United States Department of Energy

WORK PLAN FOR PHASE 1A PALEOCHANNEL STUDIES AT THE CHENEY DISPOSAL CELL, GRAND JUNCTION, COLORADO

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**WORK PLAN FOR PHASE 1A PALEOCHANNEL
STUDIES AT THE CHENEY DISPOSAL CELL,
GRAND JUNCTION, COLORADO**

November 1996

**Prepared for
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Environmental Restoration Division
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LIST OF ACRONYMS

<u>Acronym</u>	<u>Definition</u>
bgs	below ground surface
COC	chain-of-custody
DOT	U.S. Department of Transportation
EDD	electronic data deliverable
GFCI	ground fault circuit interrupt
ICP-MS	inductively coupled plasma mass spectrometry
QA/AC	quality assurance/quantity control
SOP	standard operating procedure
SOW	Statement of Work
TDS	total dissolved solids
WSAP	Water Sampling and Analysis Plan
RAC	Remedial Action Contractor
TAC	Technical Assistance Contractor
BMP	best management practice
mg/L	milligrams per liter
NVGD	national vertical geodetic datum

CHANGE HISTORY

Document version	Date	Pages/comments
Rev. 0	11/13/96	Initial Version

1.0 INTRODUCTION

1.1 PURPOSE OF DOCUMENT

This document will serve as a Work Plan for continuing paleochannel characterization activities at the Cheney disposal site near Grand Junction, Colorado. Elevated levels of nitrate were encountered in ground water from two monitor wells (GRJ-03-731 and -732) installed in alluvial paleochannels near the Cheney disposal cell in 1994. This triggered a series of investigations (Phase 1) designed to determine the source of nitrate and other chemical constituents in ground water at the site. A comprehensive summary of the Phase 1 field investigations (limited to passive monitoring and modeling studies) conducted by the Remedial Action Contractor (RAC) and Technical Assistance Contractor (TAC) to date is provided in Section 2.0 of this document. Results of Phase I were inconclusive regarding the potential interaction between the disposal cell and the paleochannels, so additional Phase 1A investigations are planned. Recommendations for Phase 1A tasks and possible future activities are discussed in Section 3.0. Detailed information on the implementation of the proposed Phase 1A tasks appears in Section 4.0 and will provide the basis for Statements of Work (SOW) for each of these tasks. A detailed sampling plan is provided to ensure quality and a consistency with previous data collection efforts.

1.2 SITE BACKGROUND

The geology, geochemistry, and geophysics of the Cheney site were extensively characterized from 1985 through 1991 prior to construction of the Cheney disposal cell. Although numerous boreholes and test pits were constructed at the Cheney site, no ground water was encountered near the disposal cell prior to installation of monitor wells and -732 in 1994 (Figure 1.1).

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FIGURE 1.1
TEST PITS, BOREHOLES, AND PALEOCHANNELS
CHENEY DISPOSAL SITE, COLORADO

Therefore no historical ground water quality data are available in this area; the only information obtained from these boreholes and test pits was soil gradations.

The nearest ground water was encountered in approximately 20 boreholes and wells in an area between 1600 and 3800 feet northeast (upgradient) of monitor wells 731 and 732. For the period of 1983 through June 1995, ground water samples were obtained from the alluvium, the shallow weathered Mancos Shale, the Mancos Shale, and the Dakota Sandstone. The results of chemical analyses, including chloride, selenium, molybdenum, uranium, sulfate, and nitrate concentrations are summarized in Table 1.1. Data obtained from water samples taken from the Dakota Sandstone are omitted because this formation is too deep to influence water quality in monitor wells 731 and 732.

During excavation activities in 1991 at the northwest corner of the disposal cell, ground water was unexpectedly encountered in a paleochannel, designated as the northwest paleochannel (Figure 1.1). This source of ground water was not sampled or analyzed, and previous investigations had not characterized this area of the disposal cell. To avoid compromising the integrity of the disposal cell, the cell footprint was truncated at the paleochannel. The paleochannel was reconstructed by backfilling the area with low-permeability, compacted, Mancos Shale material, then trenching a new channel that was backfilled with gravel thereby directing flow around the disposal cell (MK, 1991).

There is no compliance monitoring at the Cheney disposal cell because ground water in the uppermost aquifer (Dakota Sandstone) is of limited use and supplemental standards have been applied as the compliance strategy for ground water protection (40 CFR § 192.21 [1995]). However, ground water in paleochannels adjacent to the north and south sides of the disposal cell is monitored as a best management practice (BMP) to evaluate the potential impact of the disposal cell to transient ground water in the paleochannels.

Table 1.1. Summary of water quality data, Cheney disposal site, Colorado

Constituent	Wells	Frequency of Detection	Minimum ^a	Median ^a	Maximum ^a
Alkalinity	Tailings ^b	11/11	7	175	679
	731 ^c	1/1	NA	153	NA
	732 ^c	2/2	164	NA	171
	Alluvial ^d	27/27	259	321	474
	Shallow Mancos ^d	23/23	229	294	670
	Mancos ^d	6/6	369	1025	1290
Ammonium	Tailings	20/20	1.5	305	912
	731	1/1	NA	0.3	NA
	732	1/2	<0.1	NA	0.1
	Alluvial	3/28	<0.01	<0.1	0.3
	Shallow Mancos	7/22	<0.1	<0.1	0.7
	Mancos	6/6	2.1	3.0	5.0
Arsenic	Tailings	27/28	<0.01	0.095	1.7
	731	0/1	NA	<0.005	NA
	732	0/2	<0.005	NA	<0.01
	Alluvial	0/28	<0.01	<0.01	<0.01
	Shallow Mancos	3/23	<0.001	<0.01	0.01
	Mancos	1/6	<0.01	<0.01	0.012
Cadmium	Tailings	24/28	<0.001	0.19	0.35
	731	0/1	NA	<0.001	NA
	732	0/2	<0.001	NA	<0.001
	Alluvial	10/28	<0.001	<0.001	0.004
	Shallow Mancos	5/20	<0.001	<0.001	0.006
	Mancos	4/6	0.002	0.003	0.008
Calcium	Tailings	25/25	431	510	1300
	731	1/1	NA	525	NA
	732	2/2	335	NA	356
	Alluvial	28/28	62	98	135
	Shallow Mancos	23/23	86	118	530
	Mancos	6/6	11	22	237
Chloride	Tailings	19/19	705	1030	1830
	731	1/1	NA	1530	NA
	732	2/2	382	NA	553
	Alluvial	28/28	16	29	81
	Shallow Mancos	23/23	21	33	250
	Mancos	6/6	1210	1545	2480
Fluoride	Tailings	21/21	0.70	4.40	19.2
	731	1/1	NA	0.34	NA
	732	2/2	0.40	NA	0.43
	Alluvial	28/28	0.40	0.50	0.70
	Shallow Mancos	19/19	0.30	0.40	0.60
	Mancos	6/6	0.50	1.40	1.80

Table 1.1. Summary of water quality data, Cheney disposal site, Colorado

Constituent	Wells	Frequency of Detection	Minimum ^a	Median ^a	Maximum ^a
Iron	Tailings	24/28	<0.02	7.7	370
	731	0/1	NA	<0.10	NA
	732	0/2	<0.03	NA	<0.10
	Alluvial	17/28	<0.03	0.04	0.25
	Shallow Mancos	22/23	<0.03	0.23	7.7
	Mancos	6/6	0.03	0.06	0.24
Magnesium	Tailings	25/25	4	296	530
	731	1/1	NA	498	NA
	732	2/2	212	NA	231
	Alluvial	28/28	42	54	93
	Shallow Mancos	23/23	43	55	183
	Mancos	6/6	13	17	124
Manganese	Tailings	28/28	1.93	5.35	14.7
	731	0/1	NA	<0.05	NA
	732	0/2	<0.01	NA	<0.05
	Alluvial	17/28	<0.01	0.01	0.71
	Shallow Mancos	22/23	<0.01	0.37	6.6
	Mancos	6/6	0.01	0.07	0.10
Molybdenum	Tailings	22/28	0.08	0.47	4.35
	731	0/1	NA	<0.05	NA
	732	0/2	<0.01	NA	<0.05
	Alluvial	11/28	<0.01	<0.01	0.07
	Shallow Mancos	9/20	<0.01	<0.01	0.17
	Mancos	5/6	<0.01	0.03	0.21
Nitrate	Tailings	11/19	<0.1	<1.0	4600
	731	1/1	NA	41	NA
	732	2/2	174	NA	178
	Alluvial	11/28	<0.1	<1.0	1.3
	Shallow Mancos	7/23	<0.1	<1.0	7.5
	Mancos	1/6	<0.1	<0.1	4.7
Selenium	Tailings	21/28	<0.01	0.08	0.91
	731	1/1	NA	0.36	NA
	732	2/2	0.23	NA	0.34
	Alluvial	20/28	<0.005	0.009	0.023
	Shallow Mancos	9/23	0.002	<0.005	0.313
	Mancos	4/6	0.009	<0.016	<0.03
Sodium	Tailings	25/25	380	810	1230
	731	1/1	NA	620	NA
	732	2/2	1240	NA	1300
	Alluvial	28/28	56	94	324
	Shallow Mancos	23/23	65	92	260
	Mancos	6/6	1120	1640	2630
Sulfate	Tailings	19/19	1940	3190	6034
	731	1/1	NA	3310	NA
	732	2/2	3440	NA	3640
	Alluvial	28/28	216	335	864
	Shallow Mancos	23/23	145	344	1690
	Mancos	6/6	426	917	1550

Table 1.1. Summary of water quality data, Cheney disposal site, Colorado

Constituent	Wells	Frequency of Detection	Minimum ^a	Median ^a	Maximum ^a
Uranium	Tailings	27/27	0.051	1.02	29.7
	731	1/1	NA	0.019	NA
	732	2/2	0.024	NA	0.026
	Alluvial	27/27	0.005	0.007	0.074
	Shallow Mancos	22/22	0.003	0.009	0.046
	Mancos	4/6	<0.003	0.003	0.008
Vanadium	Tailings	26/28	<0.01	1.61	41
	731	0/1	NA	<0.05	NA
	732	0/2	<0.01	NA	<0.05
	Alluvial	13/28	<0.01	<0.01	0.08
	Shallow Mancos	12/23	<0.01	0.015	0.31
	Mancos	1/6	<0.01	<0.01	0.06

^a Milligrams per liter

^b Lysimeters in the tailings from the Grand Junction processing site (August 1989 through January 1990)

^c Monitor wells 731 and 732 are the Cheney paleochannel wells. All concentrations in mg/

^d Ground water quality at the Cheney disposal site (1983 through June 1995).

The two monitor wells (731 and 732) were installed downgradient of the disposal cell at the alluvium/Mancos Shale interface in November 1994 (Figure 1.1). The screened intervals intercept the boundary between the alluvium and shallow Mancos Shale, potentially tapping water flowing within the alluvium, along the boundary, or in fractures in the shallow Mancos Shale (Figures 1.2 through 1.5). Monitor well 731 is located approximately eight feet from the perimeter ditch and approximately 175 feet south of the northwestern corner of the disposal cell. Monitor well 732 is located near the southwestern corner of the disposal cell, approximately eight feet from the perimeter ditch, and 150 feet east of the low point of the perimeter ditch. The perimeter ditch collects surface water that flows in the riprap and bedding layers over the "clean fill" berms. The radon barrier, frost protection layer, and clean select fill berms are composed of local alluvial deposits and fractured Mancos Shale, which may contain chloride, selenium, molybdenum, uranium, and fluoride. Nitrate has been observed in sand samples from the bedding layer. There has only been one observed instance of water overflowing the perimeter ditch (in the southwest corner of the cell), indicating that most of the water collected in the ditch seeps into the alluvium adjacent to the disposal cell.

Ground water samples were obtained from the two monitor wells during January and June 1995, and June 1996 (results of chemical analyses are included in Table 1.1). Concentrations of nitrate in ground water were elevated, particularly in monitor well 732 at the southwest corner of the disposal cell (maximum nitrate concentration of 178 mg/L). The concentrations of nitrate in ground water were consistently elevated, indicating that they do not represent transient anomalies. The chemical constituents in both wells are similar, and it is probable that the ground water encountered in the two wells is from the same source.

NOTES:

1. FINAL GRADE IS SHOWN AS OF 8/93 PER MK AS-BUILT DWG NO. GRJ-DS-10-0230, DATED 8/93
2. CLEAN FILL BARRIER BELOW GROUND SURFACE IS LOW PERMEABILITY SOIL CONSISTING OF COMPACTED MANCOS SHALE FILL OBTAINED FROM SUBGRADE EXCAVATION.
3. GROUNDWATER LEVEL SHOWN AS OBSERVED IN WELL GRJ-03-0731 ON 9/2/95 AND IN WELL GRJ-03-0372 ON 8/27/95.
4. ELEVATION OF TOP OF WEATHERED MANCOS SHALE PLOTTED FROM FIGURE 1 OF REPORT ENTITLED "NORTHWEST PALEOCHANNEL RESTORATION AT CHENEY DISPOSAL EMBANKMENT SITE", JULY 1992.
5. ORIGINAL GROUND SURFACE PLOTTED FROM TOPOGRAPHIC INFORMATION SUPPLIED BY JACOBS ENGINEERING GROUP, INC. DATED AUGUST, 1985.
6. BOTTOM OF EXCAVATION PLOTTED FROM DESIGN DRAWING NO. GRJ-DS-10-0134, REV 5, DATED 2/90.

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FIGURE 1.2
CROSS SECTION A-A'
CHENEY DISPOSAL SITE, COLORADO

NOTES:

1. FINAL GRADE IS SHOWN AS OF 08/93 PER WK AS-BUILT DRAWING NO. GRJ-DS-10-0230, DATED 8/93.
2. GROUNDWATER LEVEL MEASURED ON 8/27/95.
3. GROUNDWATER ENCOUNTERED IN DAKOTA SANDSTONE FORMATION AT EL 4438.0 (798' BELOW GRADE). BOTTOM OF HOLE @ 897' BELOW GRADE.
4. ELEVATION OF TOP OF WEATHERED MANCOS SHALE TAKEN FROM FIGURE 1 OF REPORT ENTITLED "NORTHWEST PALEOCHANNEL RESTORATION AT CHENEY DISPOSAL EMBANKMENT SITE", JULY 1992.
5. ORIGINAL GROUND SURFACE PLOTTED FROM TOPOGRAPHIC INFORMATION SUPPLIED BY JACOBS ENGINEERING GROUP, INC. DATED AUGUST, 1985.
6. BOTTOM OF EXCAVATION PLOTTED FROM DESIGN DRAWING NO. GRJ-DS-10-0134, REV 5, DATED 2/90.
7. BOTTOM OF BOREHOLE @ 123' BELOW GRADE. NO GROUNDWATER ENCOUNTERED.

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FIGURE 1.3
CROSS SECTION B-B'
CHENEY DISPOSAL SITE, COLORADO

MODIFIED FROM MK-F, 1996.

FIGURE 1.4
CROSS SECTION C-C' SHOWING POTENTIAL SOURCES OF WATER IN WELL 731
CHENEY DISPOSAL SITE, COLORADO

MODIFIED FROM MK-F, 1996.

FIGURE 1.5
CROSS SECTION D-D' SHOWING POTENTIAL SOURCES OF WATER IN WELL 732
CHENEY DISPOSAL SITE, COLORADO

2.0 SUMMARY OF PHASE 1 ACTIVITIES

After establishing that nitrate levels in the paleochannel wells were not transient anomalies, the RAC and the TAC have jointly and separately pursued several lines of investigation aimed at determining the source of this and other constituents of concern in the paleochannel ground water. Constituents of concern are those constituents in addition to nitrate that may indicate the presence of seepage derived from the disposal cell. These include calcium, chloride, fluoride, magnesium, selenium, sodium, sulfate, and uranium. In addition, information collected during previous site-characterization activities provides constraints on the source(s) of constituents of concern in paleochannel ground water. This section summarizes Phase 1 investigations to date, including methods and results.

Phase I activities have included: 1) site reconnaissance; 2) evaluation of previous transient-drainage studies; 3) statistical evaluation of geochemical data (including data generated during the course of these investigations and data generated during site characterization activities; 4) evaluation of existing engineering data; 5) screening of parameters that might allow identification of tailings fluids in ground water; 6) analyses of surface water, ground water, and soil samples; 7) water level monitoring using data loggers, and evaluation of water level data in relationship to rainfall data from the Cheney site; and 8) identification of fingerprint parameters. Each of these activities will be addressed in approximate chronological sequence in order to highlight the thoroughness of the investigations to date.

2.1 EVALUATION OF TRANSIENT DRAINAGE STUDIES

Although there are several potential sources for constituents of concern in ground water occurring in paleochannels at the Cheney site, the primary issue is whether they might be due to seepage of tailings fluids from within the disposal cell. The disposal cell was designed to allow a small flux out of the bottom of the impoundment, and an initial period of higher flux (i.e., transient drainage) has been predicted to occur during, and resulting from, compaction of tailings materials during construction (Calculation GRJ-08-90-12-05-00). The resulting

flux was expected to infiltrate the fractured Mancos Shale beneath the cell, which has adequate storage capacity according to calculations (TAC, 1991).

Study of the site geology and evaluation of the original engineering calculations (Siegal, 1995) indicated that lateral migration of tailings fluid is possible through fractures in the Mancos Shale. However, it has not been determined that such migration is actually occurring. Further investigation is necessary to rule out or confirm this possibility.

2.2 STATISTICAL EVALUATION OF GEOCHEMICAL DATA

To determine the potential sources for constituents of concern in ground water that occur in the paleochannels, a statistical analysis was performed comparing all available data from the following sources: 1) ground water samples from paleochannel monitor wells 731 and 732; 2) samples of tailings pore fluids taken from lysimeters installed in the tailings at the processing site; and 3) ground water samples from pre-existing site-characterization wells installed at the Cheney site prior to construction of the disposal cell (including wells completed in the alluvium; the shallow weathered Mancos Shale, and the deep unweathered Mancos Shale) (Erskine, 1996) (Table 1.1). Tailings lysimeters and, for the most part, site-characterization wells no longer exist, so it is not possible to directly compare samples from these sources with current samples of paleochannel ground water.

General conclusions of the statistical analyses were:

- Ground water from the two paleochannel wells is chemically similar and is likely from the same source.

- It is unlikely that ground water from the two paleochannel wells and the pre-existing site-characterization wells completed in the alluvium and weathered Mancos Shale have the same source.
- Ground water in the unweathered Mancos Shale and the two paleochannel wells are probably from different sources.
- Ground water in the paleochannel wells is not directly from tailings pore fluid but could be related to pore fluid through geochemical modifications.

2.3 EVALUATION OF EXISTING ENGINEERING DATA

Because the results of the statistical analysis were inconclusive, the RAC was asked to develop a plan to identify potential sources of water and constituents in the paleochannel wells. This work included:

- A review of available data regarding water quality, site characteristics, cell construction, and subsurface investigations.
- Visiting the site to examine the potential differential settlement of the cell cover and possible seeps around the cell.
- Developing cross-sections of the partially completed disposal cell emphasizing correlations between paleochannel wells, surrounding construction features, and geologic conditions.
- Summarizing all available water chemistry data.

After completing these tasks, the conclusions of the study were (RAC, 1996):

- The water-quality data from the two monitor wells is comparable and the ground water is probably from the same source.

- The concentration of nitrate, sulfate, and selenium from the water samples in the two paleochannel wells exceeds background ground water quality in the now-abandoned site-characterization wells completed upgradient in the alluvium.
- Water in the two paleochannel wells differs significantly from tailings pore water, especially with respect to uranium and molybdenum.
- Possible sources of constituents of concern appearing in ground water from the paleochannel wells are as follows:
 1. Constituents from soils on the top of the cell may have been leached by storm run-off, which collects in the perimeter ditch and infiltrates in the vicinity of the paleochannel wells.
 2. Upgradient recharge water may have dissolved vadose-zone salt deposits as the water table rose in response to several years of higher-than-normal precipitation.
 3. Tailings water may have seeped through the clean fill berm or under the berm through fractures in the Mancos Shale.

2.4 SCREENING OF PARAMETERS FOR TAILINGS FLUID IDENTIFICATION

Based on the above conclusions regarding possible sources for constituents in ground water from paleochannel wells, the TAC was asked to develop a list of parameters to fingerprint tailings pore fluids at the Cheney disposal site. This effort showed there are no parameters that unequivocally indicate the presence of tailings pore fluid in ground water. However, several parameters appear to be present in tailings pore fluids at concentrations that are considerably higher than those observed in the alluvial ground water system. These parameters are nitrate, fluoride, and chloride. In addition, carbon-14 or tritium isotopic

measurements would establish the apparent age of the ground water, permitting calculation of the relative proportions of old water from the Mancos Shale and young water from the alluvium, cell runoff, or seepage. Useful secondary indicators are calcium, magnesium, selenium, sodium, and sulfate.

2.5 SURFACE WATER AND SOIL SAMPLING

Surface water and soil sampling was conducted during April and May 1996 and included sampling and analysis of 15 surface water samples and 21 surface soil samples (DOE, 1996). Surface water sampling locations are shown on Figures 2.1 and 2.2, and surface soil sampling locations are shown on Figure 2.3. The locations where elevated levels of chemicals were detected are also summarized in Table 2.1. Details of the laboratory analyses are included in Tables A-1 through A-4 in Appendix A.

2.5.1 Surface water samples

No evidence of elevated levels of nitrates and sulfates were found by MK-Ferguson in surface water samples (RAC, 1996). One surface water sample collected at the disposal cell collection pond exhibited an elevated concentration of molybdenum. However, water quality in well 732 will not be affected since the pond is downgradient. Arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver and uranium were not present in significant levels in any of the surface water samples collected during the Phase 1 investigation. After careful analysis of all available data it appears that degraded ground water quality in wells 731 and 732 is not through a direct surface water source.

2.5.2 Surface soil samples

Elevated levels of nitrates were detected in the bulk soil samples of the erosion protection material on the disposal cell embankment. Storm water run-off over the erosion protection materials could potentially transport nitrates to the low

MODIFIED FROM MK-F, 1996.

FIGURE 2.1
LOCATION AND CHEMICAL CONTENT OF ON-SITE SURFACE WATER
SAMPLED BY MK-FERGUSON DURING PHASE I
CHENEY DISPOSAL SITE, COLORADO

FIGURE 2.2
LOCATION AND CHEMICAL CONTENT OF OFF-SITE CONSTRUCTION-POND WATER
SAMPLED BY MK-FERGUSON DURING PHASE I
CHENEY DISPOSAL SITE, COLORADO

MODIFIED FROM MK-F, 1996.

MODIFIED FROM MK-F, 1996.

Table 2.1 Completion information for the remaining active wells at the Cheney disposal site

	508	701	731	732	828
Northing	14186	14480	12427	10548	13143
Easting	96169	95010	91837	92019	93276
Ground elevation	5324.1	5293.1	5213 ¹	5200 ¹	5245.9
Top of casing	5326.0	5295.0	5218.1	5202.5	5247.5
Top of screen	5293.4	5267.0	5200.6	5184.9	5228.0
Bottom of screen	5273.4	5257.0	5185.6	5169.9	5218.0
Top of Mancos*	5286.6 ²	within screened interval ²	5190 ¹	5173 ¹	below screened interval

*weathered Mancos.

All elevations are in feet NVGD (national vertical geodetic datum).

Completion information obtained from the SEE-UMTRA database except as noted.

¹From MK Ferguson drawings (see Figures 1.4 and 1.5 in this report).

²From Ward, 1996a.

point in the perimeter ditch, where they could migrate to well 732. Elevated levels of sulfates were detected around the rock and soil stockpile area north of well 731. Other than nitrates and sulfates, only strontium in elevated amounts was found in the surficial alluvial soils east of the common fill pile, west of the "C" rock pile, and in the soil/bedding material at the perimeter ditch. Since no strontium data are available for wells 731 and 732, correlation of these surface sources with ground water in the wells is not possible. Selenium was not found in any soil samples collected during this phase of the investigation.

Results of the sampling and review of ground water quality data to date suggest the following possible sources of chemical constituents encountered in wells 731 and 732:

- Leachate from the soils with high sulfates north of the pile.
- Leachate from erosion protection material with high nitrates on the disposal cell embankment.

Additional soil sampling was conducted by the TAC during June 1996 in conjunction with monitor well sampling and a site walkover (Monks, 1996). Soil samples were analyzed for nitrate using a water extraction process via EPA method 1312 (EPA, 1990). Two upgradient site characterization wells (previously thought to have been abandoned) were identified during the walkover (wells 508 and 701). Soil sampling locations are shown on Figures 2.4 and 2.5. The two upgradient site-characterization wells are shown in Figure 2.6, along with cross-gradient well 828, which is also believed to be active.

MODIFIED FROM MK-F, 1996.

FIGURE 2.4
LOCATION OF ON-SITE WELLS SAMPLED BY THE TAC DURING PHASE I
CHENEY DISPOSAL SITE, COLORADO

FIGURE 2.5
OFF-SITE SOIL LOCATION NEAR HIGHWAY 50
SAMPLED BY THE TAC DURING PHASE I
CHENEY DISPOSAL SITE, COLORADO

MODIFIED FROM MK-F, 1996.

1 0 1/2 1 MILE

FIGURE 2.6
APPROXIMATE LOCATIONS OF REMAINING ACTIVE WELLS
CHENEY DISPOSAL SITE, COLORADO

2.6 GROUND WATER SAMPLING

Wells 731 and 732 have been sampled two and three times, respectively, for a standard suite of constituents (Table 2.2). Sample collection, analysis, and data validation followed standard TAC protocols, as described in Section 4.0 of this document. Results for nitrate and other constituents of concern (calcium, chloride, magnesium, selenium, sodium, sulfate, and uranium) are shown in Figures 2.7 through 2.9 as a function of sampling date. Also shown in these figures are historical measurements from other wells screened in the shallow ground water system. The historical data spans the period from 1983 to early 1991, whereas well 732 was first sampled in late 1994, and well 731 was not sampled until early 1995 (it was dry before this).

There are two components to the shallow ground water system: the paleochannels which are located within the alluvium and in places incised into the Mancos Shale, and the upper weathered and fractured portion of the Mancos Shale, itself. Upper Mancos Shale water was sampled by wells 508, 701, and 702, whereas the other wells are screened across the shale-alluvium contact or completed only in the alluvium. Figures 2.7 through 2.9 show that, at times, upper Mancos water is more saline relative to alluvium water, especially with respect to calcium and sulfate. At other times, water quality in the two systems is indistinguishable.

Water quality in the paleochannel wells exceeds historical ranges for many constituents of concern. Chloride, magnesium, nitrate, selenium, sodium, and sulfate are all more concentrated in the recent paleochannel samples, particularly in the most recent sampling of well 731. Calcium is only slightly more concentrated in the recent paleochannel samples, and fluoride and uranium fall within historical ranges. Quantitative comparison of recent and historical data is hindered by the five-year gap between the two sets of data, during

Heavy connecting lines represent active wells; light connecting lines represent decommissioned wells.

Wells 508, 701, and 702 are completed in the Mancos Shale; other wells are screened across the shale-alluvium contact or completed only in the alluvium.

FIGURE 2.7
CALCIUM, CHLORIDE, AND FLUORIDE IN SHALLOW GROUND WATER
CHENEY DISPOSAL SITE, COLORADO

FIGURE 2.8
MAGNESIUM, NITRATE, AND SELENIUM IN SHALLOW GROUND WATER
CHENEY DISPOSAL SITE, COLORADO

Heavy connecting lines represent active wells; light connecting lines represent decommissioned wells.
Wells 508, 701, and 702 are completed in the Mancos Shale; other wells are screened across the shale-alluvium contact or completed only in the alluvium.

FIGURE 2.9
SODIUM, SULFATE, AND URANIUM IN SHALLOW GROUND WATER
CHENEY DISPOSAL SITE, COLORADO

which the shallow ground water system may have changed significantly in response to several wetter-than-normal years. Nevertheless, statistical evaluation may suggest likely correlations, as discussed previously in Section 2.2.

2.7 GROUND WATER LEVEL MONITORING

2.7.1 Ground water level monitoring background

The purpose of wells 731 and 732 was to characterize ground water flow (if any) within shallow gravel channels of the alluvium and to monitor the potential for water movement (seepage) into or out of the disposal cell. Initial monitoring of the gravel paleochannels consisted of water level measurements and trend analysis to evaluate fluctuations in storage. The following data collection objectives were identified prior to installing the wells and loggers:

- Detect ground water occurrences (if any) within the subject paleochannels,
- Evaluate ground water occurrences by measuring static ground water levels, and upon detection, assess any fluctuations in ground water levels; and
- Sample detected paleochannel waters to determine changes in chemistry and possible cell impacts.

2.7.2 Shallow hydrogeologic setting in the vicinity of wells 731 and 732

Construction of wells 731 and 732 and the other remaining active wells at the Cheney disposal site is summarized in Table 2.2.

The geologic log of well 731 indicates that the fill/alluvium consists of silty clay and sandy gravel with cobbles to a depth of approximately 14 feet. A competent clay layer was encountered from 14 to 15 feet below ground surface

Table 2.2 Locations of samples with elevated levels of chemicals (DOE, 1996)

Area	Molybdenum	Uranium	Nitrate	Sulfate
(A) Highest concentration in Soil Samples (mg/kg) for each area				
North Top @ Slope Break			460.0	
Perimeter Ditch			3.2	
Top Slope South of PCC Hole			12.0	
South Top @ Slope Break			84.0	
SE of "A" Rock Pile			1.8	
SE of Common Fill Pile			13.0	
Bedding Pile			0.4	
Interceptor Drainage Ditch		3.0	7.5	10000
East of Common Fill Pile		4.1	20.8	19100
West of "C" Rock Pile		2.9	8.7	19600
(B) Highest concentration in Water Samples (mg/L) for each area				
Disposal Cell Pond	2.10			
Decon Pond	0.02	0.029		
Interceptor Drainage Ditch		0.0003		
Common Fill Pond		0.0058		

(bgs). Although this well was eventually completed dry, the presence of wet clay on the end of the bit was noted when the bit was pulled out of the borehole from a depth of 15 feet. A split spoon pulled from the borehole from a depth of approximately 21 feet was also wet. Poorly graded sandy gravel with cobbles were encountered from approximately 15 to 21 feet followed by layers of silty and sandy wet clay to a depth of approximately 27 feet. Below this, weathered Mancos Shale was encountered. Competent Mancos Shale was encountered at approximately 31.5 feet bgs. The well was screened from 12.4 to 25.4 feet bgs.

The geologic log of well 732 indicates that the fill/alluvium consists of silty sands, gravel, and cobbles with some clay to a depth of approximately 15 feet where a silty clay layer approximately five feet thick was encountered. From approximately 20 to 26 feet bgs, interbedded layers of well-graded sandy gravel with cobbles and silty clay were encountered. At approximately 27.5 feet bgs the weathered Mancos Shale was encountered and at approximately 30.5 feet, competent Mancos Shale was encountered. The well was screened from 15.1 to 30.1 feet bgs. Ground water was first encountered at a depth of approximately 18 to 19 feet bgs. At the completion of development, the water level recovered approximately six feet in three minutes. The static water level was measured at approximately 18 feet bgs (5182 feet elevation).

It appears that in the vicinity of wells 731 and 732, ground water is perched within gravel channels in the alluvium. The water-bearing gravel channels are shallowly incised into clays within the alluvium, which in turn rests on top of the Mancos Shale. Observations elsewhere have indicated that the channels are incised directly into the top of the Mancos Shale and are in hydraulic connection with fractures which contain water in the upper weathered Mancos Shale.

Thus, the degree of hydraulic connection between the channels and the weathered Mancos Shale is variable.

Stratigraphic relationships in the vicinity of well 732 at the southwestern corner of the disposal cell are more complex than elsewhere because of an arroyo incised into the alluvium. The pre-construction topography, an interim waste water retention basin, and final grade of the area is illustrated in Figure 2.10. where the arroyo crosses the site boundary, it is 20 to 25 feet deep. At the toe of the fill in the arroyo, the elevation is 5178 feet or lower. Upgradient toward the cell, the arroyo has been filled in, with coarse rock near the bottom and clean fill as a cover. Its course veers to the east as the cell is approached, shallowing to a depth of 10 feet or less. The cross section (Figure 2.11) illustrates the relationship between the filled arroyo, the southwest paleochannel, and well 732

2.7.3 Potential influences on water occurrence and flow in the alluvium/shallow Mancos Shale

There are two primary influences on water occurrence and flow in the alluvium and shallow Mancos Shale in the vicinity of the Cheney disposal cell. These influences include regional upgradient recharge (either by precipitation or snow melt) of shallow gravels in the alluvium, and runoff due to precipitation from the Cheney disposal cell.

During characterization of the Cheney site, it was discovered that water can naturally occur regionally at or near the base of the alluvium in thin isolated gravel channels upgradient from the disposal cell footprint. The gravel channels were found to comprise several systems, none of which were identified within the footprint of the Cheney disposal cell. (The northwest paleochannel was discovered during cell construction.)

LEGEND

(5220) PROJECTED ELEVATION FROM
CROSS SECTION E-E'

FIGURE 2.11
DETAIL OF CROSS SECTION D-D'
CHENEY DISPOSAL SITE, COLORADO

Run-off from the Cheney disposal cell recharges the fill and alluvium surrounding the cell. Much of this run-off empties into the perimeter ditch and is then routed to a low area near the southwest corner of the cell. Recent water level data collected from wells 731 and 732 support a correlation between storm events and water-level increases in these wells. The correlation is particularly evident for well 732. At E-E' in Figures 2.10 and 2.11, the perimeter ditch is incised into fill rather than undisturbed Mancos Shale or alluvium. This substrate may be quite permeable, allowing water in this segment of the perimeter ditch to drain into the subsurface. Once in the fill, water would move rapidly down the arroyo channel through the coarse material there. A field check at the toe of the fill showed no evidence of seepage (Monks, 1996), suggesting that water entering the fill must percolate into the underlying alluvium and Mancos Shale. On this basis, there may be a close connection between the perimeter ditch and well 732. As water in the arroyo fill moves down-channel from E-E' toward D-D', it crosses the southwest paleochannel. At D-D', the arroyo may cut down into the Mancos at an elevation near 5180 feet; the paleochannel may potentially be rapidly recharged by flow along the alluvium-Mancos interface.

2.7.4 Ground water level fluctuations observed in wells 731 and 732

In early December 1994, data loggers were installed in wells 731 and 732. Water level data has been collected from these wells at hourly intervals from the time of installation until November 1995, when the logging interval was changed to every four hours.

Hydrographs which compare water level responses in wells 731 and 732 with quantity of daily rainfall at the site over a ten-month period are shown in Figure 2.12. To gauge intensity, hourly totals of selected storm events were also examined. Site-specific rainfall records were provided by MK-Ferguson showing daily rainfall in inches from December 1994 to present (Table 2.3) and hourly

FIGURE 2.12
GROUND WATER LEVEL AND RAINFALL HYDROGRAPHS
FOR PALEOCHANNEL MONITOR WELLS
CHENEY DISPOSAL SITE, COLORADO

Table 2.3 Daily rainfall in the vicinity of the Cheney disposal cell

DAY	DEC 94	JAN 95	FEB 95	MAR 95	APR 95	MAY 95	JUN 95	JUL 95	AUG 95	SEP 95	OCT 95	NOV 95
1	—	—	—	0.29	—	—	—	0.17	—	—	—	0.16
2	—	—	—	0.29	—	0.56	—	0.02	—	—	—	—
3	—	—	—	0.14	—	0.01	0.12	0.58	—	—	—	—
4	—	—	—	0.07	—	—	0.29	—	—	—	0.16	—
5	0.01	0.04	—	0.20	—	0.08	—	—	—	—	—	—
6	0.43	0.02	—	0.28	—	—	—	—	—	—	—	—
7	—	—	—	—	—	0.05	—	—	—	0.14	—	—
8	—	—	0.12	—	—	0.09	—	—	—	0.39	—	—
9	—	—	—	—	0.06	0.01	—	—	—	0.07	—	—
10	—	—	—	—	0.11	—	—	—	0.15	—	—	0.03
11	—	0.04	—	—	—	0.13	—	—	0.38	—	—	—
12	—	0.07	0.06	—	0.70	—	—	—	0.01	—	—	—
13	—	—	—	—	—	—	—	0.13	—	—	—	—
14	—	—	0.07	—	—	—	—	0.01	—	—	—	—
15	—	—	—	—	0.02	—	0.07	—	—	—	—	—
16	—	0.12	—	—	0.05	0.01	—	—	—	—	—	—
17	—	—	—	—	0.19	0.36	1.26	—	—	0.03	—	—
18	—	—	—	—	—	—	—	0.02	—	0.05	—	—
19	—	—	—	0.07	0.04	—	—	—	—	—	—	—
20	—	—	—	—	0.05	—	—	—	0.11	—	—	—
21	—	—	—	—	0.03	—	—	—	—	—	—	ND
22	—	—	—	—	—	—	—	—	0.01	—	0.01	ND
23	—	—	—	—	0.10	—	—	—	0.10	—	—	ND
24	—	—	—	—	—	0.01	—	—	0.01	—	0.67	ND
25	—	—	—	—	0.09	—	—	—	—	—	—	ND
26	—	—	—	—	—	—	—	—	—	—	—	ND
27	—	0.05	—	—	—	—	0.01	—	—	—	—	ND
28	—	—	—	—	—	—	0.04	—	—	—	—	ND
29	—	—	—	0.14	0.17	—	—	—	—	0.20	—	ND
30	0.03	—	—	—	0.01	0.13	0.28	—	—	—	—	ND
31	—	—	—	—	—	—	—	—	—	—	0.01	—
SUM	0.47	0.34	0.25	1.48	0.92	2.14	2.06	0.93	0.77	0.88	0.85	0.19

Note: Rainfall reported in inches.

Table 2.3 Daily rainfall in the vicinity of the Cheney disposal cell (concluded)

day	DEC 95	JAN 96	FEB 96	MAR 96	APR 96	MAY 96	JUN 96	JUL 96	AUG 96	SEP 96
1	—	—	0.14	—	—	—	—	—	—	—
2	—	—	—	—	—	—	—	—	—	—
3	—	—	—	—	—	—	—	—	—	—
4	—	—	—	—	—	—	—	—	—	—
5	—	—	—	0.18	—	—	—	—	—	0.05
6	—	—	—	0.09	—	—	—	—	—	0.10
7	—	—	—	—	—	—	—	—	—	—
8	—	—	—	—	—	—	—	—	—	—
9	—	—	—	—	—	—	—	—	—	—
10	—	—	—	—	—	—	—	—	—	—
11	—	—	—	—	0.45	—	—	—	—	0.05
12	—	—	—	—	—	—	—	—	—	—
13	—	—	—	—	0.30	—	—	—	—	0.17
14	—	—	—	—	—	—	—	—	—	0.22
15	—	—	—	—	—	—	0.01	—	—	—
16	—	—	—	—	—	—	—	—	—	0.04
17	—	0.28	—	—	—	—	—	0.13	—	0.14
18	—	—	0.02	—	0.09	—	—	0.07	0.06	0.35
19	—	—	—	—	—	—	—	—	—	—
20	—	—	0.46	—	—	—	0.01	—	—	—
21	—	—	0.47	—	—	—	0.04	—	0.03	—
22	—	—	0.07	—	—	0.29	—	—	—	0.04
23	—	0.02	—	—	0.33	—	—	—	—	0.01
24	—	—	—	—	—	0.16	—	—	—	—
25	—	—	—	0.02	—	0.25	—	—	—	—
26	—	—	—	—	—	—	0.08	—	0.01	—
27	—	—	—	—	—	—	0.20	—	—	—
28	—	—	—	—	—	—	—	—	—	—
29	—	—	—	—	—	—	—	0.06	—	—
30	—	—	—	—	—	—	—	0.01	—	—
31	—	0.24	—	—	—	—	—	—	—	—
sum	—	.54	1.16	.29	1.17	0.7	.34	.27	.10	1.17

Note: Rainfall reported in inches.

rainfall in inches for selected events (Table 2.4). The largest event occurred on June 17, 1995, producing 1.26 inches of precipitation. Assuming no losses to evaporation or retention in the cover materials of the cell, runoff to the segment of the perimeter ditch upgradient from well 731 would have been 510,000 gallons, and run-off to the perimeter ditch upgradient of well 732 would have been 810,000 gallons (Calculation GRJ-11-96-12-01, included in Appendix A). Although these estimates are only order-of-magnitude approximations, it is likely that this storm event contributed several hundred thousand gallons to segments of the perimeter ditch.

The hydrograph for well 731 shows that although the well was initially completed dry in November 1995, it was slowly recovering to static level by December. The slow recovery was probably due to the low quantity of water in the gravel channel and the lack of any well development. When the well was purged in early January 1996, its rate of recovery increased. This increase was likely due to storage of water in the gravel pack and the developmental effects of purging the well. Following an intense storm on June 17, 1995 which produced 1.26 inches of rainfall, the water level in well 731 rose approximately 1.5 feet by the following day. The water level in well 731 then began slowly declining toward its static level. After a gentle increase in water level of approximately 1.0 feet in the late winter and early spring of 1996, long-term static equilibrium appears to have been reached at an elevation of 5196.5 feet.

The hydrograph for well 732 shows that the well recovers almost immediately after purging, which is consistent with data collected during well development. The overall trend is a steady decline in water levels over the period of record, reaching a low of 5178 feet in early fall of 1996. Three significant ground water increases occurred in this well over the period of record. One of the increases occurred in early March 1996 when the water level rose approximately 1.0 foot. The second rise occurred on June 18, 1996 when the water level rose over 3.0 feet. The third increase occurred gradually in the

Table 2.4 Hourly rainfall (1) for selected rainfall events in the vicinity of the Cheney Disposal Cell

TIME	05/02/95	05/12/95	05/17/95	06/17/95
00:00	—	0.12	0.04	—
01:00	—	0.19	0.08	—
02:00	—	0.03	0.04	—
03:00	—	0.19	0.01	—
04:00	—	0.02	—	—
05:00	—	0.02	—	0.01
06:00	—	—	0.01	0.05
07:00	0.08	—	0.09	0.05
08:00	0.26	—	0.05	0.23
09:00	0.01	—	0.01	0.37
10:00	—	—	—	0.14
11:00	—	0.03	—	0.08
12:00	0.05	—	—	0.14
13:00	0.10	0.04	0.01	0.08
14:00	—	—	—	0.04
15:00	0.05	—	—	0.02
16:00	—	0.02	0.01	—
17:00	—	0.03	0.01	—
18:00	—	0.01	—	0.02
19:00	—	—	0.01	0.03
20:00	0.02	—	0.01	—
21:00	0.01	—	—	—
22:00	—	—	—	—
23:00	—	—	—	—
SUM	0.56	0.69	0.36	1.26

Note: Rainfall reported in inches.

spring of 1996 when the water level rose almost 2.0 feet over a period of several weeks. After each increase, the water level slowly declined without ever reaching static equilibrium. Thus, at well 732 the transient increases are superimposed on a long-term trend of declining water level, likely related to the presence of the filled arroyo and dam-like structure built at the toe of the fill.

Over the period of record, several significant storms occurred. The most intense was the storm on June 17, 1995. A total of 1.26 inches of rain fell in the vicinity of the cell over 10 hours, with about 60 percent falling in three hours. This rainfall event correlates with rises in water level of approximately 1.5 feet in well 731 and over 3.0 feet in well 732 on the following day, as shown in the detailed hydrograph in Figure 2.13. The storm ended at about 1900 hours on June 17, 1995, and the rise in well 732 began at about 0700 hours on June 18, 1995. The water level continued rising until June 20, 1995, at about 2000 hours. As shown by the break in slope of the hydrograph for well 732, the ground water mound created by this storm required nearly 20 days to dissipate along the southwestern margin of the cell. Although much less distinct, the hydrograph for well 731 suggests a similar time-dependency along the northwestern margin of the cell.

The rise of about 1.0 foot observed in well 732 in early March 1995 correlates with several consecutive precipitation events of 0.3 inch or less each, for a total of 1.27 inches in six days. Isolated events of similar magnitude do not correlate with water level increases. Thus, it appears that a storm must be of a certain magnitude and intensity or there must be several consecutive storms in a brief timeframe

Well 731 is much less responsive to rainfall events. The rise in water level of about 1.0 foot observed in well 732 in early March 1995 was not observed in

FIGURE 2.13
GROUND WATER LEVEL AND RAINFALL HYDROGRAPHS
FOLLOWING THE JUNE 17, 1995, RAINFALL EVENT
CHENEY DISPOSAL SITE, COLORADO

well 731, whereas the storm on June 17, 1995, was apparently of sufficient duration and intensity to cause a rise in shallow ground water around much of the cell (and perhaps regionally). The slow recovery to static water levels in both wells 731 and 732 after the June 17, 1995, storm indicates that mounding of ground water probably occurred within their paleochannels and the filled arroyo near well 732.

The record of rainfall indicates that there are several events during May 1995 for which daily totals are near 0.5 inch. While these rainfall events appear to be significant on the hydrographs, a comparison of hourly totals of the May 1995 events to the June 17, 1995, event (see) Table 2.4 shows significant differences. The June 17, 1995 storm lasted 10 hours and produced 1.26 inches precipitation, with 0.74 inch falling in three hours. The rainfall events in May 1995 were temporally isolated and of lower intensity, with daily totals of 0.69 inch or less and with three hour totals of 0.41 inch or less. These amounts apparently were insufficient to cause significant runoff from the cell.

The origin of the slow increase in water levels in the spring of 1996 is not clear. There were only a few storms, all of which produced less than 0.5 inch of rainfall, so local precipitation appears to have been inadequate. One possible explanation is that this may be a regional phenomenon related to spring snow melt and run-off.

2.8 IDENTIFICATION OF FINGERPRINT PARAMETERS

Investigations conducted to date suggest that upgradient sources are probably not responsible for observed levels of constituents of concern in the paleochannel wells. Because surface water samples from areas upgradient of the disposal cell do not show detectable levels of nitrate, further evaluation will focus on sources at or adjacent to the disposal cell. Seepage from the cell

cannot be ruled out at this point, but the presence of highly soluble nitrate salts in bedding material in the erosion protection layer on the disposal cell surface provides a likely explanation for nitrate in paleochannel wells. Water seeping from the perimeter ditch into the filled arroyo, and thence into the southwest paleochannel near well 732, is unlikely to acquire a unique geochemical signature.

The TAC (Ward, 1996) evaluated geochemical tests that might unequivocally identify the source of constituents of concern in paleochannel wells. Lead isotopes appeared to be the most promising tracer of tailings pore fluids due to the large difference in lead isotopic composition in the Mancos Shale and the composition that would be produced as a result of uranium concentration in ore deposits. However, while this approach has the potential to positively identify the presence of tailings pore fluids, it would also be costly and extremely sensitive to contaminants, and the absence of a positive result would not be conclusive. Other isotopic and geochemical indicators have the potential to be useful as well, notably strontium isotopes and the chloride-to-bromide ratio in ground water.

3

3

2

3.0 RECOMMENDED ACTIVITIES FOR PHASE 1A AND POSSIBLE FUTURE PHASES

Phase 1 was designed to provide information about the water present in the paleochannel monitor wells (731 and 732) through passive monitoring of water levels, ground water chemistry, surface soil chemistry, and geotechnical evaluations of fracture networks and transient drainage. These non-intrusive studies have suggested that runoff from the surface of the disposal cell infiltrating through the perimeter ditches may be the source of water and constituents of concern in the paleochannel system. However, this source has not been unequivocally demonstrated. Other potential contributors include water entering the paleochannel system upgradient of the site, run-off from the top of the cell infiltrating through the perimeter ditch into the paleochannel system, and leakage of water from within the cell through fractures in the Mancos Shale just beneath the clean-fill dike into the paleochannel system.

Phase 1A and possible future phases represent increasingly focused investigations designed to conclusively answer particular aspects of the origin of the paleochannel water. These future investigations may include:

- Artificial flooding of the perimeter ditch to test the degree of hydraulic connection between the perimeter ditch and the paleochannels (Phase 1A).
- Use of lead and strontium isotopes as tracers of cell-water movement.
- Investigation of bromide/chloride ratios as indicators of cell-derived water.
- Use of an organic dye to trace water movement from the cell cover into the perimeter ditch and paleochannels.
- A new geophysical survey to identify changes in near-surface saturation, using the 1989 resistivity survey (Geraghty & Miller, 1989) as a baseline for comparison.

- Intrusive sampling of water in the cell to establish its chemistry and potential ponding, particularly searching for perched zones.
- Additional monitor wells in upgradient parts of the paleochannel system to provide water level and background water quality data.

3.1 PHASE 1A ACTIVITIES

Phase 1A activities are composed of three parts: 1) perimeter-ditch flooding experiment, 2) sampling of upgradient water sources, and 3) nitrate mass-balance calculation.

3.1.1 Perimeter-ditch flooding experiment

The strong correlation between large rainfall events and stepwise increases in water levels in the paleochannel monitoring wells indicates a close connection between surface and ground water in the vicinity of the disposal cell. There are several potential pathways: 1) direct infiltration from overland flow, 2) infiltration into the cell (presumably the part that is still open) and thence through fractures into the paleochannels, and 3) run-off from the top of the cell into the perimeter ditch at the base of the cell apron and then through fill and alluvium into the paleochannels, or overland to areas of rapid infiltration to the paleochannels if the perimeter ditch is over-topped. Phase 1A will test the third pathway without over-topping the perimeter ditch.

An experimental approach will be used to demonstrate the degree of hydraulic connection between the perimeter ditch in the apron of the cell and the two bordering paleochannel monitor wells. The perimeter ditch will be flooded with clean water, and simultaneously the water level and field-measurable geochemical parameters (pH, nitrate, and electrical conductivity) will be measured in the paleochannel monitor wells and in newly installed sumps in the

perimeter ditch. Being located next to the monitor wells, the sumps will be positioned to accumulate water that has traversed the entire upgradient portions of the perimeter ditch. Water samples will be collected for laboratory analysis from the water tankers, the sumps, and the paleochannel wells.

A simultaneous rise in water level in the toe-drain sumps and the paleochannel monitoring wells would demonstrate close hydraulic connection between the two, and would imply that runoff from the cell cover is primarily responsible for the increase in water level in the paleochannels during natural rainfall events. Chemically, the flood water should dissolve any soluble salts in the perimeter ditch, becoming detectably more saline by the time it reaches the sump. The flood water should still be less salty than the paleochannel water, however, so a decrease in salinity of ground water at the paleochannel wells is anticipated. Based on knowledge of the amount of water added to the perimeter ditch and the observed water-level and chemical changes in the sumps and paleochannel wells, it may be possible to perform an approximate mass-balance calculation of the amount of water that reached the paleochannels.

Because water is scarce locally, water to flood the perimeter ditch will need to be trucked to the site. Colorado River water is comparatively saline, potentially obscuring chemical changes that might occur during infiltration and travel to the monitor wells, and thus should be avoided. A possible water source is one of the nearby communities such as White Water that obtains its water from a deep well, where total dissolved solids (TDS) is quite low. Alternatively, the water supply well used by MK-Ferguson for dust control may be closer and of adequate quality. All water should be on-site before beginning flooding so that the total volume can be added rapidly, promoting uniform distribution throughout each segment of the perimeter ditch to its sump.

The volume of water required to flood a segment of the perimeter ditch has been calculated (Calculation GRJ-11-96-1201,) included in Appendix A. The

volume of open space in the northwest and southwest perimeter ditch segments is 740,000 gallons and 810,000 gallons, respectively, similar in magnitude to potential run-off from the heaviest rainstorm measured to date. This precipitation event of 1.26 inches on June 17, 1995 added 510,000 gallons and 810,000 gallons, respectively, to the catchment areas upgradient from the northwest and southwest perimeter ditch segments. However, the volume that appeared as run-off would have been reduced because of infiltration into the bedding layer on the disposal cell.

Storage considerations make it impractical to artificially flood a perimeter ditch segment with more than approximately 100,000 gallons. This volume may be inadequate to produce a measurable increase in water level in a paleochannel monitor well if distributed over the entire length of a segment of the perimeter ditch. As an alternative, one or more dams or weirs could be installed in a perimeter ditch segment, causing water to pond upgradient. The volume of water thus trapped would be approximately 37,000 gallons (also in Calculation GRJ-11-96-1201 for a single dam, and would create ponded conditions extending 270 feet upgradient. Dams could be strategically placed to test the most likely zones of communication between the perimeter ditch and the paleochannels, thereby reducing the volume of water needed for the test.

The water sampling effort that will occur as part of Phase 1A investigations is summarized in Table 3.1. Not included here are duplicates and trip blanks needed for Quality Assurance and data evaluation; these are covered in Sections 4.3 (*Sampling Plan*) and 4.4 (*Quality Assurance Plan*). Samples directly related to the flooding experiment, to be collected for laboratory analysis, include water from monitor wells 731 and 732 before and after flooding, the two sumps after flooding, and the water that will be used for flooding. Frequent field measurements will be made of pH, nitrate, and electrical conductivity on samples from the two sumps and monitor wells 731 and 732 to trace the

Table 3.1 Phase 1A water sampling effort

Sample Description	Number of samples	Type of analysis
MWs 731, 732 before flooding	2	Laboratory
Sumps, MWs 731, 732 after flooding	4	Laboratory
MWs 508, 701, and 828	3	Laboratory
Flood water, 1 sample per tanker	2-4	Laboratory
Pond in open part of cell	1	Laboratory
Total samples for laboratory analysis:	12-14	
Hourly measurement of pH, nitrate, and electrical conductivity in 731, 732, and sumps during flooding	96	Field

evolution of the flood water chemistry. Because water levels at these locations will be monitored as well, it will not be possible to purge the well bores before sampling, so response to the changing chemical composition in the surrounding water will be sluggish. Sample the sumps every 18 to 24 hours. Water quality in the monitor wells will change much more slowly than will water levels, so the wells should be sampled before flooding, 24 hours after a water-level rise, and again 72 to 144 hours later. If budget is available, sampling and water-level monitoring should continue until static equilibrium is reached (well 731) or the previous rate of decline is re-established (well 732). Response to the June 17, 1995 rainfall event suggests that transient effects dissipate within 20 days.

3.1.2 Chronologic order flooding-experiment activities

1. Calculate volume of perimeter ditches to be filled during flooding.
2. Compare this volume to prior rainfall runoffs to ensure sufficient volume to duplicate the effects on wells 731 and 732.
3. Install sumps in the perimeter ditch adjacent to wells 731 and 732. The bottom of the sumps will be not more than 2 feet below the base of the fill material in the ditch, with a 1 foot blank section below the screened interval. The screen will extend to within 1 foot of the surface.
4. Obtain and install two shallow dataloggers (one in each sump) to measure any water flowing or standing in the perimeter ditch.
5. Obtain and store sufficient water on-site to fill the south perimeter ditch to a level similar to the prior significant rainfall events without overtopping the ditch at the southwest corner of the cell.
6. At least two weeks after any significant rainfall or snowmelt event, pump the stored water into the south drain ditch within 12 hours or less. Collect samples of the tank water prior to pumping. Collect samples of waters

- accumulating in the sump at the southwest corner after initial arrival at the sump, then at appropriate intervals (10 to 24 hours) until the water level in the sump has declined to near-stable conditions.
7. Sample water in well 732: a) Prior to pumping water into the perimeter ditch; b) 24 hours after water-level rise in well 732; and c) 72 to 144 hours after water level rise in well 732.
 8. Download all dataloggers on the site prior to moving the experiment to the northern segment of the perimeter ditch.
 9. Repeat steps 5 through 8 for the northern segment of the perimeter ditch, with sampling to be performed at well 731 and its adjacent sump. Step 6 (flooding) for this segment should commence at least 48 hours after flooding for the southern segment. Further delay between testing of the two ditch segments
 10. Analyze datalogger information and water quality results to assess the degree of hydrologic connection between the perimeter ditch segments and monitor wells.

3.1.3 Sampling of upgradient and cross-gradient water sources

Phase 1A sampling plans include several locations that will not be affected by the flooding experiment: monitor wells 508, 701, and 828, and the pond in the open part of the cell. Sampling these locations is a logical continuation of Phase 1 activities, which sought to define the compositions of likely sources of water in the paleochannels. These locations are also shown on Figure 3.1.

Well 508 is screened across the interface between alluvium and the Mancos Shale, with the upper third of the screened interval in the alluvium and the lower two-thirds in the Mancos. The weathering state of the Mancos is not known.

FIGURE 3.1
PHASE IA SAMPLING LOCATIONS
CHENEY DISPOSAL SITE, COLORADO

MODIFIED FROM MK-F, 1996.

This well will likely provide water of comparatively poor quality due to mixing of high-TDS Mancos water with relatively pure alluvial water. Well 701 is probably also screened across the Mancos/alluvium contact, but no completion report is available for this well. Drilling instructions specify that the screen should penetrate the Mancos, so water quality should be much like that of 508.

Well 828 is cross-gradient relative to the disposal cell, completed in the alluvium. Better-quality alluvial water is isolated from the poor-quality water of the weathered Mancos in this well, so it will provide useful information about the alluvial end member of water found in the paleochannels. It may be completed in the same paleochannel as is well 731.

3.1.4 Nitrate mass-balance calculation

The final component of Phase 1A activities is to calculate the approximate nitrate mass-balance for run-off from the top of the cell into the toe drains. Phase 1 sampling by MK Ferguson showed that the bedding layer beneath the riprap in the cell cover contains significant nitrate. This nitrate may dissolve during rain storms, producing high-nitrate runoff. The questions to be answered by the calculation are: 1) What mass of nitrate must dissolve to produce run-off with the same nitrate concentration as observed in monitor wells 731 and 732, and 2) What mass of nitrate is available for dissolution in the bedding material? Lack of sufficient nitrate would constitute evidence that nitrate must be derived from water originating within the cell rather than at its surface.

3.2 ACTIVITIES FOR FUTURE PHASES

These activities address specific issues related to the source of water in the paleochannels, and involve either greater expense, lower probability of providing useful information, or intrusion into the disposal cell. One or more of these

activities may provide crucial information, however, pending results of the Phase 1A investigations.

3.2.1 Lead and strontium isotopic studies

The possibility that a significant portion of the water in the paleochannels is derived from within the cell could potentially be tested by examining the isotopic systematics of a suitable tracer. Such a tracer must show significant variation in the relative abundances of its isotopes between the tailings and the ambient groundwater at the Cheney site. Two likely tracer candidates are lead and strontium. Lead is particularly promising because it is the end-product of uranium decay and thus has been directly influenced by the geochemical concentration of uranium to form the ore body; lead in the tailings will be highly anomalous because of its long association with uranium in the ore deposit.

Variations in strontium isotopic composition arise through differences in stratigraphy, with the Cheney site located on 100-million-year-old marine shale (Mancos Shale) for the ore deposit compared to 150-million-year-old continental sandstone (Morrison Formation), and have been accentuated by the milling process that partially dissolved many minerals, preferentially liberating radiogenic strontium and enhancing the contrast in strontium isotopic composition between ground water and tailings water.

The principle geochemical uncertainty associated with both lead and strontium is the likelihood of attenuation along flow paths out of the cell and along the paleochannels. At neutral to alkaline pH values, lead is strongly adsorbed by clays and iron-manganese oxyhydroxides, reducing its mobility to near zero until the available adsorption sites are saturated. Strontium from the tailings will exchange readily with strontium contained in clays of the Mancos Shale. The relative concentration of exchangeable strontium in the Mancos Shale is much larger than that in tailings-derived water, substantially diluting and retarding migration of tailings-derived strontium.

