	1.4E-11	7.3E+00	7.3E+00	3.1E+00	1.4E-06	6.8E-07	Inc	4.4E-11	2.1E-06
Benzo(b)fluoranthene	0.112	1.75E-07	8.3E-08	Inc	1.3E-11	7.3E-01	7.3E-01	3.1E-01	1.3E-07	6.1E-08	Inc	3.9E-12	1.9E-07
Benzo(k)fluoranthene	0.095	1.49E-07	7.0E-08	Inc	1.1E-11	7.3E-02	7.3E-02	3.1E-02	1.1E-08	5.1E-09	Inc	3.3E-13	1.6E-08
bis(2-Ethylhexyl) phthalat	0.205	3.21E-07	1.0E-07	Inc	2.3E-11	1.4E-02	1.4E-02	1.4E-02	4.5E-09	1.4E-09	Inc	3.2E-13	5.9E-09
Chrysene	0.270	4.23E-07	2.0E-07	Inc	3.0E-11	7.3E-03	7.3E-03	3.1E-03	3.1E-09	1.5E-09	Inc	9.4E-14	4.5E-09
Indeno(1,2,3-cd)pyrene	0.129	2.02E-07	9.6E-08	Inc	1.5E-11	7.3E-01	7.3E-01	3.1E-01	1.5E-07	7.0E-08	Inc	4.5E-12	2.2E-07
												ILCR:	3.1E-05

Notes:

[a] Based on the maximum or 95 percent upper confidence limit (95% UCL) on the mean concentration detected at the site.

1) Doses and cancer risks shown only for carcinogenic chemicals with available toxicity values.
2) Absorbed doses were calculated for dermal contact with the medium, and intakes were calculated for ingestion or inhalation of a medium
3) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor.

ILCR	Incremental lifetime cancer risk.
Inc	Incomplete pathway.
mg/kg	Milligrams per kilogram.
mg/kg-d	Milligrams per kilogram per day.
na	Not available.

TABLE K-26

NONCANCER HAZARD CALCULATIONS FOR A HYPOTHETICAL FUTURE RESIDENT
SITE FTIR-40 AREA 2 - SUBSURFACE SOILS
NATIONAL TRAINING CENTER, FORT IRWIN

Constituent	Soil Concentration[a] (mg/kg)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	VOC Inhalation Dose (mg/kg-d)	Dust Inhalation Dose (mg/kg-d)	Reference Dose (mg/kg-d)			Pathway-Specific Noncancer HI				Chemical-Specific HI
						Oral	Dermal	Inhalation	Ingestion	Dermal	VOC Inhalation	Dust Inhalation	
Inorganics													
Arsenic	10.8	3.95E-05	3.7E-06	Inc	2.8E-09	3.0E-04	3.0E-04	3.0E-04	1.3E-01	1.2E-02	Inc	9.5E-06	1.4E-01
Barium	178	6.50E-04	2.1E-05	Inc	4.7E-08	7.0E-02	7.0E-02	1.4E-04	9.3E-03	2.9E-04	Inc	3.3E-04	9.9E-03
Cadmium	0.80	2.92E-06	9.2E-09	Inc	2.1E-10	5.0E-04	5.0E-04	5.0E-04	5.8E-03	1.8E-05	Inc	4.2E-07	5.9E-03
Copper	23.5	8.58E-05	2.7E-06	Inc	6.2E-09	3.7E-02	3.7E-02	3.7E-02	2.3E-03	7.3E-05	Inc	1.7E-07	2.4E-03
Manganese	327	1.19E-03	3.8E-05	Inc	8.6E-08	2.4E-02	2.4E-02	1.4E-05	5.0E-02	1.6E-03	Inc	6.1E-03	5.7E-02
Mercury	0.17	6.21E-07	2.0E-08	Inc	4.5E-11	3.0E-04	3.0E-04	3.0E-04	2.1E-03	6.5E-05	Inc	1.5E-07	2.1E-03
Molybdenum	1.7	6.21E-06	2.0E-07	Inc	4.5E-10	5.0E-03	5.0E-03	5.0E-03	1.2E-03	3.9E-05	Inc	8.9E-08	1.3E-03
Selenium	1.1	4.02E-06	1.3E-07	Inc	2.9E-10	5.0E-03	5.0E-03	5.0E-03	8.0E-04	2.5E-05	Inc	5.8E-08	8.3E-04
Silver	1.5	5.48E-06	1.7E-07	Inc	3.9E-10	5.0E-03	5.0E-03	5.0E-03	1.1E-03	3.5E-05	Inc	7.9E-08	1.1E-03
Zinc	237	8.66E-04	2.7E-05	Inc	6.2E-08	3.0E-01	3.0E-01	3.0E-01	2.9E-03	9.1E-05	Inc	2.1E-07	3.0E-03
Organic Compounds													
Benzoic acid	0.124	4.53E-07	2.1E-07	Inc	3.3E-11	4.0E+00	4.0E+00	4.0E+00	1.1E-07	5.4E-08	Inc	8.1E-12	1.7E-07
bis(2-Ethylhexyl) phtha	0.205	7.49E-07	2.4E-07	Inc	5.4E-11	2.0E-02	2.0E-02	2.2E-02	3.7E-05	1.2E-05	Inc	2.4E-09	4.9E-05
di-n-Octylphthalate	0.199	7.27E-07	3.4E-07	Inc	5.2E-11	2.0E-02	2.0E-02	2.0E-02	3.6E-05	1.7E-05	Inc	2.6E-09	5.4E-05
Fluoranthene	0.100	3.65E-07	1.7E-07	Inc	2.6E-11	4.0E-02	4.0E-02	4.0E-02	9.1E-06	4.3E-06	Inc	6.6E-10	1.3E-05
Pyrene	0.099	3.62E-07	1.7E-07	Inc	2.6E-11	3.0E-02	3.0E-02	3.0E-02	1.2E-05	5.7E-06	Inc	8.7E-10	1.8E-05
												Total HI:	0.23

Notes:

[a] Based on the maximum or 95 percent upper confidence limit (95% UCL) on the mean concentration detected at the site.

1) Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

2) Absorbed doses were calculated for dermal contact with the medium, and intakes were calculated for ingestion or inhalation of a medium

3) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HI = Exposure Dose/Reference dose.

