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UMTRA PROJECT WATER SAMPLING AND ANALYSIS PLAN

GRAND JUNCTION, COLORADO

July 1994

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**UMTRA PROJECT WATER SAMPLING AND
ANALYSIS PLAN**

GRAND JUNCTION, COLORADO

July 1994

**Prepared for
U.S. Department of Energy
UMTRA Project Office
Albuquerque, New Mexico**

**Prepared by
Jacobs Engineering Group Inc.
Albuquerque, New Mexico**

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EXECUTIVE SUMMARY

Surface remedial action will be completed at the Grand Junction processing site during the summer of 1994. Results of 1993 water sampling indicate that ground water flow conditions and ground water quality at the processing site have remained relatively constant with time. Uranium concentrations in ground water continue to exceed the maximum concentration limits, providing the best indication of the extent of contaminated ground water. Evaluation of surface water quality of the Colorado River indicate no impact from uranium processing activities.

No compliance monitoring at the Cheney disposal site has been proposed because ground water in the Dakota Sandstone (uppermost aquifer) is classified as limited-use (Class III) and because the disposal cell is hydrogeologically isolated from the uppermost aquifer.

The following water sampling and water level monitoring activities are planned for calendar year 1994:

- Semiannual (early summer and late fall) sampling of six existing monitor wells at the former Grand Junction processing site. Analytical results from this sampling will be used to continue characterizing hydrogeochemical trends in background ground water quality and in the contaminated ground water area resulting from source term (tailings) removal.
- Water level monitoring of approximately three proposed monitor wells projected to be installed in the alluvium at the processing site in September 1994. Data loggers will be installed in these wells, and water levels will be electronically monitored six times a day. These long-term, continuous ground water level data will be collected to better understand the relationship between surface and ground water at the site. Water level and water quality data eventually will be used in future ground water modeling to establish boundary conditions in the vicinity of the Grand Junction processing site. Modeling results will be used to help demonstrate and document the potential remedial alternative of natural flushing. In the future, ground water sampling of these wells may be performed. The constituent list and sampling frequency will be consistent with those of existing monitor wells.
- Quarterly water level monitoring of two shallow monitor wells to be installed near the Cheney disposal cell in September 1994 to monitor the cyclical nature of ground water occurrence within shallow paleochannel systems. The need for sampling the paleochannel wells will be determined once the nature of ground water occurrence is determined.

The selected monitor well locations provide a representative distribution of sampling points to characterize ground water quality and ground water flow conditions in the vicinity of the processing site and disposal cell. The list of analytes has been modified with time and currently reflects constituents related to uranium processing activities.

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LIST OF ACRONYMS AND ABBREVIATIONS

<u>Acronym</u>	<u>Definition</u>
ac	acre
cm/s	centimeters per second
DCO	data collection objective
DOE	U.S. Department of Energy
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
ft	foot
ft/s	feet per second
ha	hectare
km	kilometer
m	meter
MCL	maximum concentration limit
mg/L	milligrams per liter
mi	mile
QA	quality assurance
QAIP	quality assurance implementation plan
QC	quality control
Ra	radium
SOP	standard operating procedure
TDS	total dissolved solids
UMTRA	Uranium Mill Tailings Remedial Action
WSAP	water sampling and analysis plan

1.0 INTRODUCTION

1.1 PURPOSE

This water sampling and analysis plan (WSAP) provides the basis for ground water and surface water sampling and identifies and justifies the sampling locations, analytical parameters, detection limits, and sampling frequencies for the monitoring stations at the former Grand Junction uranium mill tailings site (GRJ-01) and the Cheney disposal site (GRJ-03) near Grand Junction, Colorado.

Ground water and surface water monitoring activities are based on the U.S. Environmental Protection Agency (EPA) regulations in 40 CFR Part 192 (1994) and the proposed EPA standards of 1987 (52 FR 36000), Uranium Mill Tailings Remedial Action (UMTRA) Project standard operating procedures (SOP) (JEG, n.d.), the *Technical Approach Document* (DOE, 1989), and the most effective technical approach for the site.

This WSAP includes the results of water sampling activities from 1983 through 1993 and the water sampling activities planned for calendar year 1994.

1.2 SITE LOCATION AND HISTORY

1.2.1 Grand Junction processing site

The Grand Junction processing site is in the central part of western Colorado, in an industrial area just southeast of the city of Grand Junction, adjacent to the north side of the Colorado River (Figure 1.1). The site is in Sections 23 and 24, Township 1 South, Range 1 West, Sixth Principal Meridian, or north latitude 39-03'-30", west longitude 108-34'-00".

The Climax Uranium Company processed uranium and vanadium ore at the Grand Junction mill site from June 1951 to March 1970. The mill produced 2.2 million tons (2 million tonnes) of tailings, approximately 300,000 tons (272,100 tonnes) of which were removed from the site and used as construction material or earth fill. The locations of these materials are termed "vicinity properties." The uranium ore processed by the mill averaged 0.28 percent uranium and 1.41 percent vanadium. The ore was crushed, ground, and treated to extract the product. Shortly after the mill shut down, efforts were made to stabilize the pile. Much of the concrete and brick from demolished mill buildings was placed as riprap along the riverbank. The remainder was placed in the effluent ponds along with a portion of the mill tailings. The tailings pile was covered with 6 inches (15 centimeters) of soil. The pile was vegetated and irrigated, but little vegetation remained prior to surface remediation.

