UMTRA PROJECT WATER SAMPLING AND ANALYSIS PLAN

MEXICAN HAT, UTAH

April 1994

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**UMTRA PROJECT WATER SAMPLING AND ANALYSIS PLAN
MEXICAN HAT, UTAH**

April 1994

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

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

EXECUTIVE SUMMARY

The Mexican Hat, Utah, Uranium Mill Tailings Remedial Action (UMTRA) Project site is a former uranium mill that is undergoing surface remediation in the form of on-site tailings stabilization. Contaminated surface materials from the Monument Valley, Arizona, UMTRA Project site have been transported to the Mexican Hat site and are being consolidated with the Mexican Hat tailings. The scheduled completion of the tailings disposal cell is August 1995.

Water is found in two geologic units at the site: the Halgaito Shale Formation and the Honaker Trail Formation. The tailings rest on the Halgaito Shale, and water contained in that unit is a result of milling activities (from the hydraulic placement of tailings) and, to a lesser extent, water released from the tailings from compaction during remedial action construction of the disposal cell. Water in the Halgaito Shale flows through fractures and discharges at seeps along nearby arroyos. Flow from the seeps will diminish as water drains from the unit. Ground water in the lower unit, the Honaker Trail Formation, is protected from contamination by an upward hydraulic gradient. There are no nearby water supply wells because of widespread poor background ground water quality and quantity, and the San Juan River shows no impacts from the site.

This water sampling and analysis plan (WSAP) recommends sampling six seeps and one upgradient monitor well completed in the Honaker Trail Formation. The purposes of sampling are to evaluate changes to water quality and seep flow rate as a result of cell construction, characterize the site, and evaluate risk to human health and the environment. Samples will be taken in April 1994 (representative of high ground water levels) and September 1994 (representative of low ground water levels). Analyses will be performed on filtered samples for plume indicator parameters.

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LIST OF ACRONYMS AND ABBREVIATIONS

<u>Acronym</u>	<u>Definition</u>
AEC	U.S. Atomic Energy Commission
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
ft	foot
km	kilometer
LTSP	long-term surveillance plan
m	meter
MCL	maximum concentration limit
mg/L	milligrams per liter
mi	mile
POC	point of compliance
QA	quality assurance
QAIP	QA implementation plan
QC	quality control
RAP	remedial action plan
SOP	standard operating procedure
SPEAR	Software Program for Environmental Analysis and Reporting
TAD	Technical Approach Document
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) presents the regulatory and technical basis for water sampling at the Mexican Hat, Utah, Uranium Mill Tailings Remedial Action (UMTRA) Project site. It identifies and justifies the sampling locations, analytical parameters, and sampling frequency for the site. The water sampling data are used to characterize the site, evaluate the impact, if any, that surface remediation activities may have on water quality, and evaluate site risk.

Ground water and surface water monitoring activities are based on the U.S. Environmental Protection Agency (EPA) proposed regulations in 52 FR 36000 (1987), UMTRA Project standard operating procedures (SOP) (JEG, n.d.), the *Technical Approach Document* (TAD) (DOE, 1989), and the most effective technical approach for the site.

This WSAP includes a summary of the results from previous water sampling activities and the water sampling plan for calendar year 1994.

1.2 SITE LOCATION

The Mexican Hat UMTRA Project site is in San Juan County, Utah, east of U.S. Route 163, between the towns of Halchita and Mexican Hat (Figures 1.1 and 1.2). Via U.S. Route 163, it is approximately 18 miles (mi) (29 kilometers [km]) southwest of Bluff, Utah, and 20 mi (32 km) north of the Arizona border. The site is within the Navajo Reservation, at 37° 07' 54" north latitude and 109° 52' 30" west longitude.

Before surface remediation activities, the mill tailings were in two piles, as shown on Figure 1.2. The tailings, other surface contaminated materials, and tailings and other contaminated materials from the Monument Valley UMTRA Project site have been consolidated into one disposal cell in the area of the former lower tailings pile (Figure 1.3).