The merits and difficulties of these measurements have been discussed in greater detail (Ward, 1996). Collecting field samples with the high quality assurance/quality control (QA/QC) required for the very low expected concentration levels would be costly.

3.2.2 Bromide/chloride ratios as indicators of cell-derived water

A potentially useful chemical ratio in ground water that should be examined is chloride/bromide. In rainwater, chloride/bromide is approximately the same as in seawater (approximately 290 by weight), reflecting the origin of these halides as marine aerosols. In contrast, reagents used in uranium processing, such as hydrochloric acid and sodium perchlorate, have been stripped of bromide during their production, so that tailings have very high chloride/bromide ratios. If the absolute concentration of chloride is also high, rainwater falling on the tailings will have a negligible effect on the chloride/bromide ratio. At Cheney, the chloride/bromide ratio in well 732 is close to the seawater value, consistent with a meteoric/weathering origin for the halides. However, the tailings need to be evaluated for leachable chloride and bromide and for conformance to the model just described. Data from the Grand Junction Colorado processing site suggest that very little hydrochloric acid and sodium perchlorate were used during milling operations, potentially negating the usefulness of this indicator.

3.2.3 Organic dye as a tracer of cell runoff

A water-soluble organic dye could be applied to the surface of the cell in order to trace movement of water from the cover into the perimeter ditch and then into the paleochannels. Mass-balance calculations for a conservative tracer would constrain the amount of cell runoff appearing in the paleochannel monitor wells, and might provide an indication whether the preferred pathway is runoff into the perimeter ditch or some alternate infiltration route. Water could be derived either from natural rainfall or through artificial irrigation of the surface of

the cell. By irrigating, the precise amount of water applied to the cell would be known, but sufficiently rapid application might be difficult. Nevertheless, it would avoid a potentially long wait for natural rainfall of adequate volume and intensity, and the dye could be mixed with the water at the time of application. A possible candidate for the dye is fluorescein, frequently used as a tracer of ground water flow and detectable by photometric methods at levels of a few mg/L or better. Fluorescein detection might be automated using a datalogger and downhole probe.

3.2.4 Geophysical re-survey to detect changes in saturation

The existing geophysical survey data, (Geraghty & Miller, 1989), are comprehensive and provide a baseline against which new data could be compared. The method is sensitive to the degree of saturation in the alluvium, and may delineate the extent of saturation in the paleochannel system. Prior to construction of the cell, very little water could be extracted from the paleochannels in the vicinity of the site. Since cell construction, water has become more plentiful, as evidenced by the productivity of the two paleochannel monitor wells. If the zone of increased saturation extends significantly upgradient of the cell, the increase in water levels may be a regional phenomenon unrelated to the presence of the cell. If the on-site saturated zone is limited, it may delineate run-off flowpaths which connect to the paleochannel monitor wells.

3.2.5 Intrusive water sampling in the cell

Intrusive sampling of water within the cell may be needed to establish its chemistry, and to determine if ponding has occurred. Of particular importance would be any perched zones of ponded water, or ponded water in the northeastern portion of the cell where the bottom elevation is higher than the paleochannels. If ponding is detected, a permanent monitor well would provide

a useful point of sampling in conjunction with the dye-tracer experiment discussed in Section 3.2.3.

3.2.6 Additional monitor wells in other parts of the paleochannel system

Additional monitor wells may be needed directly upgradient from the paleochannel wells. The three presently existing upgradient monitor wells are located to the north of the site and probably do not intercept flow paths leading to well 731 at the northwestern corner of the cell. If it is found that cross-gradient well 828 has been decommissioned, another well completed approximately 300 feet upgradient of 731 in the deepest portion of the paleochannel fill is recommended. This well would monitor the head and quality of water in the northwest paleochannel upgradient of the reconstructed channel segment, prior to potential contamination by seepage from the cell. There are no presently active monitor wells upgradient from paleochannel well 732, at the southwestern corner of the cell. Such wells would provide background water quality data and confirmation of the extent of saturation as indicated by the geophysical survey (if performed).

4.0 IMPLEMENTATION OF PHASE 1A ACTIVITIES

4.1 DATA COLLECTION OBJECTIVES

The following are the data collection objectives for Phase 1A of the paleochannel studies and the Cheney disposal cell:

- Continuous water level data will be collected in the paleochannel wells (731 and 732) and in the newly installed toe-drain sumps neighboring these wells during and after flooding of the perimeter ditch with clean water. These measurements will demonstrate the degree of hydraulic connection between the perimeter ditch and the paleochannels.
- During flooding, water samples will be collected periodically from the paleochannel wells and the toe-drain sumps and analyzed for a standard suite of field-measurable parameters. These measurements will show how water quality evolves along flow paths, and may provide a geochemical link between cell run-off and paleochannel water.
- Water samples will be collected from the water to be used for flooding, from the paleochannel wells before and after flooding, and from the toe-drain sumps after flooding for laboratory analyses of a standard suite of parameters. These measurements will also show how water quality evolves along flow paths, and may also provide a geochemical link between cell run-off and paleochannel water.
- Potential sources of water upgradient and cross-gradient relative to the disposal cell will be analyzed for a standard suite of field-measurable parameters and sampled for laboratory analyses of a standard suite of parameters. These measurements will define the background water quality that would exist in the absence of the cell.

- The water-level information gained from these activities will be used to estimate the extent of hydraulic connection between the perimeter ditch and the two paleochannels. The chemical data will be used to evaluate chemical processes occurring along inferred flow paths, and to continue the evaluation of the consanguinity of water in the paleochannels relative to potential upgradient and cross-gradient sources.

4.2 DATA COLLECTION TASKS

4.2.1 Permits, clearances, and access agreements

Permits, clearances, and access agreements have been obtained in conjunction with disposal activities, and are available at the MK office at the site. No additional documentation will be necessary for activities under this work plan unless it is decided to place temporary dams in the perimeter ditch.

4.2.2 Sump and data logger installation in disposal cell toe drain

Activities will commence with installation of two sumps, one in each segment of the perimeter ditch adjacent to monitor wells 731 and 732, to be built as shown in Figure 4.1. A sump will be constructed of 18-inch PVC pipe, capped on the bottom and slotted on the sides. Total length of the sump pipe will be 6.0 to 8.0 feet. The lower 1.0 feet of the pipe will not be slotted, forming a basin that will retain water for some time after flooding. The slotted area will extend through the riprap and bedding material into the top of the clean-fill dike or underlying undisturbed soil by approximately 1.0 foot, and will be wrapped in fine screen to minimize entry of sand. Access will be restricted by a lockable cap at the surface. A schematic of an installed sump is shown in Figure 4.1. Sumps will not be grouted, but rather the bedding material and riprap will be packed around them. The sumps will be bailed and sponged dry at the conclusion of

1. BOTTOM IS CAPPED.
2. NO SLOTS IN LOWER 1 FOOT, WHICH IS EMBEDDED IN THE CLEAN FILL.
3. SLOTTED INTERVAL EXTENDS TO WITHIN 1 FOOT OF THE SURFACE AND IS WRAPPED WITH PVC/NYLON SCREEN TO EXCLUDE SAND.

ALLUVIUM

MANCOS

FIGURE 4.1
SUMP INSTALLATION IN THE PERIMETER DITCH
NEAR MONITOR WELLS 731 AND 732
CHENEY DISPOSAL SITE, COLORADO

the artificial flooding experiment, preparing them to receive and retain water from any future natural flooding. After the sumps have been installed, they will be fitted with data loggers to record the water level at intervals of 10 minutes once flooding begins. The water-level data loggers in monitor wells 731 and 732 will also be set to record at 10-minute intervals. After the flooding experiment, the data loggers will be left in place, recording water depths every 60 minutes. At this rate, the data loggers will be able to store only approximately three months of data before beginning to overwrite the earliest data, and so will need to be downloaded soon after major precipitation events to avoid loss of data.

4.2.3 Water sampling in monitor wells and sumps

Water sampling activities are performed and documented according to final draft TAC Standard Operating Procedure (SOP) 16.2.1 (see Appendix B). This SOP does not present new procedures, but rather is the consolidation of several previously-existing SOPs. Also, SOP 16.1.10 (see Appendix B) should be used to govern the measurement of field parameters (alkalinity, temperature, pH, Ec, and ORP). The mathematical conversion from ORP to Eh is discussed in SOP 16.3.3 (see Appendix B).

The relevant sections of SOP 16.2.1 include, but may not be limited to, the sections listed below:

- 5.1 Collection of surface samples
- 5.2 Well head setup, depth to water measurement, and well purging
- 5.3 Ground water sampling
- 5.7 Filtration and preservation of water samples
- 5.9 Preparation of water samples for packaging, labeling, and transport

The attachments to SOP 16.2.1 include all the forms and custody records necessary for water sampling. A synopsis of the activities necessary to

preparation for and execution of sampling is provided in a memorandum from Rob Sengebush to Anchor Holm dated 8/9/96 (attached). Appropriate sample bottle, volume, and preservative combinations must be obtained to allow for analysis of the parameters listed below:

Chloride	Cobalt
Sulfate	Iron
Sodium	Manganese
Potassium	Molybdenum
Magnesium	Nickel
Calcium	Selenium
Fluoride	Vanadium
Ammonium ^a	Zinc
Nitrate ^b	TDS
Bromide	DOC ^c
Arsenic	Lead ^d
Cadmium	Strontium ^d

^a(expressed as NH₄ for comparability with existing data)

^b(expressed as NO₃ for comparability with existing data.)

^c(filtered to give dissolved rather than total organic carbon)

^d(by ICP-MS: report both dissolved concentration and isotopic abundances

The isotopes of interest are Pb-204, Pb-206, and Pb-207 for lead, and Sr-86, Sr-87, and Sr-88 for strontium)

The use of trace-metals grade HNO₃ is imperative in preservation of the samples for metals analysis. The necessary bottles and preservatives for the parameters above are given in attachment 6.12 of SOP 16.2.1. All of the water samples taken should be field filtered, except that the H₂SO₄-preserved nutrient bottle (for NO₃ and NH₄) should not be filtered.

4.2.4 Water sampling in water tank(s)

The sampling, preservation, and shipping techniques discussed in the documents referenced above also apply to sampling the water in the tank(s). Since the access point to the tank(s) is(are) unknown at present, general remarks must suffice to describe the activity.

Care must be taken to ensure that the samples obtained are representative of the water in the tank(s) and that contamination is minimized. It is likely that the samples will be pumped out of the tank and through a filtration apparatus, and hence the standard equipment decontamination techniques will apply. However, if the samples are taken as "grab" samples, then careful consideration of possible contamination sources and representativeness will be needed.

4.2.5 Mass balance calculation of available nitrate

The approximate nitrate mass-balance for run-off from the top of the cell into the perimeter ditch and through arroyo fill will be calculated. Phase 1 sampling by MK-Ferguson showed that the bedding layer beneath the riprap in the cell cover contains significant nitrate (DOE, 1996). This nitrate may dissolve during rain storms, producing high-nitrate run-off. The questions to be answered by the calculation are: 1) What mass of nitrate must dissolve to produce run-off with the same nitrate concentration as observed in monitor wells 731 and 732, and 2) What mass of nitrate is available for dissolution in the bedding material? Supporting calculations will be required in order to estimate the volume of run-off and the volume of water in the paleochannels. Several assumptions will be necessary regarding evapotranspiration, infiltration, availability and rapidity of nitrate dissolution, and geometry of the paleochannels, probably limiting the final accuracy of the calculations to an order of magnitude.

4.3 SAMPLING PLAN

4.3.1 Sampling locations

Sampling locations are shown in Figure 3.1 and tabulated in Table 3.1.

4.3.2 Analyte selection

This will be modeled on the Water Sampling and Analysis Plan (Monks and Erskine, 1996) for the June 1996 sampling event with the addition of strontium and lead and Pb isotopic measurements by ICP-MS.

4.3.3 Sampling frequency

This investigation will be accomplished with a one-time sampling event.

4.3.4 Sample analysis

Work plans similar to the examples in Appendix B for the June sampling of the disposal site should be prepared and provided to guide the procurement of analytical services. A synopsis of the activities necessary to preparation for and execution of the analytical work is provided in a memorandum from Mark Minter to Larry Pinkel dated 8/15/96 (see Appendix B). The specific details of the UMTRA Project protocols for analytical chemistry can be found in the UMTRA Project TAC SOW for chemical analyses (see Appendix B). The SOW includes quality requirements for laboratories performing the work, all analytical and quality-control requirements, and deliverable specifications.

A laboratory having inductively coupled plasma mass spectrometry (ICP-MS) capability must be chosen for this work to accommodate the isotopic lead and strontium measurement needs. Note that unfiltered water samples are not digested prior to metals analyses in UMTRA Project work except when the initial analytical spike analyses fail. The attachments to the SOW provide the parameter codes to be used to ensure compatibility with the existing database.

The allowable analytical techniques, target reporting limits, reporting units, electronic data deliverable (EDD) format, work order forms, and holding times are also given in the attachments. In addition, for lead and strontium isotopic analyses, the ICP-MS ion optics should be focused specifically for the masses of interest, so these elements should be run individually. Reported isotopic abundances should include at least three significant figures, along with an estimate of analytical precision.

Data management procedures are described in SOP 16.3.3 (attached). Some specific sections of the SOP may not apply to work performed by non-TAC personnel. However, the SOP provides valuable guidance for review of field data and application of appropriate qualifiers. The records management practices, example forms, and other guidance may also prove to be useful.

4.3.5 Data validation

UMTRA Project data validation procedures are described in SOP 16.3.2 (see Appendix B). Data validation activities include verification that holding times were met, verification that Chain-of-Custody (COC) forms were signed and returned, review and documentation of the quality-control results, and qualification of data.

In addition to these industry-standard data validation practices, the UMTRA Project database produces an iterative, statistical comparison of newly acquired data with historical data called the Suspected Anomalies Report. Review of this report by the analytical chemist and geochemist is an additional part of UMTRA Project data validation. This report facilitates the identification of dilution factor, transcription, and units errors that cannot usually be identified via normal validation procedures. Reanalyses should be requested when analytical or reporting errors are suspected. New results should replace the original results only when the existence of errors in the original data is clearly demonstrated by the reanalyses.

4.3.6 Data evaluation methods

Data evaluation methods are described in the SOP *Validation of Chemical Analysis Data* contained in Appendix B.

4.4 QUALITY ASSURANCE PLAN

The quality assurance plan is described in the Quality Assurance Implementation Plan (QAIP) (DOE, 1995)

4.5 HEALTH AND SAFETY PLAN

4.5.1 Local contingencies and contacts

All personnel involved with the activities described herein will have the following equipment:

- Work gloves for handling and installing equipment in the perimeter ditch.
- Eight-inch-high leather safety shoes worn on-site at all times.
- Non-conducting gloves and boots when working with electrical equipment around surface water.
- Ground fault circuit interrupts (GFCI) for electrical connection of equipment when working outside a building.
- Safety glasses when using an auger or other equipment which may produce projectiles hazardous to the eyes.
- Safety vest for visibility around moving equipment and vehicles.

- Acid/corrosive resistant gloves when working with acids and bases e.g., when adjusting the pH water samples.
- Material safety data sheet (MSDS) for each chemical being used.
- Hard hats, if overhead dangers are present.
- Any other health and safety requirements imposed by MK-Ferguson (site contractor).

The location of the nearest hospital in case of emergency is St. Mary's Medical Center (303-244-2551) located in the city of Grand Junction, Colorado. The telephone number for all emergencies is 911. This information is in the Site-Specific Health and Safety Supplement for Grand Junction included in Appendix B. Everyone should be familiar with this document before work begins on the project.

4.5.2 Health and safety audits

The designated field representative shall be responsible for ensuring that all activities are in compliance with MK-Ferguson Health and Safety programs (since they are the prime contractor on site), all Occupational Safety Health Administration (OSHA) 29 CFR 1910 and 1926 regulations, all National Electric Code (NEC) codes, U.S. Department of Transportation (DOT) regulations, all state and local codes, and the UMTRA Project Site Specific Health and Safety Supplement for Grand Junction and an addendum for the project-specific Health and Safety Plan.

4.6 DATA COLLECTION TASK SCHEDULE

The tasks and accompanying tentative completion dates (durations) for this work plan are found in Table 4.1.

Table 4.1 Task schedule

Task	Completion/Duration (days)
Site visit	1
Permits (N/A)	0
Access agreements (N/A)	0
Conduct field operation readiness evaluation (FORE)	1
Equipment procurement	5
Perform field activities	10
Water sampling activities	4
Evaluate data	15
Draw conclusions	3
Recommendations for additional investigations (if any)	1

5.0 REFERENCES

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CODE OF FEDERAL REGULATIONS

- 29 CFR Part 1910, *Operational Safety and Health Standards*, Occupational Safety and Health Administration, Department of Labor (1994).
- 29 CFR Part 1926, *Safety and Health Regulations for Construction*, Occupational Safety and Health Administration, Department of Labor (1994).
- 40 CFR & 192.21 (1995)

APPENDIX A

LABORATORY PROCEDURES EMPLOYED BY MK

**TABLE A1
BULK WATER ANALYTICAL RESULTS SUMMARY 1
CHENEY DISPOSAL SITE
UMTRA PROJECT-GRAND JUNCTION, COLORADO**

Sample No.	Area	Area Description	Sample Date	Gross Alpha (pCi/l)	Gross Beta (pCi/l)	Radium-226 (pCi/l)	Thorium-230 (pCi/l)	Uranium (mg/l)	Nitrate as N (mg/l)	Nitrate/Nitrite (mg/l)	TDS (mg/l)
GRJ96001DP	1	Decon Pad	04/09/96			1.4+/-0.2	-0.1+/-0.2	0.029			1800
GRJ96003CP	2	Common Fill Pile Pond	04/17/96	7.8+/-1.7	9.0+/-1.3	0.5+/-0.2		0.0058			
GRJ96004CP	2	Common Fill Pile Pond	04/17/96								
GRJ96005CP	2	Common Fill Pile Pond	04/17/96						ND	ND	
GRJ96006RD	3	Interceptor	05/17/96	0.6+/-0.7	7.4+/-1.3	0.6+/-0.1		0.0003			
GRJ96007RD	3	Drain Ditch	05/17/96								
GRJ96008RD	3	Drain Ditch	05/17/96							ND	
GRJ96009DP	1	Decon Pad	05/17/96							ND	
GRJ96010DP	1	Decon Pad	05/17/96							ND	
GRJ96011CP	4	Disposal Cell Collection Pond	05/17/96								
GRJ96012CP	4	Disposal Cell Collection Pond	05/17/96								
GRJ96013CP	4	Disposal Cell Collection Pond	05/17/96							ND	
GRJ96001OP	5	Offsite Construction Water Pond	04/09/96	9.9+/-3.9	12+/-5	0.3+/-0.1		0.015			
GRJ96002OP	5	Offsite Construction Water Pond	04/09/96						ND		
GRJ96003OP	5	Offsite Construction Water Pond	04/09/96								
Analytical Test Method				EPA 900.0	EPA 900.0	SM-705	USAEC	ASTM D2907	EPA 300.0	EPA 353.2	EPA 160.1
Method of Preservation				HNO3	HNO3	HNO3	HNO3	HNO3	4°C	4°C	4°C
Method Detection Limit (MDL)				N/A	N/A	N/A	N/A	N/A	0.1	0.1	10
Minimum Detectable Concentration (MDC)				21	14	0.3	0.4	0.0003	N/A	N/A	N/A

Summary of Previous Analytical Test Results: Water

(Range: minimum-maximum)

Well GRJ-03-0731	2.67 (3)	NT	0.5	NT	0.019	40.5	NT	6360
Well GRJ-03-0732	10.66 - 11.14 (3)	0 (1/9/95)	0.0-0.3	NT	0.024 - 0.028	174 - 176	NT	6290 - 6420
Site Wells Screened in Alluvium (Ref: Table 3.34) (6)	0.500 - 36.000	5.000 - 13.800	0.050 - 0.800	0.025 - 0.600	0.0062 - 0.074	0.50 - 4.83	NT	636 - 1685
Site Wells Screened in Mancos Shale (Ref: Table 3.37) (6)	6.800 - 73.500	9.850 - 69.000	0.050 - 1.375	0.050 - 0.600	0.003 - 0.011	0.50 - 3.54	NT	873 - 7010
Site Wells Screened in Dakota SS (Ref: Table 3.40) (6)	0.500 - 98.000	0.250 - 180.000	1.500 - 32.000	NT	0.000 - 0.003	3.00 - 10.00	NT	10500 - 15355
Tailings Pore Water - Grand Junction (Ref: Table 3.16) (6)	113.000 - 6020.00	109.000 - 2676.00	0.000 - 689.900	NT	0.075 - 29.700	0.35 - 3465.00	NT	4663 - 10346

Notes:

- One sample from well GRJ-SS-0731 on 6/2/95, and two samples from well GRJ-SS-0731 on 1/9/95, 6/2/95.
- Gross alpha, gross beta, Ra-226, Th-230 results reported as concentration +/- 1 standard deviation.
- Gross alpha - uranium with 1mg uranium = 686 pCi
- ND: Not detected above laboratory detection limits
- NT: Not tested
- Reference: "Remedial Action Plan and Site Design for Stabilization of Inactive Uranium Mill Tailings Site at Junction, Colorado," Attachment 3: Groundwater Hydrology Report, UMTRA Project-Grand Junction, September 1991.

**TABLE A1
BULK WATER ANALYTICAL RESULTS SUMMARY 1
CHENEY DISPOSAL SITE
UMTRA PROJECT-GRAND JUNCTION, COLORADO**

Sample No.	Area	Area Description	Sample Date	TSS (mg/l)	Coliform (Col/10)	pH	Chlorine (mg/l)	Arsenic (mg/l)	Barium (mg/l)	Cadmium (mg/l)	Chromium (mg/l)	Lead (mg/l)
GRJ96001DP	1	Decon Pad	04/09/96	48				0.005	0.06	ND	ND	0.005
GRJ96003CP	2	Common Fill Pile Pond	04/17/96									
GRJ96004CP	2	Common Fill Pile Pond	04/17/96									
GRJ96005CP	2	Common Fill Pile Pond	04/17/96			9.13	ND					
GRJ96006RD	3	Interceptor	05/17/96									
GRJ96007RD	3	Drain Ditch	05/17/96									
GRJ96008RD	3	Drain Ditch	05/17/96									
GRJ96009DP	1	Decon Pad	05/17/96									
GRJ96010DP	1	Decon Pad	05/17/96									
GRJ96011CP	4	Disposal Cell Collection Pond	05/17/96					ND	ND	ND	ND	ND
GRJ96012CP	4	Disposal Cell Collection Pond	05/17/96									
GRJ96013CP	4	Disposal Cell Collection Pond	05/17/96									
GRJ96001OP	5	Offsite Construction Water Pond	04/09/96									
GRJ96002OP	5	Offsite Construction Water Pond	04/09/96									
GRJ96003OP	5	Offsite Construction Water Pond	04/09/96									
Analytical Test Method				EPA 160.2	EPA 9222B	EPA 150.1	EPA 330.4	EPA 7060	EPA 6010A	EPA 6010A	EPA 6010A	EPA 7421
Method of Preservation				4°C	4°C	4°C	4°C	HNO3	HNO3	HNO3	HNO3	HNO3
Method Detection Limit (MDL)				10	1	0.01	0.1	0.005	0.05	0.005	0.01	0.005
Minimum Detectable Concentration (MDC)				N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Summary of Previous Analytical Test Results: Water

(Range: minimum-maximum)

Well GRJ-03-0731	NT	NT	7.16-7.50	NT	<0.005	NT	<0.001	NT	NT
Well GRJ-03-0732	NT	NT	5.98 - 7.18	NT	<0.005 - 0.01	NT	<0.001 - <0.001	NT	NT
Site Wells Screened in Alluvium (Ref: Table 3.34) (6)	NT	NT	NT	NT	0.0438 - 0.030	0.035 - 0.050	0.0005 - 0.004	0.005 - 0.005	0.005 - 0.075
Site Wells Screened in Mancos Shale (Ref: Table 3.37) (6)	NT	NT	NT	NT	0.0044 - 0.0135	0.020 - 0.060	0.0014 - 0.005	0.005 - 0.010	0.005 - 0.025
Site Wells Screened in Dakota SS (Ref: Table 3.40) (6)	NT	NT	NT	NT	0.005 - 0.015	4.440 - 38.000	0.0005 - 0.005	0.005 - 0.005	0.005 - 0.025
Tailings Pore Water - Grand Junction (Ref: Table 3.16) (6)	NT	NT	NT	NT	0.005 - 1.3125	0.010 - 0.0733	0.0005 - 0.2873	0.005 - 0.0525	0.004 - 0.0670

- Notes:**
- One sample from well GRJ-SS-0731 on 6/2/95, and two samples from well GRJ-SS-0731 on 1/9/95, 6/2/95.
 - Gross alpha, gross beta, Ra-226, Th-230 results reported as concentration +/- 1 standard deviation.
 - Gross alpha - uranium with 1mg uranium = 686 pCi
 - ND: not detected above laboratory detection limits
 - NT: Not tested
 - Reference: "Remedial Action Plan and Site Design for Stabilization of Inactive Uranium Mill Tailings Site at Junction, Colorado," Attachment 3: Groundwater Hydrology Report, UMTRA Project-Grand Junction, September 1991.

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**TABLE A1
BULK WATER ANALYTICAL RESULTS SUMMARY 1
CHENEY DISPOSAL SITE
UMTRA PROJECT-GRAND JUNCTION, COLORADO**

Sample No.	Area	Area Description	Sample Date	Mercury (mg/l)	Selenium (mg/l)	Silver (mg/l)	Molybdenum (mg/l)
GRJ96001DP	1	Decon Pad	04/09/96	ND	ND	ND	
GRJ96003CP	2	Common Fill Pile Pond	04/17/96				
GRJ96004CP	2	Common Fill Pile Pond	04/17/96		ND		
GRJ96005CP	2	Common Fill Pile Pond	04/17/96				
GRJ96006RD	3	Interceptor	05/17/96				
GRJ96007RD	3	Drain Ditch	05/17/96		ND		ND
GRJ96008RD	3	Drain Ditch	05/17/96				
GRJ96009DP	1	Decon Pad	05/17/96		ND		0.02
GRJ96010DP	1	Decon Pad	05/17/96				
GRJ96011CP	4	Disposal Cell Collection Pond	05/17/96	ND	ND	ND	
GRJ96012CP	4	Disposal Cell Collection Pond	05/17/96		ND		2.1
GRJ96013CP	4	Disposal Cell Collection Pond	05/17/96				
GRJ96001OP	5	Offsite Construction Water Pond	04/09/96				
GRJ96002OP	5	Offsite Construction Water Pond	04/09/96				
GRJ96003OP	5	Offsite Construction Water Pond	04/09/96		ND		
Analytical Test Method				EPA 7470	EPA 270.2774	EPA 6010A	
Method of Preservation				HNO3	HNO3	HNO3	HNO3
Method Detection Limit (MDL)				0.001	0.005	0.01	
Minimum Detectable Concentration (MDC)				N/A	N/A	N/A	N/A

Summary of Previous Analytical Test Results: Water

(Range: minimum-maximum)

Well GRJ-03-0731	NT	0.38	NT	<0.05
Well GRJ-03-0732	NT	0.232 - 0.340	NT	<0.010 - <0.050
Site Wells Screened in Alluvium (Ref: Table 3.34) (6)	0.0001 - 0.0001	0.030 - 0.019	0.005 - 0.005	0.005 - 0.070
Site Wells Screened in Mancos Shale (Ref: Table 3.37) (6)	0.0001 - 0.0002	0.004 - 0.110	0.005 - 0.075	0.013 - 0.115
Site Wells Screened in Dakota SS (Ref: Table 3.40) (6)	0.0001 - 0.0190	0.003 - 0.015	0.005 - 0.005	0.005 - 21.000
Tailings Pore Water - Grand Junction (Ref: Table 3.16) (6)	0.0001 - 0.0003	0.0025 - 0.070	0.0026 - 0.0208	0.082 - 4.350

- Notes:
1. One sample from well GRJ-SS-0731 on 6/2/95, and two samples from well GRJ-SS-0731 on 1/9/95, 6/2/95.
 2. Gross alpha, gross beta, Ra-226, Th-230 results reported as concentration $\pm$ 1 standard deviation.
 3. Gross alpha - uranium with 1mg uranium = 686 pCi
 4. ND: not detected above laboratory detection limits
 5. NT: Not tested
 6. Reference: "Remedial Action Plan and Site Design for Stabilization of Inactive Uranium Mill Tailings Site at Junction, Colorado," Attachment 3: Groundwater Hydrology Report, UMTRA Project-Grand Junction, September 1991.

TABLE A2
BULK WATER ANALYTICAL RESULTS SUMMARY 2
CHENEY DISPOSAL SITE
UMTRA PROJECT- GRAND JUNCTION, COLORADO

Lab Sample No.		GRJ98001DP	GRJ98008DP	GRJ98010DP	GRJ98003CP	GRJ98004CP	GRJ98005CP	GRJ98006RD	GRJ98007RD
Sample Date		04/09/96	05/17/96	05/17/96	04/17/96	04/17/96	04/17/96	05/17/96	05/17/96
Sample Area No.		1	1	1	2	2	2	3	3
Area Description		Decon Pad	Decon Pad	Decon Pad	Common Fill Pond	Common Fill Pond	Common Fill Pond	Interceptor Drain Ditch	Interceptor Drain Ditch
Analytes/Units		Method							
Gross Alpha	(pCi/l)	EPA 900.0			7.8+/-1.7			0.6+/-0.7	
Gross Beta	(pCi/l)	EPA 900.0			9.0+/-1.3			7.4+/-1.3	
Radium-226	(pCi/l)	SM-705	1.4+/-0.2		0.5+/-0.2			0.6+/-0.1	
Thorium-230	(pCi/l)	USAEC	-0.1+/-0.2						
Uranium	(mg/l)	ASTM D2907	0.029		0.0058			0.0003	
Nitrate as N	(mg/l)	EPA 300.0					ND		
Nitrate-Nitrite	(mg/l)	EPA 353.2		ND			ND		
TDS	(mg/l)	EPA 160.1	1800						
TSS	(mg/l)	EPA 160.2	48						
Total Coliform	(Col/10)	EPA 9222B				ND			
pH		EPA 150.1					9.13		
Residual Chlorine	(mg/l)	EPA 330.4					ND		
Arsenic	(mg/l)	EPA 7060	0.005						
Barium	(mg/l)	EPA 6010A	0.06						
Cadmium	(mg/l)	EPA 6010A	ND						
Chromium	(mg/l)	EPA 6010A	ND						
Lead	(mg/l)	EPA 7421	0.005						
Mercury	(mg/l)	EPA 7470	ND						
Selenium	(mg/l)	EPA 270.2	ND	ND		ND			ND
Silver	(mg/l)	EPA 6010A	ND						
Molybdenum	(mg/l)	EPA		0.02					ND

TABLE A2
BULK WATER ANALYTICAL RESULTS SUMMARY 2
CHENEY DISPOSAL SITE
UMTRA PROJECT- GRAND JUNCTION, COLORADO

Lab Sample No.	GRJ96008RD	GRJ96011CP	GRJ96012CP	GRJ96013CP	GRJ96001OP	GRJ96002OP	GRJ96003OP
Sample Date	05/17/96	05/17/96	05/17/96	05/17/96	04/09/96	04/09/96	04/09/96
Sample Area No.	3	4	4	4	5	5	5
Area Description	Interceptor Drain Ditch	Disposal Cell Pond	Disposal Cell Pond	Disposal Cell Pond	Off-site Constn Water Pond	Off-site Constn Water Pond	Off-site Constn Water Pond

Analytes/Units	Method						
Gross Alpha (pCi/l)	EPA 900.0				9.9+/-3.9		
Gross Beta (pCi/l)	EPA 900.0				12+/-5		
Radium-226 (pCi/l)	SM-705				0.3+/-0.1		
Thorium-230 (pCi/l)	USAEC						
Uranium (mg/l)	ASTM D2907				0.015		
Nitrate as N (mg/l)	EPA 300.0	ND				ND	
Nitrate-Nitrite (mg/l)	EPA 353.2			ND			
TDS (mg/l)	EPA 160.1						
TSS (mg/l)	EPA 160.2						
Total Coliform (Col/10)	EPA 9222B						
pH	EPA 150.1						
Residual Chlorine (mg/l)	EPA 330.4						
Arsenic (mg/l)	EPA 7060	ND					
Barium (mg/l)	EPA 6010A	ND					
Cadmium (mg/l)	EPA 6010A	ND					
Chromium (mg/l)	EPA 6010A	ND					
Lead (mg/l)	EPA 7421	ND					
Mercury (mg/l)	EPA 7470	ND					
Selenium (mg/l)	EPA 270.2	ND	ND				ND
Silver (mg/l)	EPA 6010A	ND					
Molybdenum (mg/l)	EPA		2.1				

TABLE A3
BULK SOIL ANALYTICAL RESULTS SUMMARY 1
CHENEY DISPOSAL SITE
UMTRA PROJECT-GRAND JUNCTION, COLORADO

Sample No.	Area	Sample Date	Gross Alpha (PC/g)	Gross Beta (PC/g)	Radium-226 (PC/g)	Nitrate/Nitrite (g/m3) (ug/g)		Nitrate as N (g/m3) (ug/g)		Selenium (ug/g)	Uranium (ug/g)	Sulfate (g/m3) (ug/g)		Molybdenum (ug/g)	Strontium (g/m3) (ug/g)	
GRJ-SS-7263	1	04/01/96	9.0E0+/-2.7E0	1.9E1+/-2.7E0	7.6E-1+/-7.0E-1	12.2	3.2		NR	ND	ND		NR	NR		NR
GRJ-SS-7264	7	04/01/96	9.8E0+/-3.1E0	1.7E1+/-2.6E0	1.2E0+/-7.3E-1	6.9	1.8		NR	ND	ND		NR	NR		NR
GRJ-SS-7265	9	04/01/96	8.1E0+/-3.2E0	1.7E1+/-3.3E0	1.3E0+/-8.5E-1	49.7	13.0		NR	ND	ND		NR	NR		NR
GRJ-SS-7266	9	04/01/96	1.1E1+/-3.2E0	1.3E1+/-4.0E0	7.6E-1+/-7.4E-1	32.1	8.4		NR	ND	ND		NR	NR		NR
GRJ-SS-7267	1	04/01/96	1.2E1+/-3.1E0	2.0E1+/-2.8E0	1.5E0+/-5.9E-1	8.8	2.3		NR	ND	ND		NR	NR		NR
GRJ-SS-7268	7	04/01/96	1.1E1+/-2.9E0	2.1E1+/-2.8E0	6.0E-1+/-7.4E-1	4.6	1.2		NR	ND	ND		NR	NR		NR
GRJ-SS-7269	6	04/02/96	1.1E1+/-3.2E0	1.6E1+/-3.3E0	1.3E0+/-6.6E-1	38.2	10		NR	ND	ND		NR	NR		NR
GRJ-SS-7270	5	04/02/96	9.7E0+/-3.2E0	1.9E1+/-3.1E0	1.2E0+/-6.4E-1	53.5	14		NR	ND	ND		NR	NR		NR
GRJ-SS-7271	4	04/02/96	1.4E1+/-3.3E0	2.3E1+/-3.0E0	1.6E0+/-7.2E-1	45.8	12		NR	ND	ND		NR	NR		NR
GRJ-SS-7272	8	04/02/96	7.8E0+/-2.9E0	2.1E1+/-2.7E0	1.6E0+/-7.2E-1	320.9	84		NR	ND	ND		NR	NR		NR
GRJ-SS-7273	2	04/02/96	4.5E0+/-2.3E0	6.7E0+/-2.4E0	1.1E0+/-6.6E-1	208.3	54		NR	NT	NT		NR	NR		NR
GRJ-SS-7274	3	04/02/96	3.9E0+/-2.8E0	1.1E1+/-2.7E0	1.3E-2+/-5.0E-1		ND		NR	NT	NT		NR	NR		NR
GRJ-SS-7275	2	04/02/96	4.3E0+/-2.4E0	1.1E1+/-2.4E0	3.0E-1+/-1.0E0	359.1	94		NR	NT	NT		NR	NR		NR
GRJ-SS-7276	2	04/02/96	2.2E0+/-2.0E0	7.9E0+/-2.2E0	2.2E0+/-2.3E0	1757.4	460		NR	NT	NT		NR	NR		NR
GRJ-SS-7277	2	04/02/96	2.2E0+/-2.4E0	3.5E0+/-2.2E0	1.4E0+/-9.8E-1	4.6	1.2		NR	NT	NT		NR	NR		NR
GRJ-SS-7278	3	04/02/96	9.6E0+/-2.9E0	2.1E1+/-2.8E0	1.0E0+/-5.4E-1	11.5	3.0		NR	NT	NT		NR	NR		NR
GRJ-SS-7279	3	04/02/96	2.3E0+/-2.0E0	1.1E1+/-2.4E0	2.0E-1+/-3.6E-1	5.3	1.4		NR	NT	NT		NR	NR		NR
GRJ-SS-7280	10	03/29/96	6.2E0+/-2.8E0	2.0E1+/-2.7E0	1.3E0+/-8.2E-1	1.5	0.40		NR	ND	ND		NR	NR		NR
GRJ-SS-7290	12	05/30/96	NR	NR	2.0+/-0.4			79.5	20.8	ND	4.1	72972	19100	ND	1299.0	340
GRJ-SS-7291	11	05/30/96	NR	NR	1.1+/-0.3			28.7	7.5	ND	3.0	38205	10000	ND	760.3	199
GRJ-SS-7292	13	05/30/96	NR	NR	1.4+/-0.4			33.2	8.7	ND	2.9	74882	19600	ND	1096.5	287
Analytical Test Method			WP-EP-300	WP-EP-300	WP-EP-325	EPA 353.2 M		EPA 300.0 M		EPA 6010A	EPA 6010A	EPA 300.0 M		EPA 6010A	EPA 6010A	
Limit of Detection			Variable: 1.1-5.0	Variable: 2.0-7.3	Variable: 0.44-3.5	0.087-0.500		0.500		25-30	20	250		2.5	1.5	

Notes: 1. NT: Not tested, samples were submitted as rock, and cannot be processed.

2. NR: Analytical tests not requested.

3. ND: Not detected at or below laboratory detection limits.

4. Laboratory reported results for 5/30/96 samples in mg/kg (with the exception of uranium and Rad-226). Units for mg/kg were converted to g/m3 by the conversion: 0.0283*135g/cm3*concentration (mg/kg) [the density of the soil is approximately 135 g/cm3]

TABLE A4
BULK SOIL ANALYTICAL RESULTS SUMMARY 2
CHENEY DISPOSAL SITE
UMTRA PROJECT-GRAND JUNCTION, COLORADO

Lab Sample No.	GRJ-SS-7283	GRJ-SS-7287	GRJ-SS-7273	GRJ-SS-7275	GRJ-SS-7278	GRJ-SS-7277	GRJ-SS-7274	GRJ-SS-7278	GRJ-SS-7279
Sample Date	04/01/96	04/01/96	04/02/96	04/02/96	04/02/96	04/02/96	04/02/96	04/02/96	04/02/96
Sample Area No.	1	1	2	2	2	2	3	3	3
Area Description	Perimeter	Perimeter	Top Slope South of Slope Break	North-top @ Slope Break	North-top @ Slope Break	North-top @ Slope Break	North-top @ Slope Break	North-top @ Slope Break	North-top @ Slope Break
Sample Description	Soil/bedding material	Soil/bedding material	A" Rtx w/ white powder	Degraded "A" Rtx	A" Rtx w/ white powder	Degraded "A" Rtx	Degraded "A" Rtx	A" Rtx w/ white powder	Degraded "A" Rtx
Analytes									
Gross Alpha (pCi/g)	9.0E0+/-2.7E0	1.2E1+/-3.1E0	4.5E0+/-2.3E0	4.3E0+/-2.4E0	2.2E0+/-2.0E0	2.2E0+/-2.4E0	3.9E0+/-2.8E0	9.5E0+/-2.9E0	2.3E0+/-2.0E0
Gross Beta (pCi/g)	1.9E1+/-2.7E0	2.0E1+/-2.8E0	6.7E0+/-2.4E0	1.1E1+/-2.4E0	7.9E0+/-2.2E0	3.5E0+/-2.2E0	1.1E1+/-2.7E0	2.1E1+/-2.8E0	1.1E1+/-2.4E0
Radium-226 (pCi/g)	7.6E-1+/-7.0E-1	1.5E0+/-5.9E-1	1.1E0+/-6.6E-1	3.0E-1+/-1.0E0	2.2E0+/-2.3E0	1.4E0+/-9.8E-1	1.3E-2+/-5.0E-1	1.0E0+/-5.4E-1	2.0E-1+/-3.6E-1
Nitrate/Nitrite (µg/g)	3.2	2.3	54	94	460	1.2	ND	3.0	1.4
Nitrate as N (µg/g)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Selenium (µg/g)	ND	ND	NT	NT	NT	NT	NT	NT	NT
Uranium (µg/g)	ND	ND	NT	NT	NT	NT	NT	NT	NT
Sulfate (µg/g)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Molybdenum (µg/g)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Strontium (µg/g)	NR	NR	NR	NR	NR	NR	NR	NR	NR

Notes:

1. NT: Not tested, samples were submitted as rock, and cannot be processed.
2. NR: Analytical tests not requested.
3. ND: Not detected at or below laboratory detection limits.
4. Soil samples from Areas 7, 9, 11, 12, 13 are native alluvial soils taken at the surface.
5. All samples obtained at the surface.

TABLE A4
BULK SOIL ANALYTICAL RESULTS SUMMARY 2
CHENEY DISPOSAL SITE
UMTRA PROJECT-GRAND JUNCTION, COLORADO

Lab Sample No.	GRJ-SS-7271	GRJ-SS-7270	GRJ-SS-7269	GRJ-SS-7264	GRJ-SS-7268	GRJ-SS-7272	GRJ-SS-7285	GRJ-SS-7268	GRJ-BD-98-01
Sample Date	04/02/96	04/02/96	04/02/96	04/01/96	04/01/96	04/02/96	04/01/96	04/01/96	03/29/96
Sample Area No.	4	5	6	7	7	8	9	9	10
Area Description	Top Slope South of PCC Hole	North-top @ Slope Break	South-top @ Slope Break	SE of "A" Rock Pile	SE of "A" Rock Pile	North-top @ Slope Break	SE of common fill pile	SE of common fill pile	Bedding pile
Sample Description	Soil/gravel-bed material	Soil/gravel-bed material	Soil w/in "A" Rx-top of cel	Alluvial soil @ surface	Alluvial soil @ surface	Soil w/in "A" Rx-top of cel	Alluvial soil @ surface	Alluvial soil @ surface	Soil/gravel material
Analytes									
Gross Alpha (pCi/g)	1.4E1+/-3.3E0	9.7E0+/-3.2E0	1.1E1+/-3.2E0	9.8E0+/-3.1E0	1.1E1+/-2.9E0	7.8E0+/-2.9E0	8.1E0+/-3.2E0	1.1E1+/-3.2E0	6.2E0+/-2.8E0
Gross Beta (pCi/g)	2.3E1+/-3.0E0	1.9E1+/-3.1E0	1.6E1+/-3.3E0	1.7E1+/-2.6E0	2.1E1+/-2.8E0	2.1E1+/-2.7E0	1.7E1+/-3.3E0	1.3E1+/-4.0E0	2.0E1+/-2.7E0
Radium-226 (pCi/g)	1.6E0+/-7.2E-1	1.2E0+/-6.4E-1	1.3E0+/-6.5E-1	1.2E0+/-7.3E-1	6.0E-1+/-7.4E-1	1.5E0+/-7.2E-1	1.3E0+/-8.5E-1	7.6E-1+/-7.4E-1	1.3E0+/-6.2E-1
Nitrate/Nitrite (µg/g)	12	14	10	1.8	1.2	84	13.0	8.4	0.40
Nitrate as N (µg/g)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Selenium (µg/g)	ND	ND	ND	ND	ND	ND	ND	ND	ND
Uranium (µg/g)	ND	ND	ND	ND	ND	NR	NR	NR	NR
Sulfate (µg/g)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Molybdenum (µg/g)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Strontium (µg/g)	NR	NR	NR	NR	NR	NR	NR	NR	NR

- Notes:
1. NT: Not tested, samples were submitted as rock, and cannot be processed.
 2. NR: Analytical tests not requested.
 3. ND: Not detected at or below laboratory detection limits.
 4. Soil samples from Areas 7, 9, 11, 12, 13 are native alluvial soils taken at the surface.
 5. All samples obtained at the surface.

**TABLE A4
BULK SOIL ANALYTICAL RESULTS SUMMARY 2
CHENEY DISPOSAL SITE
UMTRA PROJECT-GRAND JUNCTION, COLORADO**

Lab Sample No.	GRJ-SS-7291	GRJ-SS-7290	GRJ-SS-7292
Sample Date	05/30/96	05/30/96	05/30/96
Sample Area No.	11	12	13
Area Description	Interceptor Drainage	East of Common FM Pile	West of "C" rock pile
Sample Description	Ditch		
	Soil/bedding material	Alluvial soil @ surface	Alluvial soil @ surface
Analytes			
Gross Alpha (pCi/g)	NR	NR	NR
Gross Beta (pCi/g)	NR	NR	NR
Radium-226 (pCi/g)	1.1+/-0.3	2.0+/-0.4	1.4+/-0.4
Nitrate/Nitrite (µg/g)	NR	NR	NR
Nitrate as N (µg/g)	7.50	20.80	8.70
Selenium (µg/g)	ND	ND	ND
Uranium (µg/g)	3.0	4.1	2.9
Sulfate (µg/g)	10000	19100	19600
Molybdenum (µg/g)	ND	ND	ND
Strontium (µg/g)	199	340	287

Notes:

1. NT: Not tested, samples were submitted as rock, and cannot be processed.
2. NR: Analytical tests not requested.
3. ND: Not detected at or below laboratory detection limits.
4. Soil samples from Areas 7, 9, 11, 12, 13 are native alluvial soils taken at the surface.
5. All samples obtained at the surface.

1

2

3

APPENDIX B

FIELD AND LABORATORY PROCEDURES EMPLOYED BY THE TAC

CALCULATION COVER SHEET

CALC NO. GRJ11961201 DISCIPLINE Hydro NO. OF SHEETS 8

PROJECT: UMTRA

SITE: Grand Junction / Cheney (GRJ03)

FEATURE: Potential run-off volumes entering the perimeter ditch segments adjacent to the northwest and southwest paleochannels, and volumes needed to fill each ditch segment.

SOURCES OF DATA:

Tables and figures in DOE, 1996: Work Plan for Phase 1A Paleochannel Studies at the Cheney Disposal Cell, Grand Junction, Colorado.

SOURCES OF FORMULAE & REFERENCES:

Not applicable. No special formulae or references were used in this calculation.

PRELIMINARY CALC. ☒ FINAL CALC. ☐ SUPERSEDES CALC. NO. _____

0		<i>David Ward</i>	<i>11/12/96</i>				
REV. NO.	REVISION	CALCULATION BY	DATE	CHECKED BY	DATE	APPROVED BY	DATE

Calculation No. GRJ11961201

Potential run-off volumes entering the perimeter ditch segments adjacent to the northwest and southwest paleochannels, and volumes needed to fill each ditch segment at Grand Junction (Cheney), Colorado

David Ward, TAC Geochemist

12 November 1996

PART 1 — POTENTIAL RUN-OFF (P.2-3)

The large rainstorm of 17 June 1995 at Cheney produced significant water level rises in the paleochannel monitoring wells GRJ03-0731 and -0732. This rainstorm produced 1.26 inches of precipitation at the Cheney site. To support design discussions for Phase 1A investigations at Cheney, the first part of this calculation calculates the potential run-off from the cell with the following assumptions: 1) There are no losses to infiltration into the erosion protection material or into the bedding layer, and 2) Evaporative losses are negligible. In other words, it is assumed that all precipitation eventually appears in the perimeter ditch, where it then seeps into the subsurface or may overtop the perimeter ditch and flow overland to surface drainages.

Triangular areas draining to the southwest and northwest perimeter ditch segments are shown in Figure 1 on p. 2, and area calculations are presented on p. 3. Results on p. 3 show that the maximum possible run-off from the 17 June 1995 storm was 810,000 gallons for the southwest segment, and 510,000 gallons for the northwest segment.

PART 2 — DITCH CAPACITY (P.4-8)

To estimate the volume of water that may be needed to flood the perimeter ditch segments for the proposed Phase 1A experiment, the volume of void space in the ditch fill is calculated for each segment, and then the volume of water that would pond behind a dam or weir constructed in the perimeter ditch is calculated. It is assumed that the riprap in the perimeter ditch has a porosity of 45%. The entire portion of each ditch segment upgradient of the monitor wells is considered here.

The southwest ditch segment has a void space of 810,000 gallons, and the northwest ditch segment has a void space of 740,000 gallons. The ditch segments are sloped, however, with an average gradient of 0.02. A dam or weir placed in the ditch would cause ponding for 270 feet upgradient, and would hold back nearly 37,000 gallons of water at the point of being overtopped.

trans and chemical contents of ^{radioactive} ~~of a~~ ^{of a} ~~from~~ ^{from} ~~water~~ ^{water} sampled by MR Ferguson during Phase 1.

Figure 1. Cell areas draining to the southwest and northwest perimeter ditch segments

Potential run-off entering the northwest and southwest perimeter ditch segments

See attached figure for triangle #s and dimensions.

Triangle #	(in) base	(in) height	(in ²) area	(ft ²) area
1	4.75	0.33	0.784	248424
2	1.68	0.13	0.109	34613
3	2.9	1.62	2.349	744560
4	3.52	1.09	1.918	608073
5	0.95	0.71	0.337	106898
6	4.18	0.23	0.481	152367

Note: area = 0.5 * base * height

scale | 563 ft/in

Catchment area for southwest ditch is triangles 1 + 2 + 3:
1027598 ft²

Catchment area for northwest ditch is triangles 4 - 5 + 6:
653543 ft²

For a the maximum observed rainfall event of 1.26 inches, the potential run-off is:

Ditch	(ft ²) area	(in) rainfall	(ft ³) volume	(gallons) volume
SW	1.03E06	1.26	1.08E05	8.07E05
NW	6.54E05	1.26	6.86E04	5.13E05

DATE 11/11/96

SUBJECT Water volume to flood a perimeter ditch segment, GRJ03

SHEET NO. 1 of 50

BY DBW

CHKD. _____

JOB NO. _____

1. See attached figures for length and cross-sectional area of the palochannels.

Area: $A = 97.5 \text{ ft}^2$

Length: NW PC: $2099 \text{ ft} + 157 \text{ ft} = 2256 \text{ ft}$

SW PC: 2461 ft

2. Volume of "pore space" in perimeter ditch segments:

a) assume $\phi = 0.45$ (45% porosity)

b) $1 \text{ ft}^3 = 7.48 \text{ gal}$

c) $V = \text{length} \times \text{area} \times \phi$

NW PC: $V = 2256 \text{ ft} \cdot 97.5 \text{ ft}^2 \cdot 0.45 = 97,438.5 \text{ gal}$

SW PC: $V = 2461 \text{ ft} \cdot 97.5 \text{ ft}^2 \cdot 0.45 = 107,663 \text{ gal}$

3. The perimeter ditch is inclined, however.

What vol. of water would be needed to ~~over top~~

a) ~~embed~~

$A = \frac{L_1 + L_2}{2} \cdot h$

At any point x ,

$L_2(x) = L_2(0) = L_2$

$L_1(x) = L_1(0) - (L_1(0) - L_2) \cdot \frac{x}{L}$

$h(x) = h(0) \cdot \frac{L-x}{L} = h(0) \cdot (1 - \frac{x}{L})$

DATE 11/11/96

SUBJECT Ditch Water volume

SHEET NO. 2 of 50

BY DBW CHKD. _____

JOB NO. _____

3. cont'd

$$A(x) = \underbrace{l_2 + \frac{l_1(x) - l_2(x)}{L}}_{\uparrow} \cdot \underbrace{\frac{x}{L}(l_1(x) - l_2)}_{\downarrow} \cdot h \cdot \left(1 - \frac{x}{L}\right)$$

= something too ugly to integrate! (at least analytically)

This is solved numerically on the attached spreadsheets.

b) L_2 may be found from h and the gradient:

$$L_2 = \frac{h}{\text{gradient}} \quad \text{Gradient} = 0.02 \text{ for both PC's}$$

$$= 5.49 \text{ ft} / 0.02 = 274 \text{ ft}$$

$$c) \int_0^{L_2} A(x) dx \approx \sum_n A\left(\frac{L_2 + 0.5 \cdot L}{n} \cdot L\right) \cdot \frac{L}{n} = \sum_n \text{delV} = 10821 \text{ ft}^3$$

$$V_2 = \sum_n \text{delV} \cdot \phi \cdot 7.48 \frac{\text{gal}}{\text{ft}^3} = \begin{array}{r} 53,628 \text{ g} \\ \hline 34,660 \text{ g} \\ \hline 36,423 \text{ g} \end{array}$$

Vol. of water needed to over-top
a dam in a perimeter ditch
segment.

Cross-Sectional Area

$$\left(\frac{L_1 + L_2}{2}\right) \cdot h = A$$

$$\left(\frac{5.45 + 1.48}{2} \right) \cdot 1.07 = 3.71 \text{ in}^2$$

$$3.71 \text{ in}^2 \cdot \left(\frac{10 \text{ ft}}{1.95 \text{ in}} \right)^2 = 97.5 \text{ ft}^2$$

- SUMP**

1. BOTTOM IS CAPPED.
2. NO SLOTS IN LOWER 1 FOOT, WHICH IS EMBEDDED IN THE CLEAN FILL.
3. SLOTTED INTERVAL EXTENDS TO WITHIN 1 foot OF THE SURFACE AND IS WRAPPED WITH PVC/NYLON SCREEN TO EXCLUDE SAND.

ALLUVIUM

MANCOS

FIGURE 4.12
SUMP INSTALLATION IN THE PERIMETER DITCH
NEAR MONITOR WELLS 731 AND 732
CHENEY DISPOSAL SITE, COLORADO

5

6

7

FIGURE 3.3
PHASE IA SAMPLING LOCATIONS
CHENEY DISPOSAL SITE, COLORADO

MODIFIED FROM MK-F, 1996.

DBD W1115C
Pitel Water Volume...
p. 14 of 28

DBW 11/11/96

Ditch Water Volume ...

p. 5 of 5 8

Volume of water needed to overtop a dammed perimeter ditch

L2	274.359	ft	Vol	10820.8	ft ³
steps	50		phi	0.45	
delL	5.49	ft	WaterVol	36423	gal
el_2	7.59	ft			
el1not	27.95	ft			
hnot	5.49	ft			
step	ft x	ft el1 x	ft h	ft ² A	ft ³ delV
1	2.74	27.75	5.43	95.97	526.6
2	8.23	27.34	5.32	92.95	510.0
3	13.72	26.93	5.21	89.97	493.7
4	19.21	26.52	5.10	87.04	477.6
5	24.69	26.12	4.99	84.15	461.8
6	30.18	25.71	4.88	81.31	446.2
7	35.67	25.30	4.77	78.51	430.8
8	41.15	24.89	4.66	75.76	415.7
9	46.64	24.49	4.55	73.05	400.8
10	52.13	24.08	4.44	70.38	386.2
11	57.62	23.67	4.33	67.76	371.8
12	63.10	23.27	4.23	65.19	357.7
13	68.59	22.86	4.12	62.65	343.8
14	74.08	22.45	4.01	60.17	330.2
15	79.56	22.04	3.90	57.73	316.8
16	85.05	21.64	3.79	55.33	303.6
17	90.54	21.23	3.68	52.98	290.7
18	96.03	20.82	3.57	50.67	278.0
19	101.51	20.42	3.46	48.41	265.6
20	107.00	20.01	3.35	46.19	253.4
21	112.49	19.60	3.24	44.02	241.5
22	117.97	19.19	3.13	41.89	229.8
23	123.46	18.79	3.02	39.80	218.4
24	128.95	18.38	2.91	37.76	207.2
25	134.44	17.97	2.80	35.77	196.3
26	139.92	17.57	2.69	33.82	185.6
27	145.41	17.16	2.58	31.91	175.1
28	150.90	16.75	2.47	30.05	164.9
29	156.38	16.34	2.36	28.24	154.9
30	161.87	15.94	2.25	26.46	145.2
31	167.36	15.53	2.14	24.74	135.7
32	172.85	15.12	2.03	23.06	126.5
33	178.33	14.72	1.92	21.42	117.5
34	183.82	14.31	1.81	19.83	108.8
35	189.31	13.90	1.70	18.28	100.3
36	194.79	13.49	1.59	16.77	92.0
37	200.28	13.09	1.48	15.32	84.0
38	205.77	12.68	1.37	13.90	76.3
39	211.26	12.27	1.26	12.53	68.8
40	216.74	11.87	1.15	11.21	61.5
41	222.23	11.46	1.04	9.93	54.5
42	227.72	11.05	0.93	8.69	47.7
43	233.21	10.64	0.82	7.50	41.2
44	238.69	10.24	0.71	6.36	34.9
45	244.18	9.83	0.60	5.26	28.8
46	249.67	9.42	0.49	4.20	23.0
47	255.15	9.01	0.38	3.19	17.5
48	260.64	8.61	0.27	2.22	12.2
49	266.13	8.20	0.16	1.30	7.1
50	271.62	7.79	0.05	0.42	2.3

To: Larry Pinkel

From: Mark Minter

Through: Anchor Holm

Date: August 15, 1996

Subject: Analytical Chemistry and Data Management for Future TAC Sampling

You have requested that Rob Sengebush and I prepare general descriptions of the processes followed in preparing for and executing UMTRA TAC sampling events for use as a planning tool in future sampling events. This memorandum contains information relevant to the analytical chemistry and data management aspects of that work. I have reviewed Rob's memorandum, dated August 9, and will generally adhere to the format he used to describe the sampling activities. The comments below include some expansion on the topics he discussed as appropriate. The activities described in this memorandum are listed immediately below. It should be understood that this summary is a grossly trivialized representation of the activities involving analytical chemistry that actually take place.

- Relevant SOPs and SOWs
- Personnel
- Sampling and analysis plan review
- Laboratory selection
- Delivery order assignment
- Cost-analysis spreadsheet preparation
- Purchase requisition preparation
- Purchase requisition approval
- Updating the delivery order status spreadsheet
- Case file preparation
- Static groundwater level data entry
- Field parameter data entry
- Review of the summary of problems encountered by the samplers, and associated qualification of the resulting data
- Review of the laboratory deliverables
- Data entry, data validation, and qualification of the analytical results
- Reanalysis requests
- Final laboratory report requests
- Document distribution
- Invoice review and approval
- Data package preparation
- Sample disposal

As with the sampling activities, the analytical chemistry performed must be consistent with TAC practices to ensure the comparability of the data acquired. Knowledge of laboratory capabilities, careful attention to detail, clear understanding of the related defensibility issues, and adherence to established TAC procedures and practices are imperative if that goal is to be achieved.

Relevant SOPs and SOWs

The data acquisition and management processes are governed by the documents listed below. These documents are available in the UMTRA Project document control center.