The Grand Junction processing site is in a primarily urbanized area, with residential, commercial, and industrial uses. The Denver & Rio Grande Western

FIGURE 1.1
LOCATION OF GRAND JUNCTION PROCESSING SITE
AND CHENEY DISPOSAL SITE

Railroad, which is situated approximately 0.5 mile (mi) (0.8 kilometer [km]) north of the site, is approximately the northern boundary of the industrial use area. Commercial and industrial land use occurs immediately west, north, and northeast of the site. The Grand Junction site is outside the incorporated area of the city of Grand Junction and therefore is not subject to city zoning restrictions. However, the area is subject to county zoning. The site and surrounding area are zoned industrial.

Examination of current data bases and intensive field reconnaissance downgradient and crossgradient from the processing site indicates that no known users of alluvial ground water within the former processing site vicinity could be influenced by processing site-related contamination.

In the vicinity of the site and the majority of the Grand Valley area, surface water supplies municipal and industrial needs. Most of the water for the Grand Valley originates as surface water on Grand Mesa.

The Mancos Shale, which underlies the alluvium in the former processing site vicinity, is not considered a ground water source in the Grand Junction vicinity. The Dakota Sandstone, which underlies the Mancos Shale, is the uppermost artesian aquifer in the tailings vicinity. No registered wells are known to be completed in the Dakota Sandstone within the potentially affected environment.

Future domestic use of shallow ground water in the affected hydrogeologic environment is not anticipated due to the availability of city water, the seasonally low quality of ground water in the alluvial aquifer, and the impact of other, (non-site-related) contaminant sources on the alluvial aquifer. Future use of ground water in the Dakota Sandstone also is not anticipated due to the poor water quality.

1.2.2 Cheney disposal site

The Cheney disposal site is approximately 18 mi (30 km) southeast of the former Grand Junction processing site on U.S. Highway 50 (Figure 1.1).

The Cheney site is within a Bureau of Land Management grazing allotment designated for cattle. Grazing is the primary land use within a 3-mi (5-km) site radius.

Several residences are within 3 mi (5 km), northeast of the site. A zone of irrigated agricultural land begins about 2 mi (3 km) north of the site in the valley of Kannah Creek.

No registered wells or shallow wells are within 2-mi (3-km) radius of the Cheney disposal site. Existing and anticipated ground water usage in the Cheney disposal site vicinity is minimal because 1) the current low population density in the area results in a low demand for water, 2) shallow ground water is limited, and 3) the quality of the shallow ground water is too poor for domestic use.

1.3 SITE STATUS

The tailings and other contaminated materials have been removed from the former processing site and stabilized in the Cheney disposal cell. The processing site is being contoured and seeded; the Cheney disposal cell is scheduled for closure in September 1998.

A baseline risk assessment for the former processing site should be complete in the late summer of 1994.

1.4 SAMPLING PLAN

The current water sampling plan for the Grand Junction processing/disposal sites is to collect water samples from selected U.S. Department of Energy (DOE) monitor wells and surface water locations. The monitor wells are located to provide a representative distribution of sampling points to assess trends in ground water quality and flow conditions in the vicinity of the sites. Figure 1.2 shows the locations of DOE monitor wells being sampled in the former processing site vicinity. The list of analytes has been modified with time, currently reflecting hazardous constituents related to uranium processing activities. Water sampling is conducted semiannually, in early summer and fall.

The next regularly scheduled water quality sampling round will occur in the fall of 1994 and will include six existing monitor wells completed in the alluvial aquifer at the processing site.

Three new DOE monitor wells are scheduled to be installed in the alluvium at and in the vicinity of the processing site in September 1994. Gathering additional time-dependent data (water levels) was deemed necessary to gain an understanding of the ground water/surface water interaction at the processing site over several years. These data will ultimately be used in future modeling to establish boundary conditions in the vicinity of the Grand Junction processing site. Data loggers will be installed in these wells and water levels will be electronically monitored six times a day. Although sampling of these wells is not planned in 1994, they may be sampled in the future.

No sampling in support of risk assessment is currently planned for 1994. However, based on results of the Grand Junction preliminary baseline risk assessment, additional surface water and sediment sampling in the vicinity of the processing site may be necessary during late fall sampling.

No monitor wells are being sampled in the Cheney disposal site vicinity. However, two shallow monitor wells are scheduled for installation in paleochannels west of the disposal cell in September. These wells are being installed as a best management practice in order to perform indirect monitoring of the disposal cell. They are being installed to gather quarterly information on

LEGEND

- 740 MONITOR WELL
- STATE HIGHWAY

0.25 0 0.5 MILES

0.25 0 1.0 KILOMETERS

FIGURE 1.2
LOCATION OF MONITOR WELLS PRESENTLY SAMPLED IN THE VICINITY OF
THE GRAND JUNCTION, COLORADO, PROCESSING SITE

water occurrence in the near-surface paleochannels. Flow in paleochannels in the vicinity of the Cheney site is known to be cyclic. Wells may be dry over much of the year. Once the nature of ground water occurrence is determined, the paleochannel wells may be sampled.

2.0 GRAND JUNCTION PROCESSING SITE

2.1 SITE CONCEPTUAL MODEL

The site conceptual model is based on available hydrogeologic information, site reconnaissance, and data from monitor wells installed in the alluvium, the Mancos Shale, and the Dakota Sandstone.