1.2.1 Surrounding land use

Land around the tailings site is controlled by the Utah Navajo Development Corporation and is used for residences and livestock grazing. The town of Mexican Hat had an estimated population of 90 in 1980 and 43 in 1985. The population of Halchita was estimated at 500 in 1985, which is approximately the 1980 population. Houses are sparsely scattered throughout the surrounding areas (DOE, 1987).

The mill buildings and related structures have been removed. Access to the tailings area is controlled, and the area is fenced. Sewage treatment ponds near

FIGURE 1.1
MEXICAN HAT, UTAH, UMTRA PROJECT SITE LOCATION

FIGURE 1.2
MEXICAN HAT UMTRA PROJECT SITE
AND LOCATIONS OF SEEPS AND MONITOR WELLS

FIGURE 1.3
CURRENT CONFIGURATION OF THE MEXICAN HAT UMTRA PROJECT SITE

the western site boundary are used by the community of Halchita. The water treatment plant for Halchita is north of the site, on the San Juan River.

1.2.2 Surrounding water use

Results from a well inventory concluded that there are no recorded uses of ground water within a 2-mi (3-km) radius of the site (DOE, 1993a). Water for the community of Halchita is supplied by a treatment facility that obtains water from the San Juan River. Results from water samples show that the quality of water in the river is not affected by the tailings. The community of Mexican Hat obtains its water from a converted oil exploration well and the San Juan River (DOE, 1993a).

1.3 SITE HISTORY

According to the remedial action plan (RAP) (DOE, 1993a), the Texas-Zinc Minerals Corporation built the mill in 1957 and operated it until 1963. It was then sold to Atlas Corporation, which operated it until it closed in 1965. Approximately 2.2 million tons of ore with an average grade of 0.28 percent uranium oxide (U_3O_8) were processed, to produce 5700 tons of U_3O_8 concentrate. The concentrate was sold to the U.S. Atomic Energy Commission (AEC). After the main plant shut down in 1965, a sulfuric acid plant was operated at the site until 1970.

The ore was treated by an acid-leach process followed by solvent extraction. Final treatment was with ammonium nitrate and magnesium hydroxide. Because the ore contained copper sulfide, copper was leached from the ore in a similar manner on the site. Tailings were piped to the piles within diked areas, thus allowing for infiltration of the liquids and decreasing the opportunity for surface runoff (DOE, 1993a).

1.4 SITE STATUS

The mill site was leased from the Navajo Nation until 1970, when the lease expired; control of the site and all structures and materials then reverted to the Navajo Nation (DOE, 1993a).

Surface remediation activities at the site are under way. The former mill buildings, windblown contaminated materials, and the upper tailings pile are being consolidated into the area of the lower tailings pile. Additionally, contaminated materials and tailings from the Monument Valley UMTRA Project site have been transported to the Mexican Hat site and consolidated. Construction of the final cover will begin in the spring of 1994. The long-term surveillance plan (LTSP) will be prepared after the cell is completed.

1.5 SAMPLING PLAN

Periodic sampling of the ground water seeps and monitor well at the site is performed to evaluate changes to water quality and seep flow as a result of the construction of the disposal cell and to provide water quality information for site characterization and the site risk evaluation. The last sampling event was June 1993. Periodic monitoring will continue, with a sampling event in April 1994 and September 1994. April will be representative of high ground water levels; September will be representative of low ground water levels.

2.0 SITE CHARACTERISTICS

2.1 PHYSIOGRAPHIC SETTING

The site is on the northern boundary of the Navajo Uplands section of the Colorado Plateau physiographic province. The topography of the Navajo Uplands section has been influenced primarily by erosion from the Colorado River and its tributaries, which include the San Juan River (DOE, 1987). The site topography is characterized by extensive areas of gently dipping sedimentary rocks deformed by warping and large areas of bedrock overlain by thin to nonexistent soils. Site elevation is about 4300 feet (ft) (1300 meters [m]) above sea level. Local topography varies from about 4100 ft (1200 m) at the San Juan River to over 5600 ft (1700 m) at Raplee Ridge, approximately 4 mi (6 km) to the east.