HI	Hazard index.
Inc	Incomplete pathway.
mg/kg	Milligrams per kilogram.
mg/kd-d	Milligrams per kilogram per day.

TABLE M-27

CANCER RISK CALCULATIONS FOR A FUTURE INDUSTRIAL WORKER
SITE FTIR-40 AREA 2 - SUBSURFACE SOILS
NATIONAL TRAINING CENTER, FORT IRWIN

Constituent	Soil Concentration[a] (mg/kg)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	VOC Inhalation Dose (mg/kg-d)	Dust Inhalation Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$			Pathway-Specific Cancer Risk				Chemical-Specific Risk
						Oral	Dermal	Inhalation	Ingestion	Dermal	VOC Inhalation	Dust Inhalation	
Inorganics													
Arsenic	10.8	3.77E-06	7.5E-07	Inc	9.9E-09	1.5E+00	1.5E+00	1.5E+01	5.7E-06	1.1E-06	Inc	1.5E-07	6.9E-06
Cadmium	0.80	2.80E-07	1.8E-09	Inc	7.3E-10	na	na	6.3E+00	0.0E+00	0.0E+00	Inc	4.6E-09	4.6E-09
Organic Compounds													
Benzo(a)anthracene	0.125	4.37E-08	4.3E-08	Inc	1.1E-10	7.3E-01	7.3E-01	3.1E-01	3.2E-08	3.2E-08	Inc	3.5E-11	6.3E-08
Benzo(a)pyrene	0.125	4.37E-08	4.3E-08	Inc	1.1E-10	7.3E+00	7.3E+00	3.1E+00	3.2E-07	3.2E-07	Inc	3.5E-10	6.3E-07
Benzo(b)fluoranthene	0.112	3.91E-08	3.9E-08	Inc	1.0E-10	7.3E-01	7.3E-01	3.1E-01	2.9E-08	2.8E-08	Inc	3.2E-11	5.7E-08
Benzo(k)fluoranthene	0.095	3.32E-08	3.3E-08	Inc	8.7E-11	7.3E-02	7.3E-02	3.1E-02	2.4E-09	2.4E-09	Inc	2.7E-12	4.8E-09
bis(2-Ethylhexyl) phthalate	0.205	7.16E-08	4.7E-08	Inc	1.9E-10	1.4E-02	1.4E-02	1.4E-02	1.0E-09	6.6E-10	Inc	2.6E-12	1.7E-09
Chrysene	0.270	9.44E-08	9.3E-08	Inc	2.5E-10	7.3E-03	7.3E-03	3.1E-03	6.9E-10	6.8E-10	Inc	7.7E-13	1.4E-09
Indeno(1,2,3-cd)pyrene	0.129	4.51E-08	4.5E-08	Inc	1.2E-10	7.3E-01	7.3E-01	3.1E-01	3.3E-08	3.3E-08	Inc	3.7E-11	6.6E-08
												ILCR:	7.8E-06

Notes:

[a] Based on the maximum or 95 percent upper confidence limit (95% UCL) on the mean concentration detected at the site.

1) Doses and cancer risks shown only for carcinogenic chemicals with available toxicity values.
2) Absorbed doses were calculated for dermal contact with the medium, and intakes were calculated for ingestion or inhalation of a medium
3) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor.

ILCR	Incremental lifetime cancer risk.
Inc	Incomplete pathway.
mg/kg	Milligrams per kilogram.
mg/kg-d	Milligrams per kilogram per day.
na	Not available.

TABLE M-28

NONCANCER HAZARD CALCULATIONS FOR A FUTURE INDUSTRIAL WORKER
SITE FTIR-40 AREA 2 - SUBSURFACE SOILS
NATIONAL TRAINING CENTER, FORT IRWIN

Constituent	Soil Concentration[a] (mg/kg)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	VOC Inhalation Dose (mg/kg-d)	Dust Inhalation Dose (mg/kg-d)	Reference Dose (mg/kg-d)			Pathway-Specific Noncancer HI				Chemical-Specific HI
						Oral	Dermal	Inhalation	Ingestion	Dermal	VOC Inhalation	Dust Inhalation	
Inorganics													
Arsenic	10.8	5.28E-06	2.1E-06	Inc	2.8E-08	3.0E-04	3.0E-04	3.0E-04	1.8E-02	7.0E-03	Inc	9.2E-05	2.5E-02
Barium	178	8.71E-05	1.1E-05	Inc	4.6E-07	7.0E-02	7.0E-02	1.4E-04	1.2E-03	1.6E-04	Inc	3.3E-03	4.7E-03
Cadmium	0.80	3.91E-07	5.2E-09	Inc	2.1E-09	5.0E-04	5.0E-04	5.0E-04	7.8E-04	1.0E-05	Inc	4.1E-06	8.0E-04
Copper	23.5	1.15E-05	1.5E-06	Inc	6.0E-08	3.7E-02	3.7E-02	3.7E-02	3.1E-04	4.1E-05	Inc	1.6E-06	3.5E-04
Manganese	327	1.60E-04	2.1E-05	Inc	8.4E-07	2.4E-02	2.4E-02	1.4E-05	6.7E-03	8.8E-04	Inc	6.0E-02	6.7E-02
Mercury	0.17	8.32E-08	1.1E-08	Inc	4.4E-10	3.0E-04	3.0E-04	3.0E-04	2.8E-04	3.7E-05	Inc	1.5E-06	3.2E-04
Molybdenum	1.7	8.32E-07	1.1E-07	Inc	4.4E-09	5.0E-03	5.0E-03	5.0E-03	1.7E-04	2.2E-05	Inc	8.7E-07	1.9E-04
Selenium	1.1	5.38E-07	7.1E-08	Inc	2.8E-09	5.0E-03	5.0E-03	5.0E-03	1.1E-04	1.4E-05	Inc	5.6E-07	1.2E-04
Silver	1.5	7.34E-07	9.7E-08	Inc	3.8E-09	5.0E-03	5.0E-03	5.0E-03	1.5E-04	1.9E-05	Inc	7.7E-07	1.7E-04
Zinc	237	1.16E-04	1.5E-05	Inc	6.1E-07	3.0E-01	3.0E-01	3.0E-01	3.9E-04	5.1E-05	Inc	2.0E-06	4.4E-04
Organic Compounds													
Benzoic acid	0.124	6.07E-08	1.2E-07	Inc	3.2E-10	4.0E+00	4.0E+00	4.0E+00	1.5E-08	3.0E-08	Inc	8.0E-11	4.5E-08
bis(2-Ethylhexyl)phtha	0.205	1.00E-07	1.3E-07	Inc	5.3E-10	2.0E-02	2.0E-02	2.2E-02	5.0E-06	6.6E-06	Inc	2.4E-08	1.2E-05
di-n-Octylphthalate	0.199	9.74E-08	1.9E-07	Inc	5.1E-10	2.0E-02	2.0E-02	2.0E-02	4.9E-06	9.6E-06	Inc	2.6E-08	1.5E-05
Fluoranthene	0.100	4.89E-08	9.7E-08	Inc	2.6E-10	4.0E-02	4.0E-02	4.0E-02	1.2E-06	2.4E-06	Inc	6.4E-09	3.7E-06
Pyrene	0.099	4.84E-08	9.6E-08	Inc	2.5E-10	3.0E-02	3.0E-02	3.0E-02	1.6E-06	3.2E-06	Inc	8.5E-09	4.8E-06
												Total HI:	**0.10**