- The UMTRA Project TAC Statement of Work for General Inorganic and Radiochemical Analyses, January 8, 1996
- The UMTRA Project TAC Statement of Work for Organic Analyses, November 16, 1995
- SOP 16.3.3, Data Management
- SOP 16.3.2, Validation of Chemical Analysis Data

Personnel

The work described should be performed by analytical chemists that are experienced in UMTRA Project work. Failure to select appropriate personnel could jeopardize TAC and event-specific data quality objectives, as well as inflating costs through inefficient or incorrect execution of the work. In addition, one person familiar with TAC data entry processes will be needed to complete the work.

Sampling and analysis plan review

A sampling and analysis plan (SAP) is prepared for each sampling event that incorporates relevant direction from the overall site SAP. Special technical and data quality objectives should be discussed in this plan. Approval of the SAP by the DOE site manager and the appropriate TAC technical manager should be obtained, and the plan submitted to the samplers and analytical chemist at least 4 weeks prior to sampling. The SAP must include the items listed below.

- The name of the site(s) to be sampled
- A written explanation of and justification for the sampling event
- The start date for the sampling
- The locations to be sampled at the site, including 5% duplicates, field blanks, and equipment blanks, as appropriate (equipment blanks are not required for grab samples)
- A list of analysis parameters for each location to be sampled, using the work order plan forms (attachments 3 and 4 to SOP 16.3.3) - one set of forms may be used for all locations if the analysis parameters are the same for all
- Required laboratory turn around time, if different from the standard 4 weeks
- A site map identifying the locations to be sampled

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- The charge number for the work

The samplers and the analytical chemist must review the SAP to ensure that all the requisite information is present and correct. This includes review of the work order plans to ensure that the appropriate bottle is specified for each parameter, and that the required blanks and field duplicates are correctly specified.

Laboratory selection

The analytical chemist must ensure that the technical needs of the SAPs author are met. To do this, laboratories having the appropriate analytical capability must be selected from those having current contracts. If special needs are noted, the analytical chemist must write specifications for the laboratory to provide direction for the work. If the sampling event is large, or if short turn around times are required, the analytical chemist must verbally negotiate with the laboratory to ensure that sufficient capacity exists to meet the need. The analytical chemist must carefully document all communication with laboratory representatives from this point on. A telephone log is kept in data management for use in recording verbal communications. Records of all communications should be copied and placed in the correspondence file for the associated delivery orders.

Delivery order assignment

The UMTRA project TAC uses a delivery order (DO) contracting system. The analytical chemist must assign delivery order numbers for the work to be performed for each new sampling event. These numbers are specific to the laboratory being used, and should be sequentially incremented for each subsequent DO. The correct number can be determined from the DO spreadsheet, located on the LAN in: i:\group\dma\mminteer\h_pzietz\excel\dostatus\do_log.xls.

Cost analysis spreadsheet preparation

The analytical chemist must prepare a cost analysis spreadsheet that uses the number of analyses of each type to compute the total cost for the event. The digestion costs must also be included in the cost analysis if applicable. The total should be padded with an additional 10% when complete, to cover the costs of possible shipping and reanalysis charges. The laboratory-specific spreadsheet containing the option 2 prices for the current contracts can be found on the LAN in: i:\group\dma\mminteer\h_pzietz\excel\cost_op2.xls.

Purchase requisition preparation

A purchase requisition must be prepared for each laboratory participating in the analyses for the event in question. The requisition should specify the type of analyses to be performed (general

inorganic, organic, radiochemical) and give the total estimated cost. Costs need not be itemized on the purchase requisitions. The site name and WBS code must be present as well.

Purchase requisition approval

Current direction for purchase requisition approval must be followed. This normally includes approval from the cost scheduler, site manager, and project manager. The purchase requisition is included under a cover memorandum to the contract representative with the complete SAP for the sampling event. This package is to be submitted by the analytical chemist, through the approval loop, to the contract representative 3 weeks prior to the beginning of the sampling event.

Updating the DO status spreadsheet

The DO status spreadsheet should be updated for each step in the sampling, analysis, validation, and data package preparation processes to facilitate tracking. A new row should be entered at the bottom of the existing spreadsheet for each new sampling event. The spreadsheet can be found on the LAN in: i:\group\dma\mminteer\h_pzietz\excel\dostatus.

Case file preparation

Case files should be prepared for each event using the instructions in attachment 6 to SOP 16.3.3. These files will have a section for each activity in the analytical process.

Static groundwater level data entry

The static groundwater level forms are provided to the analytical chemist by the samplers after the sampling event. These data, accompanied by a data entry submittal form, are submitted to data entry for incorporation into the database. The data entry submittal forms provide records that are vital to tracing database changes. When returned, the static groundwater level forms should be filed in the "field forms" section of the case file for later inclusion in the validated data package.

Field parameter data entry

The water sampling field forms contain sections for each location that summarize that field parameter results. When an oxidation/reduction potential (ORP) measurement was performed, the ORP must be converted to Eh as described in section 5.7.5.f of SOP 16.3.3, and using the table in attachment 10 to that SOP. The calculated results should be written on the field form and clearly labeled as Eh results.

Review of the field forms for information on the number of bore volumes purged and the pH of the water should be done at this time. Locations for which less than 3 bore volumes were purged,

10

11

12

13

14

other than for "low-flow sampling," should be recorded. Locations for which the pH was greater than 9, indicating grout contamination, should also be recorded. All field and laboratory data acquired in such cases must be qualified in the database ("L" for less than 3 bore volumes, and "G" for pH > 9). The field forms should be submitted for data entry, accompanied by a data entry submittal form, when the review and calculation processes are complete. Any data qualifiers needed should be specified on the data entry submittal form, and again on the data entry submittal form used with the laboratory data when they arrive.

Review of the summary of problems encountered by the samplers, and associated data qualification

If the sampling event summary is properly prepared, the purge and pH issues discussed above should be discussed there. Other data quality problems, such as failed alkalinity control sample results, should also be discussed. (Such problems can result in the need to qualify the associated data as estimated or unusable.) The sampling summary can then be used, rather than the field forms themselves, to determine the needed data qualification steps.

Review of the laboratory deliverables

The electronic and hard-copy deliverables from the laboratories should be reviewed for compliance with the reporting requirements given in section 4 of the SOW. This review should include verification that appropriate data qualifiers, resulting from the validation work described below, are present. The L, G, J, and R qualifiers are assigned by the TAC analytical chemist, and should never be present in the laboratory deliverables. Any "hits" in field or equipment blanks should be noted during this process. For parameters having hits in the blanks, all data from the same batches having parameter values > the CRDL, but ≤ 10 times the blank value, must be qualified with a "J" flag. It is therefore most expedient to review the blanks at this stage of the process. However, professional judgement must be used in qualifying data. For example, an equipment blank hit does not apply to grab samples analyzed in the same batch.

Deliverables that contain deficiencies, and that cannot readily be fixed during the review process, should be returned promptly to the laboratory. The laboratory should be notified by telephone of this action because the unacceptable deliverable does not apply to assessing on-time performance. The total turn around time is calculated from the date of receipt of the last sample at the laboratory to the date of submission of an acceptable product.

Data entry, data validation, and qualification of the analytical results

The laboratory data must be validated according to the specifications of SOP 16.3.2. Validation activities include verification that signed C-O-C form are present in the hard-copy deliverable, verification that holding times were met, examination of the results for all batch quality control samples for type, number, and acceptance criteria, and generation and examination of the suspected anomalies report (SAR). The data validation results are documented on the data

package assessment form. That form is attachment 14 to SOP 16.3.3. The database qualifiers signifying that data have not been validated should be removed when the validation process are complete.

Obviously, the contents of the electronic deliverable must downloaded into the data base before a SAR can be generated. (The analytical chemist should ensure that both the general inorganic and radiochemical electronic deliverables have successfully been downloaded before generating the SAR.) The data entry submittal process is followed for that work. The analytical chemist must remember to include instructions for application of the L and G flags discussed above when submitting these data. Further data qualification requirements resulting from the data validation activities should also be specified.

The SAR should be reviewed by the site geochemist against historical results and expected parameter ranges. Comments resulting from the geochemist's review are then reviewed by the analytical chemist, with due consideration to process knowledge and analytical technique capabilities, for compilation of a list of reanalyses to be requested. The application of professional judgement is expected, and required, in this process.

Reanalysis requests

Reanalysis requests can result from some (but not all) quality control failures, or from a suspected problem identified during the SAR review. Section 3 of the SOW gives the quality control requirements and the actions that result. Requests for reanalyses should be conveyed to the laboratory by telephone so that work can begin as soon as possible, with follow up to the verbal requests provided in writing. The reanalysis reports are subject to all of the review, validation, and distribution processes that are performed for initial reports of analytical results.

The professional judgement of an experienced analytical chemist is needed to determine whether the reanalysis results confirm or differ significantly from the original results. This is a dangerous area, because inexperienced personnel often use this process to pick and choose analytical data that suit them. Reanalyses that confirm the original results are paid for at the standard unit prices, while those that indicate errors in the original data are not paid for. Reanalysis results that are to be incorporated into the database are submitted via the data entry submittal form, and replace the original results.

Final laboratory report requests

When all review and reanalysis steps are completed, the analytical chemist must request a final report from the laboratory. This request should be made by telephone, and followed by a written request, to ensure timely delivery and proper record keeping. The final report from the laboratory will be included in the validated data package, and represents our best effort to provide complete and correct data to the client. As such, it includes the necessary reanalysis results and all the appropriate laboratory data qualifiers. The analytical chemist must instruct the laboratory regarding which reanalysis results are to be incorporated, and verify that the instructions are

correctly carried out. The final report should be the single most reliable paper record of the analytical results. Reanalysis results that confirm the original results are not incorporated in the final report.

The delivery order files for the sampling event are transferred from the active case files to the inactive case files when the final reports arrive. All associated files remain in the inactive case files until the files are purged (see below).

Document distribution

The original of each hard-copy deliverable, whether initial report, reanalysis report, or final report, is placed in a blue folder with the transmittal document stapled to the cover. (The transmittal forms are initiated by the laboratories, and completed by the analytical chemist when the deliverables arrive.) These are transferred to document control when all work related to that sampling event is complete. One copy of each deliverable is provided to the site geochemist when received, and one copy resides in the data management files until the files are purged. Files younger than 1 year should not be purged from the data management file drawers.

All memoranda associated with the procurement of analytical services should be copied to document control, with one copy maintained in the data management files (case files) for the delivery order. All records of correspondence with the laboratories should be transferred to document control when the files are purged. Until that time, all information except the original reports is maintained in data management for future reference. The data management copies of laboratory reports are not sent to document control when the files are purged. The original laboratory reports already reside in document control if correct distribution processes have been followed.

Invoice review and approval

Laboratory invoices will be routed through the analytical chemist by the UMTRA Project contracts department. The analytical chemist must review the submitted invoices against the known scope of the work to ensure that only those analyses actually performed are paid for. The reanalyses performed must be reviewed to ensure that correct payment is made for these as well. When satisfied that the charges are true and correct, the analytical chemist should authorize the invoices by signature and return them to the contracts representative.

Data package preparation

A final validated data package is prepared and submitted to the DOE for each sampling event when all work is completed. The format and content for the validated data package are specified in an example data package contents page which is included in SOP 16.3.3 as attachment 16. Instructions for preparation of validated data packages are given in section 5.10 of SOP 16.3.3.

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The data package contents page and a narrative that summarizes the data validator's findings and reanalyses performed are prepared by the analytical chemist. (The form used in the validation process is included.) A discussion of whether reanalysis results were incorporated and why should be part of the data management narrative. The data package is transmitted to the TAC site manager under a cover memorandum requesting that site manager to oversee preparation of a hydrologist/geochemist summary, the general content of which is specified in section 5.10.2 of SOP 16.3.3. The TAC site manager then assumes responsibility for transmitting the completed package to the DOE site manager.

The final entry in the DO status spreadsheet is the date when the package is sent to the TAC site manager. The entries for a completed sampling and analysis event should remain on the DO status spreadsheet for a minimum of 2 months, after which they may be deleted.

Sample disposal

The chemical analysis SOW requires laboratories to retain all remaining samples for 120 days after submission of the final report. This allows time for all necessary scrutiny of the data to proceed, and reanalysis can be requested at any time during the sample-retention period. It is not unusual to find a need for reanalysis after the initial reanalysis requests, and sometimes even after the final validated data package is submitted. In the latter case, a revision to the validated data package must be prepared that summarizes any changes. Reanalysis results for samples that have exceeded the holding time may be preferable to the original results. This is true when a transcription error, dilution factor error, or large analytical error is identified. Reanalysis (or any other) results for which the holding time had expired prior to analysis must be qualified with the "H" flag.

When the 120 day sample-retention period has passed, and the analytical chemist is satisfied that all has been done that can be done to ensure the quality of the data, the samples may be discarded. This is accomplished by sending a letter authorizing disposal to the laboratories involved. As with all correspondence, those letters are kept in the correspondence sections of the case files.

cc: John Lommler
Paul Zietz (Weston)
Lucille Maez
Ed Artiglia
Document Control

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M. M. Miller

JACOBS ENGINEERING GROUP INC., ALBUQUERQUE OPERATIONS

40-54-89

Anchor Holm to Ed & Larry

TO: Anchor Holm, TAC Technical Director

FROM: *Ed for Rob Sengebush*
Rob Sengebush, TAC Water Sampling Manager

DATE: August 9, 1996

SUBJECT: UMTRA TAC Water Sampling Procedures

Per your request, this memorandum provides a check list of UMTRA TAC water sampling procedures. The purpose of the check list is to provide a reference for the remaining technical and management staff in the event that water sampling management personnel are unavailable to plan and implement a water sampling event. This check list covers:

- Relevant SOPs
- Selection of sampling personnel
- Sampling and Analysis Plan (SAP) review
- Preparation of the Field Work Order Package (FWOP)
- Equipment selection
- Field Forms and Field Documentation
- Shipping procedures
- Field Form Review and Summary Report

The procedures outlined here are based on the assumption that the samples collected must be representative of aquifer water and defensible under DOE standards. The sampling procedures must be consistent with or equivalent to previous UMTRA sampling methods in order for new analytical data to be comparable with historical data. Thus, full documentation, quality control, quality assurance and attention to detail are essential to every aspect of the sampling procedures.

Relevant SOPs

UMTRA TAC water sampling is governed by the procedures defined in the JEG Albuquerque Operations Manual (AOM) as follows:

- 16.2.1, Collection, Preservation and Shipment of Water Samples
- 16.2.5, Low-Flow Water Sampling

AOM 16.2.1 was revised as of January 1, 1996 and reflects current water sampling practice as of the end of the TAC Groundwater Contract. AOM 16.2.5 is a new procedure which applies to low-flow sampling from wells with dedicated pumps.

The operation of water sampling equipment is documented in manufacturer literature and operating manuals. This equipment includes:

- YSI 3300 Water Quality Meter and pH, ORP, Temp, EC probes
- Pumps - bladder pump, purge master pump, peristaltic pump
- Generators - Honda 650
- Compressors
- Water Level Meters
- DR 2000 Spectrophotometer
- Power Bailer
- Sampling vehicle winch
- Other equipment, on an as-needed basis

Operating manuals are located in a blue file box which is kept in the remaining water sampling vehicle.

Selection of Sampling Personnel

Regulatory Issues:

On active UMTRA sites (with an MKF and Rust Geotech presence), the Health and Safety requirements are:

- 40 hr OSHA training with current 8 hr refresher
- CPR and First Aid
- Radiation Worker II Training.

Practical Issues:

The sampling team should be comprised of a minimum of two samplers experienced with UMTRA TAC water sampling procedures. Sampling rounds should not be treated as training missions.

Sampling and Analysis Plan (SAP) Review

The SAP is prepared by the technical staff and submitted to the Water Sampling Manager for review. The water sampling manager should check every aspect of the SAP scope to make sure the scope can be completed with the available sampling resources (time allotted, personnel and equipment).

Some common SAP problems are as follows:

- No WBS billing code
- Wells to be sampled do not exist
- Wells are not accessible or access agreements do not exist
- Maps showing well access are not current, not correct or illegible
- Laboratories and delivery numbers (D.O. No) not specified
- QA/QC requirements are absent or incorrect

Preparation of the Field Work Order Package (FWOP)

The FWOP takes the information in the SAP and translates it into a format which is more useful to the sampling team. The FWOP consists of a memorandum to the team describing the sampling round, detailed maps of the well locations and access information, a table of well specifications and previous water quality parameters, and a table listing every well and the specific bottle types required from that well to satisfy the analytical contract.

An example of each part of the FWOP is presented in AOM 16.2.1.

Equipment Selection

The equipment selected for a sampling round depends on the specifications of the wells to be sampled such as casing diameter, total depth, depth to water, screened interval, accessibility, and analyses required.

The sampling procedures may be divided into four parts, each with specific equipment.

1. Purging:
Pumps, hoses, reels, power source (compressor or generator, depending on the pump), parameter measurement meters, flow through cell.
2. Sample collection:
Usually done with the same equipment used to purge the well, and 0.45 micron water filters, high purity reagent grade water for field blank and equipment blank samples.
3. Equipment Decontamination:
Distilled water, liquinox soap, specialized pump fittings.
4. Sample containerization and preservation:
Specially cleaned bottles, bottle labels, sharpie labeling pen, clear packaging tape, ice; reagent grade nitric and sulfuric acid.

A complete list of all water sampling equipment is included in AOM 16.2.1.

Field Forms and Field Documentation

Examples of all field forms needed for UMTRA water sampling are included in the AOM 16.2.1.

Static water level forms which record the depth to water in each well must be completed during each sampling round.

Field forms must be completed for each well sampled. The field forms are placed in numerical order and turned in to the water sampling manager or equivalent upon

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completion of the sampling round, whereupon they are reviewed for completeness and accuracy, and corrected, if necessary. The field form originals for all sampling rounds are stored in document control. Copies are distributed to the hydrogeologist and the data management team. The water quality field parameters of pH, etc. are taken from the field forms and entered into the UMTRA data base by the data management group.

Chain of custody forms must be completed for every sample and copies submitted to the laboratory with the samples, and to the water sampling manager with the field forms package.

A chain of custody checklist must be completed by the sampling team at the time the coolers are loaded, as a means of checking the accuracy of the bottle labeling and to insure that that sampling scope has been completed.

Detailed field notes must also be kept by each water sampler and are submitted to the sampling manager for review along with the field forms.

Shipping Procedures

Use standard 48 quart picnic coolers for sample shipment. Install a double bladder (large clear plastic bags) then load the coolers with as many plastic sample bottles as possible, leaving room for enough ice to keep the samples a 4 degrees Centigrade until receipt by the analytical laboratory. Add fresh ice just prior to shipment. If glass bottles are used, bubble wrap and tape each glass bottle individually. Knot the bladder and tape a custody seal over the knot. Place the chain of custody forms in a zip-lock plastic bag and place in the cooler, outside of the bladder. Close the cooler and tape with clear plastic packaging tape. Place two custody seals on the outside of the bladder. Note that a lack of custody seals on the cooler may invalidate all of the samples contained in the cooler.

Prepare a label which contains the laboratory address and the TAC return address.

Prepare a Federal Express shipping label which will be fixed to the cooler at the time of the drop off. Ship the coolers priority overnight. If the coolers will arrive at the laboratory on a Saturday, call the laboratory to make sure someone will be there for a Saturday delivery. Time the shipment so that TDS analyses will be done within the seven day holding time.

Field Form Review and Summary Report

Upon completion of the sampling round, the sampling manager or equivalent reviews all of the field forms for completeness and accuracy. This review is compiled in a summary report which lists the wells sampled and provides comments regarding purge volume and other information which might be useful during future sampling rounds. Copies of the report go to the site manager, hydrogeologist and Document Control.

If anyone on the TAC has any questions regarding these sampling procedures, please feel free to contact Rob Sengebush at (505) 296-9106.

104416.452@compuserve.com

cc: E. Artiglia, TAC
L. Maez, TAC
L. Pinkel, TAC
Document Control

GRJ 03

DO#128

CORE LABORATORIES - AURORA, CO
CONTRACT No. 08-82350-S-93-0026

NO.	OPTION 2 DESCRIPTION	QTY.	ONE WEEK UNIT PRICE	ONE WEEK SUBTOTAL
1	CHLORIDE (Cl) ~	21	\$17.30	\$363.30
2	SULFATE (SO4) ~	21	\$21.18	\$444.78
3	SODIUM (Na) ~	21	\$15.75	\$330.75
4	POTASSIUM (K) ~	10	\$15.75	\$157.50
5	MAGNESIUM (Mg) ~	21	\$15.75	\$330.75
6	CALCIUM (Ca) ~	21	\$15.75	\$330.75
7	BORON (B)	0	\$15.75	\$0.00
8	FLUORIDE (F) ~	10	\$38.50	\$385.00
9	TOTAL CYANIDE	0	\$57.75	\$0.00
10	SULFIDE	0	\$48.13	\$0.00
11	AMMONIUM ~	10	\$26.95	\$269.50
12	NO2 + NO3	0	\$28.88	\$0.00
13	NITRATE (NO3) ~	21	\$28.88	\$606.48
14	TOTAL KJELDAHL NITROGEN (TKN)	0	\$57.75	\$0.00
15	SILICA (SiO2)	0	\$15.75	\$0.00
16	TOTAL PHOSPHOROUS AS PO4	0	\$34.65	\$0.00
17	BROMIDE ~	10	\$38.50	\$385.00
18	ALUMINUM (Al)	0	\$15.75	\$0.00
19	ANTIMONY (Sb) BY ICP-AES	0	\$15.75	\$0.00
19a	ANTIMONY (Sb) BY GFAA	0	\$31.50	\$0.00
20a	ARSENIC (As) BY GFAA	10	\$31.50	\$315.00
21	BARIUM (Ba)	0	\$15.75	\$0.00
22	BERYLLIUM (Be)	0	\$15.75	\$0.00
23	CADMIUM (Cd) BY ICP-AES	0	\$15.75	\$0.00
23a	CADMIUM (Cd) BY GFAA ~	10	\$31.50	\$315.00
24	CHROMIUM (Cr)	0	\$15.75	\$0.00
25	COBALT (Co) ~	10	\$15.75	\$157.50
26	COPPER (Cu)	0	\$15.75	\$0.00
27	IRON (Fe) ~	10	\$15.75	\$157.50
28	LEAD (Pb) BY ICP-AES	0	\$15.75	\$0.00
28a	LEAD (Pb) BY GFAA	0	\$31.50	\$0.00
29	MANGANESE (Mn) ~	10	\$15.75	\$157.50
30	MERCURY (Hg)	0	\$63.53	\$0.00
31	MOLYBDENUM (Mo) ~	10	\$15.75	\$157.50
32	NICKEL (Ni) ~	10	\$15.75	\$157.50
33a	SELENIUM (Se) BY GFAA ~	10	\$31.50	\$315.00
34	SILVER (Ag)	0	\$15.75	\$0.00
35	STRONTIUM (Sr) ~	0	\$15.75	\$0.00
36	TIN (Sn) BY ICP-AES	0	\$15.75	\$0.00
36a	TIN (Sn) BY GFAA	0	\$31.50	\$0.00
37	THALLIUM (Tl) BY ICP-AES	0	\$15.75	\$0.00
37a	THALLIUM (Tl) BY GFAA	0	\$31.50	\$0.00
39	VANADIUM (V) ~	10	\$15.75	\$157.50
40	ZINC (Zn) ~	10	\$15.75	\$157.50
41	TOTAL DISSOLVED SOLIDS (TDS) ~	10	\$24.06	\$240.60
42	DISSOLVED ORGANIC CARBON (DOC)	0	\$53.90	\$0.00
42a	TOTAL ORGANIC CARBON (TOC)	10	\$53.90	\$539.00
43		11	\$75.00	\$825.00
44	TCLP EXTRACTION FOR INORGANIC PARAMETERS	0	\$519.75	\$0.00
45	CLP OR EPA 3050 DIGESTION	0	\$38.50	\$0.00

Pb, Sr
isotopicTOTAL
SHIPPING AND REANALYSIS
GRAND TOTAL\$7,255.91
\$390.00
\$7,645.91

II.

WORK ORDER PLAN - CHEMICAL ANALYSIS OF UMTRA TAC SAMPLES

SAMPLE MATRIX: Ground/Surface Water

SITE HYDROLOGIST: T.Monks

NAME (print)

T Monks
SIGNATURE

5/31/96
DATE

SITE ID(s): GRJ-03

SITE GEOCHEMIST: D.Erskine

NAME (print)

Daniel W. Erskine
SIGNATURE

5/31/96
DATE

LOCATION ID(s): See Below

SAMPLES ID(S): 000X

Bottle Name	Cu	Fe	Pb	Mn	Hg	Mo	Ni	Se	Ag	Sr	Sn	Ti	U	V	Zn	TDS	TOC & DOC
A-1																X	
M-2		X		X		X	X	X						X	X		
DOC																	X
Total # of Tests		10		10		10	10	10						10	10	10	10

COMMENTS:

GRJ-03-0731-0001, GRJ-03-0732-0001, GRJ-03-0732-0002, GRJ-03-0716-0001, GRJ-03-0717-0001, GRJ-03-0718-0001, GRJ-03-0719-0001, GRJ-03-0720-0001, GRJ-03-0999-0001, GRJ-03-0999-0002.

II. WORK ORDER PLAN - CHEMICAL ANALYSIS OF UMTRA TAC SAMPLES

SAMPLE MATRIX: Ground /Surface Water

SITE HYDROLOGIST: T.Monks

NAME (print)

T Monks
SIGNATURE

5/31/96

DATE

SITE ID(s): GRJ-03

SITE GEOCHEMIST: D.Erskine

NAME (print)

Daniel W. Erskine
SIGNATURE

5/31/96

DATE

LOCATION ID(s): See Below

SAMPLES ID(S): 000X and N000X (nitrate)

Bottle Name	Cl	SO ₄	Na	K	Mg	Ca	B	F	CN	S	TKN	NH ₄	NO ₃ & NO ₂	NO ₃	SiO ₂	PO ₄	Br	Al	Sb	As	Ba	Be	Cd	Cr	Co
A-1	X	X						X									X								
M-2			X	X	X	X														X			X		X
N-1												X		X											
Total # of Tests	10	10	10	10	10	10		10				10		10			10			10			10		10

COMMENTS:

GRJ-03-0731-0001, GRJ-03-0732-0001, GRJ-03-0732-0002, GRJ-03-0716-0001, GRJ-03-0717-0001, GRJ-03-0718-0001, GRJ-03-0719-0001, GRJ-03-0720-0001, GRJ-03-0999-0001, GRJ-03-0999-0002.

Nitrate only for the following samples:

GRJ-03-0731-N0001, GRJ-03-0732-N0001, GRJ-03-0732-N0002, GRJ-03-0716-N0001, GRJ-03-0717-N0001, GRJ-03-0718-N0001, GRJ-03-0719-N0001, GRJ-03-0720-N0001, GRJ-03-0999-N0001, GRJ-03-0999-N0002.

JRE LABORATORIES - CASPER, WY
CONTRACT No. 08-62350-S-83-0031

NO.	OPTION 2 DESCRIPTION	QTY.	ONE WEEK UNIT PRICE	ONE WEEK SUBTOTAL
1	URANIUM (U)	10	\$38.00	\$380.00
2	LEAD 210 (Pb-210)	0	\$135.00	\$0.00
3	POLONIUM 210 (Po-210)	0	\$90.00	\$0.00
4	RADIUM 226 (Ra-226)	10	\$90.00	\$900.00
5	RADIUM 228 (Ra-228)	10	\$130.00	\$1,300.00
6	THORIUM 230 (Th-230)	0	\$130.00	\$0.00
7	GROSS ALPHA (GA)	0	\$38.00	\$0.00
8	GROSS BETA (GB)	0	\$38.00	\$0.00
9	RADON 222 (Rn-222)	0	\$45.00	\$0.00
10	SOILS TOTAL DISSOLUTION DIGESTION	0	\$15.00	\$0.00
11	SOILS TCLP EXTRACTION	0	\$85.00	\$0.00
12	SOILS EPA 3050 DIGESTION	0	\$15.00	\$0.00

TOTAL	\$2,580.00
SHIPPING AND REANALYSIS	\$250.00
GRAND TOTAL	\$2,830.00

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SAMPLE MATRIX: Ground /Surface Water

DATE 5/31/96

LOCATION ID(s): See Below

DATE _____

SAMPLES ID(S): 000X

COMMENTS: GRJ-03-0731-0001, GRJ-03-0732-0001, GRJ-03-0732-0002, GRJ-03-0716-0001, GRJ-03-0717-0001, GRJ-03-0718-0001, GRJ-03-0719-0001, GRJ-03-0720-0001, GRJ-03-0999-0001, GRJ-03-0999-0002,

JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

ALBUQUERQUE OPERATIONS PROCEDURES	Procedure No. 16.2.1
COLLECTION, PRESERVATION, AND SHIPMENT OF WATER SAMPLES	Date
	Effective
	Supersedes 6.5.90
	Page 1 of 20
 1.0 <u>PURPOSE</u> 1.1 To describe the procedure for water sample collection, preservation and shipment. This SOP was written to consolidate sampling procedures and replaces the following SOPs: 16.2.5, Monitor Well Sampling with an Electric Submersible Pump; 16.2.6, Monitor Well Sampling with a Bladder Pump; 16.2.7, Monitor Well Sampling with Peristaltic Pumps; 16.2.8, Quality Control Samples for Water Sampling; and 16.2.9, Monitor Well Sampling with a Bailer. 2.0 <u>SCOPE</u> 2.1 This procedure applies to members of the Technical Assistance Contractor (TAC) and to TAC's subcontractors whose responsibilities and duties include collecting, preparing, preserving, and submitting surface and ground water samples for laboratory analysis(es). Appropriate portions of TAC SOP 16.1.10 as stated herein are also applicable to this procedure. 3.0 <u>ENVIRONMENT, HEALTH AND SAFETY</u> 3.1 Some of the equipment, materials, and procedures described in this SOP may be hazardous. Water sampling should be performed only by trained personnel. Equipment such as compressors, electrical generators, pumps, etc. should be operated according to manufacturer specifications. Electrical generators shall be grounded, Ground Fault Circuit Interrupters shall be used on all electrical equipment, and fuel shall only be added when the engine is not running. 3.2 CHEMICALS AND REAGENTS 3.2.1 NOTE: Whenever required by the procedure, Jacobs Engineering Group Inc. (JEG) purchases and uses prepared, calibrated, and certified solutions from chemical supply firms. The following solutions are listed in the event that they are not readily available for use and require preparation and in the event that procedure parameters do not require the use of certified solutions. If solutions require preparation, they will be prepared at the sample preparation facility (SPF) before going into the field. Acid and base spill kits will be present in field vehicles when acids and bases are in use. MSDS sheets shall be available in every vehicle used to transport chemicals, and all containers shall be labeled.

- a. Nitric Acid: HNO_3 , 70%, 15M. Trace metal grade. Purchased from chemical supply firms. **HANDLE BOTTLE WITH RUBBER GLOVES AND SAFETY GOGGLES. USE VENTILATION HOOD WHILE ACID BOTTLE IS OPEN.** Trace metal grade HNO_3 certificates of analysis obtained from chemical supply firms shall be retained and filed with the data management department.
- b. Sulfuric Acid: H_2SO_4 , 98%, 18 M. Trace metal grade. Purchased from chemical supply firms. **HANDLE BOTTLE WITH RUBBER GLOVES AND SAFETY GOGGLES. USE VENTILATION HOOD WHILE ACID BOTTLE IS OPEN.** Sulfuric acid liberates a large amount of heat when mixed with water. Always add the chemical to water when diluting.
- c. Sodium Hydroxide: NaOH . Reagent grade in pellet form. Purchased from chemical supply firms. Handle with skin protection and safety goggles. Sodium hydroxide liberates a large amount of heat when mixed with water. Always add the chemical to water.
- d. Zinc Acetate: $\text{Zn}(\text{C}_2\text{H}_3\text{O}_2)_2$, also written $\text{Zn}(\text{Ac})_2$. Reagent grade. Purchased from chemical supply firms. 220 grams $\text{Zn}(\text{Ac})_2/\text{L}$: Dissolve 22 grams of zinc acetate in a 100 mL volumetric flask containing 5 mL deionized water and mix solution to dissolve the salt. If necessary, add 15 mL of deionized water to dissolve remaining salt, and mix solution well. Store solution in a polyethylene bottle labeled "220 grams $\text{Zn}(\text{Ac})_2/\text{L}$," "22 grams $\text{Zn}(\text{Ac})_2/100$ mL distilled water," date, and preparer's initials. Zinc solutions may not be dumped down the SPF drain. Prepare solution as needed and store old for proper disposal.
- e. pH paper (1-10): Hydriion or its equivalent.

4.0

RESPONSIBILITY

4.1 RESPONSIBILITIES OF THE TAC SITE HYDROGEOLOGIST

- 4.1.1 Prior to water sampling, the following steps must be initiated and completed by appropriate members of the TAC and its subcontractors.

4.1.2 The site hydrogeologist (SH) and site geochemist (SG) will prepare a sampling and analysis plan (SAP) which will present the site locations to be sampled, number of samples per location, and analytes to be determined in each sample by the laboratory. A justification for the locations and analytes is provided as part of the SAP. A completed analytical work order plan (WOP), presenting the required analyses and sample bottle types, will be attached to the SAP. The SAP should be approved by TAC management and the client. An example of a memo for an approved SAP is presented in Attachment 6.2. Upon TAC management and client approval, the SAP will be forwarded to the JEG water sampling manager and the data management staff at least 4 weeks prior to the scheduled sampling field work. For special analytical services, 8 weeks are required. Refer to TAC Standard Operating Procedure (SOP) 16.3.3 for specific data management activities. A WOP is presented in Attachment 6.3.

4.1.3 The SH shall inform the JEG water sampling manager of any changes made since the previous SAP regarding site locations, samples to be collected, sample volume, required parameters, or other information which will enhance water quality determinations.

4.1.4 The SH shall provide accurate site maps showing all sampling locations and locations of all monitor wells needed for depth to water (DTW) measurements. The total depth of each monitor well should also be provided to ensure the water level (WL) sounder used has adequate depth capability.

4.1.5 The SH shall verify that the required number of field quality control (QC) samples have been included in the SAP. Uranium Mill Tailings Remedial Action (UMTRA) Project data quality objectives require the collection of one field duplicate, one field blank, and one equipment blank per 20 locations sampled. The same set of QC samples are required if a site has fewer than 20 locations.

4.2 RESPONSIBILITIES OF THE TAC SAMPLING MANAGER:

4.2.1 Determine the water sampling schedule based on sampling requirements, staff resources, available equipment, and other factors. Revise and update the schedule as necessary.

4.2.2 Prepare the field work order package (FWOP) which consists of the following:

a. A site specific memorandum which provides:

- Labor charge codes for each water sampler on the TAC team.
- Water sampling crew assignments.
- Laboratory delivery order numbers for inorganic and radiochemical analyses. This information is obtained from the data management group.

- Quality control sample locations.
- Sampling order.
- Other pertinent information needed by TAC water samplers to complete the sampling scope at a specific UMTRA Project site.

An example of the memorandum is presented in Attachment 6.4

- b. A well data summary spreadsheet, which provides well interior diameter, total depth, screened interval, previous DTW measurements, recommended withdrawal method, the previous purge volume and recovery behavior, pH, electrical conductivity (EC), oxidation reduction potential (ORP), dissolved oxygen (DO), and alkalinity measurements from the previous sampling round, time required for previous sampling effort at the locations to be sampled, the estimated required purge volume, and the low flow purge rate (for low flow sampling wells). An example of the well data summary spreadsheet is presented in Attachment 6.5.
- c. An analyte spreadsheet which lists every location to be sampled and the types of sample bottles required, including filtered and unfiltered samples and QC samples. An example of the analyte spreadsheet is present in Attachment 6.6.
- d. The site-specific memorandum, well data spreadsheet, and analyte spreadsheet are stored on the UMTRA local area network (LAN) in the following files: J:\WP_DOCS\RSENGEBUWSP\plus the filenames.

Below are examples of filenames.

Memo to Sampling Team = CANM1095.DOC
Well Data Spread Sheet File = CANW1095.XLS
Analyte Spread Sheet File = CANA1095.XLS

- e. Site maps showing site access, all sampling locations and all DTW measurement locations.
 - f. A copy of the hydrogeologist's SAP memo providing additional sampling details and rationale.
 - g. A copy of the WOP charts showing the analyses required for each sampling location.
- 4.2.3 Provide the water samplers with all equipment and supplies required for sampling.
- 4.2.4 Upon completion of a sampling round, review the field form package (FFP) compiled by the water samplers. The FFP consists of the following:

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- a. A set of completed water sampling field forms (original forms completed in the field) for each sampling location requested in the work order sampling scope. In the event that a sample is not collected from a location, the field form "cover sheet" (page one of the field forms) will be completed to document the reason for not collecting the sample (Attachment 6.7).
- b. Copies of chain-of-custody forms associated with every sample, including QC samples (Attachment 6.8).
- c. Copies of the chain-of-custody checklist forms associated with every sample (Attachment 6.9).
- d. A completed static ground water level record form (Attachment 6.10).
- e. A completed standard alkalinity test form (Attachment 6.11). Refer to TAC SOP 16.1.10, Procedure 9.13.
- f. Copies of field notes from each water sampler. Field notes are to be kept in a bound notebook with numbered pages and will display the date and water sampler's initials on every page, along with the time and description of all field activities.
- g. After review and revision, as necessary, the water sampling manager will have the FFP copied and send copies to the SH, the data manager, and the water sampling manager. The original FFP will be delivered to UMTRA Project Document Control Center (UPDCC) for storage.

- 4.2.5 Compile a summary field report of water sampling based on the information in the FFP. This report will be delivered to the SH, SG, database administrator, the JEG file, and UPDCC.

4.3 DUTIES OF THE TAC WATER SAMPLERS

- 4.3.1 Review data from previous sampling rounds in the FWOP prepared by the water sampling manager. For example, review type of pump used, well response to purging, temperature, EC, and pH measurements for the sampling locations to gain knowledge of the equipment required.
- 4.3.2 Prepare and load a sufficient volume of reagents and/or solutions for preservation, field measurement, or field analysis(es).
- 4.3.3 Gather and load the equipment needed to complete the sampling scope. This includes pumps, hoses, compressors, generators, field chemistry analysis instruments, health and safety equipment, etc. Take enough equipment to provide a backup sampling method in the event of primary system failure. Utilize the equipment checklist (Attachment 6.1) to ensure that all needed equipment is taken to the field.

5.0

PROCEDURE:

5.1 COLLECTION OF SURFACE WATER SAMPLES

- 5.1.1 Surface water samples will be collected by the "grab" method (i.e., immersion of a clean sample container into a body of surface water to collect a full container of water).
- 5.1.2 Use a sample bottle (volume depending on type of sample to be collected) to directly collect the surface water sample. Use a stainless steel bucket for a bulk sample container when samples will need to be filtered prior to filling the sample bottles. Immerse the bulk container into the surface water and fill it with water. If standing in stream, stand downstream of bottle filling location. NOTE: If the surface water is frozen, do not collect ice samples in lieu of water samples.
- 5.1.3 Before collecting the sample, swirl and rinse the sample container interior three times with the sample water. If collecting filtered samples, rinse with filtered water.
- 5.1.4 Fill the sample container with the filtered or unfiltered water sample. Fill a separate container with an unfiltered water sample and obtain temperature, conductivity, and pH data on the sample solution as described in Procedures 6.0, 7.0, and 8.0 of TAC SOP 16.1.10. Record data on the water sampling field form.
- 5.1.5 If alkalinity determination is required, use an aliquot of the unfiltered sample from the container used to obtain temperature, conductivity, and pH data. Pour the aliquot down the side of and into a sample bottle labeled "For Alkalinity Analysis." Save bottle for Procedure 6.7 of TAC SOP 16.1.10.
 - a. If alkalinity determination is not required, proceed directly with Procedure 6.5 of TAC SOP 16.1.10.
 - b. Record site location, sample number, sample volume, date collected, and collector name on the field form.
- 5.1.6 Clean and store thermometer and EC and pH electrodes as described in Procedures 6.5, 7.3, and 8.1 of TAC SOP 16.1.10.
- 5.1.7 Check the water sampling field form to make sure that all of the required sampling data has been entered.
- 5.1.8 If alkalinity determination is required, take sample bottle described in Procedure 6.4 of TAC SOP 16.1.10, and proceed with Procedure 9.0 of SOP 16.1.10.

5.2 WELL HEAD SETUP, DTW MEASUREMENT, AND WELL PURGING

5.2.1 Well Head Setup

- a. Upon arrival at the well, place plastic sheeting over and around the well head to create a clean work environment around the well. Upon completion of work at the well, remove the plastic sheeting and dispose as regular waste.
- b. Prepare the water sampling field forms with date, instrument calibration data and purging schedule, etc.

5.2.2 DTW Measurement

- a. Refer to ASTM D 4750 - 87 Standard Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well), Annual Book of ASTM Standards, Vol. 04.08.
- b. Unlock the well head padlock and remove outer protective casing cap, remove inner polyvinyl chloride (PVC) slip cap, and measure DTW using a clean electronic probe measuring device. Measure from the notch or mark on the top of the PVC casing. If there is no mark or notch, measure from the north side of the casing top, then notch the measuring point with a hack saw blade, or mark with a black waterproof marker, for future reference. Do not allow PVC cuttings to enter the well.
- c. Dip the tip of the probe into the water and listen for the tone indicating the top of the water column. Measure the DTW to the nearest 0.01 feet. Pull the probe up enough for the tone to stop, then lower the probe into the water again to make a second, independent measurement. Continue to make additional measurements until at least two consecutive measurements are equivalent. When two measurements are equivalent, record the measurement on the static ground water level record, a form that is part of the FFP and is deliverable to the client.
- d. Retrieve the DTW measuring tape and decontaminate the tape and the probe with distilled water. Place the measuring device in its case for storage until the next measurement.

5.2.3 Well Purging

For monitor wells selected to be sampled using non-dedicated pumps or bailers, one (1) to three (3) bore volumes (BV) will be purged from the well bore prior to the collection of samples for analysis. As used by the TAC, BV is defined as the volume of water standing in the well casing. This volume does not include the water volume in the well bore sand pack. If three BVs cannot be obtained from a particular well, this information should be recorded on the water sampling field form.

5.2.4 For monitor wells selected to be sampled using dedicated pumps or drop tubes designed for low flow sample collection, attach the necessary equipment to the well head and purge the volume of the dedicated pump or drop tube plus the volume of the standing water in the discharge line. Pump at the rate specified in the FWOP. See TAC SOP 16.2.5 for additional low flow sampling guidance.

5.2.5 The following guidance applies to 1) medium to high yield wells which have a capacity of between one and three BV and in which ground water parameters may or may not be stable after one to three BV; 2) medium to high yield wells which will be sampled using dedicated pumps or drop tubes designed for low flow sample collection; 3) high volume wells which will be purged until ground water parameters stabilize if stabilization occurs before purging one BV; and 4) low yield wells which purge dry and recover slowly, if at all.

a. Calculate the BV as follows:

$$BV \text{ (ft}^3\text{)} = \pi r^2 h$$

Where:

$$\pi = 3.14$$

$$r^2 = [(\text{Well Interior Diameter})/2]^2 \text{ (ft}^2\text{)}$$

$$h = (\text{Well Total Depth} - \text{Depth to Water}) \text{ (ft)}$$

Convert to gallons:

$$\text{ft}^3 \times 7.48 \text{ gallons/ft}^3 = \text{gallons}$$

a. Wells which will be purged of between one and three BV before sampling (medium to high-yield wells):

b. This procedure assumes purging and sampling with a portable pump such as a bladder pump or electric submersible pump and a pumping rate of no less than one gallon per minute. The well should be purged, allowed to recover, and sampled within a reasonable length of time. A "reasonable length of time" will be defined by the water sampling manager on a case-by-case basis. Factors utilized for this definition will include: the time available for the full sampling scope at the site, the well BV and yield, and the requirements of the SH and SG. Generally, the well yield will be known from previous sampling efforts and the sampling time and the recommended purge volume will be noted in the FWOP.

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- c. Unless advised otherwise by the water sampling manager, a reasonable length of time will be defined as no more than one half of a field day (5 hours) to purge a minimum of one BV and sample the well. This could take place during a single day or could consist of purging the well one day then letting the well recharge overnight, with sampling conducted the following day.
- d. If the DTW is above the top of the screened interval, proceed to purge the well but do not draw the top of the water column down below the top of the screen because this will cause formation water to "cascade" down the inside of the screen, resulting in sample aeration. Record the amount of draw down.
- e. If the DTW is at or below the top of the screen, proceed with the purge but note that the top of the water column may draw down within the screen. Proceed with sampling upon reaching the one BV minimum or the three BV maximum, all within the 5 hour total sampling time.

5.2.6 Wells with high BV (exceeding 200 gallons per BV):

- a. If the minimum one BV purge and sampling will require more than the 5-hour maximum effort, utilize the ground water parameter stabilization method for determining when to sample. According to current literature, DO and EC are the most useful field indicator parameters for stabilization of water chemistry during purging (Barcelona, 1994). Follow the procedures suggested below:
- b. Position the pump above the screened interval or (due to DTW table, well construction, etc.) in the screened interval. Purge the well until measurements of DO and EC have stabilized as follows:

DO $\pm$ 0.2 mg-O₂/L
EC $\pm$ 10 μ S/cm

- c. U.S. EPA (1992) suggests that the turbidity measurement stabilization can also be used as a purge criteria. The turbidity measurement should be within 10 percent over two successive measurements before sampling. Sample the well after the parameter measurements are within these ranges over two successive measurements made 3 minutes apart.

5.2.7 Purging low-yield wells:

- a. Some wells purge dry even at low purge rates. In these wells, sampling may need to be performed in spite of cascading recharge.

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- b. If a well is drawn down completely during a purge and has not recharged to the original DTW within a period of 2 hours, the sample may be collected, to the extent that there is sufficient water volume for the sample (U.S. EPA, 1986). If there is not sufficient water in the well for full volume samples, then priority sampling may be conducted. Priority sampling uses less than the total recommended sample volumes for certain analytical parameters. Consult the water sampling manager or the data managers for acceptable priority sample volume for each sample type.
- c. If the well does not recharge enough for standard sampling or priority sampling within 2 hours, the samplers should call the water sampling manager for guidance. The likely outcome of this situation is that the samplers will be requested to move to other sampling locations and periodically measure DTW in the subject well to determine the well recovery rate. Sampling will be done for that well only as time permits after completing the balance of the sampling scope.

- 5.2.8 Record any odors, colors, etc., present in the water sample on the water sampling field form.
- 5.2.9 When sampling domestic wells, request and record information regarding well depth, completion interval, use, diameter, etc. (if available).
- 5.2.10 Record any deviation(s) from or modification(s) to these general procedures as well as the rationale for these changes.
- 5.2.11 Place pump and discharge hose into the well. Position pump intake above the screened interval when sufficient water is present above the top of the screen. Connect a flow-through cell and place outlet hose into a clean container to allow measurement of flow rate or install a flow meter on discharge hose. Calibrate the water quality meter for EC, ORP, and pH requirements according to Procedure 9 of TAC SOP 16.1.10. Insert T, EC, ORP, and pH electrodes into the flow-through cell.
- 5.2.12 Start pump and begin purging well. Measure temperature, EC, ORP, pH and DO on water in flow-through cell as described in Procedures 6.0, 7.0, and 8.0 of TAC SOP 16.1.10 and record data on the water sampling field forms.

5.3 GROUND WATER SAMPLING

- 5.3.1 Begin collecting the water sample after a sufficient purge, according to the guidance in Procedure 5.2.3 of this SOP.
 - a. Collect the unfiltered water samples upstream of the flow-through cell and preserve and store as required.

- b. Collect filtered water samples by inserting a new filter in-line on the pump discharge hose and fill the bottle directly from the discharge end of the filter.

5.3.2 If an alkalinity test is required, obtain an unfiltered sample, rinse the alkalinity test volumetric flask two times with the sample water, and proceed with Procedure 9.0 of TAC SOP 16.1.10.

5.3.3 Check the field form to make sure that all sample collection data have been entered on the form and that all sample bottles are appropriately labeled.

5.3.4 Clean and store water monitoring equipment as described in Procedures 6.5, 7.3, and 8.1 of TAC SOP 16.1.10.

5.3.5 Disassemble sampling apparatus. Drain hoses and pumps to ensure that all of the previous water sample is expelled. Clean (decontaminate) hoses and pumps.

- a. Pump Liquinox™ detergent and distilled water solution through the hoses and the pump. Continue pumping with fresh distilled water until all of the Liquinox™ solution is expelled. Clean outside of hoses/ pumps with Liquinox™ detergent and distilled water solution; rinse with fresh distilled water. The hoses/pumps are now ready for another sampling location or storage.

- b. If hoses and pumps are to be stored, place hoses and pumps in a clean plastic bag and seal with tape. Label with "clean," date, and initials.

5.3.6 Clean flow-through cell with Liquinox™ detergent and distilled water solution. Rinse with distilled water. Periodically disassemble cell to clean solids from around rubber seal at base and top of cell. Check rubber seals and reassemble. If the cell is to be stored, wrap unit in a clean plastic bag and seal with tape. Label with "clean," date, and initials.

5.4 GROUND WATER SAMPLING FROM A PRODUCTION WELL OR DOMESTIC WELL

5.4.1 Samples from production wells or domestic wells will be collected by the "grab" method. A "production well" can be a domestic water supply well, a livestock water supply well, an agricultural irrigation supply well, a construction water supply well, etc.

5.4.2 A well purge is not necessary because the well specifications (well diameter, total depth, screened interval, DTW, pressure tank volume, etc.) are generally unknown for production wells or domestic wells.

- a. Domestic Wells:

1. Obtain written permission to sample the domestic well. The written permission should be a formal access agreement between the well owner and the U.S. Department of Energy (DOE). The access agreement should be on file with the water sampling manager.
 2. Contact the resident either by phone or in person to schedule the sampling activity.
 3. Determine whether there is a water filtration device in use at the residence. Per direction from the TAC water sampling manager, hydrogeologist, geochemist and/or toxicologist, sample either upstream (before) the device or downstream (after) the device. Describe whether the sample was collected upstream or downstream on the field forms.
 4. When the sample is collected from a residential tap, faucet or hose connection, run the water for about 5 minutes prior to sampling.
 5. Perform temperature, conductivity, and pH measurements as described in Procedures 6.0, 7.0, and 8.0 of TAC SOP 16.1.10 and record data on field forms.
 6. Respect the resident's privacy and private property.
- b. Production Wells:
1. Obtain written permission to sample the production well. Obtain well specifications, if available, and determine the well pumping schedule.
 2. Sample as close to the well head as possible. If the well is not in continuous use, request that the well be pumped for a period of time prior to sampling to bring representative water into the well. Determine or estimate the discharge flow rate in order to estimate the total volume purged prior to sampling. It is not necessary to purge a specified number of BV unless requested to do so by the TAC management or technical staff.

5.5 GROUND WATER SAMPLING WITH A BAILER

5.5.1 A bailer should be used for purging and sampling only when it is difficult or impossible to pump from the well. Bailers made of PVC or stainless steel should be used for sampling for inorganic analysis. Only a Teflon™ bailer should be used when sampling for organic analysis.

- a. Clean the bailer as follows:

1. Disassemble bailer and wash with Liquinox™ detergent, distilled water, and a brush. Rinse at least three (3) times with distilled water to remove detergent.
 2. Reassemble bailer and rinse again with distilled water. Rinse outside of bailer with distilled water. Shake bailer vigorously to remove water. Bailer is now ready for sampling.
 - b. To purge or sample a well, lower bailer into the well, fill bailer with water, and retrieve bailer. NOTE: Avoid causing a surging or plunging motion with the bailer while it is in the well water. Also, avoid direct contact with a dirty surface; always rest bailer(s) on a clean plastic sheet. Use a new bailer rope for sampling each well, or dedicate the rope to the well by coiling the rope, placing it in a plastic bag and storing it inside of the well protective steel casing (next to capped PVC casing).
- 5.5.2 During the well purge, drain bailer into a clean sampling container such as a stainless steel bucket. When the purge is complete, unwrap and connect clean hose and peristaltic pump. Place one end of hose into bucket and remaining end of hose into a sample bottle. Check connections to make sure that they are tight.
- 5.5.3 Fill the flow-through cell with sample water for parameter measurements. Perform ground water parameter measurement in the flow-through cell periodically throughout the well purge as described in Procedures 6.0, 7.0, and 8.0 of TAC SOP 16.1.10 and record data on field forms. Dissolved oxygen measurements are not valid for wells which are purged and sampled with a bailer because the bailing action introduces atmospheric oxygen into the water column.
- 5.5.4 Pump the unfiltered water samples from the bucket into the sample bottles using a peristaltic pump. Preserve and store samples as required. See Procedure 5.6 and Attachment 6.5 of this SOP.
- 5.5.5 Collect the filtered water sample according to Filtration and Preservation of Water Samples (Procedure 5.7 of this SOP).
- 5.5.6 If an alkalinity test is required, use a fresh unfiltered sample from the bailer. Proceed with Procedure 9.0 of TAC SOP 16.1.10.
- 5.5.7 Clean bailer according to Procedures 5.5.1.a.1 and 5.5.1.a.2 above. If bailer is to be stored, wrap unit with a clean plastic bag and seal with tape. Label with "clean," date, and initials.

5.6 GROUND WATER SAMPLING FROM SEEPS AND SPRINGS

- 5.6.1** It may be necessary to obtain a water samples from a seep or spring. If possible, the sample should be collected by the grab method. A typical procedure to collect samples follows, but it may be necessary to improvise to obtain a sample.
- 5.6.2** If the seep discharge is small, place a clean bottle where the seep will drip into the container. If necessary, dig out the soil matrix to increase the flow, but document this on the field forms. NOTE: Determine temperature, conductivity, and pH data as described in Procedures 6.0, 7.0, and 8.0 of TAC SOP 16.1.10.
- a. Note and record how long it takes to obtain a sample.
- 5.6.3** If filtered samples are required, pump sample through a filter into a clean, unused, and labeled bottle.
- a. If seep discharge is too low to collect prescribed sample analytes and volumes in a reasonable amount of time, consult the TAC management or technical staff for priority analytes and volumes.

5.7 FILTRATION AND PRESERVATION OF WATER SAMPLE(S)

- 5.7.1** Whenever water samples are to be analyzed for soluble (or dissolved) analytes, insoluble matter must be removed so that the particulates do not contribute to an artificially high value for the dissolved analyte concentrations.
- a. Assemble clean hose(s) and clean pump(s). The pump discharge hose used to purge the well is commonly used with an in-line filter for the filtration procedure. An alternative is to use a hand pump and vacuum chamber. Insert a disposable filter containing a new 0.45 micrometer filter between the water source and the sample bottle. Check all connections to make sure that they are tight.
- b. Before collecting any samples, run a few hundred milliliters of the water sample through the filter. Discard this water at a location away from the water source. NOTE: If filter becomes clogged during this step, or during Procedure 5.6.3 of this Procedure, replace filter. Do not clean filter or back flush filter with the water sample.

- c. Fill the sample bottles. Allow no dirt or dust to blow into the bottles or onto the bottle caps. Rinse the inside of the bottle caps with filtered water and screw cap onto bottle. NOTE: While filling the sample bottle, and once the sample is in the bottle, do not allow the water sample to touch anything but the bottle walls. Never stick anything (such as pH paper) into the bottle. Do not smoke near open bottles. Keep the water samples out of direct sunlight.
- d. If required, add an appropriate amount of preservative after filling the sample bottles. Refer to Attachment 6.12 for volumes required and preservation techniques. Record the type of preservative on the sample label.
 1. For preservation with HNO_3 , add 2 mL of 70%, 15M trace metal grade HNO_3 per liter of sample, and mix sample well. Pour a few drops of the preserved water sample onto the litmus paper to check the pH of the water sample. Place cap on bottle and tighten. pH should be <2 . If pH is >2 , add HNO_3 , milliliter by milliliter, mixing after each addition until pH of sample solution is <2 . **HANDLE BOTTLE WITH RUBBER GLOVES AND WEAR SAFETY GOGGLES.**
 2. For preservation with H_2SO_4 , add 2 mL of 98%, 18M trace metal grade H_2SO_4 per liter of sample, mix sample well, and check sample pH. pH should be <2 . If pH is >2 , add H_2SO_4 , milliliter by milliliter, mixing after each addition until pH of sample solution is <2 . **HANDLE BOTTLE WITH RUBBER GLOVES AND WEAR SAFETY GOGGLES.**
 3. For cyanide sample preservation, add a few pellets of solid NaOH. Mix sample well and check sample pH. If pH is <12 , add additional pellets until pH is >12 . Mix sample solution well after each addition of NaOH. **HANDLE BOTTLE WITH RUBBER GLOVES AND WEAR SAFETY GOGGLES.**
 4. For sulfide sample preservation, add a few pellets of solid NaOH. Mix sample solution well and check sample pH. If pH is <9 , add additional pellets until pH is >9 . Add 2 mL of zinc acetate preservation solution per liter of sample and mix sample solution well. **HANDLE BOTTLE WITH RUBBER GLOVES AND WEAR SAFETY GOGGLES.**

5.8 PREPARATION OF SPLIT SAMPLES

- 5.8.1 Decontaminate a large volume container such as a stainless steel bucket. Thoroughly rinse the container with about one (1) gallon of distilled water or its equivalent.

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5.8.2 Rinse the container thoroughly with the sample.

5.8.3 Whenever possible, pump more than enough water sample into the split container to fill all of the primary sample containers and all of the split sample containers.

5.8.4 Dispense sample types consecutively; i.e., fill both anion bottles, then both metals bottles, etc.

5.9 PREPARATION OF WATER SAMPLES FOR PACKAGING, LABELING, AND TRANSPORT

5.9.1 Label the sample bottles with the TAC's preprinted labels prior to sampling. Fill in all appropriate information in the blank spaces with a waterproof pen. Tape over the labels with clear plastic tape.

5.9.2 While in the field, immediately place the samples requiring refrigeration into a cooler containing ice. Samples which do not require refrigeration should be placed in a cooler without ice. Keep all samples out of direct sunlight.

5.9.3 On the day that the samples are to be shipped, inventory all of the samples and write the sample numbers and bottle types on the chain-of-custody checklist form (Attachment 6.9). This will insure that all samples and chain-of-custody forms are included in the sample shipments.

5.9.4 Repack the samples requiring refrigeration into a bladder (double plastic trash bag or equivalent), inside a cooler, and place ice on and around the samples to chill the samples during transportation. It is preferable to complete this repacking procedure prior to reaching the sample drop-off point. The samples and the ice must be inside the bladder. Knot the bladder to seal and then place a custody seal on the knot closure. This bladder and custody seal system is designed to prevent fluids (ice water or sample water) from escaping the cooler during transport, should any of the sample bottles break or if the cooler is mishandled while en route to the laboratory. As a further precaution against cooler leaks, place a strip of strong adhesive duct tape over the drain plug at the base of the cooler to insure that the plug remains in the drain.

5.9.5 Place the chain-of-custody forms and the sample checklist for a group of coolers in a waterproof ziplock bag and place in a single cooler. This cooler will contain the documentation for several coolers in a group of coolers, so be sure to request that all of the coolers in the group remain together during shipping. Mark the individual coolers in a group of coolers as 1 of 3, 2 of 3, etc.