2.1.1 Physiographic setting

The Grand Junction processing site is approximately 4600 feet (ft) (1400 meters [m]) above sea level. The site is situated in the Grand Valley, a broad, semiarid valley cut by the Colorado River and bounded by the Book Cliffs escarpment, the Grand Mesa, and the Uncompahgre Plateau. The Colorado River and one of its tributaries, the Gunnison River, drain the Grand Valley.

2.1.2 Geology

The shallow stratigraphy near the processing site comprises three hydrogeologic zones (in descending order):

- A surficial disturbed zone.
- A zone of unconsolidated alluvial sediments.
- A sequence of consolidated sedimentary formations.

The surficial disturbed zone includes a variety of soil classifications and material types deposited or altered through the actions of people. The zone varies in depth from less than 1 ft (0.30 m) to more than 50 ft (15 m).

Underlying, or adjacent to, the surficial disturbed zone is a zone of unconsolidated alluvial sediments. In the processing site vicinity, this zone includes mixed gravel sand and silty layers, ranging in depth from less than 7 ft (2 m) to more than 21 ft (6 m). The bottom of the alluvial aquifer is formed by the erosional surface of the Mancos Shale, which slopes gently (about 5 ft [1.5 m] per mile) to the north (U.S. Bureau of Reclamation, n.d.).

Underlying the unconsolidated alluvial sediments is a sequence of consolidated sedimentary formations, which include (in descending order) (Lohman, 1965):

- Mancos Shale.
- Dakota Sandstone.
- Burro Canyon Formation.
- Morrison Formation.

The Mancos Shale is a thick, relatively extensive sequence of shale that includes some sandy layers and thin sandstone beds. The Mancos Shale varies in

thickness from more than 100 ft (30 m) near the former processing site to nearly absent west of the processing site.

The Mancos Shale is not considered a water source in the Grand Junction vicinity. It is an aquitard that acts as a barrier to downward migration of contamination.

The Dakota Sandstone and Burro Canyon Formation form the uppermost bedrock aquifer that underlies the Mancos Shale. The Dakota Sandstone and Burro Canyon Formation consist of beds of sandstone, conglomeritic sandstone, shale, and coal. These units are not considered productive in the Grand Junction area (Lohman, 1965). Depth to the top of the Dakota Sandstone in the processing site vicinity ranges from 70 to 170 ft (20 to 50 m) below land surface.

No other formations will be discussed because the Dakota Sandstone is the uppermost bedrock aquifer and tailings seepage will not likely impact underlying formations.

2.1.3 Groundwater hydrology

The alluvium is the uppermost aquifer in the vicinity of the Grand Junction processing site. Based on water level measurements from on-site monitor wells and piezometers, the depth to ground water in the alluvium ranges from approximately 20 ft (6 m) to less than 4 ft (1 m) in areas closest to the Colorado River. Historical water levels indicate that hydraulic gradients in the processing site vicinity trend southwest, toward the Colorado River (Figure 2.1). The Colorado River may serve as the ultimate discharge point for the alluvial ground water.

Ground water levels beneath the site fluctuate from 2 to 5 ft (0.61 to 1.5 m) annually and are lowest during fall and winter. These fluctuations occur due to changes in river stage, precipitation, local irrigation, and upgradient recharge.

Regionally, the Mancos Shale is a low-permeability formation that is not water-bearing or transmits only limited quantities of water (Cooley et al., 1969; Lohman, 1965). Although the upper weathered Mancos Shale is saturated beneath the processing site, it functions as an aquitard.

Ground water flow directions in the Dakota Sandstone have not been determined due to a lack of borings into the unit. However, flow in the unit is probably north, based on the dip of the beds. The probable recharge area is an outcrop of Dakota Sandstone south of the site (Lohman, 1965).

LEGEND

NOTE: DATA COLLECTED JUNE 1993.

- 4560- GROUND WATER CONTOUR
(FT ABOVE MSL)
(DASHED WHERE INFERRED)
- 740 ALLUVIUM WELL
- 4561 GROUND WATER ELEVATION
(FT ABOVE MSL)
- (50) STATE HIGHWAY
- ➔ GROUND WATER FLOW DIRECTION

FIGURE 2.1
WATER TABLE CONTOUR MAP OF THE ALLUVIUM IN THE VICINITY OF
THE GRAND JUNCTION, COLORADO, PROCESSING SITE

Hydraulic characteristics

The average hydraulic conductivity in the alluvium is approximately 9.8×10^{-4} feet per second (ft/s) (3×10^{-2} centimeters per second [cm/s]), as determined from aquifer pumping tests (DOE, 1991). Ground water velocity in the alluvium averages from 0.2 to 5 ft (0.06 to 1.5 m) per day, depending on location-specific conditions (DOE, 1991).

Calculated hydraulic conductivities in the Mancos Shale average 2.09×10^{-7} ft/s (6.4×10^{-6} cm/s) (DOE, 1991). The horizontal hydraulic conductivity of the shale decreases slightly with increasing depth, as confirmed by the results of slug withdrawal tests conducted at different depths in the Mancos Shale.

Limited results from two slug withdrawal tests in the upper Dakota Sandstone near the processing site indicate that its hydraulic conductivity is comparable to that of the Mancos Shale.

2.1.4 Surface water hydrology

The north channel of the Colorado River forms the southern boundary of the processing site. As previously stated, the Colorado River may be the ultimate discharge point for much of the ground water contamination migrating from the processing site. The stage of the Colorado River fluctuates seasonally with high stage occurring in May and June and low stage occurring in February and March.