Notes:

[a] Based on the maximum or 95 percent upper confidence limit (95% UCL) on the mean concentration detected at the site.

1) Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

2) Absorbed doses were calculated for dermal contact with the medium, and intakes were calculated for ingestion or inhalation of a medium

3) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HI = Exposure Dose/Reference dose.

HI — Hazard index.
Inc — Incomplete pathway.
mg/kg — Milligrams per kilogram.
mg/kd-d — Milligrams per kilogram per day.

APPENDIX N

SURFACE SOIL AND PLANT TISSUE STATISTICAL COMPARISONS

Appendix N
Phase II Validation Study
Description of Procedure and Results
Ft. Irwin, California

This workbook presents the statistical tests to determine if the following metals exceed reference concentrations:

Site FTIR-38 Area 2
(Compared to Reference Area 1)
Aluminum
Antimony
Lead

Site FTIR-40 Area 2
(Compared to Reference Area 2)
Lead

Site FTIR-40 Area 1.1
(Compared to Reference Area 2)
Aluminum
Antimony
Cadmium
Copper
Lead
Zinc

Test for normality (Gilbert, page 159)
To determine the appropriate statistical test to use, data were first analyzed using the Shapiro-Wilk W test for normality This test can determine whether a data set has been drawn from an underlying normal distribution In addition, if the test is conducted on logarithms of the data, it can also test the hypothesis of a log-normal distribution.

Denominator of test statistic:
$d = S(x_i - x_{bar})^2$ where x_{bar} = mean sum from i = 1 to n

Order the data from smallest to largest

$k = n/2$ even n
$k = (n-1)/2$ odd n where n = number of samples in data set

Find coefficients a_1 through a_k from statistical table

for	a_1 =	0 5739	**for**	a_1 =	0 459
n=10	a_2 =	0 3291	**n=22**	a_2 =	0 3156
(reference site)	a_3 =	0.2141	(Site 38-2)	a_3 =	0 2571
(Site 40-2)	a_4 =	0 1224		a_4 =	0 2131
	a_5 =	0 0399		a_5 =	0 1764
				a_6 =	0 1443
for	a_1 =	0.5359		a_7 =	0 115
n=13	a_2 =	0 3325		a_8 =	0 0878
(Site 40-1)	a_3 =	0 2412		a_9 =	0 0618
	a_4 =	0 1707		a_{10}=	0 0368
	a_5 =	0 1099		a_{11}=	0 0122
	a_6 =	0 05839			
	a_7 =	0			

$W = 1/d * (Sa_i(x_{[n-i+1]}-x_{[i]})^2$ sum from i = 1 to k

Reject hypothesis of a normal (or log-normal) distribution at 0 05 significance level if W is **less** than the quantile found in statistical tables.

n	95% W-quantile
10	0 842
13	0.866
22	0.911

Results of Shapiro Wilk W Tests:

Site/Metal	Data fits normal distribution?	Data fits log-normal distribution?	Comparison test to use?
38-2 Al	No	Yes	Logarithmic Student -T
38-2 Sb	No	No	Mann Whitney
38-2 Pb	No	Yes	Logarithmic Student -T
40-1 Al	No	No	Mann Whitney
40-1 Sb	No	No	Mann Whitney
40-1 Cd	No	No	Mann Whitney
40-1 Cu	No	No	Mann Whitney
40-1 Pb	No	No	Mann Whitney
40-1 Zn	No	No	Mann Whitney
40-2 Pb	No	No	Mann Whitney
Ref 1 Al	Yes	Yes	
Ref 1 Pb	Yes	Yes	

Logarithmic Student-T test for comparing unpaired populations (Montgomery, page 390)

A normality assumption is required to use this test procedure, but moderate departures from normality do not adversely affect the procedure.

The logarithms of two data sets with log-normal distributions (Site 38-2 aluminum and lead) were compared to the logarithms of the reference site 1 aluminum and lead data The reference data can also be characterized as a log-normal distribution.

Two data populations (Site and Reference) are compared with the following null hypothesis:

H_o: mean $_{(site)}$ - mean $_{(reference)} = 0$
H_a: mean $_{(site)}$ > mean $_{(reference)}$

A pooled estimator of the variance is:

$$S_p^2 = [(n_1-1)S_1^2 + (n_2-1)S_2^2]/(n_1+n_2-2)$$

the test statistic is:

$T = \{mean_{(site)} - mean_{(reference)}\}/\{S_p*sqrt[(1/n_1)+(1/n_2)]\}$

For Site 38-2 and Reference population 1 ($n_1 = 22$, $n_2 = 10$, degrees of freedom = 30):
compare to $t_{0.05\ 30} = 1.697$ (0.05 level of significance, degrees of freedom =30)

If T>1.697, reject the null hypothesis and conclude that the mean of the site is higher than the mean of the reference data

Results of Logarithmic T-test:

Site/Metal	T	T > 1.697?	Site Data> Ref Data?
38-2 Al	5.314	yes	yes
38-2 Pb	5.971	yes	yes

Wilcoxon Rank Sum (Mann Whitney) Test for comparing unpaired populations (Gilbert page 247, Montgomery page 744)