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- 5.9.6 Label the top of the cooler with the preprinted laboratory address labels and tape the coolers thoroughly with clear packaging tape. Use only the thick, high-grade extra sticky packaging tape. Tape the cooler with at least four complete wraps of packaging tape on each end and tape over the address label to insure it will stay on the cooler.
- 5.9.7 Place signed and dated custody seals on the front of the cooler connecting the front and top of the cooler, and on one end of the cooler, connecting the end and top of the cooler. Tape over the custody seals.
- 5.9.8 Hazardous Materials Regulations:
- a. U.S. Department of Transportation (DOT) hazardous materials regulations do not apply to water samples which are preserved according to the procedures described in this SOP and 40 CFR §136.3, Table II, note 3, as long as the preserved samples meet the following criteria:
 - b. HNO_3 in water solutions at concentrations of 0.15% by weight or less (pH about 1.62 or greater).
 - c. H_2SO_4 in water solutions at concentrations of 0.35% by weight or less (pH about 1.15 or greater).
 - d. NaOH in water solutions at concentrations of 0.080% by weight or less (pH about 12.30 or less).
- 5.9.9 Utilize Federal Express to ship samples whenever possible. Attach the preprinted Federal Express airbill to the top of the cooler. Write the laboratory delivery order number in the comments section of the airbill.
- 5.9.10 Schedule the sample shipment so that the samples do not arrive at the laboratory after 4 p.m. on a Friday or Saturday. Ship the samples so that they arrive at least 48 hours before any of the sample holding times expire. Call the laboratory to make special arrangements if a Saturday delivery is required or if certain samples need to be extracted or analyzed immediately to meet the holding time. Notify the water sampling manager and the data manager of any Saturday laboratory deliveries.

6.0

ATTACHMENTS: SUPPORTING DOCUMENTS

- 6.1 WATER SAMPLING EQUIPMENT CHECKLIST**
- 6.2 MEMO, SITE HYDROGEOLOGIST TO WATER SAMPLING MANAGER**
- 6.3 SITE HYDROGEOLOGIST WORK ORDER PLAN**
- 6.4 WATER SAMPLING MANAGER MEMORANDUM**
- 6.5 WELL DATA SUMMARY SPREADSHEET**
- 6.6 ANALYTE SPREADSHEET**
- 6.7 WATER SAMPLING FIELD FORMS**
- 6.8 CHAIN-OF-CUSTODY FORM**
- 6.9 CHAIN-OF-CUSTODY CHECKLIST**
- 6.10 STATIC GROUND WATER LEVEL RECORD**
- 6.11 STANDARD ALKALINITY TEST FORM**
- 6.12 SAMPLE PRESERVATION TECHNIQUES AND HOLDING TIMES**

7.0

REFERENCES

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- 7.3 Miller, G. D., 1982. "Uptake and Release of Lead, Chromium, and Trace Level Volatile Organics Exposed to Synthetic Well Casings," *Proc. Second National Symposium, Aquifer Restoration and Ground Water Monitoring*, 1982: 236-245.
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- 7.6 Pettyjohn, W. A., W. J. Dunlap, R. Cosby, and J. W. Keeley, 1981. "Sampling Ground Water for Organic Contaminants," *Groundwater*, 19 (2): 180-189.
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- 7.10 U.S. EPA, 1992. *RCRA Ground-Water Monitoring: Draft Technical Guidance*, PB93-139350.

JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS PROCEDURES

Procedure No. _____

Date _____

Page 20 of 20

8.0 **PROCEDURE REVIEW AND APPROVAL**

Prepared By:	<u>Rob Sengebush</u>	_____
	TAC Representative	Date
Reviewed By:	<u>Robert Saar</u>	_____
	Task Manager	Date
Reviewed By:	<u>Larry Ross</u>	_____
	Environmental, Health and Safety Manager	Date
Reviewed By:	_____	_____
	Assistant/Deputy Project Manager	Date
Reviewed By:	_____	_____
	Quality Assurance Manager	Date
Approved By:	_____	_____
	Project Manager	Date

ATTACHMENT 6.1

WATER SAMPLING EQUIPMENT CHECKLIST

UMTRA WATER SAMPLING CHECKLIST
INCLUDES PUMPS, EQUIPMENT, CHEMICALS, AND SUPPLIES
PUMPS

Bladder Pump System

- ☐ bladder pump with PVC storage case
- ☐ hose reel
- ☐ tripod and pins
- ☐ clean air and water lines
- ☐ flow meter
- ☐ pump control unit (logic unit) (Geoguard or Marschalk)
- ☐ air compressor and metal safety gas can
- ☐ 12 volt battery (optional)
- ☐ hose to connect control unit and compressor (female/female)
- ☐ hose to connect control unit to pump reel (female/male)
- ☐ power cable to connect logic unit to vehicle battery
- ☐ control unit battery (Geoguard)
- ☐ hose barb for deconning bladder pump (threaded metal barb)
- ☐ spare bladder, bladder changing tool

Peristaltic Pump (large Masterflex and small peristaltic)

- ☐ peristaltic pump (Masterflex)
- ☐ EM650 generator
- ☐ tubing
- ☐ spare tubing

Power Bailer

- ☐ tripod with pulley
- ☐ motor and reel
- ☐ cable
- ☐ cable swages and swage tool
- ☐ floating line bailer rescue loops

Electric Submersible Pump (Grundfoss Redi Flow II, Flint and Walling 2 inch, Purgemaster)

- ☐ electric submersible pump with power cable
- ☐ control unit
- ☐ clean water line
- ☐ EB 3500 generator and metal safety gas can
- ☐ ground fault circuit interrupter (GFCI), one GFCI to remain in each sampling vehicle

Checked by Sampling Team _____

Date _____

EQUIPMENT

- ☐ 2 inch diameter bailer with PVC pipe storage case
- ☐ 4 inch diameter bailer with PVC pipe storage case
- ☐ bailer decontamination brushes
- ☐ rope
- ☐ water level sounder and backup sounder
- ☐ tape measure

- ☐ flow through cell
- ☐ YSI 3500 Water Quality Meter
- ☐ backup pH meter
- ☐ pH probe and backup probes

- ☐ EC and temperature probes, and backup probes
- ☐ ORP probe and backup probes (measures to 0.6 mg/L)
- ☐ spectrophotometer with accessories (DR 2000)
- ☐ backup DO meter
- ☐ turbidity meter and calibration standards

- ☐ pails (at least 2), including stainless steel
- ☐ alkalinity test kit and backup kit - includes magnetic stir unit, stir bar, 100 mL flask and 250 mL titration flask, titrator and extra 1.6N H₂SO₄ acid cartridges, and extra acid delivery tubes (red tubes)
- ☐ squeeze bottle for DI water (2 bottles per vehicle)
- ☐ Brinkman dispensette (1 per acid) with acid bottle, in storage container, with one backup dispensette
- ☐ Eppendorf pipette with tips

- ☐ nitric acid and storage containers
- ☐ sulfuric acid and storage containers
- ☐ bulk acid storage containers
- ☐ keys to gates and wells
- ☐ cellular phone

- ☐ field work order package (FWOP)
- ☐ site specific health and safety plan
- ☐ field forms
- ☐ calculator
- ☐ log book

Checked by Sampling Team _____

Date _____

EQUIPMENT (Concluded)

- ☐ chain of custody forms
- ☐ chain of custody checklist of inorganic and radiochemical samples
- ☐ standard alkalinity test forms
- ☐ bottle labels
- ☐ custody seals

- ☐ shipping labels with printed regulatory exemption reference
- ☐ FedEx air bills and envelopes
- ☐ equipment manuals
- ☐ SOP notebook
- ☐ MSDS notebook

- ☐ Water sampling handbook
- ☐ JEG UMTRA Project business cards
- ☐ bolt cutters
- ☐ tool box
- ☐ well cap puller

- ☐ watch
- ☐ safety goggles
- ☐ hard hats (two)
- ☐ safety vests (blaze orange with reflecting tape)
- ☐ metal clipboard

- ☐ first aid kit - "First Responder Kit"
- ☐ eyewash (6 x 1 gal jugs of DI water, labeled as "Eye Wash")
- ☐ fire extinguisher (5 lb agent capacity, Type ABC refillable, inspected and tagged)
- ☐ coolers
- ☐ spare batteries for DR200, water level sounder

- ☐ flashlight
- ☐ trouble light on extension cord
- ☐ backpack
- ☐ shovel
- ☐ stainless steel trowel

- ☐ seep sampler (vacuum hand pump unit)
- ☐ winch accessory kit
- ☐ sand wedge winch anchor
- ☐ portable heaters with compressed gas cartridges
- ☐ Gatorade drink mix

Checked by Sampling Team _____

Date _____

CHEMICALS

- ☐ pH 1 buffer solution - bulk
- ☐ pH 4 buffer solution - bulk
- ☐ pH 6 buffer solution - bulk
- ☐ pH 7 buffer solution - bulk
- ☐ pH 8 buffer solution - bulk
- ☐ pH 10 buffer solution - bulk
- ☐ pH 12 buffer solution - bulk
- ☐ buffer solution "caddy" containing smaller buffer solution containers
- ☐ Reagent water carboys and detachable valve
- ☐ alkalinity unknown and site-specific alkalinity known solutions (FCS)
- ☐ Sodium hydroxide pellets
- ☐ Zinc acetate
- ☐ DO ampules (high and low range)
- ☐ any other ampules for doing Fe+2, total Fe, ... when required
- ☐ Zobell Solution
- ☐ EC Standard
- ☐ LIQUINOX™

Checked by Sampling Team

Date _____

EXPENDABLE ITEMS

- ☐ distilled water
- ☐ water filters (0.45 microns)
- ☐ pH paper
- ☐ Kimwipes
- ☐ paper towels
- ☐ Ziplock baggies
- ☐ plastic trash bags
- ☐ plastic bags for cooler bladders
- ☐ plastic sheeting
- ☐ disposable gloves
- ☐ ear protection
- ☐ 5 gallon collapsible jug
- ☐ blank field forms
- ☐ black water proof ink pens
- ☐ black water proof marker
- ☐ bottle labels
- ☐ shipping labels
- ☐ custody seals
- ☐ strapping tape
- ☐ clear tape
- ☐ WD-40
- ☐ spare batteries for meters
- ☐ 1000 mL sample bottles
- ☐ 500 mL sample bottles
- ☐ 500 mL glass amber sample bottles
- ☐ 250 mL glass amber (for TOC/DOC and priority sampling)
- ☐ 500 mL amber jars (for sediment samples)

Checked by Sampling Team _____

Date _____

VEHICLES AND RELATED EQUIPMENT

- ☐ GSA vehicle with camper
- ☐ spare set of keys mounted under engine for exterior access
- ☐ vehicle to include backup beeper tail lights
- ☐ trailer brake adjustment unit mounted under dash
- ☐ safety stairs
- ☐ safety stair bracket attached to vehicle bumper
- ☐ frame mounted trailer hitch and receiver hitch for towing trailer

- ☐ utility trailer, cable and lock to secure trailer when not in use

Checked by Sampling Team _____

Date _____

ATTACHMENT 6.2

MEMO, SITE HYDROGEOLOGIST TO

WATER SAMPLING MANAGER

JACOBS ENGINEERING GROUP INC., ALBUQUERQUE OPERATIONS

TO: RSengebush\PZietz
THROUGH: JGibb\AHolm\JMcBee
FROM: PDotson\TJackson\JMarshall
DATE: September 13, 1995
SUBJECT: Water Quality Sampling for the UMTRA Gunnison, Colorado Project Site.

Schedule and purpose

Ground water sampling of selected DOE monitor wells at the Gunnison processing site (GUN01) is scheduled for October 2 through 13, 1995; ground water sampling at the disposal (GUN08) site is scheduled for October 23 through November 3, 1995.

Water quality sampling is being conducted at the processing site to (1) ensure the protection of the health of citizens in the area, (2) for ground water compliance monitoring during and after remedial action construction, and (3) to monitor the extent of contamination. At the disposal site, sampling is being conducted to comply with the surface remediation ground water protection strategy presented in the Remedial Action Plan and Site Design for Stabilization of the Inactive Uranium Mill Tailings Site at Gunnison, Colorado (DOE, 1992).

Sampling locations

Processing Site

Ground water sampling will be conducted at 33 DOE monitor wells and 10 (11, if well - 0600 is accessible) private wells within the vicinity of the Gunnison processing site. Sampling locations for the DOE monitor wells are shown in Figure 1. Table 1 provides DOE monitor well identifications, sampling locations, screened intervals, and rationales for sampling. A letter (Attachment A) will be sent to the private well owners notifying them of the upcoming sampling event. The water samplers should contact the well owners to arrange a preferred sampling date and time. In addition, Attachment B is a sampling consent form to be completed by the private well owners at the time of sampling. The water samplers should have the owner or resident sign and return one copy of the form and leave one unsigned copy of the form with the owner or resident for their information. The completed sampling consent forms should be returned to the site hydrologist.

Wells GUN-01-0059, -0060, and -0096, identified for ground water sampling in the Gunnison Water Sampling and Analysis Plan (DOE, 1994), are not being sampled because there are nearby monitor wells screened at similar depths that provide adequate sample coverage.

Private well sampling locations are listed in Table 2. Note that an alternate private well should be sampled if one or more of the "buffer zone" wells, located on the west side of the Gunnison River (Unit 2 of the Dos Rios Subdivision), are not accessible. Details are provided in Table 2.

Two surface water samples will be collected in the vicinity of the former processing site at the locations indicated in Figure 1 and Table 3.

Disposal Site

Ground water quality samples will be collected from eight DOE monitor wells at the Gunnison disposal site (Figure 2). Monitor well identifications, relative sampling locations, screened intervals, rationales for sampling, and the general order in which to collect samples (based on monitor well locations relative to the disposal cell) are provided in Table 4. No surface water or private well samples will be collected in the vicinity of the disposal site.

Sample collection

At the processing site the following wells are to be sampled in the order listed below:

DOE wells:

GUN-01-0001
GUN-01-0002
GUN-01-0101
GUN-01-0102
GUN-01-0120
GUN-01-0121
GUN-01-0123
GUN-01-0145*
GUN-01-0147*
GUN-01-0058*
GUN-01-0163
GUN-01-0061*
GUN-01-0161*
GUN-01-0160*
GUN-01-0097*
GUN-01-0196*
GUN-01-0197*
GUN-01-0088*
GUN-01-0189*
GUN-01-0188*
GUN-01-0136
GUN-01-0130
GUN-01-0132
GUN-01-0125
GUN-01-0126

Private wells:

GUN-01-680
GUN-01-683
GUN-01-472
GUN-01-667
GUN-01-665
GUN-01-685
GUN-01-461
GUN-01-455
GUN-01-469
GUN-01-468
GUN-01-600*

GUN-01-0127
 GUN-01-0181*
 GUN-01-0183*
 GUN-01-0186
 GUN-01-0106
 GUN-01-0013*
 GUN-01-0113*
 GUN-01-0006

* indicates data logger installed in well
 a: sample only if well is accessible

In each column above, an effort has been made to prioritize sample collection from the cleanest to most contaminated wells. It is expected that the order of domestic well sampling will be dictated by the availability of the well owners. In any case, a special effort to decontaminate equipment should be made whenever the order of sampling does not follow the recommended sequence, or when switching from sampling a DOE well to sampling a domestic well.

TUBER data loggers are installed in 16 of the DOE monitor wells scheduled to be sampled (Table 1). When sampling wells outfitted with data loggers the water samplers should remove the data logger completely from the well, placing the transducer part of the data logger into a bucket filled with water purged from the well. This method will allow the data logger to remain at approximately the same temperature as it is while in the well and protect it from thermal shock. The part of the data logger that sits on top of the well should not be submerged in water, only the silver transducer part of the data logger should be placed in water. Water samplers should use care when handling the data loggers, avoiding bumping or dropping the data logger. When water sampling is complete lower the data logger back into the well as it was prior to sampling.

On 4-inch diameter wells there will be a partial cover on the well which holds the data logger. This cover should not be removed or displaced during sampling (there is a 2-inch diameter hole in it that should be sufficient for sampling). If it is necessary to remove the well cover for sampling, note its position before sampling and return it to the same position after sampling (it should be at the same place vertically on the well, any movement up or down on the well casing changes the recording position of the data logger which could cause water level measurements to be less accurate).

Water Level Measurements

Ground water level measurements shall be collected from all wells sampled at the processing site in as short a time as possible to minimize the temporal variations in ground water levels. In addition to wells being sampled, ground water level measurements shall be taken in the following DOE monitor wells at the processing site: GUN-01-0140, -0141, 0142, -0155, -0157, and the Gunnison River staff gauge location GUN-01-0794. The staff gauge (GUN-01-0794) is located on the north side of the bridge that crosses onto the Island Unit of the Dos Rios subdivision. The staff gauge is an approximately 4-inch wide

by 6 foot long ruler that allows for measurement of the river surface elevation attached to the bridge abutment. Water samplers shall record the staff gauge reading (to the nearest 0.02 ft) onto the standard Static Ground Water Level Form. The staff gauge can be read from the south bank of the river with a pair of binoculars. If binoculars are not available the water samplers should be prepared to wade to the location to record the river level.

At the disposal site, ground water level measurements shall be collected from all wells sampled and the following DOE monitor wells: GUN-08-0609, -0621, -0628, -0630 to -0635, -0640, -0665, -0709, -0710, and -0712. Ground water level measurements shall be collected in as short a time as possible to minimize the temporal variations in ground water levels.

Sample Analysis

Filtered ground water samples will be collected from the DOE monitor wells at the former processing and disposal sites and analyzed for a full suite of analytes. Unfiltered samples will be collected from private domestic/industrial wells, except for well 600, in the vicinity of the former Gunnison processing site and will be analyzed only for field parameters and uranium. If well 600 is accessible a filtered sample will be collected, as per an agreement between DOE and the Colorado Department of Public Health and Environment. Samples collected from private wells will be collected from a drinking water outlet downgradient of any private filtering system. In addition, filtered and unfiltered samples will be collected from the surface water sampling locations.

The attached work order plans show the analytes to be measured and the number of samples to be analyzed. The following parameters shall be measured in the field for all wells sampled: pH, alkalinity, dissolved oxygen, specific conductivity, temperature, oxidation/reduction potential, static water level, and total depth of well.

The attached work orders for radiological analytes at the processing site do not include polonium-210 and thorium-230. Both were identified as constituents of potential concern in Gunnison baseline risk assessments (DOE 1990 and 1994) and for this reason were included in the list of analytes to monitor in the WSAP (DOE, 1995). However, the Gunnison Base Line Risk Assessment (DOE, 1995) concluded that even at maximum observed levels, neither isotope contributed significantly to excess cancer risks associated with drinking contaminated ground water at the site. This conclusion was based on an adequate data base of several hundred analyses for each isotope in both filtered and unfiltered ground water. Further analyses for these isotopes are not warranted unless major changes occur in the chemistry of ground waters at the site. Analytes which are associated with significant excess cancer risks in the most contaminated ground waters (uranium and lead-210) will be analyzed for in the DOE monitoring wells.

If a limited quantity of water is available, then sample collection bottles should be given the following priority:

- Metals (M2) - Highest Priority
- Anions (A1)
- Gross Alpha (GAB)
- Nitrates (N1)
- Radium-226 (Ra-226)
- Radium-228 (Ra-228)
- Lead-210 (Pb-210)

PD/II
Attachments

cc: LMaez
Document Control

FIGURES

FIGURE 1
MONITOR WELL LOCATION MAP
IN THE PROCESSING SITE VICINITY, GUNNISON, COLORADO

LEGEND

- 716 MONITOR WELL (WATER QUALITY)
- 710 MONITOR WELL (WATER LEVEL ONLY)
- EPHEMERAL STREAM

FIGURE 2
LOCATION OF MONITOR WELLS IN THE DISPOSAL SITE VICINITY,
GUNNISON, COLORADO

TABLES

Table 1. DOE ground water monitoring well sampling locations at the former Gunnison processing site

Well Ids.	Location	Date Logged in Well?	Screened Interval (ft. bis)	Rationale for Sampling
001	Background	no	8.0 - 13.0	Characterize background water quality before, during, and after tailings removal.
101	Background	no	41.5 - 46.6	
002	Background	no	10.0 - 15.0	
102	Background	no	42.0 - 47.0	
163	Crossgradient	no	56.0 - 61.0	
120	Downgradient	no	20.0 - 25.0	Delineate the horizontal and vertical extent of the plume. Monitor concentration trends. Locations may be modified following completion of surface remedial action construction activities.
121	Downgradient	no	85.0 - 100.0	
123	Downgradient	no	55.0 - 60.0	
136	Downgradient	no	20.0 - 25.0	
145	Downgradient	yes	20.0 - 25.0	
147	Downgradient	yes	95.0 - 100.0	
056	Downgradient	yes	14.8 - 19.8	
097	Downgradient	yes	15.0 - 20.0	Sample beyond the current plume to detect horizontal and vertical plume migration in the buffer zone monitoring area (Dos Rios subdivision, Unit 2). Locations may be modified following completion of surface remedial action construction activities.
196	Downgradient	yes	63.0 - 58.0	
197	Downgradient	yes	83.0 - 88.0	
061	Downgradient	yes	15.0 - 20.0	
160	Downgradient	yes	63.0 - 58.0	
161	Downgradient	yes	95.0 - 100.0	
125	Downgradient	no	20.5 - 25.5	Sample downgradient monitor wells within current plume to track plume migration. Locations may be modified following completion of surface remedial action construction activities.
126	Downgradient	no	55.0 - 60.0	
127	Downgradient	no	98.2 - 101.2	
130	Downgradient	no	20.0 - 25.0	
132	Downgradient	no	95.5 - 100.5	
088	Downgradient	yes	14.0 - 19.0	
188	Downgradient	yes	65.0 - 60.0	
189	Downgradient	yes	95.0 - 100.0	
166	Downgradient	no	55.0 - 60.0	
161	Downgradient	yes	20.0 - 25.0	
163	Downgradient	yes	95.0 - 100.0	

006		On-site	no	10.0 - 15.0	Characterize on-site water quality before and during tailings removal. Locations may be modified following the completion of construction activities.
106	On-site	no		34.0 - 39.0	
013	On-site	yes		11.0 - 16.0	
113	On-site	yes		41.0 - 46.0	

1 Well designation ID is abbreviated from GUN-01-0XXX.

Table 2. Private well sampling locations downgradient from the processing site

Well Id.¹	Property Owner	Address/phone number	Description	Rationale for Sampling
461	VALCO, INC	1681 Gold Basin Rd/George Gregg 641-0951 leaseholder: Wallace Hildreth 641-2128	VALCO batch plant well	Indicates plume migration during VALCO's seasonal gravel pit dewatering operations. Monitored during surface remediation activities, as a minimum.
455	Coleman	1025 County Rd. 50/641-0441	Domestic irrigation wells that have been adversely affected by contamination from the former uranium processing site.	Assures that these wells continue to be safe for irrigation and livestock uses. Note: If the resident has been hooked up to the alternate water supply and is no longer using the designated well for irrigation, then the details of water use should be noted in the field and the well should not be sampled.
472	KOA	105 County Rd 50/641-1358		
468	Mark	529 Tomichl Trail/641-2817 (w) 641-1621		
600	Ihrke	381 Tomichl Trail/641-1452		Sample only if well is accessible.
469	Rider	7242 US Hwy 50/641-1225	Primary domestic wells: Domestic wells not affected by the uranium plume and downgradient from the area covered by the water distribution system.	The DOE has committed to monitor a "buffer zone" of domestic wells to assure that the characteristics of the uranium plume do not change and adversely affect wells in this area.
665	James and Cheryl Browder	732 Camino del Rio/641-3691	If not able to sample well then sample alternate domestic well .	
667	Pete Klingsmith	1050 Camino del Rio/641-1234		
680	Burton and Elnora Smith	326 Camino del Rio/641-1772		
683	Thomas and Janice Swineford	580 Camino del Rio/641-4663		

685	Larry and Annie Blitt	736 Camino del Rio (mailing address: P.O. Box 535)/841-3895		
686	Louis and Belva Bastian	900 Camino del Rio/841-3248	Alternate domestic wells in Unit 2 of the Dos Rios subdivision which are not affected by the uranium plume and are downgradient from the area covered by the water distribution system.	One (or more) of these alternate wells will only be sampled if one (or more) of the primary six "buffer zone" residents (listed in the row above) are not home. Alternate sampling locations have been selected so that six "buffer zone" wells will be monitored semiannually and so the geographic distribution of buffer zone sampling locations is consistent with that of the primary "buffer zone" locations (i.e., if a primary location isn't accessible, a neighboring location will be sampled as an alternate).
687	Fred and Betty Budy	904 Camino del Rio/841-0455		
688	Craig and Karen McGreen	320 Camino del Rio/841-3505		
689	Bill Rhodes	572 Camino del Rio/841-1815		
690	Harold Lee	971 Camino del Rio/841-5483		
691	Bernard and Susan Lebow	1014 Camino del Rio (mailing address: P.O. Box 885)/841-6651		

1 Well designation ID is abbreviated from GUN-01-0XXX.

Table 3. Surface water sampling locations in the vicinity of the Gunnison processing site

Surface Water Location Ids.¹	Description	Rationale for Sampling
779	KOA Campground pond	Monitor water quality to assure that human health and the environment are not at risk.
780	Northeast corner of the VALCO dewatering pond	Elevated concentrations of hazardous constituents have been detected during the VALCO seasonal dewatering operations. These constituents may be derived from the tailings pile. Coupled with samples collected from the VALCO batch plant well, this surface water sample provides useful plume tracking information.

1 Surface water designation ID is abbreviated from GUN-01-0XXX.

Table 4. DOE ground water monitoring well sampling locations at the Gunnison disposal site¹

Well Ids.	Location	Screened Interval (ft, b/s)	Rationale for Sampling
707	Background	360.0 - 370.0	Monitor potential changes in background water quality during remedial action construction.
708	Background	154.7 - 164.7	Monitor potential changes in background water quality during remedial action construction.
716	Background	185.0 - 225.0	Monitor potential changes in background water quality during remedial action construction.
663	Background	171.0 - 173.0	Monitor potential changes in background water quality during remedial action construction.
713	Background	205.0 - 225.0	Monitor potential changes in background water quality during remedial action construction.
714	Downgradient	134.0 - 144.0	Monitor water quality downgradient of the disposal site during remedial action construction.
717	Downgradient	160.0 - 200.0	Monitor water quality downgradient of the disposal site during remedial action construction.
715	Downgradient	132.0 - 172.0	Monitor water quality downgradient of the disposal site during remedial action construction.

¹ Prioritized from upgradient to downgradient

² Well designation ID is abbreviated from GUN-08-0XXX.

ATTACHMENT 6.3

SITE HYDROLOGIST WORK ORDER PLAN

JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

PAGE 1 of 2

II. WORK ORDER PLAN - CHEMICAL ANALYSIS OF UMTRA TAC SAMPLES

SAMPLE MATRIX: Ground water

SITE HYDROLOGIST: Rick Dotson
NAME (print)

Rick Dotson 8/31/95
SIGNATURE DATE

SITE ID(s): GUN01

LOCATION ID(s): See Below

SITE GEOCHEMIST: Tim Jackson
NAME (print)

Tim Jackson 8/31/95
SIGNATURE DATE

SAMPLES ID(S): Filtered (0001)

Bottle Name	Cl	SO ₄	Na	K	Mg	Ca	B	F	CN	S	TKN	NH ₄	NO ₃ & NO ₂	NO ₃	SiO ₂	PO ₄	Br	Al	Sb	A As	Se	Be	2 Cd	Cr	Co
A-1	X	X																							
M-2			X	X	X	X														X			X		X
Total # of Tests	39	39	39	39	39	39														6			39		39

COMMENTS:

GUN-01-0001-0001 GUN-01-0081-0001 GUN-01-0108-0001 GUN-01-0125-0001 GUN-01-0138-0001 GUN-01-0162-0001 GUN-01-0189-0001 GUN-01-0999-0001
GUN-01-0002-0001 GUN-01-0082-0001 GUN-01-0113-0001 GUN-01-0126-0001 GUN-01-0145-0001 GUN-01-0181-0001 GUN-01-0198-0001 GUN-01-0999-0002
GUN-01-0006-0001 GUN-01-0097-0001 GUN-01-0120-0001 GUN-01-0127-0001 GUN-01-0147-0001 GUN-01-0183-0001 GUN-01-0197-0001 GUN-01-0999-0003
GUN-01-0013-0001 GUN-01-0101-0001 GUN-01-0121-0001 GUN-01-0130-0001 GUN-01-0160-0001 GUN-01-0186-0001 GUN-01-0180-0002 GUN-01-0999-0004
GUN-01-0058-0001 GUN-01-0102-0001 GUN-01-0123-0001 GUN-01-0132-0001 GUN-01-0161-0001 GUN-01-0188-0001 GUN-01-0196-0002

NOTE: Only monitor wells GUN-01-0097, -0198 and -0197 (and QC samples at location GUN-01-0198) will be analyzed for arsenic.

* G-FAA Required.

Both GUN-01-0196-0001 + 0002 for As plus 2 samples
taken at GUN-01-0999 on the same date. Please
call me if you are confused. PZietz 50 188-1300

JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

II. WORK ORDER PLAN - CHEMICAL ANALYSIS OF
UMTRA TAC SAMPLES

SITE HYDROLOGIST: Rick Dotson
NAME (print)

SIGNATURE

DATE

SAMPLE MATRIX: Surface Water

SITE ID(s): GUN01

LOCATION ID(s): GUN-01-0779, -0780

SITE GEOCHEMIST: Tim Jackson
NAME (print)

SIGNATURE

DATE

SAMPLES ID(S): Filtered (0001)

Bottle Name	Cl	SO ₄	Na	K	Mg	Ca	B	F	CN	S	TKN	NH ₄	NO ₃ & NO ₂	NO ₃	SiO ₂	PO ₄	Br	Al	Sb	As	Ba	Be	Cd	Cr	Co
A-1		X																							
M-2			X		X	X																			
Total # of Tests		2	2		2	2																			

COMMENTS:

GUN-01-0779-0001
GUN-01-0780-0001

DO No. 117-C

1. WORK ORDER PLAN - CHEMICAL ANALYSIS OF UMTRA TAC SAMPLES

SITE HYDROLOGIST: Rick Dotson

Richard W. Davis 8/31/95

SITE ID(s): GUN01

DATE

LOCATION ID(s): See Below.

SITE GEOCHEMIST: Tim Jackson
NAME (print)

David Becker 8/5/95
SIGNATURE DATE

SAMPLES ID(S): Filtered (0001)

Bottle Name	U	Pb-210	Po-210	Ra-226	Ra-228	Th-230	Gross Alpha
QAB							X
Ra-226				X			
Ra-228					X		
Pb-210		X					
Total # of Tests		39		39	39		39

COMMENTS:

GUN-01-0001-0001	GUN-01-0001-0001	GUN-01-0106-0001	GUN-01-0126-0001	GUN-01-0136-0001	GUN-01-0163-0001	GUN-01-0189-0001	GUN-01-0999-0001
GUN-01-0002-0001	GUN-01-0006-0001	GUN-01-0113-0001	GUN-01-0126-0001	GUN-01-0146-0001	GUN-01-0181-0001	GUN-01-0196-0001	GUN-01-0999-0002
GUN-01-0003-0001	GUN-01-0007-0001	GUN-01-0120-0001	GUN-01-0127-0001	GUN-01-0147-0001	GUN-01-0183-0001	GUN-01-0197-0001	GUN-01-0999-0003
GUN-01-0006-0001	GUN-01-0008-0001	GUN-01-0121-0001	GUN-01-0130-0001	GUN-01-0160-0001	GUN-01-0186-0001	GUN-01-0180-0002	GUN-01-0999-0004
GUN-01-0013-0001	GUN-01-0101-0001	GUN-01-0123-0001	GUN-01-0132-0001	GUN-01-0161-0001	GUN-01-0188-0001	GUN-01-0198-0002	
GUN-01-0018-0001	GUN-01-0102-0001	GUN-01-0123-0001					

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JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

PAGE 2

II. WORK ORDER PLAN - CHEMICAL ANALYSIS OF UMTRA TAC SAMPLES

SAMPLE MATRIX: Surface Water

SITE HYDROLOGIST: Rick Dotson
NAME (print)

SIGNATURE

DATE

SITE ID(s): GUN-01

LOCATION ID(s): GUN-01-0779, -0780

SITE GEOCHEMIST: Tim Jackson
NAME (print)

SIGNATURE

DATE

SAMPLES ID(S): Unfiltered (N00X)

Bottle Name	Cu	Fe	Pb	Mn	Hg	Mo	Ni	Se	Ag	Sr	Sn	Ti	U	V	Zn	TDS	TOC & DOC
A-1																X	
M-2		X		X											X		
RMB																	
Total # of Tests		2		2											2	2	

COMMENTS:

GUN-01-0779-N001
GUN-01-0780-N001

DO No. 117-C

5.

1. WORK ORDER PLAN - CHEMICAL ANALYSIS OF UMTRA TAC SAMPLES

SAMPLE MATRIX: Ground water

SITE HYDROLOGIST: Rick Dotson

NAME (print)

SIGNATURE

DATE

SITE ID(s): GUN-01

LOCATION ID(s): Private Wells (see below)

SITE GEOCHEMIST: Tim Jackson

NAME (print)

SIGNATURE

DATE

SAMPLES ID(S): Unfiltered (N00X)

Bottle Name	U	Pb-210	Po-210	Ra-226	Ra-228	Th-230	Gross Alpha/Beta	
<u>M-2</u>	<u>X</u>							
Total # of Tests	10							

COMMENTS:

GUN-01-0455-N001 GUN-01-0472-N001 GUN-01-0683-N001
 GUN-01-0461-N001 GUN-01-0685-N001 GUN-01-0685-N001
 GUN-01-0468-N001 GUN-01-0687-N001
 GUN-01-0469-N001 GUN-01-0680-N001

(Alternate wells: GUN-01-0660 GUN-01-0679 GUN-01-0684 GUN-01-0661 GUN-01-0686 GUN-01-0687)

DO No. 78-W

4

ATTACHMENT 6.4

WATER SAMPLING MANAGER MEMORANDUM

To: UMTRA Water Sampling Team
From: Rob Sengebush *RS*
Date: September 28, 1995
Subject: **Gunnison, Colorado, Water Sampling Scope - October, 1995**

"The gem cannot be polished without friction, nor man perfected without trials"
Chinese Proverb

VITAL INFORMATION

Codes:

Jacobs WBS Code: S-0501-00-08-32WSP

Charge Numbers :

Jacobs/AGRA: S0501-00-08 32WSP
Geraghty and Miller: 2 0501-00-08G X9243
WESTON: 02303-010-011-0801-34

Crew Assignments:

Collins and Moran
Tagliaferri and Hiller

Shipping:

Inorganics: Core, Aurora D.O. No. 117-C

Radiochemical: Core, Casper D.O. No. R6-C

Uranium (second M2 bottle): Weyerhaeuser, D.O. 078-W

QA/QC Samples:

GUN01 160, 196

GUN08 708

Sampling Order:

The sampling order is as shown on the Analytes spread sheet.

Other

1. The October 2 - 13 sampling tour will consist of sampling only the GUN01 Processing Site area and the domestic wells. The GUN08 Disposal Site sampling will be conducted during the next tour, October 23 - November 3. This is due to the size of the work load for each of the sites.

As this sampling tour will include considerable contact with the public, please wear your UMTRA logo shirts and/or your UMTRA hat - the idea is to have the UMTRA logo visible somewhere on your person. See me if you don't have an UMTRA hat. Have your UMTRA business cards available for anyone with questions. Refer all questions from the Public, to the TAC site manager, John McBee, 505 - 888-1300,

2. Read Rick Dotson's memo, attached to this field work package.

3. There are several forms in the work order package which may need to be presented to the domestic location residents. We will discuss these forms in more detail in our kick-off meeting.

4. Data Loggers are present in wells denoted by an asterisk and listed in Rick Dotson's memo, attached to this work package. Read Rick's memo for instructions on how to handle the data loggers while sampling.

5. Water level measurements will be taken from the wells as they are sampled. In addition, water levels will also be collected from the following wells:

GUN01 140, 141, 142, 155, 157 and the Gunnison River staff gauge location 794. See Rick's memo for the location and procedure for the staff gauge measurement. Do not wade the river to get the staff gauge measurement, use binoculars if you cannot read the gauge from the edge of the river.

Next tour at the Disposal Site - GUN08 609, 621, 628, 630, 635, 640, 663, 665, 709, 710, 712

6. You may recall that last tour we were requested to not measure dissolved oxygen. This tour, please DO MEASURE DISSOLVED OXYGEN.

Work Order

Attached is the Field Sampling Plan for the current water sampling round.

The analytical suite for inorganic and radiochemical parameters are shown on the attached spread sheets and Work Order forms. A map of sampling locations is attached.

Alkalinity, dissolved oxygen (DO), temperature, conductivity, pH, and oxidation/reduction potential (ORP) will be measured in samples from all monitoring wells. No ion couple measurements are required at this site.

The order of sample importance where the groundwater volume is limited is as follows:

Metals M2 - Highest Priority
 Anions A1 and TOC/DOC
 N1
 GAB
 RA226
 RA228

There is no need to containerize the purge water.

INORGANIC ANALYSES

Volumes and preservatives for the inorganic samples are shown below.

A1	1L PI	Ice to 4C. Max holding time 7 days when TDS is an analyte.
M2	0.5L PI	HNO ₃ to pH<2.
N1	0.5L PI	H ₂ SO ₄ to pH < 2, ice to 4C.
S	2 x 0.5L PI	NaOH to pH > 9, Zn Acetate, ice to 4C. 7 day holding time.
CN	1L PI	NaOH to pH > 12, ice to 4C.
TOC/DOC	0.5L amber GI	H ₂ SO ₄ to pH < 2, ice to 4C.

RADIOCHEMICAL ANALYSES

Bottle Id	Volume/Container	Preservation	Holding Time
Ra-226	2 x 1L PI	HNO ₃ , pH<2	180 days
RA-228	2 x 1L PI	"	"
Pb-210	1L PI	"	"
Po-210	1L PI	"	"
Th-230	1L PI	"	"
GAB	500 mL PI	"	"

QA/QC Samples

Field Duplicate

At each location, the Field Duplicate sample will be identified with the site name such as NAT or SRK, then XX-YYY-0002, where XX is the site designation such as 01 or 08 and YYY is the sampling location number.

Fill an extra set of bottles at the sampling location. The field duplicate will have its own field form and chain of custody. The water should be filtered (or non-filtered) in the same way as the other samples from the other wells.

Field Blank

At each location the Field Blank sample will be identified with the site name such as NAT or SRK, then XX-999-000Y and N00Y, where XX is the site designation such as 01 or 08 and Y is 1 or 3 or 5. . . ., depending on how many field blanks are collected from the site.

Fill a separate set of bottles with the high purity water using the carboy spigot while sampling each location. The Field Blank will have its own field form and chain of custody. In some cases, the Field Blank sample will consist of bottles designated as 000Y (filtered) AND N00Y (non-filtered). In spite of these labels, all of the water in all of the Field Blank bottles should be NON-FILTERED. This is so the lab will not filter or digest the metals and radiochemistry samples when they get them. The reason you will NOT FILTER any of the Field Blank bottles is because they are all made with the high purity water from the carboy.

Equipment Blank

At each location where equipment is used to sample (such as a bailer or pump) the Equipment Blank sample will be identified with the site name such as NAT or SRK, then XX-999-000Y and N00Y, where XX is the site designation such as 01 or 08 and Y is 2 or 4 or 6. . . ., depending on how many equipment blanks are collected from the site.

Fill a set of bottles by pumping high purity water from a container such as a bucket through the decontaminated pump or other collection device. Do not open the top of the carboy and put tubing in the water to pump it out, put the high purity water into a separate container in order to make the equipment blank. The equipment blank will have its own field form and chain of custody. The water should be non-filtered, even though it is designated as 000Y (filtered) and N00Y (non-filtered). Same note regarding filtering applies here as described above for the Field Blank.

One More Thing

Take your time and check each others work, especially in the shipping procedures.

Author: PDOTSON at UMTRA
Date: 9/28/95 4:00 PM
Priority: Normal
TO: RSENGEBU
Subject: GUN - contact land owners

----- Message Contents -----

Rob -

I spoke with Wallace Hildreth since my last message. He says no problem. The water samplers do not need to contact him prior to entering.

- Rick

Forward Header

Subject: GUN - contact land owners
Author: PDOTSON at UMTRA
Date: 9/28/95 3:22 PM

Rob -

I have alerted Greg Holman, RAC (641-3935), of the water sampling scheduled to begin next week. I also contacted Rex Tippetts with the Gunnison County Airport. He is aware that they will be in the area starting next week. Please have the water samplers contact him (641-2304) prior to entering the airport property. He didn't seem too concerned about the sampling.

I also contacted VALCO (641- 0951) to alert them of the water sampling. Please have the water samplers stop in at the VALCO front desk prior to entering their property. I haven't yet, but I will, contact Wallace Hildreth who leases the VALCO property to alert him to the water samplers schedule.

- Rick

ATTACHMENT 6.5

WELL DATA SUMMARY SPREADSHEET

GUNNISON WATER SAMPLING, OCTOBER, 1995

GUNW1095.XLS

WELL DATA SUMMARY

DOE Monitoring Wells, Domestic Wells and Surface sample locations.

Most data from May 1995

No.		A		B	C								T			Purge
	L O C	WELL DIA. (IN)	SCR. INTER. (FT)	TOTAL DEPTH (FT)	PREV. DTW (FT)	WITH- DRAW. METH.	RECOV or LF Purge (L)	pH	Ec	ORP	ug/ L DO	ALK	I M E	1BV gal	3BV gal	Time in Min at 1
1	001	2	8-13	20.05	7.16	FLEX	3.2	7	280	203	0.8	190	78	2.10	6.31	6.31
2	002	2	10-15	20.05	6.91	FLEX	3	7	312	357	0.5	224	60	2.14	6.43	6.43
3	006	2	11-16	21	10.00	FLEX	3	6.6	1480	229	0.4	185	80	1.79	5.38	5.38
4	013	2	11-16	16.5	11.44	FLEX	3.2	6.8	1126	453	0.2	241	72	0.83	2.48	2.48
5	058	3	17.6-22.6	22.6	4.66	FLEX	3	6.7	362	293	0	191	75	6.59	19.76	19.76
	059	4	17.6-22.6	22.6	4.32	FLEX	3	6.9	4360	105	0.4	215	108	11.93	35.79	35.79
	060	4	17.5-22.5	22.5	5.47	FLEX	3	7.3	1830	-51	0.7	106	110	11.11	33.34	33.34
6	061	4	16.8-21.8	21.8	4.76	FLEX	3	6.7	193	436	0.3	107	63	11.12	33.36	33.36
7	088	4	16.6-21.6	21.06	6.12	FLEX	3	6.8	156	233	0.2	106	90	9.75	29.25	29.25
	096	4	17-22	22	3.8	FLEX	3	6.7	142	211	0.6	105	90	11.88	35.63	35.63
8	097	4	17-22	22	3.45	FLEX	3	6.9	142	452	0.5	90	88	12.11	36.32	36.32
9	101	2	41.5-46.5	53.5	7.72	FLEX	3	7.3	313	249	2.3	187	96	7.47	22.41	22.41
10	102	2	42-47	54	7.09	FLEX	3	7.1	414	205	0.9	257	59	7.65	22.96	22.96

GUNNISON WATER SAMPLING, OCTOBER, 1995

GUNW1095.XLS

No.		A		B	C								T I M E			Purge Time in Min at 1
	L O C	WELL DIA. (IN)	SCR. INTER. (FT)	TOTAL DEPTH (FT)	PREV. DTW (FT)	WITH- DRAW. METH.	RECOV or LF Purge (L)	pH	Ec	ORP	ug/ L DO	ALK		1BV gal	3BV gal	
11	106	2	11-16	16.5	10.45	FLEX	3	5.3	1250	228	0	33	55	0.99	2.96	2.96
12	113	2	41-46	51	11.64	FLEX	3	6.5	1345	-21	0	222	80	6.42	19.27	19.27
13	120	2	20-25	25	5.11	FLEX	3	7.8	250	381	0	153	84	3.25	9.74	9.74
14	121	2	95-100	100.17	7.86	FLEX	3	7.4	334	113	NA	205	100	15.06	45.18	45.18
15	123	2	55-60	62	7.19	FLEX	3	6.7	252	417	0.2	217	105	8.94	26.83	26.83
16	125	2	20.5-25.5	24.8	6.54	FLEX	3	7.1	408	418	0.3	213	90	2.98	8.94	8.94
17	126	2	55-60	61	7.69	FLEX	3	7	789	49	0.1	262	100	8.70	26.09	26.09
18	127	2	96.2-101.2	101	8.58	POS	3	7.2	1092	234	0.3	258	105	15.08	45.24	45.24
19	130	2	20-25	26	12.41	FLEX	3	6.6	1280	228	4.5	259	65	2.22	6.65	6.65
20	132	2	95.5-100.5	100.5	13.82	FLEX	3.7	7.6	373	229	2.1	177	85	14.14	42.43	42.43
21	136	2	55-60	61.41	6.26	FLEX	1	12	1160	37	NA/	285	260	9.00	26.99	26.99
	145	2	20-25	25.9	7.36	FLEX	3.2	7.1	346	164	0	184	83	3.02	9.07	9.07
	147	2	95-100	102.7	8.30	FLEX	3	7.5	600	170	0.5	231	169	15.40	46.21	46.21
22	160	2	53-58	58.09	5.10	FLEX	3	6.3	477	395	0.9	255	105	8.65	25.94	25.94
23	161	2	95-100	102	6.58	FLEX	3	6.4	447	396	1.8	218	75	15.57	46.71	46.71

GUNNISON WATER SAMPLING, OCTOBER, 1995

GUNW1005.XLS

No.	L O C	A		B	C								T I M E			Purge Time in Min at 1
		WELL DIA. (IN)	SCR. INTER. (FT)	TOTAL DEPTH (FT)	PREV. DTW (FT)	WITH- DRAW. METH.	RECOV or LF Purge (L)	pH	Ec	ORP	ug/ L DO	ALK		1BV gal	3BV gal	
24	163	2	56-61	61.45	9.29	FLEX	3	6.3	386	459	0.4	245	100	8.51	25.53	25.53
25	181	2	20-25	25.69	5.39	FLEX	3	6.8	538	418	0.1	202	72	3.31	9.94	9.94
26	183	2	95-100	100.91	6.03	FLEX	3	6.5	782	234	0.8	274	90	15.48	46.44	46.44
27	186	2	55-60	61.83	6.45	FLEX	3	7.1	803	228	0.1	213	63	9.04	27.11	27.11
	187	Undergoing repair, not available			4.92											
28	188	2	55-60	60.54	6.00	FLEX	3	7	486	345	0.3	162	67	8.90	26.70	26.70
29	189	2	55-60	61.08	6.38	FLEX	3 (2-day)	6.1	1369	313	0.1	900	2-day	8.92	26.77	26.77
30	196	2	53-58	63.2	5.67	FLEX	3	6	1429	259	0.1	1079	160	9.39	28.16	28.16
31	197	2	93-98	103.75	4.90	FLEX	3	6	1319	243	0	1016	175	16.13	48.38	48.38

GUN01 - DOMESTIC AND SURFACE LOCATIONS

Criteria for sampling:

1. Is resident home? If not, stop, note on cover sheet of field form. If home, go to 2.
2. Ask resident if they use city water. If so, stop, note on field form, go on to the next location. If not, sample the well or tap.
3. Ask resident if they irrigate (water the yard or pasture) with well water. If not, stop, and note on form. If so, sample from well or outlet t

GUNNISON WATER SAMPLING, OCTOBER, 1995

GUNW1095.XLS

	A		B	C									T			Purge
	L	WELL	SCR.	TOTAL	PREV.	WITH-	RECOV				ug/		I			Time
	O	DIA.	INTER.	DEPTH	DTW	DRAW.	or LF				L		M	1BV	3BV	in Min
No.	C	(IN)	(FT)	(FT)	(FT)	METH.	Purge (L)	pH	Ec	ORP	DO	ALK	E	gal	gal	at 1

Sample the wells that are NOT shaded, and that meet the above crite Data from March and June, 1994

No.	LOC.	ADDRESS/PHONE NUMBER OF RESIDENCES	pH	Ec	ORP	DO	ALK
32	461	VALCO Batch Plant Well Wallace Hildreth 641-2128	7.2	401	NA	NA	230
	454	Deschene - 259 County Road 50, downstream (after) the water treatment					
33	455	Coleman - 1050 County Road 50 (Goodwin Lane?) 641-0441	6.9	444	NA	NA	187
34	468	Marks - 529 Tomichi Trail 641-2817 (h) 641-1621 (w)	7.3	676	NA	NA	272
	474	Ajarian Residence - 277 County Road 50 641-0425					
	600	Ihrke Residence - 381 Tomichi Trail 641-2461 (h) 943-2135 (w)					
	601	Rais Residence - 463 Tomichi Trail 641-3681 (h) 641-1374 (w)					
35	469	Rider Residence - 7242 US Hwy 50 - end of Que Q 641-1225	7	189	NA	NA	94
	661	Budy Residence - 904 Camino Del Rio	6.9	155			90
36	665	Browder Residence - 732 Camino Del 641-3691	7.3	230	NA	NA	123
	666	Cummings - 59 E Cottonwood Lane, Unit 1 641-3 New					
37	667	Klingsmith Residence - 1050 Camino Del Rio 641-1234	7	178	NA	NA	90

GUNNISON WATER SAMPLING, OCTOBER, 1995

GUNW1003.XLS

No.	L O C	A WELL DIA. (IN)	B SCR. INTER. (FT)	C TOTAL DEPTH (FT)	D PREV. DTW (FT)	E WITH- DRAW. METH.	F RECOV or LF Purge (L)	G pH	H Ec	I ORP	J ug/ L DO	K ALK	L T I M E	M 1BV gal	N 3BV gal	O Purge Time in Min at 1
38	680	Smith, 326 Camino Del Rio 641-1772						7.8	163	NA	NA	89				
39	683	Swineford Residence - 560 Camino De 641-4663 Requeste						6	18	385	NA	105				
40	685	Larry and Annie Blatt 736 Camino del Rio (mailin New?						7.2	210	484	NA	98				
41	472	KOA 105 County Rd 50 641-1358 New?						8.1	181	506	NA	98				

No. LOC. SURFACE WATER SAMPLE LOCATIONS

42	779	KOA Campground Pond						8.1	330	NA	NA	182	60
43	780	VALCO gravel pond - northeast corner of west gravel pit						8.3	343	NA	NA	171	76

DISPOSAL SITE - GUN08 Data from June, 1995

1	707	4	360-370	374	364.00	PB*	Dry 1 BV	9.4	249	NA	NA	NA/375	MD**	6.53	19.58	19.58
No sample from 707. Purged the well dry on 6/2/95. No recharge as of 6/3/95.																
2	708	4	154.7-164.	166.7	143.00	G, P or PB	3	7.1	209	61	NA	115	228	15.5	46.4	46.4
3	716	4	185-225	229	181.00	PB or G	1.2.	7.3	289	-47	NA	161	255	31.3	93.98	93.98
4	713	4	205-215	219.55	54.5/137	G or P	0.5	12	2370	87	NA	274	MD	143	429.9	429.9

GUNNISON WATER SAMPLING, OCTOBER, 1995

GUNW1095.XLS

No.	L O C	A		B	C								T I M E			Purge Time in Min at 1
		WELL DIA. (IN)	SCR. INTER. (FT)	TOTAL DEPTH (FT)	PREV. DTW (FT)	WITH- DRAW. METH.	RECOV or LF Purge (L)	pH	Ec	ORP	ug/ L DO	ALK		1BV gal	3BV gal	
5	714	4	205-215	145.4	61.90	G, P or PB	3	7.8	287	-12	1.2	156	227	54.5	163.5	163.5
6	717	4	160-200	198	169.26	PB or G	3.1	7.5	256	64	NA	125	215	18.8	56.27	56.27
7	715	4	132-172	174	140.06	PB or G	1.1	7.9	193	60	NA	124	183	22.2	66.45	66.45
8	663	2	171-173	174.35	166.30	F&W or G	3	7.5	211	164	NA	112	170	1.31	3.94	3.94

Take large generator for power bailer and electric submersible pumps.

* Bailer down well from 10/94, recovered by Webster and Hiller, 6/95.

** MD = Multi-day sampling

Bore Volume Calculation as follows: $1 \text{ BV} = [(Pi) * (r^2) * h] \text{ft}^3 * (7.48) \text{ gal/ft}^3 = \text{gal}$

Using data from table and columns assigned A, B and C:

$(Pi) * ((A/2)/12)^2 * (B-C) * (7.48) = \text{gal}$

ATTACHMENT 6.6
ANALYTE SPREADSHEET

GUNNISON WATER SAMPLING, OCTOBER, 1995

GUNA1095.XLW

NOTE: COLLECT TWO M2 BOTTLES - ONE FOR "METALS" ANALYSIS AND ONE FOR "URANIUM" ANALYSIS. "METALS" M2 WILL BE SHIPPED TO CORE, AURORA FOR INORGANIC ANALYSIS. "URANIUM" M2 WILL BE SHIPPED TO WEYERHAEUSER FOR URANIUM ANALYSIS.

Processing Site GUN01	ANALYTES																				
	FILTERED										NON-FILTERED										
	0.45 Matrix Filter																				
LOCATION	A-1	M-2	DOC	GAB	Ra-226	Ra-228	Pb-210	Po-210	Th-230	A-1	M-2	N-1	S	TOC	CN	GAB	Ra-226	Ra-228	Pb-210	Po-210	Th-230
001-0001	X	XX		X	X	X	X														
001-N001																					
002-0001	X	XX		X	X	X	X														
002-N001																					
101-0001	X	XX		X	X	X	X														
101-N001																					
102-0001	X	XX		X	X	X	X														
102-N001																					
120-0001	X	XX		X	X	X	X														
120-N001																					
121-0001	X	XX		X	X	X	X														
121-N001																					
123-0001	X	XX		X	X	X	X														
123-N001																					
145-0001	X	XX		X	X	X	X														
145-N001																					
147-0001	X	XX		X	X	X	X														
147-N001																					
058-0001	X	XX		X	X	X	X														
058-N001																					
163-0001	X	XX		X	X	X	X														
163-N001																					
061-0001	X	XX		X	X	X	X														
061-N001																					
161-0001	X	XX		X	X	X	X														
161-N001																					

GUNNISON WATER SAMPLING, OCTOBER, 1995

GUNA.XLW

ANNISON WATER SAMPLING, OCTOBER, 1998																						
GUN01	0.45 Matrix Filter									NON-FILTERED												
LOCATION	A-1	M-2	DOC	GAB	Ra-226	Ra-228	Pb-210	Po-210	Th-230	A-1	M-2	N-1	S	TOC	CN	GAB	Ra-226	Ra-228	Pb-210	Po-210	Th-230	
160-0001	X	XX		X	X	X	X															
160-N001																						
160-0002 DUP	X	XX		X	X	X	X															
160-N002 DUP																						
999-0001 FB	X	XX		X	X	X	X															
999-N001 FB																						
999-0002 EB	X	XX		X	X	X	X															
999-N002 EB																						
097-0001	X	XX		X	X	X	X															
097-N001																						
196-0001	X	XX		X	X	X	X															
196-N001																						
196-0002 DUP	X	XX		X	X	X	X															
196-N002 DUP																						
999-0003 FB	X	XX		X	X	X	X															
999-N003 FB																						
999-0004 EB	X	XX		X	X	X	X															
999-N004 EB																						
197-0001	X	XX		X	X	X	X															
197-N001																						
088-0001	X	XX		X	X	X	X															
088-N001																						
189-0001	X	XX		X	X	X	X															
189-N001																						
188-0001	X	XX		X	X	X	X															
188-N001																						
136-0001	X	XX		X	X	X	X															
136-N001																						
130-0001	X	XX		X	X	X	X															

GUNNISON WATER SAMPLING, OCTOBER, 1995

GUNA1095.XLW

GUN01	0.45 Matrix Filter									NON-FILTERED												
	LOCATION	A-1	M-2	DOC	GAB	Ra-226	Ra-228	Pb-210	Po-210	Th-230	A-1	M-2	N-1	S	TOC	CN	GAB	Ra-226	Ra-228	Pb-210	Po-210	Th-230
130-N001																						
132-0001	X	XX		X	X	X	X															
132-N001																						
125-0001	X	XX		X	X	X	X															
125-N001																						
126-0001	X	XX		X	X	X	X															
126-N001																						
127-0001	X	XX		X	X	X	X															
127-N001																						
181-0001	X	XX		X	X	X	X															
181-N001																						
183-0001	X	XX		X	X	X	X															
183-N001																						
186-0001	X	XX		X	X	X	X															
186-N001																						
106-0001	X	XX		X	X	X	X															
106-N001																						
013-0001	X	XX		X	X	X	X															
013-N001																						
113-0001	X	XX		X	X	X	X															
113-N001																						
006-0001	X	XX		X	X	X	X															
006-N001																						

GUN 01 Surface Water

779-0001	X	XX																				
779-N001											X	XX										
780-0001	X	XX																				
780-N001											X	XX										

GUNNISON WATER SAMPLING, OCTOBER, 1995

GUNA1072.XLW

GUN01	FILTERED 0.45 Matrix Filter										NON-FILTERED											
	LOCATION	A-1	M-2	DOC	GAB	Ra-226	Ra-228	Pb-210	Po-210	Th-230	A-1	M-2	N-1	S	TOC	CN	GAB	Ra-226	Ra-228	Pb-210	Po-210	Th-230

GUN01 Domestic Wells Near Processing Site

Refer to Work Order Well Data Summary for address of each domestic location.

680-N001											X*											
683-N001											X*											
472-N001											X*											
667-N001											X*											
665-N001											X*											
685-N001											X*											
461-N001											X*											
455-N001											X*											
469-N001											X*											
468-N001											X*											
600-0001		X*																				
600-N001																						

X* Sample is for Uranium analysis only. Ship to Weyerhaeuser.