There are no major domestic users of Colorado River water in the vicinity of Grand Junction area (DOE, 1986)

A Mancos Shale outcrop forms the southern bank of the Colorado River in the vicinity of the processing site. Several large sand bars have been deposited in the river south and southwest of the site. During much of the year, the river flows in separate channels formed by these sand bars.

The Gunnison River flows into the Colorado River about 1.5 mi (0.90 km) west of the processing site. During dry spells, Grand Junction sometimes uses Gunnison River water, the intake being approximately one mile upstream from the confluence with the Colorado River.

In addition to major surface water features, a number of small drainage ditches are used to irrigate agricultural land in the vicinity of the site. These ditches probably have a slight seasonal influence on local ground water levels and probably contribute to background water quality in the vicinity of the site.

2.1.5 Water quality

Background water quality

Background ground water quality is defined as the quality of water that would be present if uranium processing activities had not occurred at the site. Background ground water quality was characterized by sampling monitor wells located hydraulically upgradient from the processing site and analyzing the ground water for appropriate constituents. Generally, the list of analytes includes the proposed EPA hazardous constituents and other chemical constituents recognized as indicators of uranium processing activities.

Upgradient DOE monitor wells GRJ01-0745 and -0746 were selected as the monitor wells most representative of background ground water quality (Figure 1.2). Table 2.1 summarizes the minimum, median, and maximum values for selected chemical parameters in the background ground water.

The background ground water ranges from 6.7 to 7.5 pH, with a median value of 7.0.

The total dissolved solids (TDS) in the background ground water samples range from approximately 3000 to 7200 milligrams per liter (mg/L). The background alkalinity (as mg/L CaCO_3) is between 343 and 439. Despite the relatively high alkalinity of the water, the dominant anionic species in background ground water is sulfate (median value = 2800 mg/L). The dominant cations in background ground waters are sodium, magnesium, and calcium, with median concentrations in the background ground water of 659 mg/L, 391 mg/L, and 532 mg/L, respectively.

Trace constituents such as arsenic, uranium, vanadium, and selenium are elevated or above maximum concentration limits (MCL) in the background ground water (Table 2.1). Uranium concentrations are particularly significant, with the median value in background ground water at 0.046 mg/L, slightly above its MCL.

Average TDS concentration in background ground water in the Dakota Sandstone is approximately 5500 mg/L (DOE, 1991). The background water is a sodium-bicarbonate-chloride type. Average concentrations of chloride, iron, manganese, and TDS exceed the EPA secondary drinking water standards by approximately 1 order of magnitude.

Extent of site-related contamination

Seepage of tailings fluids has contaminated ground water in the alluvium (uppermost aquifer) at the Grand Junction processing site. Contaminated ground water occurs directly below and downgradient of the former tailings pile area. The contamination extends westward approximately 3700 ft (1128 m), along which much of the affected ground water probably discharges into the

Table 2.1 Summary of filtered ground water quality at the Grand Junction, Colorado, processing site

Constituent	MCL (mg/L)	Observed			
		Minimum	Median ^a	Maximum	
		(mg/L)			
Indicator parameters					
pH	NA	6.7	7.0	7.5	
Total dissolved solids	NA	3000	NA	7200	
Inorganic constituents					
Ammonium					
Background	NA	<0.03	0.2	0.6	
Downgradient	NA	166	357	521	
Antimony					
Background	NA	<0.003	NA	0.012	
Downgradient	NA	<0.003	NA	0.012	
Arsenic					
Background	0.05	0.001	NA	0.04	
Downgradient	0.05	<0.001	0.016	0.18	
Cadmium					
Background	0.01	<0.001	NA	0.04	
Downgradient	0.01	<0.001	NA	0.42	
Calcium					
Background	NA	325	445	595	
Downgradient	NA	360	545	654	
Chloride					
Background	NA	306	598	2400	
Downgradient	NA	490	791	970	
Cobalt					
Background	NA	<0.003	NA	0.01	
Downgradient	NA	<0.001	0.03	0.66	
Fluoride					
Background ^c	NA	0.6	1.0	1.7	
Downgradient	NA	3.0	3.7	4.8	
Iron					
Background	NA	<0.005	0.4	2.2	
Downgradient	NA	0.018	3.7	16	

Table 2.1 Summary of filtered ground water quality at the Grand Junction, Colorado, processing site (Continued)

Constituent	MCL (mg/L)	Observed			
		Minimum	Median*	Maximum	
		(mg/L)			
Magnesium					
Background	NA	210	391	570	
Downgradient	NA	25	282	620	
Manganese					
Background	NA	0.9	1.3	2.3	
Downgradient	NA	1.8	4.2	334	
Molybdenum					
Background	0.1	0.01	0.11	0.23	
Downgradient	0.1	0.08	0.25	0.53	
Nickel					
Background	NA	<0.006	NA	0.12	
Downgradient	NA	<0.04	0.14	0.38	
Nitrate					
Background	44.0	<0.1	NA	16	
Downgradient	44.0	<0.01	NA	50	
Selenium					
Background	0.01	<0.001	NA	0.19	
Downgradient	0.01	<0.002	NA	0.24	
Sodium					
Background	NA	345	659	910	
Downgradient	NA	520	950	1210	
Sulfate					
Background	NA	1450	2800	11,000	
Downgradient	NA	2800	3800	4,900	
Uranium					
Background	0.044	0.017	0.046	0.072	
Downgradient	0.044	0.043	0.24	0.45	
Vanadium					
Background	NA	<0.005	NA	0.11	
Downgradient	NA	<0.01	0.14	14	

Table 2.1 Summary of filtered ground water quality at the Grand Junction, Colorado, processing site (Concluded)

Constituent	MCL (mg/L)	Observed		
		Minimum	Median*	Maximum
			(mg/L)	
Zinc				
Background	NA	<0.002	NA	1.0
Downgradient	NA	<0.005	0.05	37
Radionuclides				
Radium-226				
Background	5 pCi/L	0.0	0.1	2.3
Downgradient	5 pCi/L	0.0	2.1	29

*Calculation of the median—the 50th percentile of the data—requires that more than 50 percent of the measurements be above detection.