If the normal or log-normal distributions do not adequately characterize the site data set, non-parametric tests must be used to compare two populations

If the normality assumption is correct, the Wilcoxon rank sum test is approximately 95% as efficient as the t-test If the assumption of normality is not correct, the Wilcoxon rank sum test is a useful alternate to the t-test

The rank sum method tests the following hypothesis:
H_o: The populations from which the two data sets have been drawn have the same mean
H_a: Measurements from population 1 (site) tend to exceed those from population 2 (reference)

n_1 number of samples at site
n_2 number of samples at reference site
m total number of samples ($=n_1+n_2$)

Rank the m data from 1 to m (assign rank 1 to the smallest datum, and so on)
If several data have the same value, assign the average of the ranks that would have otherwise been assigned

W_s = sum of the ranks assigned to data from population 1
t_j = number of tied data in a group of ties
(i e , if there are three data points with rank 5 and two data points with rank 9 5, $t_1 = 3$ and $t_2 = 2$)
g = total number of tied groups

$$Z_{rs} = \frac{W_{rs} - n_1(m+1)/2}{\{n_1*n_2/12[m+1 - S[t_j(t_j^2-1)]/m(m-1)]\}^{1/2}}$$

the "tie factor" calculated from the sum of the t_j term would be as follows for the above example:
$3(9-1) + 2(4-1) = 30$

If $Z_{rs} > 1.645$, conclude that site data tends to exceed reference data at 0.05 level of significance ($Z_{0.05} = 1.645$)

Results:

Site/Metal	Wrs	Zrs	Z>1.645?	Site data>Ref data?
38-2 Sb	396.5	1.364	no	no
40-1 Al	164	0.496	no	no
40-1 Sb	156.5	0.033	no	no
40-1 Cd	204.5	3.100	yes	yes
40-1 Cu	192.5	2.265	yes	yes
40-1 Pb	180	1.490	no	no
40-1 Zn	198	2.605	yes	yes
40-2 Pb	120	1.136	no	no

Overall Results:

Metal Concentrations Exceeding Reference Data:		Not Significantly Different	
Site 38-2	Aluminum	Site 38-2	Antimony
	Lead		
Site 40-1	Cadmium	Site 40-1	Aluminum
	Copper		Antimony
	Zinc		Lead
Site 40-2	none	Site 40-2	Lead

References:

Gilbert, R.O. *Statistical Methods for Environmental Pollution Monitoring*. Van Nostrand Reinhold: NY, 1987.
Montgomery, D. and G. Runger. *Applied Statistics and Probability for Engineers*. John Wiley & Sons: NY, 1999.

APPENDIX O

DESCRIPTIONS OF APPLICABLE TECHNOLOGIES FOR SOIL REMEDIATION

APPENDIX O

DESCRIPTIONS OF APPLICABLE TECHNOLOGIES FOR SOIL REMEDIATION

O.1 NO ACTION

The no action response does not include actions to reduce the potential for adverse exposure at Sites FTIR-38 Area 2 and FTIR-40 Area 1.1. However, five-year site reviews are required as part of the no action response, in accordance with 40 CFR 300, because contaminants will remain at the sites at levels that result in adverse health risks. The CERCLA RI/FS process requires that the no action response be included in the evaluation to provide a baseline against which other technologies can be compared. The no action response is thus retained for the development of remedial alternatives.

O.2 INSTITUTIONAL CONTROLS

Institutional controls are generally intended to prevent exposure by limiting site use and development. The most commonly used institutional controls are access and land use restrictions For the purpose of this evaluation, this GRA also includes environmental monitoring to determine if contaminants at Sites FTIR-38 Area 2 and FTIR-40 are migrating to the environment. Access and land use restrictions and environmental monitoring are described in more detail below.

O.2.1 Access Restrictions

Access restrictions include the construction of security fences that prevent direct contact with potentially contaminated soil. The most common type of fence used to limit access is an 8-foot-high, chain-link fence. Barbed wire on top of the fence may be installed to further deter trespassing, and an ecological barrier may be installed at the bottom of the fence to keep small animals and reptiles out, as well as reduce potential wind erosion. Access restrictions are

retained sites where it is desired to limit exposure to soil and for those alternatives that involve some type of construction (e.g., caps, aboveground treatment systems) to prevent trucks and tanks from destroying these areas.

Access restrictions provide some protection to human health and the environment. Access restrictions are easy to implement, and are relatively inexpensive. Therefore, access restrictions are retained for the development of remedial alternatives for Sites FTIR-38 Area 2 and FTIR-40 Area 1.1.

O.2.2 Land Use Restrictions

Land use restrictions involve the prohibition of future residential land use including the construction of housing developments, schools, parks, etc., at the site, as well as limitations on other activities (e.g., vehicular traffic). The permissible use/limitations for each site are identified based on the risk and exposure pathways present at the site, as well as the remedial actions likely to be implemented. For public property, restrictive covenants, written into the land property deed, notify any potential purchaser of the property that contamination is present at the site and that the land use must be restricted to ensure isolation of the area and the integrity of any existing or future remedial action system. The effectiveness of land use restrictions depends on state and local laws, continued enforcement, and maintenance. Most restrictions are subject to changes in political jurisdiction, legal interpretation, and level of enforcement.

The U.S. Army leases the land for Fort Irwin from the Bureau of Land Management, Department of Interior, under a military withdrawal action, and therefore cannot implement a deed restriction. However, Fort Irwin does implement use restrictions, and therefore, this institutional control is retained for the development of remedial alternatives. If Fort Irwin becomes public property, then deed restrictions will be negotiated at that time.

O.2.3 Environmental Monitoring

Environmental monitoring involves periodic sample collection and analyses for groundwater and storm water (runoff). Groundwater is either absent or found at extreme depths at Sites FTIR-38 Area 2 and FTIR-40 Area 1.1. Furthermore, the fate and transport analyses have shown that the constituents detected at these sites are relatively immobile in the desert soils. Therefore, groundwater monitoring will not be conducted. Surface water runoff is not a concern because the sites are relatively flat and the annual precipitation rate at Fort Irwin is very low. Therefore, stormwater monitoring will not be conducted. Environmental monitoring is thus eliminated from further consideration.