ALTERNATE DOMESTIC WELLS

660-N001																						
661-N001																						
679-N001																						
684-N001																						
686-N001																						
687-N001																						

GUNNISON WATER SAMPLING, OCTOBER, 1995

GUNA1095.XLW

GUN01	0.45 Matrix Filter										NON-FILTERED											
LOCATION	A-1	M-2	DOC	GAB	Ra-226	Ra-228	Pb-210	Po-210	Th-230	A-1	M-2	N-1	S	TOC	CN	GAB	Ra-226	Ra-228	Pb-210	Po-210	Th-230	

GUN08 DOE Monitoring Wells at the Disposal Site

707-0001	X	XX		X	X	X	X														
707-N001												X									
708-0001	X	XX		X	X	X	X														
708-N001												X									
708-0002 DUP	X	XX		X	X	X	X														
708-N002 DUP												X									
999-0001 FB	X	XX		X	X	X	X														
999-N001 FB												X									
999-0002 EB	X	XX		X	X	X	X														
999-N002 EB												X									
716-0001	X	XX		X	X	X	X														
716-N001												X									
713-0001	X	XX		X	X	X	X														
713-N001												X									
714-0001	X	XX		X	X	X	X														
714-N001												X									
717-0001	X	XX		X	X	X	X														
717-N001												X									
715-0001	X	XX		X	X	X	X														
715-N001												X									
663-0001	X	XX		X	X	X	X														
663-N001												X									

ATTACHMENT 6.7

WATER SAMPLING FIELD FORMS

WATER SAMPLING FIELD FORM

LOW FLOW SAMPLE

0.45um CAPSULE FILTER(s) USED _____

COMMENTS

PURGE WATER DISPOSITION

[illegible]

DATE _____

JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

WATER SAMPLING FIELD FORM

SITE ID: _____ LOCATION ID: _____ DATE: _____

DEPTH TO WATER (h_2) (FT) _____
OR DEPTH TO TOP OF PUMP (FOR LOW FLOW)

GIVEN DEPTH OF WELL (h_1) (FT) _____

TOTAL DEPTH MEASURED: YES NO

VALUE: _____

WELL DIA (d) (FT) _____

BORE VOL (FT³) _____

SCREENED INTERVAL (FT) _____

SAMPLE DEPTH (FT) _____

WITHDRAWAL METHOD/ID NO. _____

DEDICATED PUMP _____

METER 90K020- 640 641 643

TEMP pH ORP EC OTHER _____

SPECTROPHOTOMETER/DO GP-0971 1102 0852

DO _____ OTHER _____

TURBIDITY METER (NTU) GP-1700 1842

PRIMARY CALIBRATION DATE _____

INITIAL SECONDARY CALIBRATION

0-10 0-100 0-1000

DAILY SECONDARY STANDARD VALUES

0-10 0-100 0-1000 WELL ID _____

pH METER STANDARDIZATION						Drift can be within 0.1 pH units * IBC: Independent Buffer Check
TIME	4.00	*IBC 6.00	7.00	*IBC 8.00	10.00	COMMENTS

ORP PROBE: INDEPENDENT ORP STANDARD CHECK

ZOBELL (mV) _____ T(°C) _____

ORP METER TEST DATE _____ LOCATION _____

EC PROBE: INDEPENDENT EC STANDARD CHECK

MEASURED EC (1000 μ mhos/cm Std): _____

MEASURED T(°C) _____

K^{25} = MEASURED EC CORRECTED TO 25°C _____

EC Meter Test Date _____ Location _____

$K^{25} = Km / (1 + 0.019(t-25))$

1BV = _____ gal

3BV = _____ gal

BORE VOL CALCULATION

$BV = (d/2)^2 p(h_1 - h_2)(7.48)$

Low Flow Purge = $[(h^1) - (h^2)] \cdot [(0.010 \text{ gal/ft}) (3.78 \text{ L/gal})] + [0.60\text{L}] = \text{Liters}$

The value of $[(d/2)^2 p]$ is: 0.022 for a 2" well; 0.086 for a 4" well

*Depth to top of pump provided in Field Work Order

JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

WATER SAMPLING FIELD FORM

ALKALINITY TITRATION

SITE ID: _____

LOCATION ID: _____

DATE: _____

ALKALINITY TEST KIT ID: _____

TITRANT: 1.6 N H₂SO₄ LOT#: _____

pH METER ID: _____

pH	ALKALINITY (mg/lCaCO ₃)			
INITIAL pH	1ST	2ND	3RD	FCS
4.50				
Field Rep:				

ALK FCS STD ID: _____ THEOR. VAL: _____

FCS EXPIRATION DATE: _____

FCS % RECOVERY ((REC/THEOR. VAL)x100): _____

ERROR AT 4.50 pH $\left| \frac{X1-X2}{X^S} \right| \times 100 = \text{_____} \%$

2nd = _____ %

FIRST AND SECOND ALKALINITY VALUES AT 4.5 pH MUST BE WITHIN 10%.

SAMPLE ALIQUOT IS 100 ML UNLESS STATED OTHERWISE.

NOTES:

TIME	pH METER STANDARDIZATION			COMMENTS
	4.00	*IBC 6.00	7.00	

- IBC: Independent Buffer Check
Drift can be within 0.2 pH units

WATER SAMPLING FIELD FORM

SITE ID: _____

LOCATION ID: _____

DATE: _____

[illegible]

ATTACHMENT 6.8
CHAIN-OF-CUSTODY FORM

JACOBS ENGINEERING GROUP INC.

ALBUQUERQUE OPERATIONS

WATER SAMPLING FIELD FORM

CHAIN OF CUSTODY

LAB: _____

ACKNOWLEDGEMENT OF RECEIPT OF SAMPLES FOR DELIVERY ORDER NO. _____

SITE ID: _____ LOCATION ID: _____ SAMPLE ID: _____

SAMPLE MATRIX (Check One)

WATER ()

SOIL ()

BOTTLE ID	VOLUME (LITERS)	REC'D	BOTTLE ID	VOLUME (LITERS)	REC'D
A1	_____	()	Th 230	_____	()
M2	_____	()	GA/B	_____	()
Pb 210	_____	()	N1	_____	()
Po 210	_____	()	CN	_____	()
Ra 226	_____	()	S	_____	()
RA 228	_____	()	TOC	_____	()
			DOC	_____	()

DATE COLLECTED: _____ TIME COLLECTED: _____

DATE SHIPPED: _____ SHIPPED BY: _____
(SIGNATURE)

METHOD OF SHIPMENT:

☐ FEDERAL EXPRESS

☐ AIRBORNE EXPRESS

☐ BUS

☐ OTHER _____

COMMENTS: _____

TO BE COMPLETED BY SUBCONTRACTING LABORATORY/LAB NAME: _____

I HEREBY ACKNOWLEDGE RECEIPT OF THE FOLLOWING ON: _____

(DATE)

(TIME)

DELIVERY ORDER NO. _____ WORK ORDER PLAN DATED: _____

RECEIVED BY: _____
(SIGNATURE)

PRINT NAME: _____

TITLE: _____

COMMENTS: _____

ATTACHMENT 6.9

CHAIN-OF-CUSTODY CHECKLIST

SITE ID: _____

LAB. _____

D.O.# _____

[illegible]

SAMPLE CUSTODIAN

DATE SHIPPED

WATER SAMPLE CHECKLIST - RADIOCHEMICAL PARAMETERS

SITE ID: _____

LAB. _____

D.O.# _____

[illegible]

SAMPLE CUSTODIAN

DATE SHIPPED

ATTACHMENT 6.10

STATIC GROUND WATER LEVEL RECORD

Page__of__

SITE ID: _____ **FIELD REP.:** _____

COMMENTS: _____

* Borehole - Top of Ground
Well - Top of Casing

ATTACHMENT 6.11

STANDARD ALKALINITY TEST FORM

JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

STANDARD ALKALINITY TEST
TITRATION TO pH 4.50

**STANDARD
SOLUTION DATA**

KNOWN VALUE ¹
(mg/l CaCO₃)

INITIAL pH

ALKALINITY TEST VALUES
(mg/l CaCO₃)

DATE: _____

REQ#: _____

LAB#: _____

TIME	pH METER STANDARDIZATION			COMMENTS
	4.00	IBC ² 6.00	7.00	

¹Known value to be recorded by Data Mangement

²IBC: Independent Buffer Check
Drift can be within 0.2 pH units

DATE OF TEST: _____

SITE ID: _____

FIELD REP ID: _____

ALKALINITY TEST KIT ID: _____

pH METER ID: _____

TITRANT LOT NO. _____

SEND TO: _____

COMMENTS: _____

Sample Preservation Volumes

<u>Bottle ID</u>	<u>Acid</u>	<u>Quantity/Bottle Volume</u>
M-2	Nitric (HNO_3)	2.5 mL/500 mL
N-1	Sulfuric (H_2SO_4)	1 mL/500 mL
S	Zinc acetate	2 mL/500 mL

JACOBS ENGINEERING GROUP INC.

ALBUQUERQUE OPERATIONS

EXAMPLE OF SAMPLE LABEL

JACOBS ENGINEERING GROUP INC.

ALBUQUERQUE OPERATIONS

WATER SAMPLE IDENTIFICATION TAG

SITE ID _____ LOCATION ID _____

SAMPLE ID _____ LOG DATE _____

BOTTLE ID _____

PRESERVATION METHOD _____

SAMPLER (S) _____

COMMENTS: _____

ICE

NO ICE

FILTERED

NON FILTERED

ALBUQUERQUE OPERATIONS MANUAL

SECTION 16.1.10

DATE 8/29/90

EFFECTIVE 9/10/90

SUPERSEDES

PAGE 1 OF 16

1.0 PURPOSE

To provide procedures by which field determinations for temperature, pH, conductivity, alkalinity, and total acidity will be performed and documented.

2.0 SCOPE

These procedures are applicable to members of the TAC and its contractors, subcontractors with responsibilities and duties for the field measurements of collected water samples prior to shipment to the analytical laboratory.

3.0 EQUIPMENT

3.1 Pumps

3.2 Hoses/Tubes

3.3 pH Meter & Electrode with "slope" adjustment feature and with temperature compensator.

3.4 Conductivity Meter & Electrode with thermometer.

3.5 Thermometer

3.6 Magnetic Stirrers and Magnetic stirring bars (Available at Laboratory)

3.7 Titrator

3.8 Filter Apparatus and Filters

3.9 Erlenmeyer Flask: 125 mL (Available at Laboratory)

3.10 Volumetric Flasks, Class A: 100, 250, 500, and 1000 mL (Available at Laboratory) All but 100 mL are required only if preparing solutions listed in 4.0.

3.11 Graduated Cylinder: 50, 100, 250, and 500 mL (Available at Laboratory) All but 100 mL are required only if preparing solutions listed in 4.0.

○

11

○

- 3.12 Beakers: 150, 250, and 400 mL (Available at Laboratory) Required only if preparing solutions listed in 4.0.
- 3.13 Sample Bottles: 250, 500, 1000 mL (or U.S. equivalents)
- 3.14 Cooler w/"blue ice" or equivalent
- 3.15 Parafilm or its equivalent

4.0 REAGENTS & SUPPLIES

NOTE: Whenever required by the procedure, JEG purchases and uses prepared, calibrated and certified solutions from chemical supply firms. The following are listed in the event certified solutions are not readily available or are used whenever procedure parameters do not require use of certified solutions. In the event that solutions require preparation, they will be prepared at the laboratory before going into the field. Items 4.12 through 4.21 are required only as needed.

4.1 Potassium Chloride: KCl. Reagent Grade. Purchased from chemical supply firms.

- 4.1.1 0.2 M Potassium Chloride: 0.2 M KCl Standard Solution (equivalent to 24,820 umhos/cm and 14,910 mg KCl/L). Weigh out 14.91 grams of KCl crystals into a 1000 mL volumetric flask containing 750 mL of distilled water. Mix solution to dissolve KCl salt. Add distilled water to 1000 mL mark, stopper flask, and mix solution well. Store solution in a polyethylene or glass bottle labelled with "24,820 umhos/cm: 14,910 mg KCl/L", "0.2 M KCl: 14.91 g KCl/L distilled water", date, and preparer's initials. Make all dilutions from this bottle.

Conductance of KCl Solutions @ 25° C.*			
<u>Concentration</u>		<u>Conductance (umho/cm)</u>	
<u>M</u>	<u>PPM</u>	<u>Equivalent</u>	<u>Specific</u>
0.0	---	149.85	---
0.0001	7.5	149.43	14.94
0.0005	37.3	147.81	73.90
0.001	74.6	146.95	147.0
0.005	373	143.55	717.8
0.01	746	141.27	1,413
0.02	1,491	138.34	2,767
0.05	3,728	133.37	6,668
0.1	7,455	128.96	12,900
0.2	14,910	124.08	24,820
0.5	37,276	117.27	58,640
1.0	74,551	111.87	111,900

*From Reference 12.1. See 12.0.

- 4.2 KCl-A Solution: Pipet 10 mL of the 0.2 M KCl Standard Solution into a 200 mL volumetric flask containing 150 mL of distilled water and mix solution well. Add distilled water to 200 mL mark of flask, stopper flask, and mix solution well. Label flask as "KCl-A", "1,413 umhos/cm", "10 mL of KCl Standard Solution/ 200 mL of distilled water", date, and preparer's initials.
- 4.3 KCl-B Solution: Pipet 10 mL of the KCl Standard Solution into a 100 mL volumetric flask containing 70 mL of distilled water and mix solution well. Add distilled water to 100 mL mark, stopper flask, and mix solution well. Label flask as "KCl-B", "2,767 umhos/cm", "10 mL of KCl Standard Solution/100 mL of distilled water", date, and preparer's initials.
- 4.4 KCl-C Solution: Pipet 25 mL of the KCl Standard Solution into a 100 mL volumetric flask containing 70 mL of distilled water and mix solution well. Add distilled water to 100 mL mark, stopper flask, and mix solution well. Label flask as "KCl-C", "6,668 umhos/cm", "25 mL of KCl Standard Solution/100 mL of distilled water", date, and preparer's initials.
- 4.5 KCl-D Solution: Pipet 50 mL of the KCl Standard Solution into a 100 mL volumetric flask containing 40 mL of distilled water and mix solution well. Add distilled water to 100 mL mark, stopper flask, and mix solution well. Label flask as "KCl-D", "7,446 umhos/cm", "50 mL of KCl Standard Solution/100 mL of distilled water", date, and preparer's initials.
- 4.6 Hydrochloric Acid: HCl. 36.5-38%, 12 M (~12 N); Reagent Grade. Purchased from chemical supply firms.
- 4.7 Nitric Acid: HNO₃. 70%, 16 M (~16 N); Reagent Grade. Purchased from chemical supply firms.
- 4.8 Sulfuric Acid: H₂SO₄. 98%, 18 M (~36 N); Reagent Grade. Purchased from chemical supply firms.
- 4.9 Sodium Hydroxide: NaOH. Reagent Grade. In pellet form. Purchased from chemical supply firms.
- 4.10 ~1 N NaOH Solution: Add 40 g of reagent grade Sodium Hydroxide pellets to a 1000 mL volumetric flask containing 900 mL of distilled water or its equivalent and swirl solution to dissolve the NaOH pellets. Cool solution in an ice water bath. Add distilled water to the 1000 mL mark, stopper flask, and mix solution well. Store solution in a polyethylene bottle labeled with "~1 N NaOH", "40 g NaOH/1000 mL of distilled water", date, and preparer's initials. Prepare fresh solution every 30 days and add new date.
- 4.11 1.6 N NaOH. HACH cartridge. Purchased from chemical supply firms.
- 4.12 0.16 N NaOH. HACH cartridge. Purchased from chemical supply firms.

- 4.13 pH 1 Buffer Solution: Certified as ± 0.02 pH units and with expiration date. Purchased from chemical supply firm. Supplied in tablet or powder form. NOTE: Prepare fresh before use as instructed. Discard solution after use.
- 4.14 pH 4 Buffer Solution: Certified as ± 0.02 pH units and with expiration date. Purchased in solution form from chemical supply firm. NOTE: Discard any solution whose expiration date has elapsed.
- 4.15 pH 5 Buffer Solution: Certified as ± 0.02 pH units and with expiration date. Purchased in solution form from chemical supply firm. NOTE: Discard any solution whose expiration date has elapsed.
- 4.16 pH 7 Buffer Solution: Certified as ± 0.02 pH units and with expiration date. Purchased in solution form from chemical supply firm. NOTE: Discard any solution whose expiration date has elapsed.
- 4.17 pH 10 Buffer Solution: Certified as ± 0.02 pH units and with expiration date. Purchased in solution form from chemical supply firm. NOTE: Discard any solution whose expiration date has elapsed.
- 4.18 pH 12.45 Buffer Solution: Certified as ± 0.02 pH units and with expiration date. Purchased from chemical supply firm. Supplied in powder form. NOTE: Prepare fresh before use as instructed. Discard solution after use. Due to the instability of this high pH buffer solution, prepare this buffer solution fresh as needed and do not store.
- 4.19 Distilled Water or Deionized Water
- 4.20 Masking Tape, Nylon Tape, Electricians Tape, and Magic Marker.
- 4.21 Plastic Sheet and Aluminum Foil.
- 4.22 Lint-free Tissue(s).
- 4.23 Data Collection Sheets: Water Quality Sampling Record Forms, Chain-of-Custody Forms, and Sample Collection Procedures.

5.0 PROCEDURE: Field Measurements of a Collected Water Sample

- 5.1 Whenever practical, final field measurements are to be taken after at least three (3) borehole volumes have been pumped from the well and as close to the time of sampling as is possible.

- 5.2 Field measurements to determine temperature, conductivity, and pH are performed on a water sample as it is being collected and are to be recorded on Attachment 16.1.10.2.
- 5.3 Alkalinity is determined on an aliquot of the raw water sample and prior to shipment of the sample to the laboratory. Titration volumes at a specified pH are observed and recorded on Attachment 16.1.10.2, page 3 of 4. Known alkalinity solution data are observed and recorded on Attachment 16.1.10.3.
- 5.4 Total Acid determinations are performed on selected groundwater or lysimeter (pore water) samples. This data is recorded in the "COMMENTS" portion of Attachment 16.1.10.2.

6.0 PROCEDURE: Temperature Measurement

A conductivity meter and electrode with a thermometer built into the electrode are strongly recommended for this procedure.

- 6.1 Clean thermometer by washing it in a solution of soap and water. Use a brush to scrub the thermometer. Rinse thermometer well with distilled water and blot dry with lint-free tissue(s).

- 6.1.1 NOTE: Always blot dry thermometer and electrode with tissue. Water droplets remaining on these probes may dilute or otherwise affect measurement data. Rubbing probes with tissue may result in warming the thermometer or produce an electrostatic charge on the electrode and so directly alter meter readings.

- 6.1.2 If Conductivity Meter has a thermometer built into the electrode, use instructions of 6.1.

- 6.2 A combination conductivity-temperature probe is used in the field. This thermometer must be checked against a lab grade mercury thermometer at least once a month. At the same time, the conductivity meter is also tested for accuracy, using the following procedure.

- 6.2.1 Pour approximately 30 mL of lab prepared KCL solution of 4.3 above into a clean beaker. Place the clean temperature- conductivity probe into the solution. Place the beaker in an ice bath, and using a lab grade mercury thermometer, chill the solution to as near 0° C as possible. Salt should be placed on the ice to reach this low temperature.

- 6.2.2 When the KCL solution has reached a maximum of 3° C, read and record the temperature from the lab thermometer and the meter.
Also read and record the conductance.

NOTE: If meter has an automatic temperature compensator (ATC), turn off ATC or turn dial to "0." Do not use ATC for this test.

- 6.2.3 Remove the beaker from the ice bath to allow it to warm. Continue reading and recording temperature pairs as well as conductance at least every 2° C up to 25° C. Remove thermometer from the beaker, clean with distilled water, pat dry with tissue(s) and store.
- 6.2.4 Remove temperature-conductivity probe from beaker, rinse with distilled water, and blot dry with tissues. Pour approximately 20 mL of the other three KCl standards (at room temperature) into four separate clean beakers. Measure and record the conductance of each solution, being sure to rinse and dry the probe between measurements.
- 6.2.5 Remove temperature-conductivity probe from the final beaker, rinse with distilled water, dry with tissue(s) and store.
- 6.2.6 Using the data from 6.2.2, 6.2.3, and 6.2.4, plot lab thermometer temperature versus meter temperature on arithmetic graph paper. Plot meter temperature versus meter conductivity and meter conductivity versus known conductivity on arithmetic graph paper. Submit the data and graphs to the water sampling manager.
- 6.2.7 The meter is now ready for measuring temperature and conductance in the field.
- 6.3 Insert the dry and clean thermometer into the flow-through cell. Allow the temperature to stabilize. Record the temperature measurements periodically on Attachment 16.1.10.2 throughout the time of pumping.
 - 6.3.1 Place the flow-through cell close to the wellhead. Be sure to keep the cell and discharge hose/tube out of direct sunlight.
 - 6.3.2 Use the temperature data to adjust the pH temperature compensator.
- 6.4 When the sample bottle is full, shut off the pump, and carefully withdraw the thermometer from the flow-through cell. NOTE: If water sample looks "dirty" and contains residue that will not be removed with distilled water, clean thermometer probe as stated in 6.1.

C

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C

6.5 Rinse thermometer probe with distilled water and blot dry with lint-free tissue(s). The probe is now ready for another water sampling activity or storage.

6.5.1 If the probe is to be stored, place it in its carrying case. Label with "clean", date, and initials.

6.6 Clean equipment as described in 8.8 through 8.10 of Section 16.2.1.

6.7 If Conductivity, pH, Alkalinity, or Total Acidity determination is required, proceed with 7.0, 8.0, 9.0, or 10.0.

6.8 To prepare sample for filtration (if required), preservation (if required), and shipment of samples to the analytical laboratory, proceed with 12.0 of Section 16.2.1.

7.0 PROCEDURE: Conductivity Measurement

A Conductivity Meter and electrode with a thermometer built into the electrode is strongly recommended for this procedure. Because conductivity measurement instruments and instrument operation instructions vary with each manufacturer, the analyst is advised to use the specific instructions for instrument operations that are provided with the conductivity meter to be used by the analyst.

If not already performed, test conductivity meter as described in Section 6.2.

7.1 Remove electrode and cable from carrying case, rinse well with distilled water, and blot dry with tissue.

7.1.1 Always blot dry electrode with tissue. Water droplet(s) remaining on the electrode may dilute or otherwise affect conductivity measurement(s). Rubbing electrodes with tissue may also produce electrostatic charges on the electrode and thus directly alter meter readings.

7.2 Insert clean and dry electrode/cable into the flow-through cell before water sampling is to begin. Read sample conductivity and record value(s) periodically throughout the sampling period and especially just after sampling is completed.

7.3 Withdraw electrode and cable, rinse well with distilled water, and blot dry with tissue paper. Electrode/cable now ready for another sampling activity or storage.

7.3.1 Label with "clean", date, and initials if electrode is to be stored.

7.4 If pH, Alkalinity or Total Acidity determination is required, proceed with 8.0, 9.0, or 10.0. If pH, Alkalinity or Total Acidity determination is not required, proceed with 12.0 of Section 16.2.1.

7.4.1 To prepare water sample(s) for filtration (if required), preservation (if required), and shipment to the analytical laboratory, proceed with 12.0 of Section 16.2.1.

7.5 Check Attachment 16.1.10.2 to make sure that all of the required sampling data has been recorded.

7.6 Proceed with 12.9 of Section 16.2.1 to complete required duties.

8.0 PROCEDURE: pH Measurement

A pH meter and electrode with a temperature compensator and a slope adjustment feature are strongly recommended for this procedure. Because pH measurement instruments and instrument operation instructions vary with each manufacturer, the analyst is advised to use the specific instructions for instrument operations that are provided with the pH meter to be used by the analyst. The meter and electrode can be readily adjusted to the temperature of the sample solution and can be calibrated with pH buffer solutions so that the analyst may easily and quickly work with samples having a pH range of 1-4, 4-7, 7-10, or >10.

8.1 Rinse the pH electrode with distilled water and blot dry with lint-free tissue(s).

8.1.1 Always blot dry pH electrode with tissue. Water droplet(s) remaining on the electrode may dilute or otherwise affect measurement data. Rubbing electrodes with tissue may result in producing an electrostatic charge on the electrode and so directly alter the meter readings.

8.1.2 When not using pH meter/electrode, always place pH electrode in a container of pH 4 buffer solution and seal with parafilm or its equivalent.

8.2 Prior to performing pH measurements in the field or in the lab, at least once per quarter, test the pH meter and Electrode: Determine Temperature and pH. The description below is for a meter with an Automatic Temperature Compensator (ATC). For meters not equipped with an ATC, the procedure is the same.

8.2.1 Prepare a pH 5.0 buffer solution as described on the pH tablet bottle and label as "pH 5.0 Buffer Solution", add date, and write initials on bottle.

8.2.2 Pour 30 mL of pH 5.0 buffer solution into each of three (3) beakers labelled as "A-pH 5.0" (beaker A), "B-pH 5.0" (beaker B), and "C-pH 5.0" (beaker C).

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C

- 8.2.3 Place beaker A in an ice water bath, beaker B on the lab bench, and beaker C in a hot water bath. Allow beakers 10-15 minutes to acclimate to their media. Swirl beakers to mix solution.
- 8.2.4 With automatic temperature compensator (ATC) off or dialed to "0", place a clean and dry pH electrode and a clean and dry lab thermometer into beaker A. Read pH to the nearest 0.01 pH units and temperature to the nearest 0.1° C. Record pH and temperature on Attachment 16.1.10.1.
- 8.2.5 Withdraw electrode and thermometer, rinse each with distilled water, and dry with tissue.
- 8.2.6 Repeat 8.2.4 and 8.2.5 with beaker B.
- 8.2.7 Repeat 8.2.4 and 8.2.5 with beaker C. Store clean electrode as stated in 8.1.2. Store clean thermometer as stated in 6.5.
- 8.2.8 Plot pH and temperature data on semi-log graph paper (pH versus temperature). Attach this data to Attachment 16.1.10.1.
- 8.2.9 Unless foregoing data indicates that pH meter/electrode are not operating properly, pH meter/electrode is ready for sample collection trip in the field or laboratory work.
- 8.3 Calibrate the pH meter and electrode with standardized pH buffer solutions. NOTE: See 4.13 to 4.21.
 - 8.3.1 If pH meter has a slope adjustment feature, calibrate pH meter and electrode with buffer solutions which bracket the sample pH.
 - A. Set ATC on pH meter to the temperature of the water sample. Use temperature data from 6.3. Alternatively, if the pH meter does not have an ATC, chill the pH buffer solution(s) to equal the water sample temperature.
 - B. To calibrate pH meter/electrode for pH 4-7 range, insert clean and dry pH electrode into a labelled beaker containing a fresh solution of pH 7 buffer. Measure pH. Adjust pH reading to 7.0. Withdraw electrode, rinse with distilled water, and blot dry with tissue. Insert clean and dry pH electrode into a labelled beaker containing a fresh solution of pH 4. Measure pH. Adjust the slope to give a pH reading of 4. Withdraw electrode, rinse with distilled water, and blot dry with tissue.
 - o To calibrate pH meter/electrode for pH 1-4 range, use pH 1 and pH 4 buffer solutions. Use pH 4 buffer

solution instead of pH 7 buffer solution and pH 1 instead of pH 4 as stated in B. above.

- o To calibrate pH meter/electrode for pH 7-10 range, use pH 7 and pH 10 buffer solutions. Use pH 7 buffer solution and pH 10 buffer solution instead of pH 4 as stated in B. above.
 - o To calibrate pH meter/electrode for pH 10-12.45 range, use pH 10 and pH 12.45 buffer solutions. Use pH 10 instead of pH 7 buffer solution and pH 12.45 buffer solution instead of pH 4 as stated in B. above.
- C. Insert clean and dry pH electrode into a labelled beaker containing a fresh solution of one of the buffers which bracket the sample. Measure pH. Withdraw electrode, rinse with distilled water, and blot dry with tissue. Repeat with the other buffer which brackets the sample.
- o If pH is within ± 0.02 units, depending on certification of pH buffer solution, proceed with 8.4 and with pH measurements of water samples.
 - o If pH is not within ± 0.02 units, depending on certification of pH buffer solution, repeat A, B, and C until pH meter/electrode gives repetitive readings. Repeat at least twice. If pH meter or electrode does not work satisfactorily, see Troubleshooting Instructions for pH meter and electrode.

8.3.2 If the pH meter does not have a slope adjustment feature, set ATC on pH meter to the temperature of the water sample. Use temperature data from 6.3. Alternatively, if the pH meter does not have an ATC, chill the pH buffer solution(s) to be used for the calibration or calibration checks to equal the water sample temperature.

- A. Insert a clean and dry pH meter into a pH 7 buffer solution. If necessary, adjust pH meter to 7 or pH reading on pH 7 buffer bottle. Record pH meter reading. NOTE: Record all pH readings on Attachment 16.1.10.2.
- B. Withdraw probe, rinse probe well with distilled water, and blot probe dry with tissue paper.
- C. Repeat A and B.
- D. Insert clean and dry pH probe into the sample solution, obtain pH reading, and record pH reading.

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- E. Repeat B.
 - F. Insert clean and dry pH probe into a pH buffer solution that best approximates the pH of the sample solution. Obtain and record pH reading.
 - G. Repeat B.
 - H. Repeat A and B. NOTE: Analyst should determine when and how often 1) pH meter should be recalibrated with pH 7 buffer solution, and 2) pH buffer solution that best approximates the sample pH should be used.
 - I. Analyst should continue with sample(s) until all of pH data has been obtained and recorded. Use A through H.
- 8.4 Insert clean and dry pH electrode into the flow-through cell soon after well pumping has begun. This will eliminate or reduce pH meter drift.
- 8.5 If the pH meter has an ATC, adjust the temperature setting on the pH meter to the temperature of the sample solution. NOTE: Use temperature measurement data from 6.3.
- 8.5.1 Alternatively, if the pH meter has no ATC, reduce the temperature of the pH buffer solutions when calibrating the pH meter.
- 8.6 Read pH and record measurement within five (5) minutes or after drift has ceased, whichever is sooner. Rinse and blot dry electrode. If possible, perform pH measurement at least three (3) times during the purging of the well.
- 8.7 Periodically during purging, check accuracy of the pH meter with buffer solution(s) that bracket the sample solution and adjust pH meter as needed according to 8.3.1 or 8.3.2.
- 8.8 When purging is completed, withdraw the electrode from the flow-through cell, rinse the electrode with distilled water, and blot dry with tissue(s). Measure the final pH of each of the two (2) bracketing buffers, being sure to clean the electrode between use of the buffer solutions.
- 8.8.1 If the meter is accurate within 0.10 units of each buffer, record the results on Attachment 16.1.10.2. Proceed to 8.9.
- 8.8.2 If the meter is inaccurate (greater than 0.10 units variance with either buffer) recalibrate the meter. Continue purging and recording pH of the sample for at least four (4) to eight (8) liters of sample. Return to 8.7 and repeat until consistent pH reading within 0.10 units is achieved.

- 8.9 When a sufficient volume of sample has been collected in the sample bottle, remove hoses and pumps from the well hole.
- 8.10 Clean pH electrode: rinse with distilled water and blot dry with tissue. pH electrode now ready for another sampling activity or storage. To store electrode, see 8.1. Label with "clean", date, and initials.
- 8.11 Clean equipment as described in 8.8 through 8.10 of Section 16.2.1.
- 8.12 Check Attachment 16.1.10.2 to make sure that all of the sampling data has been recorded on the form.
- 8.13. If Alkalinity or Total Acidity determination is required, proceed with 9.0 or 10.0 respectively.
- 8.14 To prepare sample for filtration (if required), preservation (if required), and shipment to the analytical laboratory, proceed with 12.0 of section 16.2.1.

9.0 PROCEDURE: Alkalinity Measurement

Alkalinity determination (total carbonate) is performed on an aliquot of the raw, unfiltered, and unpreserved water sample by titration of the sample with an acid and measured by a pH meter.

- 9.1 Fill in all sample information on Attachment 16.1.10.2, page 3 of 4. NOTE: Record all procedure information on Attachment 16.1.10.2, page 3 of 4.
- 9.2 Wash the Erlenmeyer flask(s) and volumetric flask(s), to be used for this determination, with soap and water. Rinse the flasks THREE (3) times with 20 mL of distilled water. Discard rinses. Set flasks upside down to drain. After 10 minutes, remove remaining water droplets by shaking flasks vigorously.
- 9.3 Connect clean pH electrode to the pH meter and rinse electrode well with distilled water and blot dry with tissue.
- 9.4 Calibrate the pH meter/electrode as described in 8.3 and store electrode as described in 8.1.
- 9.5 Without too much splashing or other vigorous agitation of the water sample, carefully pour the water sample into a labelled 100 mL volumetric flask. Add water sample to the 100 mL mark. NOTE: Pour sample down the side of the flask.
- 9.6 With as little agitation as possible, carefully pour the water sample from the flask into a labelled 125 mL Erlenmeyer flask. If available, add a magnetic stirring bar, turn magnetic stirrer on,

and stir sample slowly. Record sample aliquot volume on Attachment 16.1.10.2, page 3 of 4.

9.7 Insert the pH electrode into the sample and suspend the electrode in the water sample. Adjust the ATC on the pH meter to the temperature of the water sample. Determine sample pH and record value.

9.8 Place a 1.6 N H₂SO₄ cartridge in the titrator. Record the titrant lot number of the cartridge (on Attachment 16.1.10.2). Eject a few drops of titrant from the titrator tip, wipe tip with a clean tissue, and reset the counter to "0000".

9.9 While gently stirring the sample, titrate the sample with acid by turning the titrator delivery knob. Obtain pairs of pH and alkalinity readings at each pH value listed on Attachment 16.1.10.2, page 3 of 4. NOTE: The alkalinity value at the inflection point between pH 5 and pH 4 will be determined by the Site Hydrologist. The volume in mL equals digital titrator reading divided by 800.

9.9.1 Alkalinity titration endpoints depend upon the total alkalinity concentration. The following endpoints will be used:

<u>Alkalinity</u>	<u>End Point</u>
0-30 mg/L	pH 5.1
31-150 mg/L	pH 4.8
150 mg/L	pH 4.5

9.9.2 When the titration is complete, check pH meter calibration (See 8.3). If the meter is accurate within 0.2 units of each buffer value, record the results on Attachment 16.1.10.3. If the meter is inaccurate (greater than 0.2 units of each buffer value), recalibrate the meter and repeat the alkalinity test.

9.10 Repeat this procedure with a second Tech Rep performing the titration on a fresh aliquot of water sample.

9.11 Calculate the relative error (R.E.) as:

$$R.E. (\%) = \frac{(X_1 - X_2) \times 100\%}{X_2}$$

Where X₁ is the first alkalinity measurement at pH endpoint, X₂ is the second alkalinity measurement at pH endpoint, and X_e is the lesser of X₁ or X₂.

9.12 If the percentage error is greater than ten percent (>10%), repeat the foregoing procedure until two (2) consecutive measurements are within 10% relative error.

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9.13 Perform alkalinity determinations on three (3) known solution(s) submitted to JEG by a quality control laboratory and record the pH and alkalinity values on Attachment 16.1.10.3. When performing this procedure, the standard solution identification, site identification, alkalinity test kit identification, pH meter identification, date, and Tech Rep name must be filled out on Attachment 16.1.10.3. Send this attachment to the Quality Control Laboratory

9.13.1 Send a copy of Attachment 16.1.10.3 to the Data Manager who will record this data on a form similar to Attachment 16.1.10.3 provided by a quality control laboratory.

9.13.2 Field alkalinity values and known solution values must agree within 10% of each other or the field test will have to be repeated until the values are accurate.

9.14 To prepare the sample(s) for filtration (if required), preservation (if required), and shipment, proceed with 12.0 of Section 16.2.1.

9.15 If Total Acidity is required, proceed with 10.0.

9.16 To complete duties, proceed with 12.9 of Section 16.2.1.

10.0 PROCEDURE: Total Acidity

This procedure is performed on selected groundwater or lysimeter (pore water) samples to determine the total acidity of the solutions and to determine the acid-neutralizing potential of carbonate materials within silty soils or sediments.

Digital Titration with HACH Cartridge

10.1 Record site identification, location identification, date, and all titration data under "Comments" on the Soil Water Sampler Data Record, under "Notes" of Attachment 16.1.10.2, or on a separate data sheet.

10.2 Calibrate the pH meter/electrode as described in 8.3 and store pH electrode as described in 8.1.

10.3 Rinse a 100 mL graduated cylinder and a 125 mL Erlenmeyer flask with distilled water. Place cylinder and flask upside down to allow excess water to drain. Remove residual water droplets by vigorously shaking the cylinder and flask. NOTE: If a 100 mL cylinder is unavailable, use a 100 mL volumetric flask.

10.4 Carefully pour a 100 mL aliquot of the unfiltered water sample into the graduated cylinder and then carefully pour the sample into the 125 mL titration flask. NOTE: Pour sample down the side of the cylinder and flask.

10.4.1 If necessary, use a sample aliquot of less than 100 mL to perform a second titration. NOTE: Two (2) sample aliquots of 50 mL each with titrations on each aliquot are preferred to one (1) sample aliquot of 100 mL and one (1) titration.

10.5 Place clean pH electrode into the water sample, add a magnetic stirring bar, place sample on a magnetic stirrer, and gently stir sample. Record the initial sample pH. Withdraw pH electrode, rinse electrode with distilled water and blot dry with tissue.

10.6 Place a 1.6 N NaOH cartridge in the titrator. Record the HACH titrant lot number of the NaOH cartridge. Eject a few drops of titrant from the titrator tip, wipe tip with clean tissue, and reset the counter to "0000".

10.7 While gently stirring the sample, turn titrator delivery knob and start titration. Record sample pH and corresponding volume of NaOH titrant after every 1-2 turns of the titrator delivery knob (volume in mL = digital titrator reading divided by 800). If pH endpoint of 8.3 is obtained after less than eight (8) turns, then re-do the titration.

10.7.1 Do not use color indicator tablets to determine the pH endpoint.

10.7.2 Use a 0.16 N NaOH cartridge to re-do the titration. Record use of 0.16 N NaOH on the data sheet Form 10.1.

10.8 Rinse all glassware with distilled water. Set glassware upside down to allow excess water to drain.

10.9 Calculate the total acidity as follows:

$$\text{Acidity, u equiv/liter} = \frac{V_t \times N_t \times 10}{V_a}$$

Where V_t = Volume, in mL, of NaOH titrant used to obtain pH 8.3, N_t = Normality of NaOH used to titrate the sample, and V_a = Volume, in mL, of sample aliquot (should be 50 or 100 mL, unless lysimeter produces very little water). NOTE: Be sure to specify and record which NaOH and Volume of NaOH are used for the titration.

10.10 - Repeat the titration procedure with a second Tech Rep performing the titration unless there is insufficient sample volume produced by the well or lysimeter.

10.11 Calculate the relative error in percent (R.E., %) as previously described in 9.11.

10.12 If the relative error is greater than 10%, repeat the procedure a third time, unless there is insufficient sample volume available.

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- 10.13 Check Attachment 16.1.10.2 to see that all of the required data has been recorded on the forms.
- 10.14 See 12.9 of Section 16.2.1 to complete required duties.
- 11.0 ATTACHMENT(S): Supporting Document(s)
- 16.1.10.1 Equipment Checklist
- 16.1.10.2 Water Quality Sampling Record Form
- 16.1.10.2 Alkalinity Titration Form (page 3 of 4)
- 16.1.10.3 Standard Alkalinity Test
- 12.0 REFERENCES
- 12.1 APHA/AWWA/WPCF, 1985. Standard Methods for the Examination of Water and Wastewater, 16th Edition. American Public Health Association, Washington, D.C. 20005.
- 12.2 Korte, N. and P. Kearl, 1984. "Procedures for the Collection and Preservation of Ground Water and Surface Water Samples and for the Installation of Monitoring Wells," U.S. Department of Energy, Grand Junction, Colorado.
- 13.0 PROCEDURE REVIEW AND APPROVAL

Prepared By: *John E. Felt* 8-30-90
TAC Representative Date

Reviewed By: *Frank R. Hite* 9/7/90
Task Manager Date

Reviewed By: *Bob P. Beaulieu* 9-7-90
Quality Assurance Manager Date

Approved By: *Thomas R. Hite*
Project Manager/Deputy Project Manager Date

WATER QUALITY SAMPLING RECORD

SITE ID: _____

FINAL FIELD VALUE AT THE SURFACE

LOCATION ID: _____

SAMPLE ID: _____

pH (S.U.)

STATIC WATER LEVEL (FT) _____

Ec (μmhos/cm)

SAMPLE DEPTH (FT) _____

TEMP. (°C)

SAMPLING DATE _____

ALKALINITY (mg/l CaCO₃) @ pH 4.5

SAMPLING TIME:

TITRANT: 1.6 N H₂SO₄ LOT #

START _____

COMPLETE _____

FILTER(S) USED

COMMENTS

LOCATION DESCRIPTION

AIR TEMP.	C	D.O. (air)	mg/l	Eh soln.(.1M)	mV	at.	°C
-----------	---	------------	------	---------------	----	-----	----

FIELD REP(S)

[illegible]

WATER QUALITY SAMPLING RECORD

ALKALINITY TITRATION

SITE ID: _____

LOCATION ID: _____

DATE: _____

 ERROR AT 4.50: $\left| \frac{X1 - X2}{X^S} \right| \times 100 = \underline{\hspace{1cm}}\%$

1st = _____%

2nd = _____%

pH CHECK AFTER TITRATION

7.00 = _____

4.00 = _____

pH	ALKALINITY (mg/l CaCO ₃)		
	1st	2nd	3rd
INITIAL pH			
8.90			
8.60			
8.30			
8.05			
7.80			
7.50			
6.50			
5.70			
5.10			
4.80			
4.50			
4.25			
4.00			

SAMPLE ALIQUOT IS 100 ML UNLESS STATED OTHERWISE.

NOTES

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JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

EXHIBIT C
ATTACHMENT 4
SUBCONTRACT NO. 34-6705-S _____

ACKNOWLEDGEMENT OF RECEIPT OF SAMPLES FOR DELIVERY ORDER NO. 0

SITE ID: _____ LOCATION ID: _____ SAMPLE ID: _____

SAMPLE SHIPMENT LIST

SAMPLE MATRIX (Check one)

LOT# _____

WATER () SOIL ()

<u>BOTTLE</u> <u>ID</u>	<u>AMOUNT</u>	<u>REC'D</u> (✓)	<u>BOTTLE</u> <u>ID</u>	<u>AMOUNT</u>	<u>REC'D</u> (✓)
A1	_____	()	Th 230	_____	()
A1-A	_____	()	GA/3	_____	()
M1	_____	()	N1	_____	()
M1-A	_____	()	CN	_____	()
M2	_____	()	S	_____	()
M2-A	_____	()	TOC	_____	()
Fb 210	_____	()	Alkalinity	_____	()
Po 210	_____	()			
Ra 225	_____	()			
Ra 223	_____	()			

DATE SHIPPED: _____ METHOD OF SHIPMENT: _____

COMMENTS: _____

To be completed by subcontracting laboratory

I hereby acknowledge receipt of the following on: _____
(date)

Delivery Order No. _____ Work Order Plan dated: _____

Subcontractor: _____
Name: _____
Title: _____

COMMENTS: _____

In accordance with Exhibits B and C of the Subcontract :
Water Quality Analytical

Results due to JEG by: _____
(date)

(

)

)

JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

STANDARD ALKALINITY TEST

**STANDARD SOLUTION
ID**

**KNOWN VALUE
(mg/l CaCO₃)**

ALKALINITY TEST VALUES

pH

mg/l CaCO₃

REQ# _____

LAB# _____

REQ# _____

LAB# _____

REQ# _____

LAB# _____

SITE ID: _____

FIELD REP ID: _____

ALKALINITY TEST KIT ID: _____

pH METER ID: _____

DATE: _____

SEND TO: _____

COMMENTS: _____

ATTACHMENT 16.1.10.1
EQUIPMENT CHECKLIST

(Fill out all blanks prior to leaving for field)

pH BUFFER

Yes

No

Comments

sufficient volume 4
sufficient volume 7
sufficient volume 10

REAGENTS & BOTTLES

Litmus paper
Nitric acid (pres.)
Sulfuric acid (pres.)
not required * _____
Other reagents
not required _____

Required sample bottles:

Number of 1000 ml plastic bottles
for Al, M2, Po210, Th230, CN, S,
Pb210, Ra226, Ra228 _____

Number of 500 ml plastic bottles
for Gross Alpha-Beta, N1 _____

Number of 500 ml amber glass
bottles for TOC _____

Number of 1000 ml amber glass
bottles for TOX _____

Sufficient bottles

Alkalinity kit
ck reagent volumes
ck glass for breakage

* If required, must explain under Comments.

ATTACHMENT 16.1.10.1

EQUIPMENT CHECKLIST

(Fill out all blanks prior to leaving for field)

OTHER EQUIPMENT

Comments

squeeze bottle _____
acid dispensette _____
deionized H₂O
quantity _____ gallons
distilled H₂O _____ gallons
water level sounder _____ battery check _____
hand tape _____
cloth towels or wipes _____

FIELD FORMS AND MISCELLANEOUS EQUIPMENT:

Expected no. of samples _____ No. of forms _____
Clipboard with cover _____
Maps _____ marked with well locations _____
Well information (completion, depth, etc.) _____
Field instruction book _____
Key(s) to well(s) _____ To be picked up at _____
Clean pails _____ Transparent tape _____
WD-40 (for locks) _____ Strapping tape (nylon) _____
Marking pen _____
Coolers _____
Shipping address of lab(s):

ATTACHMENT 16.1.10.1

EQUIPMENT CHECKLIST

(Fill out all blanks prior to leaving for field)

Comments

Phone numbers and contact:

PUMPS AND FILTERS

Logic unit _____

Power cord _____

Regulator _____

Logic unit cord _____

Wrenches _____

Water hose _____

Air hose _____

PERISTALTIC PUMP

Battery cable _____

Rechargeable battery _____

Clean? yes _____ no _____

Battery charger _____

Tubing _____ Length _____

Filter system:

Inspect filter housing for cracks _____

Filter unit legs _____

Number of filters _____

Filter size _____

3

4

5

Handwritten signature

ALBUQUERQUE OPERATIONS MANUAL

SECTION 16.3.3

DATE 8/3/94

EFFECTIVE 8/3/94

SUPERSEDES 10/29/92

PAGE 1 OF 21

DATA MANAGEMENT

1.0 PURPOSE

- 1.1 This procedure outlines the steps that Uranium Mill Tailings Remedial Action (UMTRA) Project Technical Assistance Contractor (TAC) staff shall take to manage chemical analysis data.**

2.0 SCOPE

- 2.1 This standard operating procedure (SOP) provides an operational outline for the systematic management of chemical analysis data and associated UMTRA Project activities. It applies to the following activities: performing prequalification and annual systems audits of subcontract analytical laboratories; performing data package assessments at subcontract laboratories; evaluating quarterly performance evaluation (PE) sample results; preparing cost summaries for each sampling event; managing work performed by subcontract laboratories for cost and technical performance; validating chemical analysis data submitted by subcontract laboratories; authorizing sample reanalysis; distributing chemical analytical data within the UMTRA Project; preparing analytical data packages for transmittal to the U.S. Department of Energy (DOE); reviewing invoices from subcontract laboratories; archiving all original data and associated documents; and authorizing eventual disposal of samples by the subcontract laboratory.**
- 2.2 Each laboratory subcontract contains a statement of work (SOW), labeled Exhibit A, that specifies reporting and format requirements for UMTRA Project chemical analysis data submitted by subcontract analytical laboratories.**
- 2.3 This SOP provides documentation requirements and forms used to provide a record of administrative and technical activities associated with UMTRA Project chemical analysis data management.**
- 2.4 This SOP covers the management of general inorganic and radiochemical data. Since analysis for organic compounds is not typically performed for the UMTRA Project, acquisition and management of organic chemical analysis data are beyond the scope of this procedure.**

3.0 ENVIRONMENTAL, HEALTH AND SAFETY

- 3.1 Data management staff visiting subcontract laboratories shall follow standard laboratory safety practices, including the safety requirements of the facility being visited.**

4.0 RESPONSIBILITIES

4.1 Responsibilities associated with the management of chemical analytical data are as follows:

4.1.1 The Data Base Administrator (DBA) and Analytical Quality Assurance Specialist (AQAS) make up the data management group within the Data Management and Assessment Department. Data management staff member responsibilities are as follows:

- a) Conducting prequalification systems audits for potential subcontract analytical laboratories.
- b) Conducting annual quality assurance (QA) systems audits for subcontract analytical laboratories.
- c) Conducting semiannual in-process surveillance of field sampling activities.
- d) Performing semiannual data package assessments at subcontract laboratories.
- e) Managing the project-specific PE program and evaluating intercomparison study and quarterly PE sample results.
- f) Preparing summaries of PE sample results for annual site monitoring reports.
- g) Communicating with the QA Department on issues related to subcontract laboratory audits and PE sample results.
- h) Providing technical assistance to the Contracts, Characterization and Remedial Design, QA, Data Management and Assessment, and TAC Regulatory Compliance Departments with regard to analytical chemistry.
- i) Preparing technical SOWs for chemical services required by TAC staff.
- j) Scheduling analytical work sent to subcontract laboratories and providing technical assistance to the subcontract representative (SR) and subcontract laboratory.
- k) Performing liaison functions between the Information Systems Planning and Support (ISPS) Department, other TAC departments, and the subcontract laboratories.
- l) Preparing sample, parameter, and subcontract laboratory cost summaries for the chemical analyses associated with each sampling event.

- m) Verifying invoices received from subcontract laboratories for work requested and actually performed.
- n) Preparing data packages for transmittal to DOE.
- o) Evaluating laboratory capabilities and performance to ensure that the requirements of the SOW are met.
- p) Archiving original analytical data and the associated QA and quality control (QC) documents in the UMTRA Project Document Control Center.
- q) Maintaining the Software Program for Environmental Analysis Reporting (SPEAR) data base. This data base is used to store, sort, and study analytical results and other data obtained in support of the UMTRA Project.
- r) Authorizing subcontract laboratories to dispose of samples.

4.1.2 The TAC site hydrologist (SH), site geochemist (SG), and site toxicologist (STox) are responsible for informing data management staff of all events that will generate new chemical analysis data; initiating data management's involvement in the preparation of sampling and analysis plans (SAP); and reviewing and interpreting suspected anomalies in chemical analysis data. In addition, the SH, SG, and STox are responsible for reviewing completed analytical data packages and preparing a TAC Site Hydrologist/Geochemist/Toxicologist summary before transmittal to DOE.

4.1.3 The TAC site manager (SM) has overall responsibility for all TAC activities associated with a specific UMTRA Project site. The SM shall review and approve SAPs prepared by the SH, approve the purchase requisitions for site-specific subcontracted analytical work, and review and transfer completed data packages to the DOE.

4.1.4 The Data Management and Assessment Department manager or his/her designee is responsible for supervising data management staff activities, including approving purchase requisitions for non-site specific analytical services and materials.

4.1.5 The TAC Technical Services group assistant project manager (APM) is responsible for reviewing final SAPs written by the SH and SG. The Technical Services APM or designee shall approve all purchase requisitions for analytical services from subcontract laboratories.

4.1.6 The water sampling manager (WSM) is responsible for conducting all sampling activities and for transmitting field data and sampling documents to data management staff and the UMTRA Project Document

Control Center. In addition, the WSM should communicate in a memorandum to data management staff any difficulties or irregularities encountered during a sampling event.

- 4.1.7 The subcontract representative (SR) is responsible for the overall execution of subcontracts associated with UMTRA Project chemical analysis. The SR is solely authorized to procure analytical services from subcontract laboratories.
- 4.1.8 From the time of sample receipt, subcontract laboratories are responsible for the custody and chemical analysis of all UMTRA Project samples and for fulfilling all data quality and deliverable requirements specified in the subcontract.
- 4.1.9 ISPS data entry operators are responsible for entering chemical analysis data into the SPEAR data base and for generating Suspected Anomalies Reports (SAR). In addition, ISPS personnel are jointly responsible with data management staff for maintaining SPEAR.
- 4.1.10 The QA Department is responsible for monitoring analytical support services with respect to QA objectives within the UMTRA Project. The QA Department shall review all original chemical analysis data and associated documents.
- 4.1.11 The UMTRA Project Document Control Center is responsible for archiving all original chemical analysis data associated with the UMTRA Project.

5.0 PROCEDURE

- 5.1 Prequalification audits are required for any laboratory being considered for a subcontract award. Prequalification audits ensure that laboratory analytical, QA, and deliverable requirements for the UMTRA Project are reliably and routinely achievable.
 - 5.1.1 Data management staff shall conduct prequalification audits of all potential subcontract laboratories. The prequalification audit shall consist of the following:
 - a) Review and comment on the laboratory's technical proposal, SOPs, and laboratory quality assurance plan (LQAP) to determine whether UMTRA Project QA/QC and deliverable requirements are achievable. Any deficiencies should be discussed with the laboratory staff during the prequalification audit.
 - b) A review of results for prequalification PE samples submitted to potential subcontract laboratories. The procedure for this is outlined in Section 5.4.1.

- c) An on-site systems audit as outlined in Section 5.2.

5.1.2 Upon completing the prequalification systems audit, data management staff shall do the following:

- a) Report audit results to the Contracts Department. Data management staff shall provide a copy of the prequalification audit report to the QA Department manager and the Data Management and Assessment Department manager.
- b) Review and comment on proposed corrective actions, as appropriate.

5.2 Data management staff shall participate in on-site annual systems audits with the QA Department and any other UMTRA Project representatives deemed necessary. The purpose of these audits is to verify that UMTRA Project technical, QA, and deliverable requirements are being achieved, as reflected by the laboratory's daily operations adherence to the SOW, LQAP, and SOPs. The procedure for systems audits is outlined in Section 9.2.2, "Quality Audits," of the *Albuquerque Operations Manual*. The systems audit team shall develop a list of items to be inspected. In general, data management staff participating in the systems audit inspection shall do the following:

5.2.1 Notify the laboratory that it will undergo a systems audit. Data management staff normally initiate this action in a telephone conversation with the laboratory. Data management staff should document this conversation on Form 96-C-18, Record of Communication. The QA Department shall then confirm the scheduling of the audit in a letter to the laboratory.

5.2.2 Conduct a preaudit meeting. At this meeting, the audit team, laboratory management, supervisory staff, and QA staff shall define audit objectives. Outstanding issues related to the PE sample results, LQAP, and SOPs should be discussed.

5.2.3 Inspect the laboratory. During this inspection, the audit team shall examine the following:

- a) Sample receiving, handling, chain-of-custody, and storage procedures.
- b) Existence and condition of instrumentation required by the SOW.
- c) QA and QC documents, including instrument calibration and maintenance records, instrument run logs, standard and control preparation logs, digestion logs, corrective action reports (CAR) for out-of-control events, control charts, records for balances, refrigerators, and other equipment.
- d) Data review and reporting procedures.

5.2.4 For annual systems audits, hold an exit meeting. During this meeting, the audit team shall present its findings and discuss questions or problems encountered in the course of the audit. The audit team shall summarize audit findings and subsequently make recommendations in writing regarding corrective actions.

5.3 Data management staff shall conduct in-process surveillance of field sampling activities to ensure that the acquisition of field data meets UMTRA Project requirements. This shall be performed semiannually, once for each sampling team. During this surveillance, data management staff shall do the following:

5.3.1 Observe on-site field sampling procedures and measurement of field parameters.

5.3.2 Observe sample labeling, preservation, shipment, and chain-of-custody procedures.

5.3.3 Report the results of the in-process surveillance of field sampling activities to the QA Department manager, field sampling manager, and Data Management and Assessment Department manager.

5.4 Data management staff shall submit quarterly PE samples to subcontract analytical laboratories for analysis according to the requirements of the SOW. All subcontract laboratories performing radiochemical analyses for the UMTRA Project are also required by DOE Order 5400.1 to participate in the DOE Environmental Measurements Laboratory (EML) Quality Assurance Program. The SOW also requires participation by the subcontract laboratory in the U.S. Environmental Protection Agency (EPA) Environmental Monitoring Systems Laboratory-Las Vegas (EMSL-LV) Radiological Intercomparison Study (RIS). In addition, subcontract laboratories that perform general inorganic chemical analyses for the UMTRA Project are required by the SOW to participate in the EPA Water Pollution (WP) and Water Supply (WS) Laboratory Performance Evaluation Studies.

5.4.1 Quarterly PE samples shall be submitted to all laboratories actively performing chemical analysis in support of the UMTRA Project. Similarly, qualified potential subcontract laboratories shall receive prequalification PE samples as part of the evaluation process. Data management staff shall coordinate this activity as follows:

a) Data management staff shall request PE sample preparation, distribution, and verification by a laboratory independent of the chemical analysis contract structure. Currently, the DOE Grand Junction Projects Office prime contractor, RUST Geotech, is preparing PE samples.

b) The PE samples shall contain all chemical parameters that are covered by the subcontract with the laboratory. One PE sample should be at a low level and one sample at a medium to high level for each parameter, relative to the contract-required

detection limit (CRDL) or lower limits of detection (LLD). At the discretion of data management staff, alternate PE sample rounds may consist of only one low-level PE sample. Also, additional PE samples may be sent to subcontract laboratories if circumstances indicate a need for additional performance data. A table of inorganic parameter CRDLs and radiochemical parameter LLDs for the UMTRA Project is shown in Attachment 1.

- c) Data management staff shall prepare files for all documents associated with PE samples. These files shall be organized by quarterly PE sample event and shall contain a folder for each participating laboratory. Data management staff should place original documents and analytical results associated with PE samples in blue folders with the Deliverable Transmittal/Review form stapled to the front. Once the PE sample round is complete, data management staff shall route original documents to the QA Department and UMTRA Project Document Control Center.
- d) Data management staff shall submit PE sample results from laboratories to ISPS data entry operators for entry into SPEAR. The data entry operator shall enter results under the Site ID PER01, which is reserved for PE sample data. Each participating laboratory receives PE samples with unique location identifications (ID). A list of current subcontract laboratories and their associated lab codes and location IDs is shown in Attachment 2. Theoretical results from the preparing laboratory shall be entered as Sample ID OOTK (for theoretical known), and analytical results from the participating laboratories shall be entered as Sample ID OOK (for analytical known).
- e) Data management staff shall generate a Water Quality Accuracy of Knowns report for each subcontract laboratory submitting analytical results for PE samples.
- f) Data management staff shall evaluate PE sample results from each subcontract laboratory to ensure that all delivery and format requirements outlined in the SOW have been met. Data management staff shall exercise professional judgment in evaluating PE sample results. Particular care shall be taken to identify the following:
 - 1. False negatives.
 - 2. Systematic errors such as calibration deterioration.
 - 3. Large analytical errors.
- g) Data management staff shall consider analytical results for the required intercomparison programs and applicable corrective

action reports when reviewing quarterly PE results.

- h) Data management staff shall compare PE sample results for each laboratory to PE samples results submitted from all participating peer laboratories. Analytical results that are outside the acceptable range specified on the Water Quality Accuracy of Knowns report may require a CAR, if deemed necessary by data management staff. In general, data management staff may request a CAR for any deficiencies discovered in the PE sample analysis.
- i) The AQAS shall summarize PE sample results for each subcontract laboratory and communicate these findings to the QA Department, the Data Management and Assessment Department manager, the subcontract laboratory, and the UMTRA Project Document Control Center.

5.4.2 Subcontract laboratory results for the DOE EML Quality Assurance Program, EPA EMSL, EPA WP, and EPA WS intercomparison samples are due to TAC data management staff on the first day of January, April, July, and October. Data management staff shall evaluate these results as follows:

- a) Data management staff shall evaluate environmental quality assessment sample results quarterly. Data management staff may request a CAR if it is deemed necessary.
- b) Data management staff shall keep on file intercomparison sample results and associated CARs, where appropriate.

5.4.3 Data management staff shall periodically monitor reagent water quality used to prepare field blank and equipment blank samples. At data management's request, water sampling personnel shall collect samples for all necessary parameters from the reagent water supply system in the field sampling staging area. Procedures for collecting samples, performing field analyses, preserving samples, labeling samples, documenting a chain of custody, and shipping samples are provided in the *Albuquerque Operations Manual* (SOPs 16.1.10, "Field Measurements on Water Samples for Temperature, Conductivity, pH, Alkalinity, and Total Acid," 16.2.1, "Sample Collection, Preservation and Shipment of Water Samples," and 16.2.10 "Packaging, shipping, and custody of Environmental Samples"). The water samplers shall label these samples with Site ID PER01 and Location ID 0999. The DBA shall procure analytical services for these samples as outlined in Section 5.6.3.