MCL - maximum concentration limit.

NA - not applicable.

Colorado River. Ground water monitoring results show that contaminated ground water is migrating downgradient, subparallel to the Colorado River. Monitor wells downgradient from the site commonly have levels of ammonium, chloride, sulfate, and uranium above the background levels. Ammonium is strongly adsorbed by clays and is not very mobile. As a result, the migration of this constituent away from the site has lagged well behind more mobile species such as uranium, sulfate, and chloride. Uranium concentrations in downgradient ground water within the alluvium exceed the proposed EPA MCL by up to five times and provide a good indication of the contamination's extent and magnitude (Figure 2.2). The highest contaminant concentrations appear to be in the southwestern corner of the processing site. The Colorado River to the south limits the lateral extent of contamination.

To determine the effects of ground water discharge, samples taken from the Colorado River upstream and downstream from the processing site during a low stage of the river in January 1991 were analyzed for potentially hazardous constituents. Results of these analyses indicate that no concentrations of any hazardous constituents related to past processing activities exceeded proposed EPA concentration limits.

2.2 DATA COLLECTION OBJECTIVES

Data collection objectives (DCO) identify the reasons for collecting data, which include regulatory requirements, compliance monitoring, site characterization, risk assessment, and other considerations.

Data quality objectives (DQO) define the manner in which samples are collected, handled, and analyzed. This includes defining analytical support levels; following standard procedures for water sampling, preservation, transport, and various other field procedures; completing DQOs in accordance with quality assurance (QA) and quality control (QC) protocols; and providing analytical data validation. DQOs to be followed during data collection and evaluation activities are given in the WSAP guidance document (DOE, 1993a), UMTRA Project documents such as the quality assurance implementation plan (QAIP) (DOE, 1993b) and applicable SOPs (JEG, n.d.), and other DOE and EPA documents.

2.2.1 Regulatory requirements

The regulatory requirements for ground water and surface water sampling at the Grand Junction processing site are specified in 40 CFR Part 192 (1994).

2.2.2 Compliance monitoring

Ground water at the Grand Junction processing site is being sampled semiannually, until determined otherwise.

LEGEND

NOTE: DATA COLLECTED JUNE 1993.

- 0.06 — URANIUM CONCENTRATION
CONTOUR LINE (mg/L)
(DASHED WHERE INFERRED)
- 746 MONITOR WELL
- 0.064 URANIUM CONCENTRATION (mg/L)
- (50) STATE HIGHWAY

FIGURE 2.2
DISTRIBUTION OF URANIUM IN ALLUVIAL GROUND WATER IN THE VICINITY OF
THE GRAND JUNCTION, COLORADO, PROCESSING SITE

2.2.3 Site characterization

During ground water remediation, characterization of contaminant migration will be an ongoing activity. Existing monitor wells within and just beyond the area of contaminated ground water will be monitored to further characterize background water quality and assess any significant migration of contaminants. These data will eventually be used to support a selected remedial alternative. During ground water remediation, it may be necessary to install several additional downgradient monitor wells to determine the maximum extent of contamination. In addition to monitoring existing wells, approximately three proposed shallow monitor wells are projected to be installed in the fall of 1994 to monitor ground water quality and water level fluctuations in the site vicinity. These long-term, continuous ground water level data will be collected to better understand the relationship between surface and ground water at the site. Water level and water quality data eventually will be used in future ground water modeling to establish boundary conditions in the vicinity of the Grand Junction processing site. Modeling results will be used to help demonstrate and document the potential remedial alternative of natural flushing.

2.2.4 Risk assessment

Water and sediment samples for a preliminary baseline risk assessment were collected both upgradient and downgradient from the processing site in 1993. The sampling results will quantify risk to human health and the environment at the Grand Junction processing site. Although additional data may be required for risk assessment purposes, no further collection is planned for 1994.

2.3 WATER SAMPLING PLAN

2.3.1 Sampling locations

The ground water monitoring network at the Grand Junction processing site currently consists of six monitor wells screened in the alluvium (Table 2.2). The six existing monitor wells are sampled to assess ground water conditions during surface remedial action.

Three proposed wells are scheduled to be installed in September 1994. These may be sampled eventually, but current plans consist of collecting only water level data. These wells will provide additional time-dependent data for a greater understanding of ground water/surface water interactions in the site vicinity. Data loggers will be installed in these wells to electronically record water levels six times per day.