O.3 CONTAINMENT

Containment technologies for soil are those technologies that prevent vertical migration of constituents through the soil as well as prevent exposure to contaminated soil. A potentially applicable containment action for Sites FTIR-38 Area 2 and FTIR-40 Area 1.1 is capping which is described below.

O.3.1 Capping

Capping generally refers to the installation of a cover on a site. It provides a stable outside surface that prevents inhalation, dermal contact, or incidental ingestion of contaminants detected in surface soil, provided the cap is regularly inspected to ensure its integrity. Capping also prohibits the infiltration of precipitation into the soil, thereby reducing the potential for leaching of soil constituents to groundwater. Capping does not remove constituents from the environment and does not reduce the mobility of the constituents in the subsurface. Disadvantages of capping include limitations on future construction activities and uses of the sites.

The options for capping include an asphalt cap, a clay cap, a synthetic liner with soil cap, or a native soil cover. The effectiveness, implementability, and relative cost of each type of cap reflect its level of design sophistication. An asphalt cap is the most effective in minimizing

infiltration and in protecting human health and ecological receptors; however, this technology is not retained because this technology would disturb the native habitat and requires long-term maintenance and drainage controls A synthetic liner with soil cap is also very effective but is eliminated due to the high cost and long-term maintenance requirements. The clay cap is also eliminated from further consideration due to the high cost and the potential to desiccate in an arid environment. A native soil cover is less effective than the other types of caps but is also the least expensive. This technology has been retaned for the development of remedial alternatives for Sites FTIR-38 Area 2 and FTIR-40 Area 1.1 because it provides a cost-effective separation layer that would prevent direct human and animal contact with surface soils at these sites

O.4 REMOVAL AND DISPOSAL

Removal/disposal options considered in this evaluation for Sites FTIR-38 Area 2 and FTIR-40 Area 1.1 include excavation, screening (or separation), and disposal of the contaminated soils and surface debris.

O.4.1 Excavation and Disposal

Excavation of contaminated soil is a feasible and effective means of removing contaminated soil from shallow depths. At Sites FTIR-38 Area 2 and FTIR-40 Area 1.1, soil contamination appears to be limited to the top 5 feet; hence, conventional excavation equipment, such as a backhoe, is adequate. Monitoring for air quality is required during excavation. When fugitive air emissions exceed air quality standards, limitations on the quantity of soil that can be excavated per day may be imposed. During excavation, physical/chemical barriers may be used to decrease or eliminate receptor exposure to contaminants Some barriers that can be used are water sprays, dust suppressants, surfactants, and foam coverings. These techniques are also effective when transporting and dumping contaminated soils. Conventional excavation is a readily implementable option and requires moderate capital costs.

Two disposal options are considered for the excavated soil: off-site disposal and on-site disposal. The type of landfill required for the disposal of contaminated soils is dependent on the types and

concentrations of compounds in the soil. Some pretreatment (e.g. stabilization) may be required in order to meet either RCRA and non-RCRA treatment standards prior to land disposal The on-site disposal option will require construction and permitting of an on-site Class I or II landfill, followed by capping This technology is costly and may not protect the ecological receptors; and therefore, is eliminated from further consideration. Excavation and off-site disposal alleviates the contaminant problem at the site and will protect both the human health and ecological receptors. The type of contaminant and its concentration level will impact excavated soil quantities and off-site disposal requirements. The cost and implementability of this technology is also dependent on the cleanup levels of the contaminants of concern; the lower the cleanup level is for a contaminant, the more difficult and expensive the technology will be to implement The excavation and off-site disposal option will be retained for further evaluation for both sites.

O.4.2 Screening/Separation

The screening/separation remedial alternative is a physical separation process that will consist of running the excavated soils through screens of a pre-determined size to remove lead fragments and other pieces of metal from the soil. The coarse material, including spent bullet fragments, captured on the screen will be transported and disposed of at an appropriate location. The fine material that passes through the screen is not expected to have a significant amount of lead; however, screening alone may not be sufficient in removing the finer lead species from the soil. Therefore, to meet the cleanup goals, screening is only effective when used in conjunction with another remedial technology i.e., excavation and stabilization Additionally, screening would cause significant disturbance of natural habitat and therefore, is eliminated from further consideration.

O.4.3 Surface Debris Removal

Surface debris removal includes removal of wood, metals, glass and other debris from Site 40 Area 1 1 to improve the aesthetics of the site and reduce the risk of injury to humans and native

habitat. This technology is only effective when used conjunction with other remedial technologies and is retained as a support remedial alternative for further evaluation.

O.5 TREATMENT

O.5.1 Soil Washing

Soil washing is a water-based process for scrubbing soils to remove contaminants. Soil washing processes include: changing the pH by acid leaching; changes in system ionic strength by addition of salt; changes in redox potential by addition of a reducing agent; and formation of complexes by addition of a ligand such as ethylenediamineetetraacetic acid. Soil washing is effective over the long-term and eliminates any future exposure to metals in the soils by removing the metals from the impacted soil. However, this technology is expensive and can be difficult to implement because of the large volumes of water required, numerous process trains, and wet wastestreams generated during process operations. Therefore, soil washing is eliminated from further consideration

O.5.2 In-Situ Stabilization

In-situ stabilization is achieved by a deep soil mixing technique that directly applies stabilizing agents to the soils to reduce the mobility of the compounds. Mobility is reduced by binding the compounds into a soil mass with low permeability that resists leaching. Various additives have been used to enhance binding, such as cement-based, pozzolanic- or silicate-based, and asphalt-based additives Stabilization technologies have been most widely successful when applied to inorganic constituents. Bench-scale treatability studies are essential for determining the applicability of the method and for evaluating the choice of critical parameters, such as selection of stabilizing agents and other additives, waste-to-additive ratio, and mixing and curing conditions. The presence of a variety of compounds is expected to reduce the effectiveness of the stabilization process Disadvantages include the unknown long-term behavior of the stabilized mass and the potential limitations on the future uses of the site depending on the final properties of the stabilized soil material. Furthermore, continued monitoring of the site may be

required since the contamination is left on site In-situ stabilization is readily implementable if the equipment is available and requires moderate capital expenditure. However, it is costly and does not protect ecological receptors. In-situ stabilization is thus not retained for further evaluation.