5.4.4 As specified in the SOW, each subcontract laboratory shall submit a monthly progress report (MPR) to Jacobs Engineering Group Inc. (JEG) data management by the 15th day of each month. These MPRs should include changes in analytical SOPs, summaries of out-of-control events,

descriptions to changes in the LOAP, changes in key personnel, and changes in certification status.

5.4.5 As specified in the SOW, data management staff have the option to suspend a subcontract laboratory from participation in the UMTRA Project TAC chemical analysis program for failure to provide intercomparison study results, PE sample analyses, or MPRs.

5.5 Data management staff shall perform in-laboratory reviews of completed data packages from each subcontract laboratory performing analyses for the UMTRA Project as outlined below:

5.5.1 Data management staff shall perform an in-laboratory review of a completed data package for each subcontract laboratory providing analytical services to the UMTRA Project. The purpose of this data package review is to verify that all UMTRA Project QA criteria and data quality objectives have been met. This activity shall be performed twice per calendar year: once during the annual systems audit of each subcontract laboratory and again approximately 6 months later. Data management staff shall evaluate each data package inspected against data deliverable and QA/QC criteria outlined in the SOW and the EPA Contract Laboratory Program (CLP) Statement of Work for Inorganic Analysis, ILMO2.0, 1991, where applicable, and against the requirements outlined in the *Albuquerque Operations Manual*, SOP 16.3.2, "Validation of Chemical Analysis Data," which details data validation criteria.

5.5.2 Data management staff shall submit a written report of the in-laboratory data package review to the QA Department and to the Data Management and Assessment Department manager. Data management staff shall also keep this report on file.

5.5.3 Data management staff have the option to suspend a subcontract laboratory from further participation in the UMTRA Project TAC chemical analysis program for serious subcontract violations or deficiencies identified during semiannual data package reviews.

5.6 Data management staff shall prepare sample, parameter, and cost summaries for each sampling event. If the requested services are not covered under current subcontracts, data management staff members shall provide technical advice to the JEG Contracts Department. Data management staff may be required to prepare a SOW to procure non-routine analytical services.

5.6.1 For each sampling event, data management staff shall receive a SAP in the form of a memorandum from the SH, SG, STox, or other TAC staff requesting that sampling and analysis be performed. The SAP shall be transmitted through the SM and TSG APM to the WSM and DBA or AQAS at least 4 weeks before sampling is to begin. The SAP shall include the following:

- a) The name of the UMTRA Project site(s) where sampling is to be conducted.
- b) An explanation and justification of the required sampling and analyses.
- c) The approximate date when sampling is to begin at the site(s).
- d) Sampling location(s) within each site, including duplicate samples, field blanks, and equipment blanks. One duplicate and one field blank shall be acquired per 20 locations sampled. In addition, one equipment blank shall be acquired per 20 groundwater monitoring locations sampled.
- e) A list of analysis parameters for each location and the associated sample container identification. This shall be accomplished using Work Order Plans JEG-AL-ENG-63A and/or JEG-AL-ENG-63 (Attachments 3 and 4). The SG or designee shall approve each Work Order Plan.
- f) The required laboratory analysis turnaround time, if different from the standard 4 weeks.
- g) A map of the UMTRA Project site identifying locations to be sampled.
- h) The Work Breakdown Structure (WBS) code against which associated labor and analytical costs should be charged.
- i) Any other requirements or information pertinent to the sampling event.

5.6.2 The WSM shall prepare a memorandum notifying the SH that the sampling has been completed and outlining any problems encountered while sampling. The WSM shall send copies of this memorandum to the SM, data management group, SR, and UMTRA Project Document Control Center.

5.6.3 Data management staff shall assign delivery order (DO) numbers to each work order plan received and prepare the necessary cost analysis and purchase requisitions as follows:

- a) Upon receiving the SAP from the SH, data management staff shall determine which subcontract laboratory to use based on eligibility and capacity.
- b) Data management staff shall assign the next sequential DO number found in the DO logbook for each general inorganic and each radiochemical work order plan.

- c) Data management staff should review the work order plan to ensure that the correct sample container has been specified for each parameter of interest. Sample container IDs, preservation techniques, and sample volumes are given in Attachment 5.
- d) For each DO, data management staff shall perform a subcontract laboratory cost analysis using the appropriate spreadsheet templates. The location of this spreadsheet is H:\USER\DBA Name\COST\Lab Name. For each subcontract laboratory, data management staff shall update analysis pricing information for 1-, 2-, 3-, and the routine 4-week turnaround times contained in the spreadsheet template when subcontract options are exercised on April 1 of each year.
- e) For each DO, data management staff shall complete a purchase requisition for subcontract laboratory analytical services.
- f) Data management staff shall write a brief memorandum specifying the DO number, sampling date(s), and subcontract laboratory. Data management staff shall send the memorandum to the SR through the SM, TSG APM, and TAC Project Manager for approval and processing. The purchase requisition, a copy of the cost analysis, a copy of the work order plan, and the SAP should be attached to the memorandum. Data management staff shall send copies of the memorandum with the attachments to the WSM and the UMTRA Project Document Control Center.
- g) Data management staff shall update the DOSTATUS spreadsheet to include an entry for the newly scheduled sampling event (refer to Section 5.7.9).

5.6.4 Data management staff shall prepare files for all documents associated with the sampling event. These files shall be prepared as outlined in Attachment 6 and shall be placed in the active sampling event files.

5.6.5 Upon the completion of water sampling activities, the WSM shall forward copies of the Static Groundwater Level Record, JEG-AL-ENG-14, and Water Quality Sampling Records, JEG-AL-ENG-44, to the DBA and the UMTRA Project Document Control Center (Attachments 7 and 8).

5.7 Data management staff shall provide technical management of analytical work subcontracted to laboratories as outlined below.

5.7.1 Data management staff shall verify that all format and content requirements for data deliverables from the subcontract laboratory have met the requirements in the SOW. In addition, data management staff shall verify that delivery due dates have been met. Data deliverable due dates are as follows:

- a) Initial reports are due 4 weeks after the subcontract laboratory receives the last sample.
- b) Reanalysis reports are due 2 weeks after the date of request for general inorganic delivery orders (3 weeks for radiochemical delivery orders).
- c) Final analysis reports are due 1 week after the date of request.

5.7.2 Data management staff shall monitor the subcontract laboratories' compliance with deliverable due dates. The laboratory subcontracts shall outline penalties for late data deliverables. Generally, the subcontract laboratory may be penalized 10 percent per week late. Data management staff should exercise professional judgment in imposing penalties.

5.7.3 Data management staff should not accept incomplete or improperly formatted data deliverables. Incomplete data deliverables may be returned to the subcontract laboratory for completion or correction, and a late penalty charge may be enforced when the invoice for analytical services is reviewed (refer to Section 5.9). Data management staff may correct minor errors; however, the final report shall be complete and correct.

5.7.4 Data management staff shall maintain necessary communications with the subcontract laboratory to monitor the subcontract laboratory's progress in sample analysis; monitor deadlines for the analytical data deliverables; give technical assistance with the analytical work; request reanalyses; give notification of unacceptable analyses; request final analysis reports; and authorize sample disposal by the subcontract laboratory. Data management staff should document telephone conversations with the subcontract laboratory representative. Data management staff shall send a copy of all written correspondence with the subcontract laboratory to the QA Department and the UMTRA Project Document Control Center.

5.7.5 Data management staff shall process initial reports from the subcontract laboratory as follows:

- a) Upon receiving the data package from the subcontract laboratory, data management staff shall inspect the data package to ensure that criteria outlined in the SOW have been met.
- b) Data management staff shall complete the appropriate section of the JEG Deliverable Transmittal/Review form and staple the form to the front of a blue folder. The Deliverable Transmittal/Review form shall specify that the enclosed documents shall be routed from the DBA or AQAS to the SM through the QA representative. Data management staff shall place the blue

folder containing the original report data in the appropriate active sampling event file folder.

- c) Data management staff shall note the receipt of the deliverable report on the DOSTATUS spreadsheet. The use of this spreadsheet is described in Section 5.7.9.
- d) Data management staff shall photocopy the Deliverable Transmittal/Review form, highlight the SR name, and place the blue folder in distribution.
- e) Data management staff shall deliver one copy of the deliverable to the SG.
- f) Data management staff shall review a photocopy of the Water Quality Sampling Record forms with field measurement results for sample type (ST), pH, specific conductivity (Ec), temperature (T), alkalinity (ALK), bore volumes (BV) withdrawn, and other field parameters. Sample type codes are listed in Attachment 9. For samples where an oxidation/reduction potential (ORP) measurement was performed, calculate the Eh potential as follows:

$$Eh, mV = (ORP, V)(1000 mV/V) + E, mV$$

where E is the correction factor in millivolts at the temperature of the measurement. These correction factors are from "Eh-pH Determination," in *Procedures in Sedimentary Petrology* by Donald Langmuir, and are shown in Attachment 10. Enter the calculated Eh potential in millivolts on page 1 of the Water Quality Sampling Record for that location. In addition, if more than one field measurement was taken for a specific field parameter, data management staff should calculate an average value for entry into the data base. All field and laboratory data associated with monitor well samples that were acquired with less than 3.0 bore volumes purged from the monitor well should be qualified with the "L" flag.

- g) Data management staff shall review the initial report analytical data for technical and quality control integrity as outlined in Section 5.8. Data management staff may request reanalysis for daily QC failures as outlined in Section 5.7.6.
- h) Data management staff shall complete a Data Entry Submittal form, JEG-AL-AD-30 (Attachment 11), and include photocopies of the UMTRA TAC Chemical Analysis Results form, the Water Quality Sampling Records, and the Static Groundwater Level Record, JEG-AL-ENG-14, if applicable, with the data entry submittal.

- i) When ISPS data entry and processing enters the initial laboratory data into the SPEAR data base, the data shall be qualified with the flag "#." This flag indicates that the data have not yet been validated and is automatically assigned to each record by the data entry software.
- j) When the data entry operator has entered all the field, general inorganic, and radiochemical initial reports in the UMTRA Project SPEAR data base, the DBA shall generate a SAR for the initial reported data. The data entry operator shall submit to data management staff all documents specified in Section 5.7.5.h. Upon generating the SAR, data management staff shall transmit the original SAR to the SG and photocopies of the SAR to the SH and STox. Data management staff shall file the remaining documents in the active initial report file folders.
- k) The SG, SH, and STox shall review and sign the original SAR. The SG, SH, and STox shall complete and sign a single Anomalous Data Review Check Sheet, JEG-AL-ENG-87 (Attachment 12). The SG shall return the signed and initialed SAR and Anomalous Data Review Check Sheet to data management staff for inclusion in the data package to be delivered to DOE.
- l) Data management staff may request reanalyses from the subcontract laboratory as outlined in Section 5.7.6. If no reanalyses are to be performed and no format or other reporting errors are discovered, data management staff shall request a final analysis report from the subcontract lab as outlined in Section 5.7.7.

5.7.6 Data management staff shall request sample reanalysis and process reanalysis analytical data from the subcontract laboratory as follows:

- a) Initiate sample reanalysis where necessary after data management staff, the SH, the SG, and the STox have reviewed the initial report and the SAR. Data management staff should request reanalysis in writing to the subcontract laboratory representative and send a copy of the written request for reanalysis to the UMTRA Project Document Control Center. Data management staff shall note the reanalysis request on the DOSTATUS spreadsheet. To avoid a mail delay, data management staff may make reanalysis requests by telephone where practical.
- b) Upon receiving the reanalysis analytical results from the subcontract laboratory, process the deliverable as outlined in Sections 5.7.5.a through e.

- c) Review the reanalysis results for technical and QC integrity as outlined in Section 5.8. Minor errors discovered in reanalysis reports may be lined through, corrected, initialed, and dated by data management staff. More serious mistakes should be resolved at the subcontract laboratory and the report reissued.
- d) Determine whether the reported reanalysis results should be included in the data base in place of the initial results. In general, reanalyses performed due to failure to meet daily QC requirements outlined in the SOW should be included in the data base and final report, provided the reanalysis results themselves are valid. Data management staff shall employ professional judgment to determine whether reanalyses performed to confirm initial reported results should be included in the data base and the final report in place of the initial results.
- e) If appropriate, deliver the second photocopy of the reanalysis analytical results to be included in the data base with a completed UMTRA Project SPEAR Data Entry Submittal form to ISPS data entry and processing. When the data entry operator has entered the reanalysis results in the UMTRA Project SPEAR data base, the data entry operator shall return all documents to the DBA. Data management staff shall file these documents with the originals in the active reanalysis report file folder.
- f) Request final reports from the subcontract laboratory once they have reviewed the reanalysis results and have found them satisfactory (refer to Section 5.7.7).

5.7.7 Data management staff shall process final analysis reports from the subcontract laboratory as follows:

- a) Request in writing final analysis reports from the subcontract laboratory representative. Data management staff may request that specific reanalysis results be included in the final report. Data management staff shall send a copy of this written request to the UMTRA Project Document Control Center and shall note the request for final analysis reports on the DOSTATUS spreadsheet. Where practical, data management staff may request final reports by telephone to avoid mail delay.
- b) Process the final report from the subcontract laboratory as outlined in Sections 5.7.5.a through e.
- c) Remove the hanging folders from the active sampling event filing cabinet, extract all blue folders containing original water quality data, and transmit the data to the UMTRA Project Document Control Center through the QA Department.

- d) Keep a photocopy of the final report in the inactive case files in the data management office or nearby for 1 year.

5.7.8 Deadlines applying to the above data management group activities are as follows:

- a) Data management staff should assign DO numbers and complete other activities specified in Section 5.6.3 at least 10 working days before sampling is to begin, when possible.
- b) The ISPS data entry operator should enter initial reports data and generate SARs within 5 working days after receiving a Data Entry Request from the data management group, if possible.
- c) Data management staff should validate initial reports from subcontract laboratories within 10 working days after receiving the data package, unless reporting errors or other circumstances make this impossible.
- d) The ^HSG, SG, and STox should review the SAR and complete the Anomalous Data Review Check Sheet associated with each initial report within 3 working days of receipt, when possible.
- e) Data management staff should request reanalysis of selected samples, if any, within 2 days after receiving the signed SAR and Anomalous Data Review Check Sheet.
- f) Data management staff should review the reanalysis data package and request final reports within 5 working days after receiving the package if no further reanalyses are required.
- g) Data management staff should assemble the data package as outlined in Section 5.10 for transmittal to the DOE within 5 working days after receiving the final report from the subcontract laboratory.

5.7.9 Data management staff shall track the progress of data deliverables through the TAC data management system. This is accomplished using Lotus 1-2-3 spreadsheet software on the UMTRA Project local area network (LAN). The location of this spreadsheet is H:\USER\DBA Name\DOSTATUS\MMDDYY.WK1. Sequentially updated copies of this file are named by the current date. A printout of this spreadsheet is shown in Attachment 13. Data management staff should update this spreadsheet as required. Since it is not advisable to store old copies of these spreadsheet files on the LAN, data management staff should periodically move these files to a 5 1/4" disk.

5.8 Data management staff shall review and validate analytical chemical data obtained from subcontract analytical laboratories as follows:

5.8.1 Carefully record all technical and QC errors on the Data Package Assessment form, JEG-AL-ENG-86 (Attachment 1-4). Data management staff should discuss these technical errors with the subcontract laboratory representative and resolve them if possible. Data management staff may request a CAR from the subcontract laboratory.

5.8.2 Once all data for a specific DO and sampling event have been QC checked and validated, data management staff shall remove all "Q", not QC'd" flags from the UMTRA Project SPEAR data base records for these samples. In addition, data management staff shall qualify data as appropriate with the flags shown in Attachment 15.

5.9 Data management staff shall review invoices from subcontract analytical laboratories. Generally, the subcontract laboratory may bill for 70 percent of the cost of the analysis when the initial analytical report is sent and may bill for the balance when the final analytical report is sent.

5.9.1 Data management staff shall process the invoices as follows:

- a) Review the Invoice Transmittal/Review Record to ensure that the invoicing subcontract laboratory identity, site, DO number, and balance due are correct.
- b) Document unacceptable analyses that are not to be paid for in the "Comments" section of the Invoice Transmittal/Review Record and on the itemized invoice.
- c) Indicate the amount approved, date and sign the Invoice Transmittal/Review/Approval Record, and forward it to the SR through the SM.

5.10 Data management staff shall prepare deliverable data packages for transmittal to the DOE as follows:

5.10.1 Assemble the data by item as listed on the Data Package Contents page (Attachment 16). A brief description of the contents of each item listed shall be included in the Data Package Contents.

5.10.2 The data package shall contain as the first item a TAC Site Hydrologist/Geochemist/Toxicologist Summary. The summary should briefly answer the following four questions as appropriate:

- a) Was the maximum concentration limit (MCL) for any parameter exceeded in a domestic supply sample?
- b) Were any exceedances recorded in point-of-compliance monitor wells?
- c) Were applicable surface water and sediment sample guidelines for any parameter exceeded?

- d) - Was new or increased contamination observed at any location that would indicate movement or surface discharge of the contaminant plume?

5.10.3 The data package shall contain a Data Management Narrative describing any problems with the data package discovered during the data review and validation process. This narrative shall indicate a final disposition based on professional judgment of data quality.

5.10.4 The data package shall contain the SAR, which shall have been reviewed, commented on, and signed by the SG, SH, and STox. If no previous data are listed for the site locations associated with the sampling event, this item is not required.

5.10.5 The data package shall contain an Anomalous Data Review Check Sheet, which lists the subset of data from the SAR that requires explanation or follow-up action. This item shall also describe TAC staff judgments on the listed suspected anomalies.

5.10.6 The data package shall include a copy of the UMTRA data base printout by parameter of all data associated with the sampling event. All UMTRA Project SPEAR QC flags should be entered into the UMTRA Project SPEAR data base, as specified in Section 5.8.2, before this report is generated. An example of an UMTRA Project data base printout is shown in Attachment 17. The data package shall also include a magnetic copy of the data file(s) from which the UMTRA data base printout was generated for all sampling events within the state of Colorado.

5.10.7 The data package shall include a copy of the Static Groundwater Level Measurement Record.

5.10.8 The data package shall include a copy of the SAP with a map of the site(s) identifying the locations sampled.

5.10.9 Once the deliverable data package has been assembled, data management staff shall write a memorandum to the SM stating that the deliverable data package requires a TAC Site Hydrologist/Geochemist/Toxicologist Summary before delivery to the DOE. Data management staff shall send copies of this memorandum, with the data package attached, to the SH, SG, STox, and UMTRA Project Document Control Center.

5.10.10 Data management staff shall enter into the Completed Data Package Logbook the site, date sampled, number of samples, DO number(s), subcontract laboratory, and the date the data package was completed.

5.10.11 Data management staff shall update the status of this deliverable on the DOSTATUS spreadsheet as complete. This deliverable should remain on the DOSTATUS spreadsheet as complete for 2 months, after which it may be deleted.

5.11 Data management staff shall transmit all original data and associated documents to the UMTRA Project Document Control Center, where they will be archived. Data management staff shall place the final Deliverable Transmittal/Review forms in the Correspondence file for the associated sampling event.

5.12 If after 120 days no further analysis of samples associated with a completed data package is needed, data management staff shall authorize the subcontract laboratory, in writing, to dispose of the samples.

5.13 Data management staff shall work with the ISPS Department to maintain UMTRA Project SPEAR software in the following ways:

5.13.1 Developing new software in the SPEAR data base.

5.13.2 Resolving problems in the SPEAR data base.

5.13.3 Developing and revising SOPs related to UMTRA Project data acquisition.

5.13.4 Assigning new SPEAR location IDs when requested by TAC staff. This shall be accomplished as follows:

- a) Data management staff shall request ISPS data entry to reserve new location IDs in the name of the person requesting the IDs.
- b) As required by the *JEG Albuquerque Operations Manual*, SOP 8.2.6, "Data Entry," the SH shall complete a Borehole/Test Pit/Well Summary form, JEG-AL-ENG-4, for each new location ID. The SH shall submit this form to data management staff, and data management staff shall enter the location information into SPEAR.
- c) After defining the location ID in SPEAR, data management staff shall forward the original Borehole/Test Pit/Well Summary form to the UMTRA Project Document Control Center and transmit a photocopy to the SH.

6.0 REFERENCES

JEG (Jacobs Engineering Group, Inc.), 1993. *Statement of Work, UMTRA Project TAC General Inorganic and Radiochemical Analyses*, Exhibit A, February 1993, RFP No. 05-62350-R-93-0010, prepared by Jacobs Engineering Group for the U.S. Department of Energy, UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

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U.S. Environmental Protection Agency. *Methods for Chemical Analysis of Water and Wastes*, EPA 600 4-79-020, revised March 1983.

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7.0 ATTACHMENTS

1. UMTRA Project Contract Required Detection Limits	(2 pages)
2. UMTRA TAC Laboratory Codes and PE Sample Location IDs	(1 page)
3. JEG-AL-ENG-63A (2/93), Work Order Plan	(1 page)
4. JEG-AL-ENG-63 (2/93), Work Order Plan	(2 pages)
5. Sample Preservation Techniques and Holding Times	(1 page)
6. File Folder Labels for Water Quality Data	(1 page)
7. JEG-AL-ENG-14 (6/87), Static Groundwater Level Record	(1 page)
8. JEG-AL-ENG-44 (2/93), Water Sampling Field Form	(4 pages)
9. SPEAR Sample Type Codes	(1 page)
10. Correction Factors for ORP Measurements With Ag/AgCl
Reference Electrode	(1 page)
11. JEG-AL-AD-30 (3/94), UMTRA SPEAR Data Entry Submittal	(1 page)
12. JEG-AL-ENG-87 (10/92), Anomalous Data Review Check Sheet	(1 page)
13. Data Package Status Sheet	(1 page)
14. JEG-AL-ENG-86 (10/92), Data Package Assessment	(1 page)
15. UMTRA Project SPEAR Analytical Data QC Flag Codes	(1 page)
16. Data Package Contents	(1 page)
17. UMTRA Data Base Printout	(1 page)

Prepared By:

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Quality Assurance Manager

Reviewed By:

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UMTRA Project Contract Required Detection Limits (CRDLs) and Acceptable Techniques

Parameter	CRDL, mg/L	Technique(s) ¹
Aluminum	0.05	ICP-AES
Ammonium as NH ₄	0.10	Colorimetric
Antimony	0.003	GFAA, ICP-MS
Arsenic	0.005	GFAA, NaBH ₄
Barium	0.10	ICP-AES
Beryllium	0.005	ICP-AES
Boron	0.10	ICP-AES
Bromide	0.10	IC
Cadmium	0.001	GFAA, ICP-MS
Calcium	0.50	ICP-AES
Chloride	0.50	IC, colorimetric
Chromium	0.01	ICP-AES
Cobalt	0.05	ICP-AES
Copper	0.02	ICP-AES
Dissolved organic carbon (DOC)	1.0	UV promoted oxidation-IR
Total cyanide	0.010	Colorimetric
Fluoride	0.10	ISE
Iron	0.03	ICP-AES
Lead	0.003	GFAA, ICP-MS
Magnesium	0.10	ICP-AES
Manganese	0.01	ICP-AES
Mercury	0.0002	CVAA
Molybdenum	0.01	ICP-AES
Nickel	0.04	ICP-AES
Nitrate as NO ₃	1.0	Colorimetric, IC
Potassium	0.10	ICP-AES, FAA
Selenium	0.005	GFAA, NaBH ₄
Silver	0.01	ICP-AES
Silica as SiO ₂	0.10	ICP-AES
Sodium	1.0	ICP-AES, FAA
Strontium	0.01	ICP-AES
Sulfate	1.0	IC
Sulfide	1.0	Titrimetric, colorimetric
Thallium	0.005	GFAA, ICP-MS
Tin	0.05	ICP-AES, GFAA, ICP-MS
Total dissolved solids	10	Gravimetric
Total kjeldahl nitrogen	1.0	Colorimetric
Total organic carbon (TOC)	1.0	UV promoted oxidation-IR
Total phosphorus as PO ₄	0.10	Colorimetric
Uranium	0.001	ICP-MS, fluorometric
Vanadium	0.01	ICP-AES
Zinc	0.05	ICP-AES

UMTRA Project Lower Limits of Detection (LLDs) and Suggested Techniques

Parameter	LLD, pCi/L	Technique(s)¹
Gross alpha	1.0	PC
Gross beta	0.5	PC
²¹⁰ Pb	1.5	LSc, PC
²¹⁰ Po	1.0	AS, PC
²²⁶ Ra	1.0	AS, ASsc
²²⁸ Ra	1.0	PC
²³⁰ Th	1.0	AS

¹Where more than one technique is specified, the first technique listed is preferred. Technique acronyms and abbreviations are defined below.

AS	Alpha spectrometry
ASc	Alpha scintillation
CVAA	Cold vapor atomic absorption spectroscopy
FAA	Flame atomic absorption spectroscopy
GFAA	Graphite furnace atomic absorption spectroscopy
IC	Ion chromatography
ICP-AES	Inductively coupled plasma-atomic emission spectroscopy
ICP-MS	Inductively coupled plasma-mass spectrometry
IR	Infrared
ISE	Ion specific electrode
LSc	Liquid scintillation
NaBH ₄	Sodium borohydride reduction atomic absorption spectroscopy
PC	Proportional counter
UV	Ultraviolet

Attachment 2

UMTRA TAC Laboratory Codes and PE Sample Location IDs

<u>Laboratory</u>	<u>Lab Code</u>	<u>PER01 Location IDs</u>
ACZ Laboratories - Steamboat Springs, CO	ACZ	0601 and 0602
Core Laboratories - Aurora, CO	COR	0101 and 0102
Core Laboratories - Casper, WY	CWY	1601 and 1602
ES&E - Gainesville, FL	ESE	0301 and 0302
IEA - Cary, NC	IEA	0901 and 0902
IT Corporation - Earth City, MO	ITC	1001 and 1002
Lockheed Analytical Services - Las Vegas, NV	LAL	0701 and 0702
Roy F. Weston - Lionville, PA	RFW	1201 and 1202
RUST Geotech - Grand Junction, CO	CNG	NA
Savannah Laboratories - Savannah, GA	SVA	1401 and 1402
Weyerhaeuser Laboratories - Federal Way, WA	WEY	0501 and 0502

JACOBS ENGINEERING GROUP INC.

ALBUQUERQUE OPERATIONS

I. WORK ORDER PLAN - CHEMICAL ANALYSIS OF UMTRA TAC SAMPLES

SITE HYDROLOGIST: _____
NAME (print) SIGNATURE DATE

SAMPLE MATRIX: _____

SITE ID(s): _____

SITE GEOCHEMIST: _____
NAME (print) SIGNATURE DATE

LOCATION ID(s): _____

SAMPLE ID(s): _____

Bottle Name	U	Pb-210	Po-210	Ra-226	Ra-228	Th-230	Gross Alpha/Beta	
Total # of Tests								

COMMENTS:

JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

II. WORK ORDER PLAN - CHEMICAL ANALYSIS OF UMTRA TAC SAMPLES

PAGE 1 OF 2

SITE HYDROLOGIST: _____
NAME (print) SIGNATURE DATE

SAMPLE MATRIX: _____

SITE ID(s): _____

SITE GEOCHEMIST: _____
NAME (print) SIGNATURE DATE

LOCATION ID(s): _____

SAMPLE ID(s): _____

Bottle Name	Cl	SO4	Na	K	Mg	Ca	B	F	CN	S	TKN	NH4	NO3 & NO2	NO3	SiO2	PO4	Br	Al	Sb	As	Ba	Be	Cd	Cr	Co
Total # of Tests																									

COMMENTS:

JACOBS ENGINEERING GROUP INC.

ALBUQUERQUE OPERATIONS

II. WORK ORDER PLAN - CHEMICAL ANALYSIS OF UMTRA TAC SAMPLES

PAGE 2 OF 2

SITE HYDROLOGIST:

NAME (print)

SIGNATURE

DATE

SAMPLE MATRIX: _____

SITE ID(s): _____

LOCATION ID(s): _____

SITE GEOCHEMIST:

NAME (print)

SIGNATURE

DATE

SAMPLE ID(s): _____

Bottle Name	Cu	Fe	Pb	Mn	Hg	Mo	Ni	Se	Ag	Sr	Sn	Ti	U	V	Zn	TDS	TOC & DOC
Total # of Tests																	

COMMENTS:

Attachment 5

Sample Preservation Techniques and Holding Times

Bottle ID	Parameter(s)	Volume/Container	Preservation	Holding Time
A-1	Br, Cl, F, SiO ₂ , SO ₄	1 L Plastic	None, 4° C	28 days
	TDS			7 days
M-2	Ag, Al, As, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Sn, Sr, Ti, U, V, Zn	1 L Plastic	HNO ₃ , pH < 2	180 days
N-1	NH ₄ , NO ₃ , TKN PO ₄	500 mL Plastic	H ₂ SO ₄ , pH < 2 4° C	28 days
CN	Total CN	1 L Plastic	NaOH, pH > 12 4° C	14 days
S	Sulfide	2x500 mL Plastic	NaOH, pH > 9 Zn Acetate 4° C	7 days
DOC	DOC	500 ml Amber Glass	H ₂ SO ₄ , pH < 2 4° C	28 days
TOC	TOC	500 ml Amber Glass	H ₂ SO ₄ , pH < 2 4° C	28 days
Ra-226	Ra-226	2x1 L Plastic	HNO ₃ , pH < 2	180 days
Ra-228	Ra-228	2x1 L Plastic	HNO ₃ , pH < 2	180 days
Pb-210	Pb-210	1 L Plastic	HNO ₃ , pH < 2	180 days
Po-210	Po-210	1 L Plastic	HNO ₃ , pH < 2	180 days
Th-230	Th-230	1 L Plastic	HNO ₃ , pH < 2	180 days
GAB	Gross Alpha, Gross Beta, U	500 mL Plastic	HNO ₃ , pH < 2	180 days

Attachment 6

**File Folder Labels
for
Water Quality Data**

Names of files for: INORGANIC

Correspondence
Field Forms
PR and Work Order Plans
Initial Report
Re-analysis
Final Analysis
QA/QC

RADCHEM

Correspondence
PR and Work Order Plans
Initial Report
Re-analysis
Final Analysis
QA/QC

Make one file folder label for each of these files in the following format:

INORGANIC	Site	DO #	DATE	RADCHEM	Site	DO #	DATE
	(name of file)				(name of file)		

Make two sets of labels for hanging folders for each site in the following format:

SITE DO# DATE # samples

**WATER QUALITY DATA
SITE DO #**

ALBUQUERQUE OPERATIONS

WATER SAMPLING FIELD FORM

FINAL FIELD VALUES AT THE SURFACE

pH (S.U.) _____

Ec (umhos/cm) _____

TEMP. (C) _____

ORP (mV) _____

DO (mg/l) _____

ALKALINITY (mol CaCO₃) @ pH 4.5 _____

TURBIDITY (NTU) _____

0.45um CAPSULE FILTER(S) USED

COMMENTS _____

LOCATION DESCRIPTION _____

FIELD REP(s) _____

[illegible]

DATE

JACOBS ENGINEERING GROUP INC.

ALBUQUERQUE OPERATIONS

PAGE 2 OF 4

WATER SAMPLING FIELD FORM

SITE ID: _____ LOCATION ID: _____ DATE: _____

DEPTH TO WATER (h_2) (FT.) _____ THERMOMETER ID _____GIVEN DEPTH OF WELL (h_1) (FT.) _____ Ec METER ID _____TOTAL DEPTH MEASURED: ☐ YES ☐ NO Ec METER TEST DATE _____

VALUE: _____ pH METER ID _____

WELL DIA. (d) (FT.) _____ PUMP ID _____

BORE VOL. (FT.) _____ O.R.P. METER ID _____

SCREENED INTERVAL (FT) _____ D.O. METER ID _____

SAMPLE DEPTH (FT) _____ SOUNDER ID _____

WITHDRAWAL METHOD _____

TIME	pH METER STANDARDIZATION			COMMENTS
	4.00	7.00	10.00	

NOTES:

BORE VOL CALCULATION

$$\left(\frac{d}{2}\right)^2 \pi (h_1 - h_2) *$$

* The value of $\left(\frac{d}{2}\right)^2 \pi$ is : .022 for a 2" well
 .086 for a 4" well

WATER SAMPLING FIELD FORM**ALKALINITY TITRATION**

SITE ID: _____

LOCATION ID: _____

DATE: _____

ALKALINITY TEST KIT ID: _____

TITRANT: 1.6 NH₂ SO₄ LOT # _____

pH METER ID: _____

ERROR AT 4.50: $\left| \frac{X1 - X2}{X^S} \right| \times 100 = \text{_____}\%$

1st = _____%

2nd = _____%

pH CHECK AFTER TITRATION

7.00 = _____

4.00 = _____

pH	ALKALINITY (mg/l CaCO ₃)			
	1st	2nd	3rd	4th
INITIAL				
pH				
8.90				
8.60				
8.30				
8.05				
7.80				
7.50				
6.50				
5.70				
5.10				
4.80				
4.50				
4.25				
4.00				
Field Rep:				

SAMPLE ALIQUOT IS 100 ML UNLESS STATED OTHERWISE.

NOTES:

JACOBS ENGINEERING GROUP INC.

ALBUQUERQUE OPERATIONS

PAGE 4 OF 4

WATER SAMPLING FIELD FORM**CHAIN OF CUSTODY**

LAB: _____

ACKNOWLEDGEMENT OF RECEIPT OF SAMPLES FOR DELIVERY ORDER NO. _____

SITE ID: _____ LOCATION ID: _____ SAMPLE ID: _____

SAMPLE MATRIX (Check One)

WATER ()

SOIL ()

BOTTLE ID	VOLUME (LITERS)	REC'D	BOTTLE ID	VOLUME (LITERS)	REC'D
A1	_____	()	Th 230	_____	()
M2	_____	()	GA/B	_____	()
Pb 210	_____	()	N1	_____	()
Po 210	_____	()	CN	_____	()
Ra 226	_____	()	S	_____	()
RA 228	_____	()	TOC	_____	()
			DOC	_____	()

DATE COLLECTED: _____ TIME COLLECTED: _____

DATE SHIPPED: _____ SHIPPED BY: _____ (SIGNATURE)

METHOD OF SHIPMENT:

☐ FEDERAL EXPRESS☐ AIRBORNE EXPRESS☐ BUS☐ OTHER _____

COMMENTS: _____

TO BE COMPLETED BY SUBCONTRACTING LABORATORY/LAB NAME: _____

I HEREBY ACKNOWLEDGE RECEIPT OF THE FOLLOWING ON: _____

(DATE)

(TIME)

DELIVERY ORDER NO. _____ WORK ORDER PLAN DATED: _____

RECEIVED BY: _____ (SIGNATURE)

PRINT NAME: _____

TITLE: _____

COMMENTS: _____

Attachment 9

SPEAR Sample Type Codes

<u>Sample Type</u>	<u>Sample Code</u>
Acid Blank	A
Equipment Blank	E
Field Sample	F
Field Blank	FB
Field Sample with Replicates	FR
Known	K
Laboratory	L
Not Known	NK
Replicate	R
Trip Blank	TB

Attachment 10

Correction Factors for ORP Measurement with Ag/AgCl Reference Electrode¹

<u>Temp., C</u>	<u>E, mV</u>
5	234.1
6	233.6
7	233.0
8	232.5
9	231.9
10	231.4
11	230.8
12	230.3
13	229.7
14	229.2
15	228.6
16	228.0
17	227.4
18	226.8
19	226.2
20	225.6
21	224.9
22	224.3
23	223.6
24	223.0
25	222.3
26	221.7
27	221.1
28	220.5
29	219.9

¹Donald Langmuir, "Eh-pH Determination," Procedures in Sedimentary Petrology, ed. Robert E. Carver, (John Wiley & Sons, Inc., 1971), 597-631.

**UMTRA SPEAR
DATA ENTRY SUBMITTAL**

SUBMITTAL DATE: _____ **ENTRY DATE:** _____

SUBMITTED BY: _____

SITE CODE: _____

DATA ENTRY TYPE: _____

DELIVERY ORDER NUMBER (DO#): _____

COMMENTS: _____

ALBUQUERQUE OPERATIONS

SITE: _____ **SAMPLING DATE(s):** _____

SITE TOXICOLOGIST: _____

NAME (print)	SIGNATURE	DATE
--------------	-----------	------

SITE HYDROLOGIST: _____

NAME (print)	SIGNATURE	DATE
--------------	-----------	------

SITE GEOCHEMIST: _____

NAME (print)	SIGNATURE	DATE
--------------	-----------	------

DATE OF REVIEW: _____

[illegible]

Site ID	Sample Matrix Type/ID	Date Sampled	Delivery Order Number	Initial Due Date	Date Initial Received	Date SAR to SH/SG	Date SAR Returned	Date CAP/Reanalyze Requested	Date CAP/Reanalyze Received	Date Final Requested	Date Final Received	Date Data Plg. to SM SH/SG & ST	Date Data Plg. to DOE	Comments
BELO1 BOW01	Water/13 Soil/9 Eco Baseline Risk Assessment	11/3 - 11/4/99	73-C V4-C	(12/6/99) 12/6/99	1/24/04 12/1/03									DV complete DV complete, no QC issues. BELO1 G05020021 BOW01 G05020002
BELO1 BOW01	Water/41 Water/54	6/5 - 6/6/03 7/15 - 7/21/00	67-C M4-C	8/8/03 (8/8/03)	8/8/03 8/15/03	10/18/03	12/7/03	2/6/04 12/10/03	1/12/04	1/15/04	1/29/04			BELO1 sample splits being shipped to CORE--Aurora from CORE--Casper for metals re-analyze DV complete, no QC issues.
CAND1	Water/58	(10/25 - 11/5/03)	38-W A5-C	(12/6/03) 12/7/03	12/6/03 12/7/03	1/5/04		1/26/04						DV complete, no QC issues. G05010001
CAND1.03	Water/33	7/15 - 7/22/00	31-W L4-C	(8/23/03) (8/23/03)	8/23/03 8/27/03	11/4/03		1/26/04						DV complete, no remaining QC issues. DV complete, no QC issues.
CAND1 Eco Baseline Risk Assessment	Water/9 Soil/7	(10/25 - 11/5/03)	74-C W4-C	11/19/03 11/19/03	11/22/03 11/19/03	1/5/04		1/26/04						DV complete, need to flag results assoc. with failed Fe, Mo, and Zn dup. *. DV complete, no QC issues. G05020001
DUR01.02.03	Water/40	(10/25 - 11/05/03)	37-W Z4-C	(12/27/03) (12/6/03)	12/28/03 1/3/04	2/2/04								DV complete, no QC issues. DV complete, no QC issues. DUR01.02 G05010003 DUR03 G35010008
DUR01.02 Eco Baseline Risk Assessment	Water/28 Soil/12	(11/8 - 11/12/03)	77-C C5-C	(12/13/03) (12/13/03)	12/27/03 12/8/03	NA NA	NA NA	NA NA	2/3/04 2/3/04					DV complete. SO3, NO3, and Zn present in field blanks. G05020103
FCT03	Water/17	4/26 - 4/30/00	66-C Z3-C	8/1/03 8/1/03	8/7/03 8/22/03	7/28/03	11/1/03	NA NA	NA NA	12/3/03 12/3/03	12/13/03	1/26/04		G05010009
FCT03	Water/44 Water/44 Water/5	(9/13 - 9/24/03)	66-C O4-C 35-W	10/22/03 11/2/03 10/21/03	10/26/03 11/8/03 10/19/03	1/5/04								DV complete, no QC issues. DV complete, FCT03-0904-0001 ODC incomplete. DV complete, no QC issues.
FCT08	Water/23	(1/24 - 2/4/04)	9-L	(3/4/04)										G05010120110
FCT03	Water/58	(3/7 - 3/16/04)	61-C G5-C	(4/16/04) (4/16/04)										G05080120
GRU01 Eco Baseline Risk Assessment	Water/11 Soil/10	8/28/03	70-D S4-C	10/22/03 10/22/03	11/5/03 11/1/03	NA NA	NA 11/19/03	NA 11/22/03 (Verbal)	11/19/03 11/22/03 (Verbal)	12/7/03 11/29/03	1/26/04			G05020008
GRU01	Water/9	(1/26 - 12/17/03)	3-F C1-I	(1/9/04) (1/9/04)	1/21/04 1/10/04									DV complete, numerous problems outlined in RFW03.LTR. DV complete, GB MB 5.52 pCi/L. S05010005
GRN01	Water/14	8/22 - 8/26/00	64-C T1-A	7/8/03 7/26/03	7/26/03 7/26/03	8/30/03	11/4/03 11/8/03	NA 11/29/03	11/6/03 12/3/03	11/16/03 12/13/03	12/17/03			
GRN01 Eco Baseline Risk Assessment	Water/10 Soil/8	8/22/00	71-C T4-C	10/22/03 10/22/03	11/6/03 11/9/03	NA NA	NA NA	NA NA	12/3/03 12/3/03	12/13/03 12/13/03	2/2/04			G05020010
GRN01	Water/4	(10/18/03)	6-L Y4-D	(10/22/03) (10/22/03)	10/26/03 10/26/03	NA NA	NA NA	NA NA	10/26/03 10/26/03	11/16/03 11/17/03	11/17/03			
Pump test water GRN01	Water/28 Water/30 (Security)	(1/26 - 1/21/04)	78-C E5-C 41-W	(2/21/04) (2/24/04) (2/24/04)										G35020210

JACOBS ENGINEERING GROUP INC.

ALBUQUERQUE OPERATIONS

DATA PACKAGE ASSESSMENT

DELIVERY ORDER NUMBERS: _____ SITE: _____

LABORATORY: _____ SAMPLING DATES: _____

REVIEWER: _____

NAME (print)

SIGNATURE

DATE

CHAIN OF CUSTODY FORMS ALL PRESENT _____ SIGNED _____

	ICP	GFAA	FAA	Hg	Anions	Rad	S ²⁻	TDS	CN
HOLDING TIME	_____	_____	_____	_____	_____	_____	_____	_____	_____
CALIB. VERIFICATION	_____	_____	_____	_____	_____	N/A	N/A	N/A	_____
PREP. BLANKS	_____	_____	_____	_____	_____	_____	N/A	N/A	_____
ICS (ICP ONLY)	_____	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
LCS	_____	_____	_____	_____	_____	_____	N/A	_____	N/A
DUPLICATES	_____	_____	_____	_____	_____	_____	_____	_____	_____
POSTDIGEST. SPKS.	_____	_____	_____	N/A	N/A	N/A	N/A	N/A	_____
MATRIX SPKS.	_____	_____	_____	_____	_____	_____	N/A	N/A	_____
OVERALL ASSESS.	_____	_____	_____	_____	_____	_____	_____	_____	_____

ITEMS REQUIRING ATTENTION: _____

AREAS OF CONCERN: _____

REVIEWER COMMENTS: _____

Attachment 15

UMTRA Project SPEAR Analytical Data QC Flag Codes

<u>Code</u>	<u>Definition (Comments)</u>
E	Estimated value because of interference, see case narrative
G	pH > 9, possible grout contamination
H	Hold time expired, value suspect
I	Increased DL due to required dilution
J	Estimated value
L	Less than 3 bore volumes removed before sampling, value suspect
M	Duplicate injection precision not met (HGA)
N	Spike sample recovery not within control limits
R	Unusable data point
S	Reported value determined by method of standard addition (MSA)
W	Post-digestion spike out of control limits while sample absorbance < 50% spike absorbance
*	Duplicate analysis not within control limits
+	Correlation coefficient for MSA < 0.995

Attachment 16

DATA PACKAGE CONTENTS

This data package includes the following information:

<u>Item No.</u>	<u>Description of Contents</u>
1.	TAC Site Hydrologist/Geochemist/Toxicologist Summary
2.	Data Package Assessment, which contains the following: <ul style="list-style-type: none">a. Confirmation that chain-of-custody forms were maintained and signed.b. Confirmation that holding time requirements were met.c. Evaluation of the adequacy of the QC sample results.
3.	Data Management's Narrative, which describes problems identified in the data validation process and summarizes the validator's findings.
4.	Suspected Anomalies Report generated by the UMTRA database system. This report compares the new data set with historical data and designates "suspected anomalies" based on the many criteria listed as footnotes on each page. In aggregate, these criteria cause the suspected anomaly program to be very conservative; many of the data shown in the tables are not, in TAC's judgement, truly anomalies, but merely natural variations in data or routine changes in laboratory detection limits. The designation "OK" affirms the judgement that the particular entry is not an anomaly and, therefore, requires no further inquiry.
5.	Anomalous Data Review Checksheet which lists the subset of data from the Suspected Anomalies Report that merits explanation or follow-up action. The "Disposition" column of this report describes the TAC judgements on the listed anomalies.
6.	UMTRA Database Printout and magnetic copy of database file.
7.	Static Groundwater Level Measurement Worksheet
8.	Sampling and Analysis Plan.

**GROUNDWATER QUALITY DATA BY PARAMETER
SITE:**

REPORT DATE:

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PVI	PARAMETER VALUE	FLAGS	DETECTION LIMIT	PARAMETER UNCERTAINTY
ALKALINITY	0472	05/16/93	N001	AL	D	MG/L CaCO3		207		.	.
	0474	05/19/93	N001	AL	D			188		.	.
	0600	05/18/93	N001	NR	N			294		.	.
	0601	05/19/93	N001	NR	N			286		.	.
	0661	05/18/93	N001	AL	C			97		.	.
	0665	05/18/93	N001	AL	C			129		.	.
	0667	05/16/93	N001	NA	N			79		.	.
	0681	05/17/93	N001	NR	N			87		.	.
	0683	05/17/93	N001	NR	N			112		.	.
ARSENIC (TOTAL)	0454	05/18/93	N001	AL	D	MG/L	<	0.005		0.005	.
	0455	05/18/93	N001	AL	D		<	0.005	W	0.005	.
	0461	05/18/93	N001	AL	O		<	0.005	W	0.005	.
	0463	05/16/93	N001	AL	D		<	0.005		0.005	.
	0466	05/19/93	N001	AL	D		<	0.005	W	0.005	.
	0468	05/19/93	N001	AL	D		<	0.005	W	0.005	.
	0468	05/19/93	N002	AL	D		<	0.005	W	0.005	.
	0469	05/19/93	N001	AL	D		<	0.005	W	0.005	.
	0472	05/16/93	N001	AL	D		<	0.005		0.005	.
	0474	05/19/93	N001	AL	D		<	0.005		0.005	.
	0600	05/18/93	N001	NR	N		<	0.005		0.005	.
	0601	05/19/93	N001	NR	N		<	0.005		0.005	.
	0661	05/18/93	N001	AL	C		<	0.005	W	0.005	.
	0665	05/18/93	N001	AL	C		<	0.005		0.005	.
	0667	05/16/93	N001	NA	N		<	0.005	W	0.005	.
	0681	05/17/93	N001	NR	N		<	0.005		0.005	.
	0683	05/17/93	N001	NR	N		<	0.005		0.005	.
CADMIUM (TOTAL)	0454	05/18/93	N001	AL	D	MG/L	<	0.001	J	0.001	.
	0455	05/18/93	N001	AL	D		<	0.001	J	0.001	.
	0461	05/18/93	N001	AL	O		<	0.001	J	0.001	.
	0463	05/16/93	N001	AL	D		<	0.001	J	0.001	.
	0466	05/19/93	N001	AL	D		<	0.001	J	0.001	.
	0468	05/19/93	N001	AL	D		<	0.001	J	0.001	.
	0468	05/19/93	N002	AL	D		<	0.001	J	0.001	.
	0469	05/19/93	N001	AL	D		<	0.001	J	0.001	.
	0472	05/16/93	N001	AL	D		<	0.001	J	0.001	.

FORMATION OF COMPLETION CODE:

AL - ALLUVIUM
NR - NO RECOVERY OF DATA FOR CLASSIFYING
NA - NAVAJO SANDSTONE

FLOW RELATIONSHIP CODE:

D - DOWN GRADIENT
N - UNKNOWN
C - CROSS GRADIENT
O - ON-SITE

PARAMETER VALUE INDICATOR (PVI): < - LESS THAN DETECTION LIMIT

OTHER PARAMETER VALUE FLAGS:

J - ESTIMATED VALUE
W - POST-DIGEST SPIKE OUT OF CNTR LIM WHILE SAMP ABS < 50% SPIKE

SAMPLE ID CODES:

N001 - UNFILTERED SAMPLE
N002 - UNFILTERED REPLICATE SAMPLE

10
11
12
13

14

15

ALBUQUERQUE OPERATIONS MANUAL

SECTION 16.3.2

DATE 11/1/94

EFFECTIVE 11/1/94

SUPERSEDES 10/29/92

PAGE 1 **OF** 16

VALIDATION OF CHEMICAL ANALYSIS DATA

1.0 PURPOSE

- 1.1** The purpose of this document is to provide a procedure that will allow UMTRA Project data management personnel to verify and validate general inorganic and radiochemical water quality data that are acquired in the field or received from subcontract laboratories.

2.0 SCOPE

- 2.1** This procedure provides the criteria for validation of the results of radiochemical and general inorganic chemical analyses reported by subcontractor laboratories, and documentation of the evaluation(s). Field records are examined to verify compliance with standard operating procedures (SOP) for sampling. Analysis for organic compounds is not typically performed on the UMTRA Project, and hence organic data validation is beyond the scope of this procedure. This procedure is applicable to all UMTRA Project Technical Assistance Contractor (TAC) staff, listed in section 4.0 below, involved in the validation of chemical analytical data.
- 2.2** Activities associated with the collection of field water quality data (SOP 16.1.10, Field Measurement of Water Samples for Temperature, Conductivity, pH, Alkalinity, and Total Acid), the collection of ground and surface water samples (SOP 16.2.1, Sample Collection, Preservation, and Shipment of Water Samples), and the management of the water quality data base (SOP 16.3.3, Data Management) may be found in the Albuquerque Operations Manual.

3.0 ENVIRONMENT, HEALTH AND SAFETY

- 3.1** Work done under this SOP shall be performed in a way that is compatible with ergonomic and emergency action plans prepared for the UMTRA Project TAC offices.

4.0 RESPONSIBILITIES

- 4.1** UMTRA TAC staff involved in the validation of water quality data consists of the database administrator (DBA), the analytical QA specialist (AQAS), site hydrologists (SH), site geochemists (SG), site toxicologists (STox), the water sampling manager (WSM), and data entry personnel. The responsibilities for these staff members are specified in the sections that follow.

5.0 PROCEDURE

5.1 Reporting field measurements

5.1.1 The data quality objectives (DQOs) for the UMTRA Project require routine field measurements meet Level A or B data quality criteria as described in the DOE's, *Quality Control Requirements for Field Methods*, Hazardous Waste Remedial Actions Program, DOE/HWP-69/R1, 1990 (HAZWRAP).

5.1.2 The WSM shall report field water quality measurements made by UMTRA Project water samplers to the DBA at the completion of each sampling round. These data are located on page 1 of the Water Sampling Field Form, form number JEG-AL-ENG-44, and the Static Ground Water Level Record, JEG-AL-ENG-14 (6/87).

5.1.3 Quality control (QC) sample analysis results accompany the field water quality measurements, as appropriate.

5.1.4 Field measurements will be made in accordance with the appropriate SOP. Any deviation from the SOP must be documented with the reason for the deviation given. The WSM or his designee shall examine all field measurement records to verify conformance with the appropriate SOPs prior to submission to data management.-

5.1.5 Data management staff shall examine the field sampling records for each sampling event. Specifically, data management staff shall perform the following:

- a) Flag all data associated with a monitor well sample which was acquired without purging 3 full bore volumes with the "L" data qualifier in the UMTRA Project's software program for environmental analysis and reporting (SPEAR) data base.
- b) Flag all data associated with a monitor well for a given sampling event for which a sample pH of ≥ 9.0 was measured with the "G" flag in the SPEAR data base. This qualifier indicates possible grout contamination.

5.2 Reporting laboratory analytical measurements

5.2.1 As required by the DQOs for the UMTRA Project, subcontract laboratories shall routinely provide chemical analysis to the UMTRA Project which meets DOE Level C data quality criteria as described in HAZWRAP. Routine data deliverables provided to the UMTRA Project by subcontract laboratories are required by the UMTRA Project

Attachment 7.1
Page 1 of 2

UMTRA Project Contract Required Detection Limits (CRDLs) and Acceptable Techniques

Parameter	CRDL, mg/L	Technique(s) ¹
Aluminum	0.05	ICP-AES
Ammonium as NH ₄	0.10	Colorimetric
Antimony	0.003	GFAA, ICP-MS
Arsenic	0.005	GFAA, NaBH ₄
Barium	0.10	ICP-AES
Beryllium	0.005	ICP-AES
Boron	0.10	ICP-AES
Bromide	0.10	IC
Cadmium	0.001	GFAA, ICP-MS
Calcium	0.50	ICP-AES
Chloride	0.50	IC, colorimetric
Chromium	0.01	ICP-AES
Cobalt	0.05	ICP-AES
Copper	0.02	ICP-AES
Dissolved organic carbon (DOC)	1.0	UV promoted oxidation-IR
Total cyanide	0.010	Colorimetric
Fluoride	0.10	ISE
Iron	0.03	ICP-AES
Lead	0.003	GFAA, ICP-MS
Magnesium	0.10	ICP-AES
Manganese	0.01	ICP-AES
Mercury	0.0002	CVAA
Molybdenum	0.01	ICP-AES
Nickel	0.04	ICP-AES
Nitrate as NO ₃	1.0	Colorimetric, IC
Potassium	0.10	ICP-AES, FAA
Selenium	0.005	GFAA, NaBH ₄
Silver	0.01	ICP-AES
Silica as SiO ₂	0.10	ICP-AES
Sodium	1.0	ICP-AES, FAA
Strontium	0.01	ICP-AES
Sulfate	1.0	IC
Sulfide	1.0	Titrimetric, colorimetric
Thallium	0.005	GFAA, ICP-MS
Tin	0.05	ICP-AES, GFAA, ICP-MS
Total dissolved solids	10	Gravimetric
Total kjeldahl nitrogen	1.0	Colorimetric
Total organic carbon (TOC)	1.0	UV promoted oxidation-IR
Total phosphorus as PO ₄	0.10	Colorimetric
Uranium	0.001	ICP-MS, fluorometric
Vanadium	0.01	ICP-AES
Zinc	0.05	ICP-AES

UMTRA Project Lower Limits of Detection (LLDs) and Suggested Techniques

Parameter	LLD, pCi/L	Technique(s) ¹
Gross alpha	1.0	PC
Gross beta	0.5	PC
²¹⁰ Pb	1.5	LSc, PC
²¹⁰ Po	1.0	AS, PC
²²⁶ Ra	1.0	AS, ASc
²²⁸ Ra	1.0	PC
²³⁰ Th	1.0	AS

¹Where more than one technique is specified, the first technique listed is preferred. Technique acronyms and abbreviations are defined below.

AS	Alpha spectrometry
ASc	Alpha scintillation
CVAA	Cold vapor atomic absorption spectroscopy
FAA	Flame atomic absorption spectroscopy
GFAA	Graphite furnace atomic absorption spectroscopy
IC	Ion chromatography
ICP-AES	Inductively coupled plasma-atomic emission spectroscopy
ICP-MS	Inductively coupled plasma-mass spectrometry
IR	Infrared
ISE	Ion specific electrode
LSc	Liquid scintillation
NaBH ₄	Sodium borohydride reduction atomic absorption spectroscopy
PC	Proportional counter
UV	Ultraviolet

Attachment 7.2

UMTRA Project SPEAR Analytical Data QC Flag Codes

<u>Code</u>	<u>Definition (Comments)</u>
E	Estimated value because of interference, see case narrative
G	pH > 9, possible grout contamination
H	Hold time expired, value suspect
I	Increased DL due to required dilution
J	Estimated value
L	Less than 3 bore volumes removed before sampling, value suspect
M	Duplicate injection precision not met (HGA)
N	Spike sample recovery not within control limits
R	Unusable data point
S	Reported value determined by method of standard addition (MSA)
W	Post-digestion spike out of control limits while sample absorbance < 50% spike absorbance
*	Duplicate analysis not within control limits
+	Correlation coefficient for MSA < 0.995
#	Data not validated

JACOBS ENGINEERING GROUP INC.

ALBUQUERQUE OPERATIONS

DATA PACKAGE ASSESSMENT

DELIVERY ORDER NUMBERS: _____ SITE: _____

LABORATORY: _____ SAMPLING DATES: _____

REVIEWER: _____

NAME (print)

SIGNATURE

DATE

CHAIN OF CUSTODY FORMS ALL PRESENT _____ SIGNED _____

	ICP	GFAA	FAA	Hg	Anions	Rad	S ²⁻	TDS	CN
HOLDING TIME	_____	_____	_____	_____	_____	_____	_____	_____	_____
CALIB. VERIFICATION	_____	_____	_____	_____	_____	N/A	N/A	N/A	_____
PREP. BLANKS	_____	_____	_____	_____	_____	_____	N/A	_____	_____
ICS (ICP ONLY)	_____	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
LCS	_____	_____	_____	_____	_____	_____	N/A	_____	N/A
DUPLICATES	_____	_____	_____	_____	_____	_____	_____	_____	_____
POSTDIGEST. SPKS.	_____	_____	_____	N/A	N/A	N/A	N/A	N/A	_____
MATRIX SPKS.	_____	_____	_____	_____	_____	_____	N/A	_____	_____
OVERALL ASSESS.	_____	_____	_____	_____	_____	_____	_____	_____	_____

ITEMS REQUIRING ATTENTION: _____

AREAS OF CONCERN: _____

REVIEWER COMMENTS: _____

Attachment 7.4

Sample Preservation Techniques and Holding Times

Bottle ID	Parameter(s)	Volume/Container	Preservation	Holding Time
A-1	Br, Cl, F, SiO ₂ , SO ₄	1 L Plastic	None, 4 ± 2° C	28 days
	TDS			7 days
M-2	Ag, Al, As, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Sn, Sr, Tl, U, V, Zn	1 L Plastic	HNO ₃ , pH < 2	180 days
N-1	NH ₄ , NO ₃ , TKN PO ₄	500 mL Plastic	H ₂ SO ₄ , pH < 2 4 ± 2° C	28 days
CN	Total CN	1 L Plastic	NaOH, pH > 12 4 ± 2° C	14 days
S	Sulfide	2x500 mL Plastic	NaOH, pH > 9 Zn Acetate 4 ± 2° C	7 days
DOC	DOC	500 ml Amber Glass	H ₂ SO ₄ , pH < 2 4 ± 2° C	28 days
TOC	TOC	500 ml Amber Glass	H ₂ SO ₄ , pH < 2 4 ± 2° C	28 days
Ra-226	Ra-226	2x1 L Plastic	HNO ₃ , pH < 2	180 days
Ra-228	Ra-228	2x1 L Plastic	HNO ₃ , pH < 2	180 days
Pb-210	Pb-210	1 L Plastic	HNO ₃ , pH < 2	180 days
Po-210	Po-210	1 L Plastic	HNO ₃ , pH < 2	180 days
Th-230	Th-230	1 L Plastic	HNO ₃ , pH < 2	180 days
GAB	Gross Alpha, Gross Beta, U	500 mL Plastic	HNO ₃ , pH < 2	180 days

JACOBS ENGINEERING GROUP INC.