Table 2.2 DOE ground water monitor well locations at the former Grand Junction, Colorado, processing site

Well ID	Location	Screened interval (ft, bls)	Rationale for sampling
GRJ01-0590	Downgradient	7-15	Track contaminant migration.
GRJ01-0736	Downgradient	10-15	Track contaminant migration.
GRJ01-0740	Downgradient	12-17	Track contaminant migration.
GRJ01-0742	Crossgradient	18-23	Assess crossgradient influence of contamination.
GRJ01-0745	Background	15-20	Further characterize background water quality.
GRJ01-0746	Background	20-25	Further characterize background water quality.

bls - below land surface.

2.3.2 Constituent selection

The ground water monitoring program includes collecting and analyzing ground water samples from the monitor wells previously listed. Ground water samples initially were evaluated for hazardous constituents expected to be found in or derived from the residual radioactive material related to uranium processing activities. The list of constituents analyzed has been modified during subsequent sampling events, based on the historical data base, to focus on hazardous constituents related to uranium processing activities at this site. Based on existing ground water quality data, the list of constituents to be analyzed during 1994 includes the following:

- Field parameters: alkalinity, dissolved oxygen, oxidation/reduction potential, pH, specific conductivity, and temperature.
- Laboratory analyses: ammonium, arsenic, cadmium, calcium, chloride, cobalt, gross alpha, fluoride, iron, magnesium, manganese, molybdenum, nickel, nitrate, radium (Ra)-226 and Ra-228, selenium, sodium, sulfate, TDS, uranium, vanadium, and zinc.

The constituents listed above were selected based on several factors. Potentially hazardous constituents detected in the tailings source term and the relative concentrations measured in background were compared with the recent baseline risk assessment of the former Grand Junction processing site. Some of these analytes may be omitted from the WSAP based on further analysis and recommendations.

Arsenic, cadmium, cobalt, fluoride, iron, manganese, molybdenum, nickel, Ra-226, sulfate, uranium, vanadium, and zinc were found to be contaminants of potential concern during the recent baseline risk assessment. Ammonium, gross alpha, nitrate, selenium, and Ra-228 have been associated with uranium processing activities. Additional constituents monitored for hydrogeochemical site characterization during the transition from surface remedial activities to ground water remedial activities include calcium, chloride, magnesium, sodium, and TDS. These parameters can provide valuable insight into geochemical processes that may be occurring as a result of tailings removal (geochemical conditions may have changed from acid to more alkaline).

2.3.3 Sampling frequency

Ground water at the Grand Junction site has been performed since 1983. Semiannual sampling of three existing wells (Figure 1.2) will be conducted to collect representative samples during high stage conditions (relative to the Colorado River) in the early summer and low flow conditions in the late fall. This sampling frequency will allow for evaluation of trends in ground water flow conditions and ground water quality and will also provide additional information and continuity of the data base, which will be useful during the UMTRA Project's ground water remediation phase.

The three new wells being installed in September may be sampled eventually, but current plans consist of collecting only water level data. Data loggers will be installed in these wells to electronically record water levels six times a day. Water level data will be downloaded and analyzed on a quarterly basis. If the new wells are sampled in the future, a sampling frequency will be selected at this time.

2.3.4 Data interpretation

Water sampling data collected in 1994 will be analyzed and evaluated according to prescribed UMTRA Project procedures and will be compared with the existing data base. Trend analyses will be conducted to detect any variations in ground water flow conditions and ground water quality. Variations will be evaluated and modifications to the sampling plan will be noted, justified, and implemented as appropriate.

2.3.5 Anomalous data evaluation

If results from the water sampling are beyond the range of expected values, the suspect data will be evaluated to determine the cause. If the deviation cannot be related to an error in sample collection or analysis or to processes reasonably expected to occur in the hydrogeologic environment, the location will be resampled during the next scheduled sampling round, or sooner if an urgent need exists regarding potential impact to human health and the environment. The WSAP guidance document (DOE, 1993a) includes detailed procedures for evaluating anomalous data.

3.0 CHENEY DISPOSAL SITE

3.1 SITE CONCEPTUAL MODEL

The site conceptual model is based on available hydrogeologic information, site reconnaissance, and data from borings and monitor wells installed in the Mancos Shale and Dakota Sandstone. The site conceptual model is summarized below.

3.1.1 Physiographic setting

The Cheney site is on a broad pediment surface on the western flank of Grand Mesa, east of the Gunnison River (Figure 1.1). The moderately sloping surface consists of alluvium, colluvium, and terrace gravels.

3.1.2 Geology

The Cheney site can be divided into four separate stratigraphic zones (Figure 3.1):

- A surficial layer of unconsolidated deposits consisting of alluvium, colluvium, and terrace gravels collectively referred to as alluvium.
- The upper weathered zone of the Mancos Shale.
- The lower, less weathered portion of the Mancos Shale.
- The Dakota Sandstone and all other deeper formations.

The Cheney site is underlain by 5 to 40 ft (1.5 to 12 m) of alluvium. Landslides, slumps, and mudflows have greatly influenced the alluvial composition. Rapidly eroding sedimentary units along the flanks of Grand Mesa have been responsible for mass wasting, particularly slumping. Debris movement from the high parts of the mesa onto the surrounding slopes and stream valleys resulted in a highly heterogenous surficial mantle that may include clay, sand, gravels, cobbles, or boulders.