O.5.3 Ex-Situ Stabilization

Ex-situ stabilization can also be performed, using the same types of additives described above. The resulting soil mass would require disposal at a landfill or some on-site location once stabilization is complete. One disadvantage of this technology is that the long-term behavior of the stabilized mass is unknown. Ex situ stabilization requires treatability studies prior to implementation and has moderate capital cost. Ex situ stabilization will not be considered further because this technology would cost more to implement than in situ stabilization due to the high costs of excavation and storing.

APPENDIX P

REMEDIAL ALTERNATIVES COST ANALYSIS

TABLE P-1

SITE 38, AREA 2
COST ESTIMATE FOR ALTERNATIVE 1 - NO ACTION

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	EXTENDED COST
	DIRECT CAPITAL COST (DCC)				
Construction Cost (CC)					
	TOTAL CAPITAL COST				$0.00
	ANNUAL OPERATION AND MAINTENANCE (O&M) COSTS				
	TOTAL COST OF O&M				$0.00
	FIVE YEAR SITE REVIEW (FOC)				
1	Site Visits/Reporting	1	ls	$8,000.00	$8,000 00
2	Contingency			20% of FOC	$1,600 00
	TOTAL COST OF FIVE-YEAR SITE REVIEW				$9,600 00
	PRESENT VALUE				
				Interest Rate	7%
				Years	5
	TOTAL PRESENT VALUE				$7,000.00

TABLE P-2

SITE 38, AREA 2
COST ESTIMATE FOR ALTERNATIVE 2 - INSTITUTIONAL CONTROLS

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	EXTENDED COST
	DIRECT CAPITAL COST (DCC)				
Construction Cost (CC)					
	General				
1	USA, Secure Site Site Preparation access roads	1	ls	$5,000 00	$5,000 00
2	UXO Clearance	1	ls	$12,000 00	$12,000 00
	Subtotal-General				*$17,000 00*
	Field Work				
3	Install signs/labor and materials	1	ls	$3 500 00	$3 500.00
	Subtotal-Field Work				*$3 500 00*
	SUBTOTAL CONSTRUCTION COST (CC)				*$20 500 00*
	Supervision and Contingency				
4	Contractor Supervision		5% of CC		$1,025 00
5	Health and Safety	1	3% of CC		$615 00
6	Bid Contingency	1	10 % of CC		$2 050.00
7	Scope Contingency	1	10% of CC		$2,050 00
	Subtotal- Supervision and Contingency				*$5 740 00*
	SUBTOTAL DIRECT CAPITAL COST				*$26 240 00*
	INDIRECT CAPITAL COST				
8	Land Use Restrictions	1	ls	$50,000 00	$50,000 00
	Subtotal Indirect Costs				*$50,000 00*
	TOTAL CAPITAL COST				**$76,240.00**
	ANNUAL OPERATION AND MAINTENANCE (O&M) COSTS				
9	Annual O&M	1	ls	$6,000 00	**$6,000.00**
10	Contingency		20% of O&M		$1 200 00
	TOTAL COST OF O&M				**$7,200.00**
	FIVE YEAR SITE REVIEW (FOC)				
11	Site Visits/Reporting	1	ls	$8,000 00	$8,000 00
12	Contingency		20% of FOC		$1,600 00
	TOTAL COST OF FIVE-YEAR SITE REVIEW				**$9,600.00**
	PRESENT VALUE				
				Interest Rate	7%
				Years	5
	TOTAL PRESENT VALUE				**$113,000.00**

TABLE P-3

SITE 38, AREA 2
COST ESTIMATE FOR ALTERNATIVE 3 - REMOVAL/DISPOSAL

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	EXTENDED COST
	DIRECT CAPITAL COST (DCC)				
	Construction Cost (CC)				
	General				
1	USA. Secure Site Site Preparation access roads	1	ls	$10,000.00	$10,000.00
2	Plans	1	ls	$15,000.00	$15,000.00
3	UXO Clearance	1	ls	$20,000.00	$20,000.00
4	Permits for Disturbance of Native Habitat Excavation etc	1	ls	$5,000.00	$5,000.00
5	Mobilize Equipment	1	ls	$8,000.00	$8,000.00
	Subtotal-General				*$58,000.00*
	Field Work				
6	Dust control	100	hr	$80.00	$8,000.00
	Surface Debris Removal and Disposal	1	ls	$8,000.00	$8,000.00
7	Excavate Contaminated Soil	180	cy	$50.00	$9,000.00
8	Trucking of contaminated soil	13	load	$1,200.00	$15,600.00
9	Pretreatment/disposal as RCRA waste	352.8	ton	$120.00	$42,336.00
10	Purchase of backfill	252	cy	$5.00	$1,260.00
11	Trucking of backfill	13	load	$1,000.00	$13,000.00
12	Placement of backfill	252	cy	$40.00	$10,080.00
13	Geotechnical Testing reporting	1	ls	$7,500.00	$7,500.00
	Subtotal-Field Work				*$114,776.00*
	Analytical				
14	Metals	30	ea	$50.00	$1,500.00
15	Labor	24	hr	$75.00	$1,800.00
	Subtotal-Analytical				*$3,300.00*
	Demobilzation				
16	Decon Equipment	1	ls	$5,000.00	$5,000.00
17	Demob Equipment	1	ls	$8,000.00	$8,000.00
18	Site Restoration (Remove temp facilities fencing regrading)	1	ls	$10,000.00	$10,000.00
	Subtotal-Demobilization				*$23,000.00*
	SUBTOTAL CONSTRUCTION COST (CC)				*$199,076.00*
	Supervision and Contingency				
19	Contractor Supervision		5% of CC		$9,953.80
20	Health and Safety		3% of CC		$5,972.28
21	Bid Contingency		10 % of CC		$19,907.60
22	Scope Contingency		10% of CC		$19,907.60
	Subtotal- Supervision and Contingency				*$55,741.28*
	SUBTOTAL DIRECT CAPITAL COST				*$254,817.28*
	INDIRECT CAPITAL COST				
23	Land Use Restrictions	1	ls	$50,000.00	$50,000.00
24	Construction Management		10% of DCC		$25,481.73
25	Contract Administration		15% of DCC		$38,222.59
26	Engineering Services		6% of DCC		$15,289.04
	Subtotal Indirect Costs				*$128,993.36*
	TOTAL CAPITAL COST				**$383,810.64**
	ANNUAL OPERATION AND MAINTENANCE (O&M) COSTS				
27	Annual O&M (signage site walks native habitat count erosion control etc)	1	ls	$10,000.00	$10,000.00
	Contingency		20% of O&M		$2,000.00
	TOTAL COST OF O&M				**$12,000.00**
	FIVE YEAR SITE REVIEW (FOC)				
28	Site Visits/Reporting	1	ls	$8,000.00	$8,000.00
29	Contingency		20% of FOC		$1,600.00
	TOTAL COST OF FIVE-YEAR SITE REVIEW				**$9,600.00**
	PRESENT VALUE				
				Interest Rate	7%
				Years	5
	TOTAL PRESENT VALUE				**$440,000.00**