ALBUQUERQUE OPERATIONS

ANOMALOUS DATA REVIEW CHECKSHEET

SITE: _____ **SAMPLING DATE(s):** _____

SITE TOXICOLOGIST: _____

NAME (print)	SIGNATURE	DATE
--------------	-----------	------

SITE HYDROLOGIST: _____

NAME (print)	SIGNATURE	DATE
--------------	-----------	------

SITE GEOCHEMIST: _____

NAME (print)	SIGNATURE	DATE
--------------	-----------	------

DATE OF REVIEW: _____

[illegible]

the USEPA CLP SOW ILMO2.0. Only JEG data management staff shall assign the data qualifiers G, L, J, and R to records in the data base. Data management staff shall remove the data qualifier # (data not validated) from records in the UMTRA Project's data base only when all outstanding quality assurance (QA) and QC issues have been resolved.

5.3 Laboratory QC documentation

Members of the UMTRA TAC data management staff are responsible for verifying that the required laboratory QC information is included in the laboratory data packages, and that those data meet the acceptance criteria specified in the SOW. To allow for possible rounding discrepancies, results that are within 1% of the windows defined in this section will be accepted without qualification.

5.3.1 The analytical data shall be accompanied by signed chain-of-custody (COC) forms and the summary of laboratory QC results.

- a) Time and date of receipt, as well as the signature or initials of the person accepting custody shall be noted on the COC forms.
- b) The COC forms shall include notation of sample cooler temperature, sample bottles which were damaged in transit, missing bottles, and any other irregularity such as broken custody seals or illegible sample labels.
- c) Data management staff shall confirm on the Data Package Assessment Form, JEG-AL-ENG-86 (Attachment 7.3), that original signed copies of all COC forms have been received from the subcontract laboratory.
- d) Analytical results associated with a sample which was improperly preserved shall be qualified as estimated or unusable, J and R respectively, as appropriate in the data base.
- e) Irregularities which impact the legal defensibility of the analytical results, such as broken custody seals, must be discussed in the subcontract laboratory's analytical case narrative and should be discussed in the UMTRA Project TAC data management narrative.

5.3.2 Data management staff shall confirm that all samples were analyzed within the applicable holding times. Holding times are measured from the date and time of sampling to the date and time of sample analysis. Data management staff shall record the results of this data check on the Data Package Assessment Form. Parameter holding times and preservation techniques may be seen in Attachment 7.4. Analytical

subcontract laboratory statement of work (SOW) to meet only Level C reporting requirements. For the purposes of the UMTRA Project subcontract laboratory SOW, Level D criteria are considered identical to those outlined in the U.S. Environmental Protection Agency (EPA) *Contract Laboratory Program (CLP) Statement of Work for Inorganic Analysis, Multi-media, Multi-concentration, ILMO2.0*. Exhaustive supporting documentation needed for Level D deliverables, such as standard preparation logs, digestion logs, instrument print-outs, and other "raw" data, are required by the SOW to be maintained at the subcontract laboratory and shall be made available to the UMTRA Project upon request. All data received from subcontract laboratories shall meet the specifications outlined in the SOW. Contract required detection limits (CRDLs), lower limits of detection (LLDs), and analytical techniques required by the SOW may be seen in Attachment 7.1. The acronym, CRDL, as used in this SOP refers exclusively to the UMTRA Project CRDLs.

- 5.2.2 Data management staff shall validate laboratory QC data as outlined in section 5.3 of this SOP by determining whether they meet the acceptance criteria given in the SOW. Data management staff may request reanalysis at the subcontract laboratories' expense if they encounter failed QC data.
- 5.2.3 General inorganic results reported to the UMTRA Project in units of mg/L or mg/kg, and which are less than the CRDLs, shall be reported as "< CRDL" where CRDL is expressed in mg/L for water, or dilution factor times CRDL in mg/kg for soils. For soil analyses, the CRDLs refer to the digestion solution being analyzed. Because data less than the UMTRA Project CRDLs are not routinely reported, the USEPA CLP reporting conventions for results below the CRDL, indicated by the B data qualifier, and below instrument detection limit (IDL) results, indicated by the U data qualifier, are not used for data entered into the project's data base. However, these conventions may be used in QC data deliverables.
- 5.2.4 Radiochemical data are reported to the UMTRA Project in units of pCi/L or pCi/g, and shall be reported as they are calculated. Negative results for these parameters shall be reported as zero. All radiochemical results shall be reported with a calculated detection limit and total uncertainty value for the 95% confidence level.
- 5.2.5 Data qualifiers which are used by the UMTRA Project along with their associated definitions may be seen in Attachment 7.2. The use of these data qualifiers by subcontract laboratories is outlined in the SOW and/or

2. If the ICV or CCV %R is within the range of 111-125% (total cyanide, 116-130%; mercury, 121-136%), results less than the CRDL are acceptable without qualification.
 3. If the ICV or CCV %R is less than 75%, (total cyanide, < 70%; mercury, < 65%), qualify all results as unusable, R.
 4. If the ICV or CCV %R is greater than 125%, (total cyanide > 130%; mercury, > 135%), qualify results greater than the CRDL as unusable, R; results less than the CRDL are acceptable without qualification.
- e) Radiochemical calibrations, other than those for total uranium, are not typically performed on a daily basis, and hence, analysis of a calibration verification standard is not required. These periodic calibrations should be performed according to the subcontract laboratory's QA protocols.
- f) No instrument calibration is employed in the determination of sulfide or total dissolved solids. These analyses are also exempted from the instrument calibration verification requirements. However, the iodine solution employed in sulfide analysis should be calibrated against a titrant of known normality at least once a week. The results of iodine solution calibration should be recorded on the chemist's worksheet, but need not be reported in the QC summary.

5.3.4 Initial calibration blank (ICB) and CCB analyses must be run immediately following the associated calibration verification samples. The calibration blank matrix is the same as that of the calibration verification sample. That is, if the calibration standards and verification samples are digested, then the calibration blanks are also digested.

- a) Calibration blanks are run with the same frequency as calibration verifications.
- b) If the absolute value of the blank result exceeds the CRDL the analysis must be terminated and the problem corrected. Recalibration followed by calibration verification and blank samples must be performed prior to resuming the analytical run.
- c) If re-analysis within sample holding time is not possible, all analytical data reported as ≤ 10 times the absolute value of the associated ICB or CCB analysis which was greater than the CRDL are considered as estimated values and shall be qualified with the "J" flag in the SPEAR data base.

results associated with expired holding times must be qualified with the "H" flag on the analytical reports by the subcontract laboratory. An analytical result associated with a sample for which the holding time has been greatly exceeded should be qualified as unusable, R. Data management staff should exercise professional judgement to determine when such data should be qualified as unusable.

5.3.3 Required calibration verification data include the initial calibration verification (ICV) and continuing calibration verifications (CCV), where applicable. Validation shall consist of confirming the presence of these data and determining that they meet the criteria listed below in section 5.3.3 (c). The results of this data check shall be recorded on the Data Package Assessment Form.

The calibration verification sample analysis requirement is not applicable to all the analytes routinely measured for the UMTRA Project. The analyses exempted from this requirement are listed in section 5.3.3 (e) and (f), below.

- a) ICV analysis is conducted immediately after the instrument has been calibrated. This verification consists of analysis of a standard solution within the range of calibration. The ICV standard must be from a source different from that used to prepare the calibration standards.
- b) CCV analysis is conducted every two hours or after every tenth analytical sample, whichever is more frequent. The same standard must be used for all CCV analyses. The CCV, followed by a continuing calibration blank (CCB), must be analyzed at the end of each analytical run.
- c) ICV and CCV results must be within $\pm 10\%$ of the known value except for cyanide ($\pm 15\%$) and mercury ($\pm 20\%$).
- d) In the event that either the ICV or CCV data fall outside of these limits the analytical run shall be terminated and the instrument recalibrated. All samples analyzed since the last successful calibration verification shall be reanalyzed. If sample re-analysis is not possible, data management staff shall use professional judgement to qualify all associated data. The following guidelines are suggested.
 - 1. If the ICV or CCV percent recovery (%R) falls outside the acceptance criteria but within the range 75-89% or 111-125% (total cyanide, 70-84% or 116-130%; mercury 65-79% or 121-135%), qualify results greater than the CRDL as estimated, J.

- a) The interference check sample results must agree within $\pm 20\%$ of the true value. If this criterion is not met, the analyst may either terminate the analysis or continue and run the failed constituents at a later time.
- b) Validation shall consist of confirming that the data for interference check samples are present and that these data meet the above criterion. The results of this data check shall be recorded on the Data Package Assessment Form.
- c) ICS analysis results outside the $\pm 20\%$ control limit should be followed-up with a reanalysis request for all affected parameters. If sample re-analysis is not possible, such as when the entire sample has been consumed by prior analyses, data management staff shall use professional judgement to qualify all data associated with a failed ICS. The following guidelines are suggested:
 - 1. If the ICS recovery for an element is greater than 120 %R and the sample result is less than the CRDL, the data are acceptable without further qualification.
 - 2. If the ICS recovery for an element is less than 80 %R, qualify the result as unusable, R.
 - 3. If the ICS recovery is greater than 120 %R and the sample result is greater than the CRDL, qualify the sample result as unusable, R.

5.3.7 A laboratory control sample (LCS) must be analyzed using the same sample preparation and analysis methods used for the UMTRA Project samples. One laboratory control sample will be analyzed with each digestion batch of up to 20 samples. Metals determination for field filtered samples does not require digestion prior to analysis, therefore an LCS is not required for such samples.

- a) The aqueous laboratory control sample analytical results must agree within $\pm 20\%$ of the true value. Exceptions to the acceptance criterion for LCS are silver and antimony, for which there are no specified acceptance criteria. Solid LCS results must fall within the control limits specified by the agency that prepared the reference material.
- b) Validation shall consist of confirming that the LCS data are present and that these data meet the above criteria. The results of this data check shall be recorded on the Data Package Assessment Form.

5.3.5 Preparation blanks (reagent or method blanks), consisting of deionized water and the appropriate reagents, are included in each batch of samples requiring digestion (e.g. ground water samples analyzed for total metals content, total cyanide, and all mercury analyses). A preparation blank must be included for every 20 samples or one per analytical batch, whichever is more frequent.

- a) Preparation blanks are required for all analyses requiring sample preparation prior to analysis, except those cases for which reagents are automatically added to all samples by an autoanalyzer.**
- b) Radiochemical preparation blanks are subject to laboratory QC protocols and are exempt from the acceptance criteria discussed below. The data reviewer may, however, ask for reanalysis or corrective action if professional judgement suggests that an unacceptable blank contribution exists.**
- c) If any analyte concentration in the blank exceeds of the CRDL, the concentration in the associated samples must be at least 10 times the concentration in the blank. All samples with a concentration less than 10 times that of the blank but above the CRDL must be redigested and reanalyzed.**
- d) Validation shall consist of confirming that the data for preparation blanks are present and that the data meet the above criterion. The results of this data check will be recorded on the Data Package Assessment Form.**
- e) If re-analysis within sample holding time is not possible, all analytical data reported as ≤ 10 times the value of the associated PB analysis which was greater than the CRDL are considered as estimate values and shall be qualified with the "J" flag in the SPEAR data base.**

5.3.6 Interference check samples (ICS) for ICP analyses will be run a minimum of twice in each eight-hour shift, or at the beginning and end of each analysis run, whichever is more frequent. The constituent composition of the interference check samples for CLP target analytes is specified in the EPA Contract Laboratory Program (CLP) Statement of Work. The metals not covered by the USEPA CLP SOW should be spiked into the ICS at concentrations not greater than 1 mg/L. The true values for the additional analytes may be calculated if diluted from certified materials.

- c) A different measure of precision, the replicate error ratio (RER), is employed for radiochemical replicate results. The RER is calculated as follows:

$$RER = \frac{|S-R|}{2\sigma_s + 2\sigma_R}$$

Where, RER = Replicate Error Ratio

S = Sample value (original)

R = Replicate sample value

$2\sigma_s$ = Sample uncertainty (95%)

$2\sigma_R$ = Replicate uncertainty (95%)

- d) Radiochemical replicates (other than uranium) must agree when the 95% confidence level uncertainties are considered. That is, the RER must be less than or equal to one.
- e) Validation shall consist of confirming that data for replicate samples are present and that these data meet the above criteria. All results associated with a failed replicate analysis shall be qualified with the "*" flag in the data base. In addition, data management staff shall use professional judgement when determining if the additional data qualifier J should be used to denote an estimated result. The results of this data check will be recorded on the Data Package Assessment Form.

5.3.9 When sample preparation prior to analysis is required, matrix spike analyses are performed as a measure of the ability to recover the analyte. A matrix spike analysis is required at a minimum frequency of one per analytical batch or one per 20 samples, whichever is more frequent. Samples identified as field blanks and equipment blanks shall not be used for matrix spike sample analysis.

- a) Where no sample preparation is required, analytical spikes are performed by adding a known amount of analyte to the sample at the time of analysis. Matrix spikes or analytical spikes, as appropriate, will be performed for all analytes other than sodium, potassium, magnesium, calcium, sulfide, and TDS.
- b) In addition, post digestion spike analysis will be performed for flame AA, ICP, and cyanide when matrix spike recovery falls outside the control limits specified below and the sample result does not exceed 4 times the spike added, see section 5.3.9 (f) below. Post digestion spikes should be added at twice the indigenous level or at twice the CRDL, whichever is greater.

- c) LCS analysis is not required for mercury and cyanide, since the ICV is always digested for these analyses.
- d) If data associated with a failed LCS analysis are reported and sample re-analysis is not possible, data management staff shall use professional judgement to qualify data associated with a failed LCS. The following guidelines are suggested for LCS samples:
 - 1. If the LCS %R for any parameter is within the range of 50-79% or 120-150% and the result is greater than the CRDL (or the calculated detection limit for radiochemical parameters), qualify the results as estimated, J.
 - 2. If the results are less than the CRDL (or the calculated detection limit for radiochemical parameters) and the LCS %R is greater than 120%, the results are acceptable without further qualification.
 - 3. If the LCS %R is less than 50% or greater than 150%, qualify the results as unusable, R.

5.3.8 One replicate sample must be analyzed from each batch, with a minimum frequency of one per 20 samples. As is required by the SOW, samples identified as field blanks or equipment blanks may not be used as laboratory replicate samples. Field blank and equipment blank samples are identified as having Location ID 0999. Field blank samples have Sample ID 000n, equipment blank samples have Sample ID 000m, where n is an odd integer and m is an even integer.

- a) The replicate relative percent difference (RPD) is the measure of precision used for uranium and all general inorganic constituents. The RPD is calculated as follows:

$$RPD = \frac{|S-R|}{(S+R)/2} \times 100\%$$

Where, RPD = Relative Percent Difference

S = Sample value (original)

R = Replicate sample value

- b) The RPD must be less than or equal to 20 percent for samples with concentrations greater than or equal to five times the CRDL. For samples with concentrations less than five times the CRDL but greater than the CRDL, the control limit is $\pm$ CRDL. No RPD can be calculated for samples with both concentrations less than the CRDL.

2. If the spike %R is 126-170% or 30-74% and the sample result is greater than the CRDL (or the calculated detection limit for radiochemical parameters), qualify the result as estimated, J.
 3. If the spike %R is within the range or 30-74% and the sample result is less than the CRDL (or the calculated detection limit for radiochemical parameters), qualify the sample result as estimated, J.
 4. If the spike %R is less than 30% or greater than 170%, qualify the sample result as unusable, R.
- i) Data management shall use professional judgement to evaluate graphite furnace atomic absorption post digestion spike data which are outside the acceptance criteria of $\pm 15\%$. All GFAA data shall be qualified as required by the USEPA CLP SOW ILMO2.0. In addition, the following guidelines are suggested for samples associated with a failed post digestion spike analysis:
1. If the post digestion spike %R is less than 40% but greater than or equal to 10 %R, qualify the sample result as estimated, J. Such data should be accompanied by an E data qualifier from the subcontract laboratory.
 2. If the post digestion spike recovery is less than 10%, and the sample result is less than the CRDL, qualify the sample result as unusable, R. Such data should be accompanied by an E data qualifier from the subcontract laboratory.
 3. If the sample absorbance or concentration is less than 50% of the spike absorbance or concentration and the %R of the furnace post digestion spike is outside the $\pm 15\%$ acceptance criteria, qualify the sample result as estimated, J. Such data should be accompanied by a W data qualifier from the subcontract laboratory.
 4. If method of standard additions (MSA) was required as per the USEPA CLP SOW but was not performed, qualify the sample result as estimated, J.
 5. If any sample measured using MSA were not spiked at appropriate levels, qualify the sample result as estimated, J.

- c) For CLP target analytes, the spiking levels are listed in the USEPA CLP SOW ILMO2.0. Analytes which are not specifically addressed by the USEPA CLP SOW, and which are not exempted above, should be spiked at meaningful levels to be determined by subcontract laboratory personnel. Generally, matrix spikes for such samples should be approximately two times the indigenous level of the analyte or two times the CRDL, whichever is greater.
- d) The percent recovery (%R) for spiked samples is calculated as follows:

$$\%R = \frac{SSR - SR}{SA} \times 100\%$$

Where, SSR = Spiked sample result
SR = Sample result
SA = Spike added

- e) When the analyte concentration for a sample is less than the instrument detection limit, SR = 0 shall be used in the spike recovery calculation.
- f) The spike recovery must fall within the limits of 75-125 percent. An exception to these control limits is made in the case for which the sample result exceeds four times the spike added. No control limits are applied in this case since the spike signal rapidly becomes negligible with respect to the sample analyte signal.
- g) Validation shall consist of confirming that the required spike data are present and that these data meet the above criteria. All data associated with a failed matrix spike analysis shall be qualified with the "N" flag in the data base. The results of this data check shall be recorded on the Data Package Assessment Form.
- h) Data management staff shall use professional judgement to qualify data associated with matrix spike analyses which are reported as outside the acceptance criteria. The following guidelines are suggested for samples associated with a failed matrix spike analysis:
1. If the spike %R is greater than 125% and the reported sample result is less than the CRDL (or the calculated detection limit for radiochemical parameters), the sample result is acceptable without further qualification.

- a) Reanalysis should be requested by telephone and confirmed in writing.
- b) Validation of the data package may be postponed until the receipt of the reanalysis data.
- c) Validation criteria for the reanalysis data shall be the same as for the original analytical data.

5.7 Subcontract laboratory performance evaluation samples

5.7.1 Performance evaluation (PE) samples will be submitted to each active contract analytical laboratory four times a year, as described in SOP 16.3.3. An independent laboratory shall prepare, ship, and verify parameter concentrations and activities in the PE sample.

5.7.2 The results of the PE sample analyses will be transmitted to the UMTRA Project TAC in the format specified for all other analytical data.

5.8 On-site data package evaluations

5.8.1 Data management staff shall visit subcontract laboratories at least twice per year, as described in SOP 16.3.3. During these visits they shall examine and evaluate at least one data package and supporting documentation to determine whether the requirements outlined in the SOW have been met.

- a. Data management staff shall request a complete data package that includes all supporting documentation at the time of the visit.
- b. Data management staff shall document the results of the data package evaluation in a report to the TAC Data Management and Assessment Department Manager and the TAC QA Department within twenty working days of the visit.

6. If the MSA correlation coefficient is <0.995 , qualify the sample result as estimated, J.

5.3.10 Analytical results associated with a ICP-AES serial dilution analysis which is outside the $\pm 10\%$ control limit shall be qualified as estimated, J, in the data base. Such results are required to be qualified with the "E" flag on the analytical reports by the subcontract laboratory.

5.4 Field QC sample analytical data

5.4.1 For field blank (FB) and equipment blank (EB) results reported above the CRDL for any parameter, all analytical data reported as ≤ 10 times the value of the associated FB or EB result are considered as estimate values and shall be qualified with the "J" flag in the SPEAR data base.

5.4.2 There is no review criterion for field replicate data. Data management staff should use professional judgement when evaluating field replicate data. Data management staff should discuss poor field replicate results in the data management case narrative.

5.5 Validation of data consistency

5.5.1 All newly acquired analytical data will be checked for consistency with all other data from the same sample location. Using SPEAR a Suspected Anomalies Report (SAR) shall be generated and distributed to the TAC SH, STox, and GC.

5.5.2 The TAC SH, STox, and the SG, shall review and evaluate the SAR after each sampling round. They shall evaluate all anomalous data and suggest a disposition for each datum noted on the Anomalous Data Review Checksheet, Attachment 7.5. The TAC SH, STox, and SG shall sign the Anomalous Data Review Checksheet.

5.5.3 Data management staff shall review all completed Anomalous Data Review Checksheets. Data management staff shall determine if reanalysis requests made by other TAC staff are appropriate and should be performed.

5.6 Request for reanalyses

5.6.1 In the event that a significant deviation from historical data is identified for one or more analytes, or if QC data are either missing or outside the control limits, the DBA and the AQAS have the option of requesting the missing documentation or the reanalysis of any or all samples within the

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7.0 ATTACHMENTS

7.1	UMTRA Project CRDLs and Acceptable Techniques	2 pages
7.2	UMTRA Project Data Qualifiers	1 page
7.3	JEG-AL-ENG-86 (10/92) Data Package Assessment Form	1 page
7.4	Sample Holding Times and Preservation Techniques	1 page
7.5	JEG-AL-ENG-87 (10/92) Anomalous Data Review Checksheet	1 page

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JACOBS ENGINEERING GROUP INC.

ALBUQUERQUE OPERATIONS

EXHIBIT A

DATED: JANUARY 8, 1996

STATEMENT OF WORK

UMTRA PROJECT TAC GENERAL INORGANIC AND RADIOCHEMICAL ANALYSES

Introduction

The Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978, Public Law 95-604, grants the Secretary of Energy the authority and responsibility to perform such actions as are necessary to minimize radiation health hazards and other environmental hazards caused by inactive uranium mill sites. The U.S. Department of Energy (DOE) Uranium Mill Tailings Remedial Action (UMTRA) Project prime Technical Assistance Contractor (TAC) is Jacobs Engineering Group Inc. (JEG). The UMTRA Project TAC is responsible for acquiring chemical analytical services in support of UMTRA Project activities. This statement of work (SOW) outlines the requirements for analytical services provided to the UMTRA Project by subcontract laboratories.

Environmental samples obtained for chemical analysis in support of UMTRA Project activities will consist of soil, waste, groundwater, surface water, and domestic supply water. The sections below detail specific quality assurance (QA) protocols, analytical practices and procedures, analytical quality control (QC) requirements, and deliverable format and schedule requirements. Collectively, these conventions have been established to ensure that UMTRA Project data quality objectives (DQO) are met, and that data obtained from subcontract laboratories are comparable.

The subcontract laboratory shall perform all chemical analyses of samples received. Express written permission shall be obtained by the subcontract laboratory before sending any samples to a secondary laboratory for analysis. Secondary laboratories shall successfully pass an UMTRA Project TAC systems audit and submit analysis results for performance evaluation samples prior to providing analytical support to the subcontract laboratory. In the event that a secondary laboratory is approved and does receive samples, all delivery schedules shall remain unchanged.

EXHIBIT A

DATED: JANUARY 8, 1996

STATEMENT OF WORK

UMTRA PROJECT TAC GENERAL INORGANIC AND RADIOCHEMICAL ANALYSES

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EXHIBIT A

DATED: JANUARY 8, 1996

STATEMENT OF WORK

UMTRA PROJECT TAC GENERAL INORGANIC AND RADIOCHEMICAL ANALYSES

1.0 ANALYSIS REQUESTS AND SAMPLE SHIPMENT

1.1 Work orders

Approximately 1 week before the start of sample collection, the JEG Subcontract Representative shall notify the subcontractor, in writing, of the scheduled shipment of samples. The notification shall take the form of a delivery order issued against the subcontract. The delivery order shall include Work Order Plan forms, which detail the samples to be submitted and the analyses requested.

1.2 Sample custody

Sample custody is transferred to the subcontract laboratory at the time of sample receipt, after which the subcontract laboratory is responsible for maintenance of unbroken chain of custody (COC). By definition, a sample is in custody if it is 1) in one's possession, 2) in view, or 3) in a controlled access area. section 2.9.1. of this document provides additional detail regarding sample receipt procedures.

1.3 Shipping charges

Sample shipping charges shall typically be paid by JEG. However, it may become necessary on occasion to ship samples collect. In such cases, the subcontractor shall be reimbursed for the shipping charges. Reimbursement shall be in accordance with the invoicing requirements specified in Exhibit D.

1.4 Itemized analytical charges

Unit prices provided by subcontract laboratories shall include the cost of all quality assurance, quality control, analytical, reporting, storage, and disposal requirements specified in this SOW.

1.5 Analyte definitions

For chemical analyses performed under this SOW, the term "general inorganic" shall refer to the analytes listed on page 1 of Attachment 5. The term "radiochemical" shall refer to the analytes listed on page 2 of Attachment 5.

1.6 Time definitions

All references to days, weeks, or months are defined as calendar days, weeks, and months.

2.0 QUALITY ASSURANCE REQUIREMENTS**2.1 Data quality objectives****2.1.1 References for data quality objectives (DQO)**

The DQOs for the UMTRA Project require the chemical analysis data provided by the subcontract laboratory to meet Level D criteria as described in the DOE's, Requirements for Quality Control of Analytical Data, Hazardous Waste Remedial Actions Program, DOE/HWP-65/R, 1990 (HAZWRAP). For the purpose of this SOW, Level D criteria are considered identical to those outlined in the U.S. Environmental Protection Agency (EPA) Contract Laboratory Program (CLP) Statement of Work for Inorganic Analysis, Multi-media, Multi-Concentration, ILMO2.0. The QA and QC requirements discussed in these documents apply to all chemical and physical parameters of interest to the UMTRA Project, including those parameters not specifically mentioned in the EPA CLP SOW. In cases for which the specific QA and QC protocols cannot be extended to parameters of interest to the UMTRA Project, professional judgment shall be employed in adhering as closely as possible to the spirit of these protocols. This means that the subcontract laboratory should extend all standard documentation practices, such as standards preparation, digestion, and run logs, where applicable, to parameters and analytical techniques that are not covered in the CLP SOW. The laboratory shall formulate an approach to documentation of analytical processes and procedures in light of the fact that it is the goal of JEG to obtain legally and technically defensible data in support of UMTRA Project activities.

- Specific QC requirements for the UMTRA Project are discussed in detail in section 3.0 of this SOW.

2.1.2 Reporting levels

UMTRA Project data deliverables routinely provided by the subcontract laboratory, unless otherwise requested, need only meet Level C reporting requirements as described in HAZWRAP. Analytical data deliverable requirements are fully outlined in section 4.0 of this document.

2.2 Subcontract laboratory quality assurance plan**2.2.1 Specific requirements**

The subcontract laboratory, and any secondary laboratories, shall provide a laboratory quality assurance plan (LQAP) which meets the criteria listed in HAZWRAP, section 5.2.1. Specifically, the LQAP shall contain sections addressing all of the following items at minimum:

- a) Title page with provision for approval signatures and dates of revision.
- b) Table of contents.
- c) Subcontract laboratory organizational structure and key personnel responsibilities.
- d) Personnel training, with required training frequency and methods of records maintenance specified.
- e) Sample receipt, custody, and management practices. This section shall specify a formal vehicle for notifying the analytical group of holding times near expiration, in order to minimize occurrences of expiration prior to analysis.
- f) Facilities and equipment, including a description of security procedures, sample storage practices, and a list of equipment available at the subcontract laboratory.
- g) List of all subcontract laboratory analytical procedures by method number and matrix. Subcontract laboratory policy shall require that controlled copies of analytical procedures be available to the analysts.

- h) Instrument calibration procedures, including documentation of calibration standards, coefficients resulting from linear or higher order polynomial regression calculations, and calibration curve correlation coefficients. These procedures shall specify that linear regression calibration curve correlation coefficients shall be ≥ 0.995 .
- i) Instrument detection limits (IDL), where applicable, for analytical techniques to be employed in the analysis of UMTRA Project samples for general inorganic parameters. The section addressing IDLs shall specify the method of calculating IDLs, and the frequency with which this is done. IDL study requirements are discussed in greater detail in section 3.3 of this SOW.
- j) Daily QC practices. The LQAP shall specify default criteria for QC sample type, number, and data acceptance. This section shall also discuss the QC data review processes employed by the subcontract laboratory. Subcontract laboratories performing radiochemical analysis of UMTRA Project samples shall specify minimum internal tracer and carrier recovery criteria in the LQAP. QC data requirements and acceptance criteria for UMTRA Project work are discussed in detail in section 3.4 of this SOW.
- k) Corrective action reports (CAR). A copy of a CAR Form shall be provided in the LQAP.
- l) Document control. The LQAP shall outline document flow, including review steps, from COC to the final report.
- m) Data review. The process for data review and approval shall be outlined in the LQAP. Provision shall be made for peer, supervisory, or QA review of all chemist worksheets.
- n) Holding times and preservatives. Holding times and preservation techniques for UMTRA Project samples are outlined in Attachment 1.
- o) Internal audits and outside agency approvals. The frequency and method of documentation for internal audits shall be discussed. In addition, the LQAP shall list approvals and certifications from states and external agencies.
- p) QA reports to management. The LQAP shall specify the frequency and contents of QA reports to management.

- q) Subcontract laboratory policy on reporting significant figures. The LQAP shall specify the subcontract laboratory policy regarding the number of significant figures to be used in reporting analytical results. The LQAP or an SOP shall require the use of leading zeros for numbers less than one, and that units accompany all numbers that are not dimensionless.
- r) Material procurement and control. The LQAP shall describe procedures for material procurement, quality inspection, inventory, and storage.

2.3 Performance evaluation sample analysis requirement

2.3.1 Schedule

The subcontract laboratory shall perform the analysis of performance evaluation (PE) samples provided to the subcontract laboratory by the UMTRA Project quarterly. The analytical and deliverable requirements for these PE samples are the same as all UMTRA Project samples. Payment for the analysis of PE samples shall be made according to the fees specified in the subcontract.

2.3.2 PE sample analysis

The analytical techniques and standard operating procedures (SOP) used in the analysis of PE samples shall be the same as those used in routine analysis of UMTRA Project samples.

2.3.3 Proficiency

A summary of analytical results and theoretical values for each PE round will be provided to each subcontract laboratory by JEG data management after all the data for that round are in. Any requests for CARs necessitated by subcontract laboratory PE sample failures will accompany the summary report. CARs requested by JEG data management shall be due no later than 4 weeks from the date of the request. JEG data management reserves the right to request accelerated delivery of CARs if circumstances make this necessary. Failure to respond promptly to a request for corrective action may result in temporary suspension of the subcontract laboratory from the UMTRA Project chemical analysis program.

2.4 Systems and internal audit requirements

2.4.1 Annual systems audits

The subcontract laboratory shall undergo an UMTRA Project TAC systems audit at least once per year. The purpose of this audit is to verify subcontract laboratory compliance with the LQAP and the specifications of this SOW. In addition, recommendations may be made to subcontract laboratory personnel regarding possible quality improvements in light of good laboratory practices and/or industry standards. A formal audit report will be issued following this activity.

2.4.2 On-site data package review

A data package review shall be conducted at the subcontract laboratory at least twice per year. The focus of these reviews shall be to ensure that raw data and supporting documentation (Level D) are maintained in a complete data package. The data package to be reviewed will be chosen at the time of the review activity.

2.4.3 Internal audits

The subcontract laboratory shall perform an annual internal QA audit. Findings of the subcontract laboratory's internal QA audits shall be provided to JEG data management upon request.

2.5 Participation in interlaboratory comparison studies

2.5.1 Required intercomparison programs

The subcontract laboratory shall participate in the interlaboratory comparison studies administered by the agencies listed below, where appropriate. Subcontract laboratories performing chemical analysis of UMTRA Project samples under a general inorganic analysis subcontract shall participate in (a), (b), and (e), below. Subcontract laboratories performing chemical analysis under a radiochemical analysis subcontract shall participate in (c), (d), and (e), below.

- a) Water Supply Laboratory Performance Evaluation Studies (WS), U.S. Environmental Protection Agency, Cincinnati, Ohio.
- b) Water Pollution Laboratory Performance Evaluation Studies (WP), U.S. Environmental Protection Agency, Cincinnati, Ohio.

- c) Radiation Science Branch Performance Evaluation Study, U.S. Environmental Protection Agency, Characterization Research Division, Las Vegas, Nevada.
- d) Interlaboratory Quality Assurance Program (QAP), U.S. Department of Energy, Environmental Measurements Laboratory (EML), New York, New York.
- e) Mixed Analyte Performance Evaluation Program (MAPEP), U.S. Department of Energy, Idaho Operations Office, Idaho Falls, Idaho.

2.5.2 Reporting intercomparison results

The subcontract laboratory shall report results of the intercomparisons specified in section 2.5.1, above, to JEG data management quarterly. This report is due on the first day of January, April, July, and October. All results received by the subcontract laboratory since the last quarterly report and more than 2 weeks before the due date shall be included in this deliverable. Results received less than 2 weeks before the due date may be held for inclusion in the next quarter's deliverable. Failure to participate in and report the results for the applicable intercomparisons may result in suspension of the subcontract laboratory from the UMTRA Project chemical analysis program.

2.6 Subcontract laboratory training and personnel requirements

2.6.1 Employee qualifications

It is suggested that subcontract laboratory personnel meet equivalent or specific education and training requirements outlined in the CLP SOW.

2.6.2 Documenting employee proficiency

JEG data management is conscious of the value and worth of experience. Years of analytical experience may often gain equivalency to or outweigh academic achievement. The subcontract laboratory shall gauge and document the competence of experienced individuals and specify additional training provided for all personnel.

2.7 Subcontract laboratory instrumentation, equipment, and reagent maintenance**2.7.1 Instrument logs and response checks**

- a) The subcontract laboratory shall have an SOP that specifies the requirements for maintaining logbooks. These requirements shall specifically address QA protocols for error correction, as well as schedules for peer, supervisory, or QA review of logbooks. In addition, the use of indelible ink to make logbook entries shall be explicitly required.
- b) The subcontract laboratory shall maintain an instrument logbook for all instruments used to acquire data for the UMTRA Project. The instrument logbook shall be clearly labeled to indicate its association with a particular piece of laboratory equipment.
- c) The subcontract laboratory shall have an SOP requiring that instrument response checks or other appropriate instrument performance checks be performed daily. The requirements shall include recording the results of such checks in the associated instrument maintenance log.
- d) Subcontract laboratories performing radiochemical analysis of UMTRA Project samples shall perform quarterly instrument background data acquisition, at a minimum, and shall record this information in the associated instrument logs.

2.7.2 Balances, volumetric pipettes, and sample storage refrigerators

- a) The subcontract laboratory shall have a calibration SOP for analytical balances, specifying that balances be checked daily against certified standards, and that balances not accurate to within at least ± 1 percent be recalibrated or removed from service. The subcontract laboratory shall maintain logbooks in which the daily analytical balance calibration checks are recorded.
- b) The subcontract laboratory shall have an SOP that requires daily temperature monitoring for refrigerated sample storage areas, and the corrective action that will be initiated if a measurement falls outside the range $4^{\circ}\text{C} \pm 2^{\circ}\text{C}$. The subcontract laboratory shall maintain logbooks for sample storage refrigeration units in which the daily temperature checks are recorded.

- c) The subcontract laboratory shall have a calibration SOP for volumetric pipettes, other than glass pipettes, that deliver 100 μL or more. This SOP shall specify that pipettes be checked daily by weighing deionized (DI) water, and that pipettes failing to deliver to within ± 1 percent accuracy be recalibrated or removed from service.

2.7.3 Reagent water production

- a) The subcontract laboratory shall have an SOP for reagent water or DI water production and system maintenance. This SOP shall outline specific control criteria for reagent or deionized water quality, daily water-quality measurement, and specific corrective actions to be taken in the event of an out-of-control event.
- b) Daily records of water quality shall be kept in a logbook designated for that purpose.

2.7.4 Control of standards

The subcontract laboratory shall have an SOP outlining policy on shelf life, labeling, and stock maintenance for reagents, stock solutions, intermediate dilutions, and working standards.

- a) The SOP shall specify a shelf life no greater than 1 year for stock solutions prepared from salts.
- b) The SOP shall specify a shelf life of no greater than 1 year for intermediate dilutions and vendor-supplied stock solutions, other than radionuclide solutions, when the constituent concentrations are 10 milligrams per liter (mg/L) or higher. General inorganic analyte solutions with constituent concentrations less than 10 mg/L should be defined as working standards.
- c) The SOP shall specify that working standards, other than radionuclide solutions and multielement inductively coupled plasma-atomic emission spectroscopy (ICP-AES) working standards, be prepared fresh daily.
- d) The SOP shall specify that multielement ICP-AES working standards be prepared fresh at least once a month.
- e) The SOP shall specify that anion stock solutions be kept in refrigerated storage.

- f) Subcontract laboratories performing radiochemical analysis of UMTRA Project samples shall address radionuclide solution maintenance in their radiological safety plan and/or in the LQAP.
- g) The SOP shall require that stock solutions and intermediate dilutions prepared in the subcontract laboratory be logged in a standards preparation log. The SOP should give specific guidelines on what information is to be included in log entries. Expiration dates for solutions prepared from multiple sources shall coincide with the earliest expiration date of the starting materials.
- h) Minimum labeling requirements for stock solutions and intermediate dilutions that are intended for long-term use shall be addressed in the SOP, and should include the following:
 - Preparer's initials.
 - Date of preparation.
 - Matrix.
 - Concentration of constituents.
 - Expiration date.
 - Unique standard name that is traceable to a standards preparation log.
- i) The SOP shall specify that expired standards be removed from the standards storage areas to a separate area to await disposal.

2.7.5 Glassware

- a) The subcontract laboratory shall have an SOP for glassware cleaning.
- b) All volumetric glassware used to make standard and sample dilutions in UMTRA Project work shall be American Society for Testing and Materials (ASTM) Class A glassware.

2.8 Analytical and QA standard operating procedures

2.8.1 Control of standard operating procedures

The subcontract laboratory shall maintain controlled copies of approved SOPs for each analytical method or general procedure performed by subcontract laboratory personnel. The subcontract laboratory shall set and demonstrably adhere to a schedule of periodic review for SOPs. Changes in subcontract laboratory SOPs that affect the analysis or documentation of UMTRA Project samples shall be transmitted to JEG data management for approval prior to implementation.

2.8.2 Availability of SOPs

Controlled copies of SOPs shall be readily available to all personnel performing analytical work in support of the UMTRA Project chemical analysis program. This may be accomplished either by issuing a copy to each analyst, or by placing a library of SOPs in a place that is accessible to analysts.

2.8.3 Analyst familiarity with SOPs

To ensure that the contents of subcontract laboratory QA and analytical SOPs are effectively communicated to personnel performing chemical analysis of UMTRA Project samples, analyst familiarity with SOPs shall be documented. Laboratory procedures shall require that method training and QA indoctrination be performed and documented.

2.9 Sample receipt and storage requirements

2.9.1 COC forms

Each UMTRA Project sample received by the subcontract laboratory will be accompanied by a COC form. An examples of this form is provided as Attachment 2.

- a) At the time of sample receipt, this form will have been partially completed by the sampling crew, and should indicate the subcontract laboratory name, delivery order number, site identification (ID), location ID, sample ID, sample matrix, bottle ID, bottle volume, date collected, time collected, date shipped, and method of shipment.

- b) Individual sample bottles are labeled with the site ID, location ID, sample ID, logdate (date sampled), bottle ID, preservation method, sampler's identity, and comments. An example of a JEG sample bottle label is provided as Attachment 3.
- c) The subcontract laboratory sample custodian receiving the sample shall verify that the information listed on the COC form is correct and accurately describes the contents of the shipment.

2.9.2 Acknowledgment of sample receipt

At the time of receipt, the subcontract laboratory sample custodian shall sign and date the COC form in indelible ink to acknowledge sample receipt and custody. The sample custodian shall place a check mark in the "REC'D" field on the COC form for each bottle received.

2.9.3 Documentation of anomalies

The subcontract laboratory sample custodian shall note on the COC form and sample login worksheets any irregularities observed with the shipment, temperature, preservation, condition, and custody seals of samples received. The pH of all sample fractions, preserved and unpreserved, shall be checked during sample login. If no anomalies are encountered for a sample shipment, a brief statement of this fact shall be provided on login worksheets and in the case narrative.

2.9.4 Communication of anomalies

A subcontract laboratory representative shall notify UMTRA Project data management immediately by telephone of any irregularities noted during the sample receiving process. Any such problems that adversely affect data quality are to be described in the case narrative that accompanies the report of analytical results for that delivery order.

2.9.5 Sample retention

The subcontract laboratory shall retain and store all UMTRA Project samples associated with a specific delivery order for a period of 120 days after issuance of the final analytical report for that delivery order. At the end of this sample retention time, the subcontract laboratory shall notify JEG data management before disposing of the samples. As JEG procedures for comparison of new data with historical data are refined, the need for the 120-day sample retention time may be decreased. JEG data management shall notify the subcontract laboratory, in writing, if the sample retention time is to be decreased.

2.9.6 Sample disposal

The subcontract laboratory is solely responsible for lawful disposal of UMTRA Project water samples after the 120-day sample storage requirement is fulfilled. Soil samples may be returned to JEG for disposal at an UMTRA Project facility.

2.9.7 Return of shipping coolers

Subcontract laboratories shall ship sample coolers back to JEG within five days of receipt. Sample coolers should be shipped to the address given below unless different instructions are provided by JEG data management.

Jacobs Engineering Group, Inc.
c/o US Forestry Services Bldg.
2205 Columbia SE
Albuquerque, NM 87106

2.10 Analysis holding time requirements**2.10.1 UMTRA Project holding times**

Analytical holding times for the UMTRA Project are specified in Attachment 1.

2.10.2 Definition

For all UMTRA Project analyses, the holding time interval is defined to begin at the time and date that the sample was taken.

2.10.3 Matrix types

The holding times specified in Attachment 1 apply to all sample matrix types.

2.10.4 Meeting holding times

It is crucial that the subcontract laboratory perform chemical analyses within the specified holding times. The subcontract laboratory shall promptly notify JEG data management if it determines, upon sample receipt or thereafter, that one or more analyses cannot be performed within the holding times. Analyses not performed within the holding time and reported without prior explanation may not be paid for.

2.10.5 Violations

The subcontract laboratory shall provide a written explanation for all holding time violations in the case narrative.

2.11 Subcontract laboratory data verification and review requirements

2.11.1 Worksheet review

All chemist worksheets describing and providing results for chemical analysis of UMTRA Project samples shall undergo supervisory or peer review. A field should be provided on each worksheet for the reviewer's initials.

2.11.2 Report review

All data transmitted to JEG data management by the subcontract laboratory shall undergo data verification and review by the subcontract laboratory's QA or technical staff. Signature evidence of this review in the case narrative is required.

2.12 Subcontract laboratory record maintenance requirements

The subcontract laboratory shall maintain a case file containing all documents and records associated with a specific delivery order for a period of 10 years. All raw data, worksheets, run logs, digestion logs, shipping and login records, custody forms, and communication records must be included in the case file. Case files shall be reviewed for completeness, and signature evidence of the review provided. This supporting documentation may be used to verify compliance with the requirements outlined in this document, or to support the data in a court of law.

2.13 Corrective action for out-of-control events

2.13.1 Requests for CARs

The subcontract laboratory may be required to provide a CAR for any out-of-control event associated with analytical services provided to the UMTRA Project.

2.13.2 Delivery of CARs

Requested CARs shall be due to JEG data management within 4 weeks of the date of the request. JEG data management reserves the right to request delivery of CARs in less than 4 weeks if circumstances indicate that this is necessary. Failure to submit requested CARs may result in suspension of the subcontract laboratory from the UMTRA Project chemical analysis program.

2.14 Monthly progress report requirement

2.14.1 Contents of monthly progress reports

The subcontract laboratory shall submit monthly progress reports (MPR) according to the provisions of HAZWRAP, section 5.4.1. Monthly progress reports are due to JEG data management by the 15th day of each month. Emphasis should be placed on the following for inclusion in MPRs:

- a) New analysis methods and changes in old methods.
- b) Summaries of out-of-control incidents during the reporting period, and copies of the associated CARs.
- c) Descriptions of changes in the LQAP that affect the analysis or documentation of UMTRA Project samples.
- d) Changes in QA and key technical personnel, including resumes of new personnel.
- e) Changes in certification status with any regulatory or certifying agencies.

If no significant changes occurred during the reporting period, and if no CARs were generated, then a simple statement of these facts shall suffice to meet the MPR requirement.

2.14.2 Exclusion of control charts

Unless specifically requested by JEG data management, the subcontract laboratory need not provide QC parameter control charts with MPRs.

2.14.3 Exclusion of COC forms

The requirement stated in HAZWRAP that COC forms be included in the MPRs does not apply, since COC forms for each delivery order accompany the initial report of analytical results.

2.14.4 Compliance

Failure to comply with the MPR requirement specified in HAZWRAP and in this SOW may result in suspension of the subcontract laboratory from the UMTRA Project chemical analysis program.

2.15 Primary contact person**2.15.1 Subcontract laboratory contact person**

The subcontract laboratory shall assign a technical staff member to be the primary contact person for issues relating to the analysis of UMTRA Project samples.

2.15.2 JEG contact persons

The technical representatives in JEG data management shall be the Analytical QA Specialist and the Data Base Administrator.

2.16 Radioactive materials license requirements

The subcontract laboratory shall have a current radioactive materials license. If the radioactive materials license has expired, the laboratory shall have a letter of timely renewal on file. Photocopies of new or updated licenses shall be provided to JEG data management.

3.0 ANALYTICAL AND QUALITY CONTROL REQUIREMENTS**3.1 Standard preparation and instrument calibration requirements****3.1.1 Working standards**

- Standard preparation for analysis of UMTRA Project samples shall be performed according to the specifications in (a) through (h) of section 2.7.4 of this SOW.

- a) Working standard preparation information accompanying daily analysis worksheets shall be sufficiently detailed to demonstrate compliance. Initial calibration verification solutions, if applicable, shall be documented in sufficient detail to make clear that they derived from a source different from that used to prepare the calibration standards.
- b) Calibration standards used in atomic spectroscopy shall be prepared using water that meets ASTM Type I purity standards.
- c) Calibration standard used in the analysis of all other analytes shall use water that meets ASTM Type II purity standards, or better.

3.1.2 Calibration

Instrument calibration shall be performed according to the specifications of the CLP SOW, where applicable. Calibration for analytical techniques that are not addressed in the CLP SOW shall be performed according to the specifications of the analytical procedure adaptations used by the subcontract laboratory.

- a) Instruments used to acquire general inorganic data shall be calibrated daily or once every 24 hours, and each time the instrument is set up.
- b) Instruments used to acquire radiochemical data shall be calibrated at the frequency specified by the calibration section of the LQAP.
- c) Subcontract laboratories performing radiochemical analyses shall acquire background data for all counting instruments at least once every 90 days.

3.2 Sample analysis requirements

3.2.1 Worksheet requirements

Chemist worksheets used to record analytical data shall present a complete record of all information pertinent to the analysis. UMTRA Project DQOs require the acquisition of routine analytical data that are technically and legally defensible. To this end, significant emphasis shall be placed on careful and complete documentation of every analysis. A completed chemist worksheet is required for each analytical run. Chemist worksheets shall record the following information in addition to the analysis data:

- a) The name of the person performing the analysis.

- b) The instrument used in the analysis. If the subcontract laboratory has more than one instrument of a particular model, a unique designation shall be given to each.
- c) The name or initials of the peer, supervisory, or QA reviewer.
- d) Calibration information as specified in section 2.2.1 (h) of this SOW.
- e) Standards information, including the name; preparation date; and expiration date of calibration, calibration verification, and laboratory control sample standards, as applicable.
- f) The analytical procedure used.
- g) Calculations used to obtain results.
- h) The date and time (beginning and ending) that the analysis was performed.

Indelible ink shall be used to record all data associated with the analysis of UMTRA Project samples.

3.2.2 Sample preparation

Sample preparation shall be conducted according to the specifications of the analytical procedures, except as noted below.

- a) Water samples submitted for dissolved metals analysis, other than Hg determination, may be run by direct injection or aspiration without prior digestion. Such samples shall have sample ID "0001," indicating that they have been filtered in the field. If, however, visible precipitate is present in the sample container, the sample shall be digested according to the specifications of (b), below. In addition, if in the analyst's judgment the sample's color, odor, or turbidity make sample digestion advisable, the sample may be digested according to the specifications of section (b). All digestions performed on field filtered samples shall be discussed in the case narrative.

- b) Water samples submitted for the determination of total metals content shall be digested prior to analysis according to the technique-specific digestion procedures given in the CLP SOW. Such samples shall have sample ID "N001," indicating that they were not filtered prior to shipment to the subcontract laboratory. Microwave digestion procedures may be submitted to JEG data management as proposed alternatives to the CLP digestions. Microwave digestion procedures must be approved by JEG data management prior to use.
- c) For ICP-MS total metals analysis of water samples, the CLP digestion for GFAA shall be used.
- d) Soil samples submitted for general inorganic parameter analysis shall be digested according to the digestion procedures for soil given in the CLP SOW, unless different procedures are requested in the work order plan. Examples of the Work Order Plan forms are included as Attachment 4.
- e) Soil sample preparation prices shall be specified by subcontract laboratories performing analyses under a general inorganic subcontract for CLP or 3050 digestion, total dissolution digestion (HNO_3 , HClO_4 , HF), and toxicity characteristic leaching procedure (TCLP) extractions. Subcontract laboratories that do not have hoods for perchloric acid digestions need not submit a digestion price for total dissolution. Microwave digestion procedures for soils may be submitted for approval as discussed in section (b), above.
- f) Soil samples submitted for radiochemical parameter analysis shall be dried, crushed to -200 mesh, and homogenized prior to analysis.
- g) Percent solids measurements shall be made for all UMTRA Project soil samples submitted for analysis. Unless otherwise specified, all soil sample results shall be reported on a dry weight basis.
- h) Silicon concentration, reported as SiO_2 , shall be determined on a dissolved basis only. That is, water samples shall never be subjected to an HF acid digestion.

3.2.3 Initial dilution of samples

Since some UMTRA Project samples have a high solids content, initial dilution of samples for analysis by GFAA, ICP-AES, and ICP-MS will be allowed according to the criterion specified in (a), below.

- a) Water samples having total dissolved solids (TDS) content greater than 4000 mg/L may be diluted, prior to analysis, by the smallest integer dilution factor required to bring the solids content down to below 2000 mg/L TDS. If TDS was not requested by JEG, a sample's specific conductivity may be used to estimate TDS. For this purpose, the specific conductivity of the unpreserved sample fraction in $\mu\text{mho/cm}$ shall be considered equal to the sample TDS in mg/L. Field measured specific conductivity values can often be found on the sample's COC.
- b) Screening of samples against calibrated instruments to determine whether initial dilution is indicated shall not be allowed in the analysis of UMTRA Project samples.
- c) Results obtained for samples diluted according to the criterion specified in (a), above, shall be qualified with an "I" flag.

3.2.4 Analytical techniques and SOPs

The subcontract laboratory shall employ approved analytical techniques and SOPs in the analysis of UMTRA Project samples. If a nonstandard technique is required to achieve a specific UMTRA Project objective, the subcontract laboratory will be asked to provide a schedule of charges for the work on a case-by-case basis.

- a) The subcontract laboratory shall perform routine sample analyses using the analytical technique(s) specified in Attachment 5. Approved adaptations of DOE, EPA, American Public Health Association (APHA), or other SOPs that employ the specified analytical techniques shall be used. Adaptations of such SOPs to the specific subcontract laboratory environment shall refer to the parent procedures.
- b) For GFAA analyses, the subcontract laboratory shall adhere to the analytical and data qualification procedures specified in exhibit E, section V of the CLP SOW.
- c) If, due to catastrophic instrument failure, the specified technique(s) cannot be used, a subcontract laboratory representative shall contact JEG data management to obtain approval for the use of an alternate technique. If the proposed alternate technique will not yield results suitable to the end use of the data, instructions for shipment of samples or sample splits to another subcontract laboratory will be provided by JEG data management.

- d) In the event that samples or sample splits must be sent by the subcontract laboratory to another subcontract laboratory, the subcontract laboratory initiating the shipment shall be responsible for demonstrating unbroken COC up to the time of shipment, and for ensuring that the samples are properly packed for shipment.

3.3 Quarterly detection limit study requirement

3.3.1 IDL determination

The IDL for all general inorganic parameters shall be determined and the results submitted to JEG data management quarterly. Subcontract laboratories performing radiochemical analysis of UMTRA Project samples, and those performing uranium analysis under a general inorganic contract, shall submit quarterly IDL studies for total uranium.

- a) A report of IDLs shall be due to JEG data management on the first day of January, April, July, and October, to coincide with the due dates for reports of intercomparison study results. The IDL studies shall be conducted during a time period not to exceed 1 month prior to the report date. Exceptions to the delivery schedule shall be made on a case-by-case basis for subcontract laboratories that are participating in the EPA CLP, in an effort to accommodate IDL study schedules that have been established for the purpose of compliance with CLP requirements.
- b) IDL determination methodology shall comply with the guidance in the CLP SOW, except for the express requirement that digestion and distillation steps employed in Hg and CN analyses shall also be used in the determination of IDLs for those parameters. Thus, the reported IDLs shall be 3 times the average of the standard deviations obtained on three nonconsecutive days from the analysis of a standard solution, with seven consecutive measurements per day. The standard solutions analyzed shall be prepared at a concentration of 3 to 5 times the instrument manufacturer's suggested IDL. In cases for which such estimated IDLs are not available, the procedure-specific method detection limit (MDL) shall be used.
- c) If any quarterly IDL result is not less than the corresponding UMTRA Project TAC contract required detection limits (CRDL), a discussion of the problem and planned corrective action shall accompany the IDL report deliverable. Failure to implement effective corrective action may render the subcontract laboratory ineligible to receive samples for which determination of that parameter is requested.

- d) In some cases, the available wavelengths in ICP-AES may consistently yield IDLs very close to, but higher than, the specified CRDLs. In such an event, the subcontract laboratory may be granted permission by JEG data management to report to the slightly elevated IDLs.
- e) The quarterly reports for IDLs should be in tabular summary form. Raw data generated in the determination of IDLs shall not be included as part of the deliverable, but may be specifically requested for examination by JEG data management during audit and data package assessment activities. The format of the EPA CLP form X-IN, or equivalent, shall meet the IDL reporting requirement.

3.4 Analytical QC requirements

3.4.1 Calibration verification

Required calibration verification data are the initial calibration verification (ICV) and continuing calibration verifications (CCV), where applicable.

The calibration verification sample analysis requirement is not appropriate for all UMTRA Project analytes. The analyses exempted from this requirement are listed in (e), below.

- a) ICV for general inorganic analysis is conducted immediately after the instrument has been calibrated. This verification consists of analysis of a standard solution within the range of calibration. The ICV standard for general inorganic analysis shall be from a source different from that used to prepare the calibration standards.
- b) CCV for general inorganic analysis is conducted every 2 hours or after every 10th analytical sample, whichever is more frequent. The same standard shall be used for all CCVs. The CCV standard and a calibration blank shall be analyzed at the end of each analysis run.
- c) ICV and CCV results shall be within ± 10 percent of the known value except for cyanide (± 15 percent) and mercury (± 20 percent).
- d) In the event that either the ICV or CCV data fall outside of these limits, the instrument shall be recalibrated and all of the samples run since the last successful calibration verification shall be reanalyzed.

- e) No instrument calibration is employed in the determination of sulfide, oil and grease, or TDS. These analyses are exempted from the instrument calibration verification requirements. However, the iodine solution used in sulfide analysis shall be calibrated against a titrant of known normality at least once a week. The results of iodine solution calibration shall be recorded on the chemist's worksheet, but need not be reported in the QC summary.

3.4.2 Calibration blanks

Initial calibration blanks (ICB) and continuing calibration blanks (CCB) shall be run immediately following the associated calibration verification samples. The calibration blank matrix is the same as that of the calibration verification sample; that is, if the calibration standards and verification samples are digested, then the calibration blanks are also digested. No calibration blank analysis is required for radiochemical parameters.

- a) Calibration blanks are run with the same frequency as calibration verifications.
- b) If the absolute value of the blank result for general inorganic parameters exceeds the CRDL, the analysis shall be terminated and the problem corrected. A table of CRDLs is included as Attachment 5. Recalibration followed by calibration verification and blank samples shall be performed prior to resuming the analytical run.

3.4.3 Preparation blanks

Preparation blanks (PB) (reagent blanks) consisting of DI water and the appropriate reagents are included in each batch of samples requiring digestion. One preparation blank shall be included for every 20 samples or one per batch, at a minimum.

- a) PB analysis is applicable to all analyses requiring sample preparation prior to analysis, except those cases for which reagents are automatically added to all samples by an autoanalyzer.

- b) Radiochemical preparation blanks are subject to subcontract laboratory QC protocols and are exempt from the acceptance criteria discussed in (c), below. JEG data management may, however, ask for reanalysis or corrective action if professional judgment suggests that an unacceptable blank contribution exists. Preparation blanks for alpha spectrometry, gas flow proportional counter, and Lucas cell techniques shall be placed randomly or sequentially, such that the blank position varies from batch to batch. Instrument run logs shall be maintained to demonstrate compliance with this requirement.
- c) If any analyte concentration in the blank is in excess of the CRDL, the lowest reported concentration in the associated samples must be at least 10 times the concentration in the blank. All samples having that analyte's concentration less than 10 times that of the blank but above the CRDL shall be redigested and reanalyzed.

3.4.4 Interference check samples

Interference check samples (ICS) for ICP-AES analyses shall be run a minimum of twice in each 8-hour shift or at the beginning and end of each analysis run, whichever is more frequent. The constituent composition of the interference check samples is specified in the CLP SOW. The UMTRA Project analytes not covered by the CLP target analyte list (TAL) shall be spiked into the ICS at 1 mg/L. The true values for the additional analytes may be calculated if diluted from certified materials.

The results for the analytes in the interference check sample (solution AB) shall agree within ± 20 percent of the true value. If this criterion is not met, the analyst may either terminate the analysis, or continue and run the failed constituents at a later time. Analyte data obtained during an analytical run for which the ICS result does not pass the above criterion are not to be reported to JEG data management.

3.4.5 Laboratory control samples

Laboratory control samples (LCS) shall be analyzed using the same sample preparation and analysis methods used for the submitted UMTRA Project samples, except in dissolved metals determination for aqueous samples. Since dissolved metals are determined by direct aspiration or injection, the ICV is equivalent to a LCS. However, use of the ICV for an LCS does not change the ICV acceptance criterion. One LCS shall be analyzed with each batch of up to 20 samples, where applicable. LCS standards shall derive from a source different from that used to calibrate the instrument.

- a) Two additional exceptions to the LCS requirements are mercury and cyanide. Since the ICV is always digested for these analyses it is again equivalent to a LCS.
- b) The aqueous LCS analytical results shall agree within ± 20 percent of the true value. Exceptions to the acceptance criterion for LCS are silver and antimony, for which there is no specified acceptance criterion, and TDS, for which the criterion is ± 10 percent.
- c) Solid LCS results shall fall within the control limits specified by the agency that prepared the reference material. The subcontract laboratory shall include the preparing agency's control limits in the QC portion of the deliverable.
- d) If the LCS data fail to meet the specified acceptance criterion, the analysis shall be terminated and the samples associated with that LCS shall be redigested and reanalyzed.