Beneath the alluvium is 700 to 750 ft (210 to 220 m) of Mancos Shale, which overlies the Dakota Sandstone. The Mancos is a gray marine shale with a few thin limestone and sandstone beds. Among the consolidated sedimentary formations, only the Mancos Shale and the Dakota Sandstone are of interest with respect to the tailings disposal. The Mancos Shale is generally recognized as a low permeability unit (Cooley et al., 1969; Lohman, 1965) that can provide a barrier to downward migration of contamination. The Dakota Sandstone is the uppermost aquifer beneath the disposal site. Regionally, the Mancos Shale is an aquitard and the Dakota Sandstone is not a highly productive aquifer and contains water of poor quality.

FIGURE 3.1
DIAGRAMMATIC CROSS SECTION OF THE CHENEY DISPOSAL CELL

3.1.3 Hydrology

Three hydrostratigraphic zones contain ground water at the Cheney disposal site: the alluvial paleochannels, the unweathered Mancos Shale, and the Dakota Sandstone. Age dating, hydraulic testing, and chemical analyses, however, indicate very little if any hydraulic interconnection between these units.

Ground water in the Cheney disposal site vicinity occurs in isolated, thin paleochannels within the basal portion of the alluvium. However, detailed field investigations identified a large area suitable for the disposal cell that is devoid of water-filled paleochannels. The bedrock contour map (Figure 3.2) illustrates the results of investigations to determine the presence and pathways of shallow paleochannel ground water. Three separate ground water flow systems have been identified.

The northernmost paleochannel system (system I) is the only system in which flow is sustained downgradient to the west of the disposal cell footprint. The southernmost tributary of system I passes within approximately 100 ft (30 m) of the northwestern corner of the disposal cell footprint. The paleochannel systems flowing east (system II) and along the southern margin (system III) of the footprint stop conducting water before they reach the eastern boundary of the disposal cell. Systems II and III are within 2600 ft (790 m) of the footprint. Surface geophysics originally was used to define the deeply incised paleochannels of systems II and III. Paleochannel system III loses its water at the southeastern tip of the cell footprint (DOE, 1991). Water is assumed to percolate into the unweathered Mancos Shale unit in the Cheney disposal cell vicinity (DOE, 1991).

Ground water in the Mancos Shale occurs in unweathered discontinuous zones separated both laterally and vertically by large regions of unsaturated rock. The highly fractured, weathered Mancos Shale was found to be unsaturated in all excavations and drill cuttings from more than 100 boreholes.

Low-porosity beds of unsaturated Mancos Shale and sandstone confine ground water in the Dakota Sandstone. Although ground water is encountered in the upper Dakota Sandstone, data suggest that it exists mostly in discontinuous fractures. Upon well completion, ground water levels in the monitor wells rose more than 360 ft (110 m) above the elevation at which ground water was encountered, indicating the presence of substantial confining pressures in the Dakota Sandstone.

Hydraulic characteristics

The horizontal hydraulic conductivities of the alluvium, weathered Mancos Shale, and unweathered Mancos Shale are approximately 5.5×10^{-6} ft/s (1.7×10^{-4} cm/s), 1.7×10^{-6} ft/s (5.1×10^{-5} cm/s), and 8.8×10^{-8} ft/s (2.7×10^{-6} cm/s), respectively (DOE, 1991).

3-4

FIGURE 3.2
BEDROCK CONTOUR MAP SHOWING WATER-FILLED PALEOCHANNELS
CHENEY DISPOSAL SITE, COLORADO

No analysis was performed to evaluate the yield from the Dakota Sandstone. However, drilling records for a 1760-ft-deep construction water supply well estimate the yield from the Dakota Sandstone at 5 to 10 gallons per minute (20 to 40 liters per minute).

Surface water

The Cheney disposal site is on a drainage divide that gently slopes southwest at approximately 2 percent. Total relief across the proposed disposal area is approximately 60 ft (20 m). The pediment surface on which the site is located forms a divide between two small ephemeral washes, one approximately 88 ft (27 m) north of the proposed pile location and one approximately 1700 ft (500 m) south. These washes merge with Indian Creek 0.1 to 0.5 mi (0.2 to 0.8 km) below the site. Indian Creek flows into Kannah Creek 4 to 5 mi (6 to 8 km) below the ephemeral wash confluences, and Kannah Creek empties into the Gunnison River approximately 2 mi (3 km) below the Indian Creek confluence.

An area of approximately 240 acres (ac) (100 hectares [ha]) drains toward the Cheney disposal site. Slopes in the watershed range from 2 to 5 percent. Elevations range from approximately 5250 to 5600 ft (1600 to 1700 m) above mean sea level.

3.1.4 Water quality

Because ground water in the uppermost aquifer (Dakota Sandstone) is limited-use (Class III) and hydrogeologically isolated from the Cheney disposal cell, no ground water compliance monitoring will be conducted. This discussion will contain information regarding the background ground water quality that existed prior to placement of tailings in the disposal cell.

Alluvium

Background ground water quality in the alluvium has TDS concentrations ranging from approximately 600 to 1700 mg/L. Average concentrations of hazardous constituents in the alluvium do not exceed the EPA MCLs. However, average concentrations of sulfate and TDS exceed the EPA National Secondary Drinking Water Standards by factors of less than 2. Water quality results indicate that background ground water is a mixed cation-sulfate water quality type on a trilinear diagram.

Mancos Shale

Background ground water quality in the Mancos Shale has elevated TDS levels. There is a relatively wide range (an order of magnitude) of TDS concentration in the Mancos Shale, from 873 to 7010 mg/L, and the average TDS concentration exceeds the EPA secondary drinking standard of 500 mg/L by five times (DOE, 1991). Average background selenium concentrations slightly exceed the proposed EPA MCL.