TABLE P-4

SITE 40, AREA 1.1
COST ESTIMATE FOR ALTERNATIVE 1 - NO ACTION

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	EXTENDED COST
	DIRECT CAPITAL COST (DCC)				
Construction Cost (CC)					
	TOTAL CAPITAL COST				$0.00
	ANNUAL OPERATION AND MAINTENANCE (O&M) COSTS				
	TOTAL COST OF O&M				$0.00
	FIVE YEAR SITE REVIEW (FOC)				
1	Site Visits/Reporting	1	ls	$8,000.00	$8,000.00
2	Contingency			20% of FOC	$1,600.00
	TOTAL COST OF FIVE-YEAR SITE REVIEW				$9,600.00
	PRESENT VALUE				
				Interest Rate	7%
				Years	5
	TOTAL PRESENT VALUE				$7,000.00

TABLE P-5

SITE 40, AREA 1.1
COST ESTIMATE FOR ALTERNATIVE 2 - INSTITUTIONAL CONTROLS

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	EXTENDED COST
	DIRECT CAPITAL COST (DCC)				
Construction Cost (CC)					
	General				
1	USA, Secure Site, Site Preparation	1	ls	$3,000 00	$3,000 00
2	UXO Clearance	1	ls	$10 000 00	$10 000 00
	Subtotal-General				*$13 000 00*
	Field Work				
3	Install signs/labor and materials	1	ls	$3.500 00	$3 500 00
	Subtotal-Field Work				*$3 500 00*
	SUBTOTAL CONSTRUCTION COST (CC)				*$16 500 00*
	Supervision and Contingency				
4	Contractor Supervision		5% of CC		$825 00
5	Health and Safety	1	3% of CC		$495 00
6	Bid Contingency	1	10 % of CC		$1,650 00
7	Scope Contingency	1	10% of CC		$1,650 00
	Subtotal- Supervision and Contingency				*$4.620 00*
	SUBTOTAL DIRECT CAPITAL COST				*$21 120 00*
	INDIRECT CAPITAL COST				
8	Land Use Restrictions	1	ls	$50 000 00	$50,000 00
	Subtotal Indirect Costs				*$50 000 00*
	TOTAL CAPITAL COST				**$71,120.00**
	ANNUAL OPERATION AND MAINTENANCE (O&M) COSTS				
9	Annual O&M	1	ls	$6.000 00	**$6,000.00**
10	Contingency		20% of O&M		$1,200 00
	TOTAL COST OF O&M				**$7,200.00**
	FIVE YEAR SITE REVIEW (FOC)				
11	Site Visits/Reporting	1	ls	$8 000 00	$8,000.00
12	Contingency		20% of FOC		$1.600.00
	TOTAL COST OF FIVE-YEAR SITE REVIEW				**$9,600.00**
	PRESENT VALUE				
				Interest Rate	7%
				Years	5
	TOTAL PRESENT VALUE				**$108,000.00**

TABLE P-6

SITE 40, AREA 1.1
COST ESTIMATE FOR ALTERNATIVE 3 - INSTITUTIONAL CONTROLS WITH SURFACE DEBRIS REMOVAL

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	EXTENDED COST	
	DIRECT CAPITAL COST (DCC)					
Construction Cost (CC)						
	General					
1	USA, Secure Site, Site Preparation, access roads	1	ls	$3,000.00	$3,000.00	
2	UXO Clearance	1	ls	$15,000.00	$15,000.00	
3	Permits (relocation of habitat)/relocation	1	ls	$0.00	$0.00	
4	Mobilize Equipment	1	ls	$5,000.00	$5,000.00	
	Subtotal-General				*$23,000.00*	
	Field Work					
5	Dust control	16	hr	$120.00	$1,920.00	#REF!
6	Trucking of surface debris	2	load	$1,200.00	$2,400.00	
7	Pretreatment/disposal as RCRA waste	80	ton	$120.00	$9,600.00	
8	Install signs/materials and labor	1	ls	$2,200.00	$2,200.00	
	Subtotal-Field Work				*$16,120.00*	
	Demobilzation					
9	Demob Equipment	1	ls	$5,000.00	$5,000.00	
	Subtotal-Demobilization				*$5,000.00*	
	SUBTOTAL CONSTRUCTION COST (CC)				*$44,120.00*	
	Supervision and Contingency					
10	Contractor Supervision		5% of CC		$2,206.00	
11	Health and Safety	1	3% of CC		$1,323.60	
12	Bid Contingency	1	10 % of CC		$4,412.00	
13	Scope Contingency	1	10% of CC		$4,412.00	
	Subtotal- Supervision and Contingency				*$12,353.60*	
	SUBTOTAL DIRECT CAPITAL COST				*$56,473.60*	
	INDIRECT CAPITAL COST					
14	Land Use Restrictions	1	ls	$50,000.00	$50,000.00	
15	Contract Administration		15% of DCC		$8,471.04	
	Subtotal Indirect Costs				*$58,471.04*	
	TOTAL CAPITAL COST				**$114,944.64**	
	ANNUAL OPERATION AND MAINTENANCE (O&M) COSTS					
16	Annual O&M	1	ls	$7,200.00	**$7,200.00**	
	FIVE YEAR SITE REVIEW (FOC)					
17	Site Visits/Reporting	1	ls	$8,000.00	$8,000.00	
18	Contingency		20% of FOC		$1,600.00	
	TOTAL COST OF FIVE-YEAR SITE REVIEW				**$9,600.00**	
	PRESENT VALUE					
				Interest Rate	7%	
				Years	5	
	TOTAL PRESENT VALUE				**$152,000.00**	