2.2 GEOLOGY

Tailings at the site are on the Halgaito Shale Formation, the lowermost member of the Cutler Group. Beneath the Halgaito Shale is the Honaker Trail Formation, the uppermost formation of the Hermosa Group (Figure 2.1).

The Halgaito Shale is approximately 200 ft (60 m) thick and consists primarily of interbedded silty sandstone and siltstone. Calcareous, well-cemented beds alternate with less-cemented beds. There are also some thin lenticular beds of limestone and conglomerate (DOE, 1993a). The conglomerate consists of siltstone and limestone pebbles in a silty matrix; therefore, the permeability of the conglomerate is probably low. Nearly vertical fractures that trend east-west and northeast-southwest have been identified in the Halgaito Shale at the site (DOE, 1990). The orientation of the fractures is shown on Figure 2.2.

The Honaker Trail Formation consists of interbedded siltstones, limestones, shales, and sandstones. The limestone units are predominantly fine- to very fine-grained and crystalline. The sandstone units are very fine- to fine-grained. Chert and limestone nodules are found throughout the siltstone beds (DOE, 1993a). The total thickness of the unit is not known because no wells at the site fully penetrate the Honaker Trail Formation.

2.3 HYDROLOGY

2.3.1 Surface water

The disposal cell is within a drainage basin that flows toward the northeast into Gypsum Creek. From the confluence with the site drainage basin, Gypsum Creek flows approximately 1000 ft (300 m) into the San Juan River. Surface water is present in the site drainage basin and Gypsum Creek after heavy rain. Additionally, surface water is usually found at areas along Gypsum Creek near seeps; however, the seeps cannot sustain surface water flow within the creek.

FIGURE 2.1
TYPICAL GEOLOGIC CROSS SECTION AT THE MEXICAN HAT UMTRA PROJECT SITE

FIGURE 2.2
ORIENTATION OF FRACTURES IN THE HALGAITO SHALE FORMATION
MEXICAN HAT UMTRA PROJECT SITE

The San Juan River is a perennial tributary to the Colorado River. The site is about 240 ft (70 m) higher than the San Juan River.

The disposal cell is located within an arroyo that originally directed surface water flow northeastward to Gypsum Creek. Drainage channels were constructed upslope and downslope from the cell, and other local drainages were improved to divert surface water away from the cell. The surface drainage pattern is shown on Figure 1.3.

Although there is no perennial flow in Gypsum Creek or within the site drainage basin, there are seeps along the outcrops of Halgaito Shale. Ground water discharged from seeps in the North Arroyo is water that was used during the milling operations (for process water and to place the tailings) and water released from the tailings as a result of compaction into the disposal cell. The source of water discharged from seeps in Gypsum Creek is likely a combination of discharge from the underlying Honaker Trail Formation and water from the milling and remedial action activities. The source of water used at the mill was the San Juan River; no production wells exist on site. Water from the seeps is sampled as part of the periodic monitoring.

2.3.2 Ground water

Halgaito Shale Formation

Ground water is contained in two units at the site: the Halgaito Shale Formation and the Honaker Trail Formation. According to the RAP (DOE, 1993a) and a 1990 seep study (DOE, 1990), the uppermost geologic unit, the Halgaito Shale, was dry prior to milling operations. Water currently contained in the Halgaito Shale is a result of former milling operations (discharge of process water and water used to place the tailings) and transient drainage from the disposal cell. Over time, water will drain from the Halgaito Shale and the unit will return to its unsaturated, pre-milling state. Because of the temporary nature of the ground water, the limited extent of saturation, and the low yield of wells completed in the Halgaito Shale, the unit is not considered an aquifer. The base of the Halgaito Shale probably acts as a confining unit for water contained in the Honaker Trail Formation.