Dakota Sandstone

Ground water in the Dakota Sandstone has been determined Class III (limited-use) because TDS concentrations in background ground water in the Dakota Sandstone exceed 10,000 mg/L (DOE, 1991). The Dakota Sandstone is not considered a domestic water supply source. In addition, water within this unit contains natural gas and average concentrations of combined Ra-226 and -228 that exceed the proposed EPA MCL. Ground water in the Dakota Sandstone at the disposal site is a sodium-bicarbonate type.

3.2 DATA COLLECTION OBJECTIVES

DCOs identify the reasons for collecting data, which include regulatory requirements, compliance monitoring, site characterization, risk assessment, and other considerations.

DQOs define the manner in which samples are collected, handled, and analyzed. This includes 1) defining analytical support levels; 2) following standard procedures for water sampling, preservation, transport, and various other field procedures; 3) performing in accordance with QA and QC protocols; and 4) providing analytical data validation. DQOs to be followed during data collection and evaluation activities are given in the WSAIP guidance document (DOE, 1993a), QAIP (DOE, 1993b) and applicable SOPs (JED, n.d.), and DOE and EPA documents.

3.2.1 Regulatory requirements

The regulatory requirements for ground water and surface water sampling at the Grand Junction site are specified in 40 CFR Part 192 (1994).

3.2.2 Compliance monitoring

Ground water in the uppermost aquifer (Dakota Sandstone) beneath the Cheney disposal site is not a current or potential source of drinking water and meets the EPA criterion for Class III (limited-use) designation because the TDS concentration is in excess of 10,000 mg/L (40 CFR §192.11(e)(1)). Postclosure monitoring of ground water in the uppermost aquifer is not proposed due to the Class III designation. Also, any ground water at depth is protected because it is hydrogeologically isolated from potential seepage of leachate from the disposal cell by approximately 750 ft (230 m) of confining shales and sandstones of the Mancos Shale, and there is an upward vertical gradient due to confinement of ground water in the Dakota Sandstone.

Small quantities of ground water occur in isolated narrow alluvial paleochannels incised into the upper surface of the eroded and weathered Mancos Shale bedrock (Figure 3.2). Recharge to the paleochannels is limited, and no evidence exists of ground water discharge from the paleochannels to the surface in the disposal site vicinity. Also, ground water from the paleochannels is not likely to

enter the disposal cell and cause any impact. Existing or anticipated use of shallow ground water from the paleochannels is minimal due to the insignificant yield to a well and the low population density resulting in low demand for water.

The disposal cell has been located and designed to restrict migration of any potentially contaminated seepage to isolated paleochannels peripheral to the cell (no paleochannels are beneath or immediately adjacent to the disposal cell) or to the land surface in the area. Leachate from the disposal cell probably would not move a sufficient lateral distance to reach paleochannels in the area. Evidence exists that any potential leachate migrating from the disposal cell would percolate into the surrounding weathered/fractured bedrock (Mancos Shale) rather than preferentially seeking the paleochannels. Leachate somehow getting into the paleochannels should not cause any significant impact to human health and the environment.

Although seepage of leachate from the disposal cell probably will not interact with ground water in the alluvial paleochannels and impact human health and the environment, an indirect monitoring program (initially consisting of periodic water level monitoring of two shallow wells) will be implemented as a best management practice to aid in confirming proper operation of the disposal cell and protection of human health and the environment to the extent required and practical.

3.3 WATER SAMPLING PLAN

3.3.1 Sampling locations

Ground water sampling of paleochannel wells is not scheduled for 1994. Sampling may be performed following a period of water level monitoring, when the nature of ground water occurrence is determined.

The monitoring program will consist of installation and ground water level monitoring of two monitor wells in paleochannels downgradient from the disposal cell, adjacent to the northwestern and southwestern corners of the cell (Figure 3.3). The monitor wells will be screened in the basal part of the paleochannels to monitor the variability in water occurrence.

3.3.2 Constituent selection

If paleochannel wells are sampled, the constituent list will be similar to the current constituent list for sampling at the Grand Junction processing site. This list may include selected indicator parameters.

3.3.3 Sampling frequency

Ground water sampling frequency for paleochannel wells will be determined if sampling becomes necessary.

Water levels will be monitored on a quarterly basis until determined otherwise.

3.3.4 Data Interpretation

If water quality data are obtained from the two paleochannel wells, the data will be analyzed and evaluated according to prescribed UMTRA Project procedures and compared with the existing data base. Trend analyses will be conducted to detect any variations in ground water flow conditions and ground water quality. Variations will be evaluated and modifications to the sampling plan will be noted, justified, and implemented as appropriate.

3.3.5 Anomalous data evaluation

If results from the water sampling are beyond the range of expected values, the suspect data will be evaluated to determine the cause. If the deviation cannot be related to an error in sample collection or analysis, or to processes reasonably expected to occur in the hydrogeologic environment, the location will be resampled during the next scheduled sampling round, or sooner if an urgent need exists regarding potential impact to human health and the environment. The WSAP guidance document includes detailed procedures for evaluation of anomalous data.

4.0 LIST OF CONTRIBUTORS

The following individuals contributed to the preparation of this document.

Name	Contribution
T. Monks	Overall document responsibility; authorship
J. Blount, M. Day, and A. Holm	Document review
L. Keith	Text processing
T. Gagliano	Graphic design
D. Thalley, J. Torline, and K. Walston	Technical editing

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