TABLE P-7

SITE 40, AREA 1.1
COST ESTIMATE FOR ALTERNATIVE 4 - LIMITED SOIL REMOVAL TO 3 FEET

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	EXTENDED COST
	DIRECT CAPITAL COST (DCC)				
Construction Cost (CC)					
	General				
1	USA, Secure Site Site Preparation, access roads	1	ls	$9 000 00	$9 000.00
2	Plans	1	ls	$15 000 00	$15,000 00
3	UXO Clearance	1	ls	$20 000.00	$20 000 00
4	Permits (relocation of habitat)/relocation	1	ls	$0.00	$0 00
5	Mobilize Equipment	1	ls	$8,000 00	$8 000.00
	Subtotal-General				*$52.000.00*
	Field Work				
6	Dust control	100	hr	$80 00	$8.000 00
7	Excavate Contaminated Soil	510	cy	$10.00	$5,100.00
8	Trucking of contaminated soil	715	ton	$37 00	$26,455 00
9	Pretreatment/Disposal as RCRA waste/Taxes	715	ton	$175 00	$125 125 00
10	Purchase of backfill	510	cy	$5 00	$2 550.00
11	Trucking of backfill	715	ton	$15 00	$10.725.00
12	Placement of backfill	510	cy	$12 00	$6 120 00
13	Geotechnical Testing reporting	1	ls	$7,500.00	$7 500.00
	Subtotal-Field Work				*$191 575 00*
	Demobilzation				
16	Decon Equipment	1	ls	$5,000 00	$5,000 00
17	Demob Equipment	1	ls	$8 000 00	$8,000 00
18	Site Restoration (Remove temp facilities fencing regrading)	1	ls	$8 000 00	$8,000 00
	Subtotal-Demobilization				*$21,000 00*
	SUBTOTAL CONSTRUCTION COST (CC)				*$264,575 00*
	Supervision and Contingency				
19	Contractor Supervision		5% of CC		$13,228 75
20	Health and Safety		3% of CC		$7,937 25
21	Bid Contingency		8% of CC		$21,166 00
22	Scope Contingency		8% of CC		$21 166 00
	Subtotal- Supervision and Contingency				*$63,498.00*
	SUBTOTAL DIRECT CAPITAL COST				*$328,073 00*
	INDIRECT CAPITAL COST				
23	Land Use Restrictions	1	ls	$30.000 00	$30,000 00
24	Construction Management		10% of DCC		$32,807.30
25	Contract Administration		8% of DCC		$26.245.84
26	Engineering Services		6% of DCC		$19.684 38
	Subtotal Indirect Costs				*$108.737 52*
	TOTAL CAPITAL COST				**$436,810.52**
	ANNUAL OPERATION AND MAINTENANCE (O&M) COSTS				
27	Annual O&M	1	ls	$10.600 00	**$10,600 00**
	FIVE YEAR SITE REVIEW (FOC)				
28	Site Visits/Reporting	1	ls	$8.000 00	$8.000 00
29	Contingency		20% of FOC		$1,600 00
	TOTAL COST OF FIVE-YEAR SITE REVIEW				**$9,600.00**
	PRESENT VALUE				
				Interest Rate	7%
				Years	5
	TOTAL PRESENT VALUE				**$488,000.00**

TABLE P-8

SITE 40, AREA 1.1
COST ESTIMATE FOR ALTERNATIVE 5 - CLEAN CLOSURE SOIL REMOVAL TO RAOs

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	EXTENDED COST
	DIRECT CAPITAL COST (DCC)				
Construction Cost (CC)					
	General				
1	USA, Secure Site Site Preparation access roads	1	ls	$9 000 00	$9 000 00
2	Plans	1	ls	$15 000 00	$15,000 00
3	UXO Clearance	1	ls	$20 000 00	$20,000 00
4	Permits (relocation of habitat)/relocation	1	ls	$0 00	$0 00
5	Mobilize Equipment	1	ls	$8 000 00	$8,000 00
	Subtotal-General				*$52 000 00*
	Field Work				
6	Dust control	120	hr	$80 00	$9 600 00
7	Excavate Contaminated Soil	1500	cy	$10 00	$15,000 00
8	Trucking of contaminated soil	2000	ton	$37 00	$74,000 00
9	Pretreatment/Disposal as RCRA waste/taxes	2000	ton	$175 00	$350 000 00
10	Purchase of backfill	1500	cy	$5 00	$7,500 00
11	Trucking of backfill	2000	ton	$15 00	$30 000 00
12	Placement of backfill	1500	cy	$12 00	$18,000 00
13	Geotechnical Testing reporting	1	ls	$7,500 00	$7,500 00
	Subtotal-Field Work				*$511,600 00*
	Analytical				
14	Metals	15	ea	$50 00	$750 00
15	Labor	24	hr	$75 00	$1,800 00
	Subtotal-Analytical				*$2 550 00*
	Demobilzation				
16	Decon Equipment	1	ls	$5,000 00	$5 000 00
17	Demob Equipment	1	ls	$8 000 00	$8 000 00
18	Site Restoration (Remove temp facilities fencing regrading)	1	is	$8 000 00	$8,000 00
	Subtotal-Demobilization				*$21 000 00*
	SUBTOTAL CONSTRUCTION COST (CC)				*$587,150 00*
	Supervision and Contingency				
19	Contractor Supervision		5% of CC		$29 357 50
20	Health and Safety		3% of CC		$17 614 50
21	Bid Contingency		8 % of CC		$46 972 00
22	Scope Contingency		8% of CC		$46,972 00
	Subtotal- Supervision and Contingency				*$140,916 00*
	SUBTOTAL DIRECT CAPITAL COST				*$728,066 00*
	INDIRECT CAPITAL COST				
23	Construction Management		10% of DCC		$72,806 60
24	Contract Administration		8% of DCC		$58 245 28
25	Engineering Services		6% of DCC		$43,683 96
	Subtotal Indirect Costs				*$174 735 84*
	TOTAL CAPITAL COST				**$902,801.84**
	ANNUAL OPERATION AND MAINTENANCE (O&M) COSTS				**$0.00**
	FIVE YEAR SITE REVIEW (FOC)				**$0.00**
	PRESENT VALUE				
				Interest Rate	7%
				Years	5
	TOTAL PRESENT VALUE				**$902,802.00**