Water within the Halgaito Shale is contained in the fractures and is perched on lower permeability zones within the unit. Monitor wells installed in the Halgaito Shale updip (south) of the cell were dry; therefore, the unit contains no water in that vicinity. Water present in the fractures travels toward the seeps in North Arroyo and is the likely source of the water discharged from those seeps. Water discharged from the seeps in Gypsum Creek may consist of a combination of discharge from the Halgaito Shale and the Honaker Trail Formation (DOE, 1990).

Two wells completed in the Halgaito Shale (911 and 912) were located within the northern portion of the lower tailings pile, about 50 ft (15 m) apart. The

wells were destroyed when the tailings were relocated, but some hydrogeologic information was obtained from them. Well 911 was screened from 93 to 103 ft (28 to 31 m) below grade, and well 912 was screened from 62 to 82 ft (19 to 25 m). Water level measurements taken from the wells during 1985 and 1988 indicate a downward hydraulic gradient. Water levels in the shallow well were about 20 ft (6 m) or more above the water levels in the deep well.

Honaker Trail Formation

The Honaker Trail Formation, which is beneath the Halgaito Shale, is considered the uppermost aquifer. Ground water contained in the Honaker Trail Formation in the vicinity of the disposal cell is confined. Because there is an upward hydraulic gradient from the Honaker Trail toward the Halgaito Shale, contaminants in the Halgaito Shale cannot enter the Honaker Trail Formation. Ground water in the Honaker Trail Formation downgradient from the disposal cell is not monitored, and there are no point-of-compliance (POC) wells in the unit because of the upward hydraulic gradient (DOE, 1993a).

Ground water in the Honaker Trail Formation flows northeast, toward the San Juan River (Figure 2.3). Discharge areas for water contained in the unit are the San Juan River, and possibly the Halgaito Shale, Gypsum Creek seeps (or contributions to Gypsum Creek seeps), and areas within the base of Gypsum Creek where the Halgaito Shale is thin or absent due to erosion. Yields from wells completed in this unit are very low, and there are no nearby water wells because of the low yield and poor water quality.

2.4 WATER QUALITY

2.4.1 Background ground water quality

Halgaito Shale Formation

Background ground water quality is characterized by the results from analyses performed on water samples from Halgaito Shale monitor wells 911 and 912.

Water contained in the Halgaito Shale is a result of milling activities; therefore, background ground water quality is the existing water quality (DOE, 1993a). The shallower well, 912, was sampled on four occasions: April and July 1985, and May and August 1988. The data are contained in the Software Program for Environmental Analysis and Reporting (SPEAR) data base (DOE, 1992). The water is considered a calcium magnesium sulfate type, with the following ranges of constituents: total dissolved solids (TDS) from 5250 to 6670 milligrams per liter (mg/L); sulfate from 3040 to 3910 mg/L; calcium from 530 to 640 mg/L; magnesium from 423 to 550 mg/L; and sodium from 340 to 600 mg/L. The pH ranged from 6.2 to 6.7. Results from the analyses also show that the maximum concentration limits (MCL) established in 40 CFR Part 192 (1987) were exceeded for chromium, gross alpha, molybdenum, nitrate, and

FIGURE 2.3
POTENTIOMETRIC SURFACE OF THE HONAKER TRAIL FORMATION
MEXICAN HAT UMTRA PROJECT SITE

uranium. The highest nitrate concentration was 286 mg/L and the highest uranium concentration was 0.776 mg/L.

The deeper well, 911, was sampled once, in April 1985. Samples were not taken on other occasions because water level measurements indicate that the well was dry. Water quality data from this well indicate lower concentrations of parameters in well 911 than in shallower well 912. TDS were 1960 mg/L, sulfate was 3170 mg/L, calcium was 575 mg/L, magnesium was 348 mg/L, and sodium was 454 mg/L. The TDS concentration is lower than the concentration of sulfate and lower than the sum of the concentrations of the major cations and anions. This may be due to the laboratory analytical procedures. The pH was 7.7 and the nitrate concentration was 8.1 mg/L. The MCLs established in 40 CFR Part 192 (1987) were exceeded only for uranium, which had a concentration of 0.602 mg/L.