3.4.6 Replicate analyses

One replicate sample shall be analyzed from each batch, with a minimum frequency of one per 20 samples.

- a) The replicate relative percent difference (RPD) is the measure of precision used for uranium and all general inorganic constituents. The RPD is calculated as follows:

$$RPD = \frac{|S - R|}{(S + R)/2} \times 100\%$$

where, RPD = relative percent difference
S = sample value (original)
R = replicate sample value

The RPD shall be less than or equal to 20 percent for samples with concentrations greater than or equal to 5 times the CRDL. For samples with concentrations less than 5 times the CRDL but greater than the CRDL, the control limit is $\pm$ CRDL. No precision criterion applies to samples with concentrations less than the CRDL.

- b) A different measure of precision, the replicate error ratio (RER), is employed for radiochemical replicate results. The RER is given by:

$$\text{RER} = \frac{|S - R|}{2\sigma_S + 2\sigma_R}$$

where, RER = replicate error ratio
S = sample value (original)
R = replicate sample value
 $2\sigma_S$ = sample uncertainty (95%)
 $2\sigma_R$ = replicate uncertainty (95%)

Radiochemical replicate determinations shall agree when the 95 percent confidence level uncertainties are considered. That is, the RER shall be less than one.

- c) If the above criteria are not met for water samples, or soil samples that have been crushed and homogenized, all samples in the analytical batch must be redigested (if applicable) and reanalyzed. If the replicate precision criteria are not met in the second analysis, the results associated with the best replicate result shall be reported and qualified with the "*" flag as specified in section 4.1.9 (e) of this SOW. For soil samples that have not been crushed and homogenized, results associated with a failed replicate analysis may be qualified and reported without reanalysis.
- d) Samples identified as blanks shall not be used to satisfy the replicate analysis requirement. Field blanks and equipment blanks will be assigned the location ID "0999."

3.4.7 Spiked sample analyses

When sample preparation prior to analysis is required, matrix spike analyses are performed as a measure of the ability to recover analyte. As with replicate analyses, the minimum frequency is one per batch or one per 20 samples, whichever is more frequent. Samples identified as field blanks shall not be used for matrix spike sample analysis.

The percent recovery for spiked samples is calculated as follows:

$$\% \text{ Recov} = \frac{\text{SSR} - \text{SR}}{\text{SA}} \times 100\%$$

where, SSR = spiked sample result
SR = sample result
SA = spike added

When the analyte concentration for a sample is less than the IDL, use $SR = 0$ in the spike recovery calculation.

- a) Where no sample preparation is required, analytical spikes are performed by adding a known amount of analyte to the sample at the time of analysis. Matrix spikes or analytical spikes, as appropriate, shall be performed for all analytes other than sodium, potassium, magnesium, calcium, sulfide, oil and grease, Rn-222, and total dissolved solids.
- b) If a matrix spike result is outside the control criterion specified in section (f), below, all samples associated with the analytical batch shall be redigested and reanalyzed. If the control criterion is not met for the second matrix spike analysis, the results associated with the best matrix spike analysis shall be qualified "N" and reported as specified in section 4 of this SOW.
- c) If an analytical spike result for ICP-AES, ICP-MS, and FAA metals is outside the control criterion specified in section (f), below, all samples associated with the analytical batch shall be digested and reanalyzed. If the control criterion is not met for the matrix spike associated with the digested batch, the results associated with the best of the two spike analyses shall be qualified "N" and reported as specified in section 4 of this SOW.
- d) For ion chromatography, ion specific electrode, and colorimetric techniques for which no digestion is employed, if an analytical spike result is outside the control criterion specified in section (f), below, all samples associated with the analytical batch shall be reanalyzed. If the control criterion is not met for the second analytical spike, the results associated with the best of the two spike analyses shall be qualified "N" and reported as specified in section 4 of this SOW.
- e) The required spiking levels are those listed in the CLP SOW. For general inorganic analytes not addressed in the CLP SOW and not exempted above, spikes shall be prepared at meaningful levels to be chosen by the subcontract laboratory. For radiochemical analyses, sample spiking levels shall not exceed 100 pCi/L or 100 pCi/g.

- f) The spike recovery control limits are 75 to 125 percent. An exception to these control limits is made in the case for which the sample result exceeds 4 times the spike added. No control limits are applied in this case, since the spike signal rapidly becomes negligible with respect to the sample analyte signal.
- g) Samples identified as blanks shall not be used to satisfy the spike analysis requirement. Field blanks and equipment blanks will be assigned the location ID "0999."

3.4.8 Recovery requirements for radionuclides

- a) Correction of analytical results for radionuclide chemical recovery shall be performed sample specifically unless JEG data management has given prior approval for a batch correction procedure. Rn-222 is exempt from this requirement.
- b) Minimum recovery guidelines shall be 30% for Po-210, and 50% for Pb-210, Ra-226, Ra-228, and Th-230. Recoveries that do not meet these guidelines must be approved by JEG data management prior to submission of the deliverable.

3.5 Request for reanalysis

3.5.1 Incomplete reports and random errors

In the event that a suspected random analytical error is identified by comparison with historical data, or if QC data are either missing or outside the control limits, JEG data management reserves the right to request delivery of the missing documentation or the reanalysis of any or all samples within the sample lot.

3.5.2 Reimbursement for reanalysis costs

Reanalyses shall be requested by telephone and confirmed in writing. Payment for reanalyses requested by JEG data management shall be made according to the following guidelines:

- a) Reanalyses requested because failed QC data were reported to JEG data management shall not be paid for.
- b) Reanalyses that are requested because of a suspected significant random error, and that confirm the original results within reasonable analytical error, shall be paid for by JEG.

- c) Reanalysis that are requested because of a suspected significant random error, and that indicate that an analytical or reporting error was made in the first analysis, shall not be paid for by JEG.

4.0 ANALYTICAL DATA DELIVERABLE REQUIREMENTS

4.1 Analytical data package contents and format

4.1.1 Analytical reports

The initial analytical data package provided to JEG data management shall contain all the items discussed in sections (a) through (g), below. Revision reports shall contain all items discussed in sections (a) through (d). Final reports shall contain the items discussed in sections (a) and (c). A comprehensive case narrative for final reports may be also be requested by JEG data management.

- a) A completed Deliverable Transmittal/Review form, JEG-AL-AD-29. An example of the document transmittal form is provided as Attachment 6.
- b) A case narrative describing the contents of the data package, an index of samples associated with the delivery order including both UMTRA Project IDs and subcontract laboratory sample IDs, and problems encountered in the analysis of the samples associated with the delivery order. The case narrative shall describe the circumstances leading to the use of data qualifiers and list the affected samples. In addition, for general inorganic analysis of soil samples, the type of digestion used shall always be clearly specified in the case narrative.
- c) One original Chemical Analysis Results form for each sample associated with the deliverable. The required contents of each Chemical Analysis Results form are outlined in section 4.1.2 of this document.
- d) QC data deliverables consisting of completed CLP QC data reporting forms or equivalent, for all sample analyses associated with the delivery order. The QC data deliverables are discussed in detail in section 4.1.8.
- e) Original COC forms received with each sample, indicating sample receipt and custody by the subcontract laboratory.

- f) Two photocopies of items (a) through (e) above.
- g) One magnetic copy of the analytical data formatted as outlined below in section 4.1.5 of this SOW. The magnetic copy is not to include the QC data.

Instrument printouts, standard preparation logs, digestion logs, analyst work sheets, or other forms of "raw" data shall not be included unless specifically requested. This material will be inspected during the semiannual data package assessment.

4.1.2 Reporting forms for analytical results

The Chemical Analysis Results form shall be used to report parameter concentrations or activities measured by the subcontract laboratory. An example of this form is given in Attachment 7.

- a) The subcontract laboratory shall specify the UMTRA Project site ID, location ID, sample ID, date sampled, laboratory code, date received, delivery order number, report date, the report type (initial, revision, or final), and a qualitative description of sample appearance on each page of the Chemical Analysis Results form. Alternatively, subcontract laboratories may provide sample descriptions by including sample digestion logs or a tabular summary of qualitative descriptions with the deliverable. For each result, the subcontract laboratory shall provide the parameter code, parameter value, uncertainty value (where applicable; see section 4.1.4), detection limit, units of measure, data qualifier(s), method of analysis, and analysis date on the Chemical Analysis Results form.
- b) Each Chemical Analysis Results form shall have a "reviewed by" and "date reviewed" field, where evidence of the required QA review is provided.

4.1.3 "Less than" results

Reporting of analytical results that are less than the detection limit.

- a) General inorganic analytical results that are less than the UMTRA Project CRDLs shall be qualified with a "<" flag. This "less than" symbol shall be placed in the associated "parameter value indicator" field on the Chemical Analysis Results form, and in the corresponding field of magnetic data deliverable. The CRDLs apply to the solutions being analyzed, whether water samples or soil digestate.

- b) Uranium concentration results that are less than the CRDL, whether produced under a radiochemical or a general inorganic subcontract, shall be reported in accordance with (a), above.
- c) In cases for which the IDL is less than the CRDL, and when samples shall be diluted for any reason other than to bring the parameter concentration down within the calibration range, the IDL, and not the CRDL, should be multiplied by the dilution factor. The result of this calculation shall be reported as the detection limit for that parameter and sample in the deliverables discussed in (a), above.
- d) The "less than" symbol shall not be used to report results for radionuclides, gross alpha emission, or gross beta emission. Results for these parameters shall be reported as they are calculated, down to zero. Negative results for these parameters shall be reported as zero.
- e) Sample-specific detection limits for the parameters listed in (d), above, shall be reported according to section 4.1.4 (d) of this SOW.

4.1.4 Analytical uncertainties and detection limits

Requirements for reporting analytical uncertainties and detection limits associated with measured values are as follows:

- a) General inorganic parameter results shall not be reported with associated analytical uncertainties. That is, the "uncertainty" field shall be left blank on both the hard copy and the magnetic deliverable.
- b) Radiochemical parameter results, other than for uranium, shall be reported with the associated analytical uncertainty, calculated at the 95 percent confidence level. The reported uncertainty value should include all significant sources of error, and not be limited to counting error alone.
- c) The analytical uncertainty values for radiochemical parameters shall be reported on both the hard copy and the magnetic deliverable.
- d) Sample-specific detection limits shall be calculated in accordance with the appendix to the US Nuclear Regulatory Commission, Regulatory Guide 4.14, Revision 1, 1980. However, this calculation shall be revised to replace the background count rate with the batch-blank count rate.

4.1.5 Magnetic deliverable format

Format requirements for the magnetic copy of analytical data are listed below. An example of the format for the American Standard Code for Information Interchange (ASCII) magnetic deliverable is provided as Attachment 8.

- a) An ASCII file shall be prepared to accompany the hard-copy deliverable for the initial report of analytical results only. Magnetic copies of data reports are not required for reanalysis and final reports. The field width and contents, beginning at the left, shall be as described in the paragraphs below. No spaces are to be put between fields, such that the sum of the field widths is equal to the total width of the file. The contents of all fields in the magnetic deliverable shall be left-justified.
- b) The "site ID" field is five characters wide. Site IDs are always composed of three alphabetic followed by two numeric characters.
- c) The "location ID" field is four characters wide. Since location numbers are typically three characters long, a zero precedes the location designation, such that the location ID will fill this field.
- d) The "sampling date" field is eight characters wide. The first four characters shall be the year, followed by two characters for the month, and finally by two characters for the day.
- e) The "sample ID" field is four characters wide. The sample ID is used to indicate whether the sample was filtered (sample ID 0001) or not filtered (sample ID N001) at the time of sampling. This field may also be used for other purposes, such as designation of field duplicates.
- f) The "lab ID" field is three characters wide. The subcontract laboratory will be assigned a unique three-character identifier to be placed in this field for all analytical results.
- g) The "parameter code" field is 10 characters wide. A list of valid parameter codes is provided as Attachment 9.
- h) The "parameter value indicator" field is one character wide. This field is reserved exclusively for the "less than" symbol used to indicate an analytical result that is less than the CRDL.
- i) The "other parameter flags" field is used for data qualifiers. Data qualifiers are discussed in detail in section 4.1.9 of this SOW.

- j) The "parameter value" field is 13 characters wide. The measured parameter concentration or activity is placed in this field.
- k) The "parameter uncertainty" field is 11 characters wide. The 95 percent confidence level uncertainty in measured values for radionuclides and gross alpha and gross beta emission is placed in this field.
- l) The "detection limit" field is 11 characters wide. This field contains sample specific detection limits for radiochemical parameters, UMTRA Project CRDLs for general inorganic parameters, or IDLs multiplied by dilution factors for general inorganic parameters.
- m) The "units of measure" field is 10 characters wide. Acceptable units of measure for UMTRA Project work are discussed in section 4.1.6.

4.1.6 Reporting units for chemical analysis reports

- a) General inorganic parameter results for water and soil shall be reported in mg/L and milligrams per kilogram (mg/kg), respectively.
- b) Radiochemical parameter results for water and soil shall be reported in units of picocuries per liter (pCi/L) and picocuries per gram (pCi/g), respectively.
- c) No units of measure, other than those specified in (a) and (b), above, shall be used in reporting chemical analysis results to UMTRA Project data management.

4.1.7 Reporting conventions

Anion reporting conventions are as listed below:

- a) Ammonium is reported as NH_4 .
- b) $\text{NO}_2 + \text{NO}_3$ is reported as N.
- c) Nitrate is reported as NO_3 .
- d) Total phosphorus is reported as PO_4 .
- e) Sulfate is reported as SO_4 .

4.1.8 QC deliverables

The QC data deliverable shall be composed of the items listed below. The delivery order number and site ID shall be referenced on each page of the QC data deliverable.

- a) ICV and CCV analysis data are required for all parameters except sulfide, oil and grease, and TDS. Frequency and acceptance criteria for calibration verification analyses are discussed in section 3.4.1 of this SOW. For each analytical batch associated with the delivery order, provide the parameter name, true ICV concentration, found ICV concentration, ICV percent recovery, true CCV concentration, found CCV concentration(s), and each CCV percent recovery. The use of EPA CLP Form II-IN, or an equivalent format that presents the same information, is acceptable.
- b) ICB and CCB analysis data are required for all parameters except sulfide, oil and grease, TDS, and radiochemical parameters expressed in units of activity. Frequency and acceptance criteria for calibration blank analyses are discussed in section 3.4.2 of this SOW. For each analytical batch associated with the delivery order, provide the parameter name, ICB analysis result, and CCB analysis result(s). The use of EPA CLP Form III-IN, or equivalent, is acceptable.
- c) PB analysis data are required for all analyses for which a digestion or distillation step is performed prior to the analysis. Frequency and acceptance criteria are discussed in section 3.4.3 of this SOW. Provide the parameter name and PB results for each analytical batch. The use of EPA CLP Form III-IN, or equivalent, is acceptable.
- d) ICS analysis data are required for all parameters that are determined using ICP-AES. Frequency and acceptance criteria are discussed in section 3.4.4 of this SOW. Provide the parameter name, true concentration values for solutions A and AB, initial measured values for solutions A and AB, initial percent recovery for solution AB, final measured values for solutions A and AB, and the final percent recovery for solution AB. The use of EPA CLP Form IV-IN, or equivalent, is acceptable.

- e) Spike analysis data are required for all parameters except calcium, potassium, magnesium, sodium, oil and grease, TDS, and sulfide. The frequency and acceptance criteria are outlined in section 3.4.7 of this SOW. Provide the parameter name, spiked sample result, sample result, spike added, and spike percent recovery for each spike analysis. In addition, include the required data qualifiers for spike analyses that fall outside the control limits. The use of EPA CLP Form V (Part 1)-IN, or equivalent, is acceptable.
- f) Replicate analysis data are required for all parameters. The frequency and acceptance criteria are discussed in section 3.4.6 of this SOW. Provide the parameter name, sample result, replicate result, and RPD or RER, as appropriate. Sample and replicate results for radionuclide and gross radiation determinations shall be accompanied by the 95 percent uncertainty values. In addition, include the required data qualifiers for replicate analyses that fall outside the applicable control limit. The use of EPA CLP Form VI-IN, or equivalent, is acceptable.
- g) LCS analysis data are required for all parameters except mercury, total cyanide, and sulfide. The frequency and acceptance criteria are discussed in section 3.4.5 of this SOW. Provide the parameter name, true concentration of the LCS, measured concentration of the LCS, and the percent recovery for the LCS. The use of EPA CLP Form VII-IN, or equivalent, is acceptable.
- h) Standard addition results shall be reported for GFAA, as appropriate. The use of CLP Form VIII-IN, or equivalent, is acceptable.
- i) Provide analysis run logs, EPA CLP Form XIV-IN or equivalent, for parameters that are determined using GFAA and ICP-AES.
- j) Radionuclide tracer or carrier recoveries, or standard recoveries used for batch correction, shall be reported in the QC deliverable. Recoveries that fail to meet the criteria specified in section 3.4.8 shall be reported by telephone and explained in the case narrative.

4.1.9 Data qualifiers

Data qualifiers available for use by the subcontract laboratory are listed and discussed below. The use of these data qualifiers is required on the Chemical Analysis Results form, the magnetic data deliverable, and the QC data deliverable. Of the qualifiers discussed below, only the "H, I, N," and "*" may be used in reporting radionuclide and gross radiation results.

- a) In the event that the holding time for a particular parameter had expired prior to analysis, flag the associated results with an "H" on the Chemical Analysis Results form and the magnetic data deliverable.
- b) Analytical results obtained for samples that required dilution prior to analysis, as outlined in section 3.2.3 of this SOW, shall be qualified with the "I" flag if elevated detection limits resulted from the dilution. Analytical results that are negatively impacted by the presence of an interference (increased DL, etc.) shall also be flagged with an "I."
- c) Data associated with failed ICP-AES serial dilution results shall be flagged with the "E" flag. The "E" flag shall also be used to qualify GFAA data according to the guidelines specified in the CLP SOW. In both cases, the specific requirements of the EPA CLP SOW apply to the use of this qualifier. When this flag is used, an explanatory note shall always be included in the case narrative.
- d) Analytical results associated with a spike analysis that was outside control limits shall be qualified with the "N" flag.
- e) Analytical results associated with a replicate analysis that was outside the control limit shall be qualified with a "*" flag.
- f) GFAA analytical results associated with a post-digestion spike that was outside the control limits, while the sample absorbance was less than 50 percent the spike absorbance, shall be qualified with the "W" flag. The use of this data qualifier is discussed in the CLP SOW.
- g) GFAA analytical results associated with a duplicate injection that failed to meet the duplicate injection precision criterion shall be qualified with the "M" flag. The precision criterion for use of this data qualifier is further discussed in the CLP SOW.
- h) GFAA analytical results obtained by the method of standard addition (MSA) shall be qualified with the "S" flag.
- i) GFAA analytical results obtained by MSA, and for which the MSA correlation coefficient is less than 0.995, shall be qualified with the "+" flag.

4.1.10 Parameter codes

- a) The parameter codes indicating total analysis shall be used only for unfiltered water samples and for filtered water samples that are digested due to the presence of visible precipitate.
- b) The parameter codes indicating total analysis shall not be used in reporting analytical results for soil samples.

4.1.11 Completeness

Partial deliverables shall not be submitted to JEG data management unless specifically requested.

4.1.12 Significant figures

- a) A maximum of two significant figures shall be used to report analytical result, uncertainty, and detection limit values. Results for PE samples may be reported using additional significant figures.
- b) The number of decimal places reported for any analytical result shall not exceed the number of decimal places given in the CRDL list in Attachment 5.
- c) Calculated uncertainties for radiochemical parameters and detection limits may be reported to one additional decimal place beyond those given for the CRDLs in Attachment 5.

4.2 Analytical data deliverable deadlines**4.2.1 Initial report deliverables**

An "initial report" of analytical results is due to JEG data management 4 weeks from the date of receipt of the last sample associated with each delivery order, when standard turnaround time is requested. Turnaround times for accelerated delivery requests shall be 1, 2, or 3 weeks, and shall be mutually agreed upon by subcontract laboratory staff members and JEG data management. The contents of the initial report of analytical results are specified in section 4.1.1 of this SOW. The subcontract laboratory may submit an invoice for 50 percent of the total projected cost of analysis as soon as the initial report has been submitted to JEG data management.

4.2.2 Revision report deliverables

A "revision report" will be requested by JEG data management when reanalysis results or error corrections are to be incorporated. Revision reports shall include only those results that are being changed, listed by sample on Chemical Analysis Results forms. No magnetic deliverable shall be included in revision reports unless specifically requested by JEG data management. Requests for revision reports shall be made by telephone.

- a) General inorganic revision reports are due to JEG data management 2 weeks from the date of the request.
- b) Radiochemical revision reports are due to JEG data management 3 weeks from the date of the request.
- c) Revision reports that are issued for the purpose of communicating reanalysis results shall have the designation "reanalysis" added in parentheses after the delivery order number in the "deliverable" field of the Deliverable Transmittal/Review Form.
- d) Summaries of QC data obtained during sample reanalysis shall accompany the revision reports. The QC data for sample reanalysis shall be reported according to the specifications of section 4.1.8.

4.2.3 Final report deliverables

A "final report" of analytical results shall be requested by telephone when all issues for a particular delivery order have been satisfactorily resolved. All final reports are due 1 week from the date of the request, and shall incorporate those results issued in revision reports that are specified for inclusion by JEG data management, as well as all remaining data from the initial report. That is, the final report shall provide a comprehensive summary of all final analytical results for each delivery order. As with the revision report, no magnetic deliverable or other documentation shall be submitted with the final report unless specifically requested by JEG data management.

4.2.4 Level D report deliverables

Level D (CLP-type) deliverables are not typically requested, but may be needed in specific instances to support the data in court or for some other reason.

- a) Level D documentation shall be maintained at the subcontract laboratory unless it is specifically requested for delivery to JEG data management.
- b) In the event that a Level D report is requested, the deliverable shall be on 8½- by 11-inch paper, one-sided, and paginated.
- c) When Level D deliverables are requested to support data that have been delivered previously, the Level D deliverable shall be due 2 weeks from the date of the request.
- d) When Level D deliverables are requested in advance of performance of the analyses, 1 additional week from the normal initial report due date shall be allowed.
- e) The charge for the preparation of formal Level D data packages upon request shall be specified by the subcontract laboratory.

4.2.5 Penalties

All deliverables shall be due at the specified time unless express permission to deviate from the deliverable schedule is given by JEG data management. Penalties may be imposed for late deliverables at the discretion of JEG data management, according to the stipulations of the subcontract article titled "Subcontract Amount."

4.2.6 Reporting PE results

As for the initial reports for all UMTRA Project samples, the reports for quarterly PE samples shall be due 4 weeks from the date of sample receipt. However, no additional report need be sent to JEG data management, and hence the report of PE sample results should not be labeled as initial or final. The subcontract laboratory may submit an invoice requesting payment of the entire cost of analysis when the report of PE sample results has been submitted.

5.0 SUBCONTRACT LABORATORY HEALTH AND SAFETY REQUIREMENTS**5.1 Health and safety plans**

The subcontract laboratory shall have the documents listed below, as applicable, and demonstrate their implementation through maintenance of employee training records.

- A chemical hygiene plan.
- A waste management plan.
- A radiological safety plan.

The radiological safety plan requirement is applicable only to laboratories performing radiochemical analysis of UMTRA Project samples.

6.0 REFERENCES

U.S. Department of Energy, EML Procedures Manual, Environmental Measurements Laboratory, 27th Edition, Vol. I, HASL-300, New York, New York, Revised February 1992.

U.S. Department of Energy, Requirements for Quality Control of Analytical Data, Hazardous Waste Remedial Actions Program, DOE/HWP-65/R, 1990.

U.S. Environmental Protection Agency, Methods for the Determination of Metals in Environmental Samples, EPA 600 4-91-010, June 1991.

U.S. Environmental Protection Agency, Contract Laboratory Program Statement of Work for Inorganic Analysis, Multi-media, Multi-Concentration, ILMO2.0, 1991.

U.S. Environmental Protection Agency, Quality Assurance/Quality Control Guidance for Removal Activities: Sampling QA/QC Plan and Data Validation Procedures, EPA/540/G-99/004, April 1990.

U.S. Environmental Protection Agency, Functional Guidelines for Evaluating Inorganic Analyses, Prepared for the Hazardous Site Evaluation Division, July 1988.

U.S. Environmental Protection Agency, Data Quality Objectives for Remedial Response Activities Development Process, Office of Solid Waste and Emergency Response, March 1987.

U.S. Environmental Protection Agency, Test Methods for Evaluating Solid Waste, Report SW-846, Third Edition, November 1986.

U.S. Environmental Protection Agency, Radiochemistry Procedures Manual, USEPA Eastern Environmental Radiation Facility, Montgomery, Alabama, EPA 520/5-84-006, August 1984.

U.S. Environmental Protection Agency, Methods for Chemical Analysis of Water and Wastes, EPA 600 4-79-020, Revised March 1983.

U.S. Environmental Protection Agency, Prescribed Procedures for Measurement of Radioactivity in Drinking Water, EPA 600 4-79-032, August 1980.

7.0 ATTACHMENTS

- Holding times and preservation techniques (two pages).
- Chain of custody forms (two pages).
- Sample bottle label (one page).
- Work Order Plan form (three pages).
- Analytical techniques and CRDLs (two pages).
- JEG Document Transmittal form (one page).
- Chemical Analysis Results form (one page).
- Format of ASCII file magnetic deliverable (one page).
- Parameter codes (three pages).

Sample Preservation Techniques and Holding Times

Bottle ID	Parameter(s)	Volume/Container	Preservation	Holding Time ¹
A-1	Br, Cl, F, SO ₄ , SiO ₂	1 L Plastic	None, 4°C	28 days
	TDS	Above	None, 4°C	7 days
M-2	Ag, Al, As, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Mg, K, Mn, Mo, Na, Ni, Pb, Sb Se, Sn, Sr, Tl, U, V, Zn	500 mL Plastic	HNO ₃ , pH < 2	180 days
	Hg	Above	HNO ₃ , pH < 2	28 days
N-1	NH ₄ , NO ₃ , TKN PO ₄	500 mL Plastic	H ₂ SO ₄ , pH < 2 4°C	28 days
CN	Total CN	1 L Plastic	NaOH, pH > 12 4°C	14 days
S	Sulfide	2x500 mL Plastic	NaOH, pH > 9 Zn Acetate 4°C	7 days
DOC	DOC	500 ml Amber Glass	H ₂ SO ₄ , pH < 2 4°C	28 days
TOC	TOC	500 ml Amber Glass	H ₂ SO ₄ , pH < 2 4°C	28 days
O&G	Oil and Grease	1 L Glass	H ₂ SO ₄ , pH < 2 4°C	7 days
TPH	TPH	1 L Glass	H ₂ SO ₄ , pH < 2 4°C	7 days
TPhenol	Tot. Recov. Phenols	1 L Glass	H ₂ SO ₄ , pH < 2 CuSO ₄ , 4°C	7 days

¹Holding time is calculated from the date and time the sample was taken.

Sample Preservation Techniques and Holding Times

Bottle ID	Parameter(s)	Volume/Container	Preservation	Holding Time¹
Ra-226	Ra-226	2x1 L Plastic	HNO ₃ , pH < 2	180 days
Ra-228	Ra-228	2x1 L Plastic	HNO ₃ , pH < 2	180 days
Rn-222	Rn-222	3x40 mL Glass	None	72 hours
Pb-210	Pb-210	1 L Plastic	HNO ₃ , pH < 2	180 days
Po-210	Po-210	1 L Plastic	HNO ₃ , pH < 2	180 days
Th-230	Th-230	1 L Plastic	HNO ₃ , pH < 2	180 days
GAB	Gross Alpha, Gross Beta, U	500 mL Plastic	HNO ₃ , pH < 2	180 days

¹Holding time is calculated from the date and time the sample was taken.

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ALBUQUERQUE OPERATIONS

PAGE 4 OF 4

WATER SAMPLING FIELD FORM**CHAIN OF CUSTODY**

LAB: _____

ACKNOWLEDGEMENT OF RECEIPT OF SAMPLES FOR DELIVERY ORDER NO. _____

SITE ID: _____ LOCATION ID: _____ SAMPLE ID: _____

SAMPLE MATRIX (Check One)**WATER ()****SOIL ()**

BOTTLE ID	VOLUME (LITERS)	REC'D	BOTTLE ID	VOLUME (LITERS)	REC'D
A1	_____	()	Th 230	_____	()
M2	_____	()	GA/B	_____	()
Pb 210	_____	()	N1	_____	()
Po 210	_____	()	CN	_____	()
Ra 226	_____	()	S	_____	()
RA 228	_____	()	TOC	_____	()
			DOC	_____	()

DATE COLLECTED: _____ TIME COLLECTED: _____

DATE SHIPPED: _____ SHIPPED BY: _____

(SIGNATURE)

METHOD OF SHIPMENT:☐ FEDERAL EXPRESS☐ AIRBORNE EXPRESS☐ BUS☐ OTHER _____

COMMENTS: _____

TO BE COMPLETED BY SUBCONTRACTING LABORATORY/LAB NAME: _____

I HEREBY ACKNOWLEDGE RECEIPT OF THE FOLLOWING ON: _____

(DATE)

(TIME)

DELIVERY ORDER NO. _____ WORK ORDER PLAN DATED: _____

RECEIVED BY: _____

(SIGNATURE)

PRINT NAME: _____

TITLE: _____

COMMENTS: _____

JACOBS ENGINEERING GROUP INC.

ALBUQUERQUE OPERATIONS

SOIL SAMPLE CHAIN OF CUSTODY FORM

PROJECT NAME: _____

SITE ID: _____

SAMPLERS (SIGNATURE): _____

SAMPLE CONTAINER CONTENTS

RELINQUISHED BY: (SIGNATURE)	DATE/TIME	RECEIVED BY: (SIGNATURE)
RELINQUISHED BY: (SIGNATURE)	DATE/TIME	RECEIVED BY: (SIGNATURE)
RELINQUISHED BY: (SIGNATURE)	DATE/TIME	RECEIVED BY: (SIGNATURE)
RELINQUISHED BY: (SIGNATURE)	DATE/TIME	RECEIVED BY: (SIGNATURE)
RECEIVED FOR LABORATORY BY: (SIGNATURE)	DATE/TIME	REMARKS:

REMARKS/COMMENTS:

JACOBS ENGINEERING GROUP, INC.
ALBUQUERQUE OPERATIONS

SAMPLE IDENTIFICATION TAG

SITE ID _____ LOCATION ID _____

SAMPLE ID _____ LOG DATE _____

BOTTLE ID _____

PRESERVATION METHOD _____

SAMPLER (S) _____

COMMENTS: _____

ICE
FILTERED

NO ICE
NON FILTERED

II. WORK ORDER PLAN -
CHEMICAL ANALYSIS OF UMTRA TAC SAMPLES

SITE HYDROLOGIST: _____
NAME (print) SIGNATURE DATE

SAMPLE MATRIX: _____

SITE ID(s): _____

SITE GEOCHEMIST: _____
NAME (print) SIGNATURE DATE

LOCATION ID(s): _____

SAMPLE ID(s): _____

Bottle Name	Cl	SO4	Na	K	Mg	Ca	B	F	CN	S	TKN	NH4	NO3 & NO2	NO3	SiO2	PO4	Br	Al	Sb	As	Ba	Be	Cd	Cr	Co
Total # of Tests																									

COMMENTS:

II. WORK ORDER PLAN - CHEMICAL ANALYSIS OF UMTRA TAC SAMPLES

SITE HYDROLOGIST: _____
NAME (print) SIGNATURE DATE

SAMPLE MATRIX: _____

SITE ID(s): _____

LOCATION ID(s): _____

SITE GEOCHEMIST: _____
NAME (print) SIGNATURE DATE

SAMPLE ID(s): _____

Bottle Name	Cu	Fe	Pb	Mn	Hg	Mo	Ni	Se	Ag	Sr	Sn	Ti	U	V	Zn	TDS	TOC & DOC
Total # of Tests																	

COMMENTS:

OBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

I. WORK ORDER PLAN - CHEMICAL ANALYSIS OF UMTRA TAC SAMPLES

SITE HYDROLOGIST:

NAME (print)

SIGNATURE

DATE

SAMPLE MATRIX:

SITE ID(s):

LOCATION ID(s):

SITE GEOCHEMIST:

NAME (print)

SIGNATURE

DATE

SAMPLE ID(s):

Bottle Name	U	Pb-210	Po-210	Ra-226	Ra-228	Th-230	Gross Alpha/Beta	
Total # of Tests								

COMMENTS:

UMTRA Project Contract Required Detection Limits (CRDLs) and Acceptable Techniques

Parameter	CRDL, mg/L	Technique(s)¹
Aluminum	0.05	ICP-AES
Ammonium as NH ₄	0.10	Colorimetric
Antimony	0.003	GFAA, ICP-MS
Arsenic	0.005	GFAA, NaBH ₄
Barium	0.10	ICP-AES
Beryllium	0.005	ICP-AES
Boron	0.10	ICP-AES
Bromide	0.10	IC
Cadmium	0.001	GFAA, ICP-MS
Calcium	0.50	ICP-AES
Chloride	0.50	IC, Colorimetric
Chromium	0.01	ICP-AES
Cobalt	0.05	ICP-AES
Copper	0.02	ICP-AES
Dissolved Organic Carbon (DOC)	1.0	UV Promoted Oxidation-IR
Total Cyanide	0.010	Colorimetric
Fluoride	0.10	ISE
Iron	0.03	ICP-AES
Lead	0.003	GFAA, ICP-MS
Magnesium	0.10	ICP-AES
Manganese	0.01	ICP-AES
Mercury	0.0002	CVAA
Molybdenum	0.01	ICP-AES
Nickel	0.04	ICP-AES
Nitrate as NO ₃	1.0	Colorimetric, IC
Potassium	0.10	ICP-AES, FAA
Oil and Grease	5.0	Gravimetric
Selenium	0.005	GFAA, NaBH ₄
Silver	0.01	ICP-AES
Silver	0.0002	GFAA, ICP-MS
Silica as SiO ₂	0.10	ICP-AES
Sodium	1.0	ICP-AES, FAA
Strontium	0.01	ICP-AES
Sulfate	1.0	IC
Sulfide	1.0	Titrimetric, Colorimetric
Thallium	0.005	GFAA, ICP-MS
Tin	0.05	ICP-AES, GFAA, ICP-MS
Total Dissolved Solids	10	Gravimetric
Total Kjeldahl Nitrogen	1.0	Colorimetric
Total Organic Carbon (TOC)	1.0	UV Promoted Oxidation-IR
Total Recoverable Phenols	0.05	Colorimetric
Total Phosphorus as PO ₄	0.10	Colorimetric
Total Petroleum Hydrocarbons	1.0	IR Spectrophotometric
Uranium	0.001	ICP-MS, Fluorometric
Vanadium	0.01	ICP-AES
Zinc	0.05	ICP-AES

UMTRA Project CRDLs and Acceptable Techniques

Parameter	CRDL, pCi/L	Technique(s)¹
Gross Alpha	1.0	PC
Gross Beta	2.0	PC
²¹⁰ Pb	1.5	LSc, PC
²¹⁰ Po	1.0	AS, PC
²²⁶ Ra	1.0	AS, AS _c , PC
²²⁸ Ra	1.0	PC
²²² Rn	200	LSc
²³⁰ Th	1.0	AS

¹Where more than one technique is specified, the first technique listed is preferred. Technique acronyms and abbreviations are defined below.

AS	Alpha Spectrometry
AS _c	Alpha Scintillation
CVAA	Cold Vapor Atomic Absorption Spectroscopy
FAA	Flame Atomic Absorption Spectroscopy
GFAA	Graphite Furnace Atomic Absorption Spectroscopy
IC	Ion Chromatography
ICP-AES	Inductively Coupled Plasma-Atomic Emission Spectroscopy
ICP-MS	Inductively Coupled Plasma-Mass Spectrometry
IR	Infrared
ISE	Ion Specific Electrode
LSc	Liquid Scintillation
NaBH ₄	Sodium Borohydride Reduction Atomic Absorption Spectroscopy
PC	Proportional Counter
UV	Ultraviolet

JACOBS ENGINEERING GROUP INC.

ALBUQUERQUE OPERATIONS

DELIVERABLE TRANSMITTAL/REVIEW

SUBCONTRACT NO: _____ SITE: _____ PROJ. NO: 05-62350

SUBCONTRACTOR: _____

PLEASE CHECK APPROPRIATE BOX(ES):

☐ DRAFT☐ FINAL☐ PARTIAL☐ INITIAL☐ REVISION

DELIVERABLE _____

TITLE/DESCRIPTION OF DOCUMENTS Chemical Analysis Results

_____ NO. ORIG. REQ. _____ NO. REC'D. _____ (INIT.)

_____ NO. COPY REQ. _____ NO. REC'D. _____ (INIT.)

_____ NO. DISKETTES REQ. _____ NO. REC'D. _____ (INIT.)

DO NOT WRITE BELOW THIS LINE - FOR USE BY JACOBS ENGINEERING GROUP INC. ONLY

REC'D _____ Routed _____ SUSPENSE _____

	TO	ACCEPTED	* NOT ACCEPTED	SIGNATURE / DATE
1. (DM)	PZietz	☐	☐	_____/____
2. (TR)	MMinteer	☐	☐	_____/____
3. (QA)	MAlewine	☐	☐	_____/____
4. (SM)	_____	☐	☐	_____/____

TO DOC. CONTROL (DATE) _____ BY: _____

(Technical Representative)

FILE NO. _____

(DC) _____ ☐ ☐ _____/____

CC: (WITHOUT ATTACHMENTS)

(CR) RMuniz _____ (SM) _____

(TR) MMinteer _____ (DM) _____

* COMMENTS: _____

Attachment 7

UMTRA TAC CHEMICAL ANALYSIS RESULTS FORM

Site ID: _____ Location ID: _____ Sample ID: _____ Sample Date: _____

Delivery Order: _____ Lab Code: _____ Lab Sample ID: _____

Report Reviewed By: _____
Name Initial Date

PARAMETER CODE	PVI	PARAMETER VALUE	UNCERTAINTY VALUE	DETECTION LIMIT	UNITS OF MEASURE	ANALYSIS DATE	FLAGS	METHOD USED
AGT	<	0.010		0.010	mg/L	05-05-93		EPA 200.7
RA-228T		0.0	0.5	0.5	pCi/L	05-05-93	*	EPA 904

Comments: _____

ATTACHMENT 8

MAGNETIC DELIVERABLE FORMAT

SITE ID	LOCATION ID	SAMPLING DATE	SAMPLE ID	LAB ID	PARAMETER CODE	PAR VALUE INDICATOR	OTHER PAR FLAGS	PARAMETER VALUE	PARAMETER UNCERTAINTY	DETECTION LIMIT	UNITS OF MEASURE
5 CHARS	4 CHARS	8 CHARS	4 CHARS	3 CHARS	10 CHARS	1 CHARS	5 CHARS	13 CHARS	11 CHARS	11 CHARS	10 CHARS
DUR03	0605	19900715	0001	XXX	RA-228		N	1.0	1.3 ..	0.8	PCI/L

PARAMETER MENU

Parameter Name	Code	Units (Water/Soil)	
ALUMINUM	AL	mg/L	mg/kg
ALUMINUM (TOTAL)	ALT	mg/L	
AMMONIUM AS NH4	NH4	mg/L	mg/kg
ANTIMONY	SB	mg/L	mg/kg
ANTIMONY (TOTAL)	SBT	mg/L	
ARSENIC	AS	mg/L	mg/kg
ARSENIC (TOTAL)	AST	mg/L	
BARIUM	BA	mg/L	mg/kg
BARIUM (TOTAL)	BAT	mg/L	
BERYLLIUM	BE	mg/L	mg/kg
BERYLLIUM (TOTAL)	BET	mg/L	
BORON	B	mg/L	mg/kg
BORON (TOTAL)	BT	mg/L	
BROMIDE	BR	mg/L	mg/kg
CADMIUM	CD	mg/L	mg/kg
CADMIUM (TOTAL)	CDT	mg/L	
CALCIUM	CA	mg/L	mg/kg
CALCIUM (TOTAL)	CAT	mg/L	
CARBON, DISSOLVED ORGANIC	DOC	mg/L	
CARBON, TOTAL ORGANIC	TOC	mg/L	mg/kg
CHLORIDE	CL	mg/L	mg/kg
CHROMIUM	CR	mg/L	mg/kg
CHROMIUM (TOTAL)	CRT	mg/L	
COBALT	CO	mg/L	mg/kg
COBALT (TOTAL)	COT	mg/L	
COPPER	CU	mg/L	mg/kg
COPPER (TOTAL)	CUT	mg/L	
CYANIDE, TOTAL	TOTAL CN	mg/L	mg/kg
FLUORIDE	F	mg/L	mg/kg
GROSS ALPHA	GA	pCi/L	pCi/g
GROSS ALPHA (TOTAL)	GAT	pCi/L	
GROSS BETA	GB	pCi/L	pCi/g
GROSS BETA (TOTAL)	GBT	pCi/L	
IRON	FE	mg/L	mg/kg
IRON (TOTAL)	FET	mg/L	
LEAD	PB	mg/L	mg/kg
LEAD (TOTAL)	PBT	mg/L	
LEAD-210	PB-210	pCi/L	pCi/g
LEAD-210 (TOTAL)	PB-210T	pCi/L	
MAGNESIUM	MG	mg/L	mg/kg
MAGNESIUM (TOTAL)	MGT	mg/L	
MANGANESE	MN	mg/L	mg/kg

PARAMETER MENU

Parameter Name	Code	Units (Water/Soil)	
MANGANESE (TOTAL)	MNT	mg/L	
MERCURY	HG	mg/L	mg/kg
MERCURY (TOTAL)	HGT	mg/L	
MOLYBDENUM	MO	mg/L	mg/kg
MOLYBDENUM (TOTAL)	MOT	mg/L	
NICKEL	NI	mg/L	mg/kg
NICKEL (TOTAL)	NIT	mg/L	
NITRATE AS NO3	NO3	mg/L	mg/kg
NITROGEN, NO2 + NO3	NO2 + NO3-N	mg/L	mg/kg
OIL AND GREASE	O&G	mg/L	mg/kg
PERCENT SOLIDS	% SOLIDS		%
POLONIUM-210	PO-210	pCi/L	pCi/g
POLONIUM-210 (TOTAL)	PO-210T	pCi/L	
POTASSIUM	K	mg/L	mg/kg
POTASSIUM (TOTAL)	KT	mg/L	
RADIUM-226	RA-226	pCi/L	pCi/g
RADIUM-226 (TOTAL)	RA-226T	pCi/L	
RADIUM-228	RA-228	pCi/L	pCi/g
RADIUM-228 (TOTAL)	RA-228T	pCi/L	
RADON-222	RA-222	pCi/L	
SELENIUM	SE	mg/L	mg/kg
SELENIUM (TOTAL)	SET	mg/L	
SILICA	SiO2	mg/L	mg/kg
SILVER	AG	mg/L	mg/kg
SILVER (TOTAL)	AGT	mg/L	
SODIUM	NA	mg/L	mg/kg
SODIUM (TOTAL)	NAT	mg/L	
STRONTIUM	SR	mg/L	mg/kg
STRONTIUM (TOTAL)	SRT	mg/L	
SULFATE	SO4	mg/L	mg/kg
SULFIDE	SULFIDE	mg/L	mg/kg
THALLIUM	TL	mg/L	mg/kg
THALLIUM (TOTAL)	TLT	mg/L	
THORIUM-230	TH-230	pCi/L	pCi/g
THORIUM-230 (TOTAL)	TH-230T	pCi/L	
TIN	SN	mg/L	mg/kg
TIN (TOTAL)	SNT	mg/L	
TOTAL DISSOLVED SOLIDS	TDS	mg/L	
TOTAL KJELDAHL NITROGEN	TKN	mg/L	mg/kg
TOTAL PETROLEUM HYDROCARBONS	TPH	mg/L	mg/kg
TOTAL PHOSPHORUS AS PO4	PO4	mg/L	mg/kg
TOTAL RECOVERABLE PHENOLS	TPHENOL	mg/L	mg/kg

PARAMETER MENU

Parameter Name	Code	Units (Water/Soil)	
URANIUM	U	mg/L	mg/kg
URANIUM (TOTAL)	UT	mg/L	
VANADIUM	V	mg/L	mg/kg
VANADIUM (TOTAL)	VT	mg/L	
ZINC	ZN	mg/L	mg/kg
ZINC (TOTAL)	ZNT	mg/L	

**TAC SITE-SPECIFIC
HEALTH AND SAFETY SUPPLEMENT**

FOR Grand Junction, CO

January 30, 1995
DATE

Larry E. Ross
TAC ES&H MANAGER

-Walt Mizdel
SITE MANAGER

SITE-SPECIFIC HEALTH AND SAFETY SUPPLEMENT
FOR GRAND JUNCTION, CO

I. Objective

- Review the important safety and health items discussed in the UMTRA Project Environmental Health and Safety Plan.
- Define the hazards or potential hazards unique to the site such as biological, chemical, electrical and excavation,
- Provide telephone numbers and locations of emergency medical, fire, and police services.

This plan is to serve as a supplement to the UMTRA TAC Site Health and Safety Plan developed for the field visitor.

II. Site Characteristics

The tailings pile at the mill site is:

Uncovered ☐ The Remedial Action Contractor (RAC) is not present on the site. The tailings are exposed and contaminated areas may or may not be fenced and marked at the site. The attached map of the mill site shows the contaminated areas of the site.

In Process ☒ The RAC is ^{(Cheney) disposal} present on the site. Controlled areas have been fenced and marked. While in the controlled area of the site or in the trailers and parking area at the entrance of the site, you are a visitor and your health and safety is the responsibility of the RAC. The RAC ES&H representative on the site is Nancy Miller. All TAC employees shall make the RAC aware of their presence on the site.

Where discrepancies exist, the RAC ES&H plan supersedes this plan while employees are on property controlled by the RAC. All employees shall obey posted signs and follow all instructions given by the RAC. All employees shall be escorted by a RAC employee or shall be issued a site radio. When outside areas controlled by RAC, all employees shall follow this plan.

Complete ☒ ^{former processing} The site has been remediated. The contaminated tailings ~~are covered~~ and no longer present a hazard to TAC employees.
have been removed

III. Radiological hazards

☒ External exposure (at Cheney Site)

There is potential for external exposure of personnel to penetrating gamma radiation from radionuclides in the piles. HP personnel will determine if it is necessary to wear an LTD badge before entering the controlled area.

Note: All personnel in the controlled area shall be surveyed for contamination before leaving the job site.

☒ Internal exposure (at Cheney Site)

The potential exists for ingestion and inhalation of radioactive dust and ⁵silica. To minimize airborne contamination hazards, the resuspension of dust by traffic and equipment should be reduced as much as possible. Respirators may be worn as a protective measure.

☒ Eating, drinking, chewing gum, smoking, or chewing tobacco shall be prohibited while inside the controlled area, or while working on or around the tailings piles.

IV. Personal protective equipment

Personal protective equipment (PPE) shall be worn as required by the hazards of the work and/or the location of the site, as determined by the Job Hazard Analysis completed by employees and reviewed by the Health and Safety staff.

V. Site hazards

Use the TAC Pager system to report the discovery of an unknown material. This includes the discovery of unusual soil colors, stains, liquids, and strong or unusual odors that are not expected.

☒ Hazardous chemicals (acids, bases, solvents, coolants, gases, plastics, epoxies and polymers, cleaners, fuels and other petroleum products) are on site. (Cheney)
Personnel shall not move or handle any chemicals for which they have no responsibility. All chemicals shall be labeled, stored, and transported in accordance with the Department of Transportation and OSHA regulations by trained hazardous chemical shippers. Other chemical hazards at this site include:

☐ Hazardous waste is not present on site.

☒ Hazardous waste has not been found on the site, but could be present.

☐ Hazardous waste is present on the site. The approximate location and known description are given on the accompanying map.

____ Since abandoned buildings may be structurally unsound and/or may contain hazardous materials, employees should not enter any abandoned buildings.

____ Some of the potential hazards arising from the multiple use of the site include:

____ Explosives, uncovered holes, pits, or shafts may be present in or around the site area.

____ Appropriate safety precautions shall be observed when working over or near water.

✓ Heavy equipment is operating on site. All personnel shall establish eye contact with the heavy-equipment operator, make appropriate gestures, and yield the right-of-way to heavy equipment. *(Cheney Site only)*

____ Buried tanks have not been reported, but could be present.

____ Buried tanks are present on the site. The approximate locations of those that are known to exist are given on the accompanying map.

The local electric company, Public Service Co., indicates there are:

____ No electric power lines crossing the site.

____ Buried electric power lines. Contact the utility company before beginning any drilling, excavation, or other activities that involve disturbing the ground.

____ Buried utilities have not been identified or marked. Contact the utility company before any drilling, excavation, or other activities that involve disturbing the ground.

✓ Electric power lines crossing the site. Contact the local utility company to determine the minimum distance of a crane or drilling rig to the lines, and the closest approach to a power line when in transit.

(303) 244-2790

The local natural gas utility, Public Service Co.,

____ Indicates that gas pipelines do not cross the site.

____ Indicates that gas pipelines are present on the site. Their locations are marked as follows: _____

* Must be consulted before drilling at the site.

* Colorado Utility Notification Center

(800) 922-1987

VI. Industrial Hygiene Hazards

Biological hazards include:

☒ Hantavirus from rodent feces

☐ Hepatitis "A" from wastes, sewers, or garbage

☒ Poisonous snakes and insects

☐ Other biological hazards at this site include: _____

☒ Heat stress

Working in protective clothing can greatly increase the likelihood of heat stress, heat exhaustion, and heat stroke, the latter being a life-threatening condition. Employees shall be alert to the possibility and symptoms of heat stress. Should extreme fatigue, cramps, dizziness, headache, nausea, profuse sweating, or pale and/or clammy skin occur, the employee is to immediately leave the work area, rest, cool off, and drink plenty of cool water. Sufficient cool water and disposable drinking cups shall be in the rest area. If the symptoms do not subside after a reasonable rest period, the employee shall notify their supervisor and shall be provided medical assistance.

☒ Cold Stress

Hypothermia is a physical condition that develops from cold exposure. Blood from the extremities concentrates in the body core, leaving the extremities susceptible to frostbite. A person with hypothermia becomes confused, sleepy, and irritable. They should be warmed immediately.

Frostbite is most likely to occur in extremities, especially fingers, toes, cheeks, and ears. The affected body parts may feel numb. Individuals may experience pain and loss of flexibility in the affected body part, and skin may become waxy or translucent.

Individuals who have frost bite should be moved to a warm room and covered with blankets. Frostbitten tissue should not be rubbed. Frostbite is a very serious condition that requires immediate medical treatment.

Severe weather/natural disasters

All employees shall stop work and seek appropriate shelter when severe weather threatens life or health, or when instructed to do so. Personnel working on structures should remove all tools, equipment, and materials and descend to ground level.

When an electrical storm is approaching, personnel should leave unprotected areas and seek appropriate shelter. Suitable shelter shall be all passenger vehicles, buildings and low areas or ground depressions. Arroyos and other drainage ditches are not suitable shelters due to possible flash flooding. Personnel working on or around drill rigs should distance themselves from the rig immediately.

Additional hazards at the site include:

GRAND JUNCTION SITE MAP

VII. EMERGENCY INFORMATION FOR GRAND JUNCTION, CO

FIRE: 911 or BLM (303) 243-6555

AMBULANCE: 911

POLICE/SHERIFF: 911 or Hwy Patrol (303) 248-7277

NEAREST AVAILABLE TELEPHONES: a) MK-F Site Trailers (Cheney)
b) Residences/Businesses near
the remediated processing site

NEAREST EMERGENCY ROOM: St. Mary's Medical Center
7th AND PATTERSON (SEE MAP)
(303) 244-2551

TAC PAGER SYSTEM:

(USE IN ALL CASES. The system will notify H&S staff, site managers, other UMTRA staff as appropriate, and initiate reporting processes if necessary)

PAGER 1: (505) 845-0142 2465 + the area code and number where you are

PAGER 2: (505) 845-0142 2464 + the area code and number where you are

SITE TELEPHONE NUMBER: (303) 241-9132

MK-F SITE H&S CONTACT: NANCY MILLER

MK-F Site Mgr.
~~IMMEDIATE SUPERVISOR:~~ Lyle Lauer

Directions from GRJ Sites
to St. Mary's Hospital in Grand Junction, CO

From Former GRJ Processing Site

1. Exit the site and head north on South 9th Street.
2. Turn left (west) on Ute Avenue and proceed two blocks to 7th Street.
3. Turn right (north) onto 7th Street and follow it past North Avenue and Orchard Avenue to Center Avenue.
4. Turn left (west) on Center Avenue. St. Mary's Hospital is just to the north of Center Avenue (see map).

From Cheney Disposal Site

1. Exit the site on the access road.
2. Turn north on US 50 and follow it north into Grand Junction. US 50 joins with 5th Street before it crosses the Colorado River.
3. Follow 5th Street north through the downtown area to North Avenue.
4. Turn right on North Avenue and travel 2 blocks east to 7th Street.
5. Turn left on 7th and proceed north to Center Avenue.
6. Turn left on Center Avenue and head west. St. Mary's Hospital is just to the north of Center Avenue (see map).

Route from Cheney Disposal Site to Grand Junction

Routes to St. Mary's Hospital, Grand Junction, CO

Information for Contacting and Using St. Mary's Air Life Helicopter Service

St. Mary's

AIR LIFE

For emergency medical air service or
questions regarding medical transfer call:

Colorado Toll Free: 1-800-332-4923

Nationwide Toll Free: 1-800-525-4224

— CHECKLIST OF EMERGENCY INFORMATION —

FLIGHT

1. Location of patient
2. Location of landing zone
 - a. Obstructions, wires, poles, trees, etc.
 - b. Size of landing zone (100' x 100' minimum)
 - c. How area is marked
 - d. Altitude
3. Weather conditions
 - a. Visibility
 - b. Wind
 - c. Temperature
4. Communications
 - a. Radio frequency
 - b. Telephone number
 - c. Person to contact

TRAUMA TRIAGE CRITERIA

- Patient is recommended to be transferred to a Trauma Center when:
- Patient is involved in a high speed motor vehicle accident (greater than 40 MPH), or patient is hit by a motor vehicle at greater than 20 MPH.
 - Patient falls greater than 15 feet.
 - Patient has penetrating injury to any body region.
 - Patient has blunt injury to two or more body regions.
 - Patient has trauma scores of 12 or less or Glasgow Coma scores of 10 or less.

ST. MARY'S HOSPITAL

The Regional Medical Center

P.O. Box 1428 - Grand Junction, CO 81502-1428

Air Methods, Inc.

TO SUMMON AMBULANCE OR AIR LIFE HELICOPTER

This information will be needed:

1. Description of accident or illness.
2. Specific injuries, specifics of illness.
3. a) Patient breathing - not breathing?
- b) Patient conscious - unconscious?
- c) Patient's skin - warm, cool, pale, red, blue, normal
- d) Pulse rate: _____/min.
Respiratory rate: _____/min.
4. Address or specific geographic location.
5. Number of patients.

911 or 116

DISPATCH CENTER:
CALL THE LOCAL EMERGENCY
IN CASE OF EMERGENCY,

NOTES: _____

— TIME —

Respir.
Pulse
Skin
Awake

COURTESY DIVISION OF WILDLIFE AND
ST. MARY'S HOSPITAL AND MEDICAL CENTER

HEALTH AND SAFETY PLAN FOR GRAND JUNCTION PALEOCHANNEL PROJECT

ADDENDUM

I. Purpose

The purpose of this plan is to recognize the specific hazards associated with the Phase 1A activities of the Grand Junction (GRJ) Paleochannel Sampling Project and specify health and safety controls to minimize the risk to contractor personnel from these hazards. This plan will be an addendum to the Site-Specific Health and Safety Supplement for Grand Junction, Colorado.

II. Location of Sample Collection

The location of the sample collection will be on the east side of the Cheney Cell. Approximately 1000 gallons of water will run along drainage ditches at the base of the cell. Water sampling will take place on the surface in addition to ground water sampling.

III. Data Collection Tasks

The data collection tasks associated with Phase 1A are:

1. Permits, clearances, and access agreements
2. Sump and data logger installation in disposal cell toe drain
3. Water sampling in monitor wells and sumps
4. Water sampling in water tank
5. Mass balance calculation of available nitrate

IV. Potential Hazards and Required Controls

1. Surface water flow always adds the risk of drowning. Two people will work together at all times when taking samples from flowing water. Flotation devices will be present when water depth or flow velocity presents a drowning hazard.
2. Sampling wells may contain off-gases which present a toxic or flammable hazard. Once opened, the well shall be allowed to vent for approximately 15-20 minutes to allow gases to escape into the atmosphere.
3. Electrical shock hazards exist when working with equipment, such as sump pumps, which require electrical energy to operate. Ground fault circuit interrupters (GFCIs) shall be used with line current or electrical generators. Non-conducting boots and gloves shall be used when working with electricity around surface water. All equipment shall have grounding plugs or be double insulated.

4. Heat stress is a risk when working under a hot sun, especially when wearing coveralls or tyveks. Fresh potable water with drinking cups shall be available at all times. Breaks out of the sun shall be given as appropriate.

5. When conditions turn cold, the body loses heat to the environment and hypothermia may occur. This can be prevented by wearing layered clothing and keeping the clothing dry. Heated trailers shall be provided under these conditions to allow workers to warm up.

6. Lifting heavy equipment can injure a worker's back. Objects weighing more than 50 pounds shall be lifted by two or more persons. Proper lifting techniques shall be used when lifting heavy objects.

7. When insects are present in large numbers, insect sprays shall be provided to workers. Insecticides shall be used, as appropriate, to exterminate hazardous insects. Sprayers of insecticides shall follow the manufacturer's instructions on spraying the insecticide. EPA regulations shall be followed when disposing of any insecticides.

8. When working in areas where poisonous snakes may be a hazard, chaps and leather boots shall be worn to reduce the risk of snake bite.

9. Personal protective equipment (PPE) shall include 8 inch leather boots (safety boots), hard hats (as required), safety glasses (when flying projectiles are a risk), and any other requirements enforced by MK-Ferguson.

10. Chemicals (acids and bases) may be used to fix water samples before sending to a laboratory for analysis. All requirements promulgated by the Hazard Communication Standard are required. An MSDS sheet on each chemical must be present. All containers must be labeled appropriately.

11. Chemicals shall be stored and transported appropriately. Current DOT training is required for any hazardous materials being packaged, manifested and sent via commercial carrier.

12. Moving vehicles are a hazard when working in close proximity to Cheney Cell. Everyone shall be made aware of traffic patterns at the cell and everyone will yield/stay clear of trucks entering and leaving the cell.

13. Trips and falls are always possible when working on uneven surfaces. A minimum of one First Aid/CPR trained person will be present at all times to provide coverage in case of an accident.

14. In cases where emergency response is required, follow the instructions in the H&S Site-Specific Supplement.

15. Any potentially ORPS reportable incidents shall be reported to your immediate manager. ORPS reporting to the DOE will be done through MK-Ferguson, since they are the prime contractor on site.