Honaker Trail Formation

The RAP (DOE, 1993a) describes background ground water quality for the Honaker Trail Formation through the use of analyses from wells 907, 908, 909, and 930. The water is classified as a sodium calcium sulfate type with the following approximate ranges of constituents: TDS, 1800 to 6400 mg/L; sodium, 330 to 1250 mg/L; calcium, 160 to 550 mg/L; sulfate, 1200 to 3900 mg/L; magnesium, 60 to 200 mg/L; and nitrate, below detection limits (less than 1 mg/L) to 7 mg/L.

Ground water seeps

A study performed in 1990 (DOE, 1990) concludes that the source of water that discharges from the seeps in the North Arroyo is most likely the Halgaito Shale. Therefore, the water is a result of the milling operations and transient drainage from the disposal cell; the discharge rate will decrease over time, and water discharge will gradually cease. The water chemistry of the North Arroyo seeps is similar to the water chemistry of the Halgaito Shale monitor wells, except that the seeps have a lower TDS (DOE, 1990).

The study also concludes that, based on water chemistry and the locations of the seeps, the source of water discharged from the Gypsum Creek seeps is most likely a combination of ground water from the Halgaito Shale and Honaker Trail Formation (DOE, 1990).

2.4.2 Magnitude of site-related contamination

According to the RAP (DOE, 1993a), tailings seepage related to milling operations created a condition of saturation within the Halgaito Shale Formation. Section D.7.8 of the RAP defines the existing water quality as baseline water quality for the Halgaito Shale Formation. Therefore, no contamination of native groundwater has occurred within the Halgaito Shale Formation. However, water in the Halgaito Shale Formation exceeds the EPA MCLs for several

constituents, including chromium, molybdenum, net gross alpha, nitrate, and uranium.

Contamination due to tailings seepage has not been detected within the Honaker Trail Formation or the San Juan River. Contamination due to tailings has been found only in seeps that discharge ground water from the Halgaito Shale Formation in the vicinity of the existing Mexican Hat tailings piles.

A plume map for the Halgaito Shale cannot be drawn because of the limited amount of water quality data from monitor wells. Because water discharged from the seeps is water contained in the Halgaito Shale, the seeps represent good locations to monitor water quality.

3.0 DATA COLLECTION OBJECTIVES

3.1 DATA QUALITY OBJECTIVES

Data quality objectives (DQO) define the way in which samples are collected, handled, and analyzed. This includes defining analytical support levels; following standard procedures for water sampling, preservation, transport, and other procedures; performing analyses in accordance with quality assurance (QA) and quality control (QC) protocols; and providing analytical data validation. DQOs that will be followed during data collection and evaluation activities are defined in the guidance document (DOE, 1993b), applicable SOPs (JEG, n.d.), and other DOE and EPA documents.

3.2 REGULATORY REQUIREMENTS

The regulatory requirements for water sampling at the Mexican Hat site are contained in the EPA proposed ground water protection standards, 52 FR 36000 (1987).

3.3 COMPLIANCE MONITORING

A performance monitoring plan for the disposal cell will be presented in the LTSP, which will be prepared after the cell is completed. A conceptual plan for monitoring existing contamination is presented in Appendix E of the RAP (DOE, 1993a). Because the seeps are hydraulically connected to the uppermost water-bearing unit (the Halgaito Shale), the water quality of the seeps will be monitored to evaluate changes with time. Monitoring of point-of-compliance wells is not recommended. However, this WSAP recommends monitoring the upgradient monitor well whenever the seeps are sampled to evaluate water quality changes. Monitoring of the deeper Honaker Trail Formation is also not recommended because there is an upward hydraulic gradient that will prevent contamination.

3.4 SITE CHARACTERIZATION

Monitoring of the seeps and the upgradient monitor well is part of ongoing site characterization activities.

3.5 RISK EVALUATION

Results from water quality analyses will be used for risk evaluation, which will be addressed under a site observational work plan to be prepared at a future date. At this time, no additional data collection activities are required for risk evaluation purposes.

4.0 WATER SAMPLING PLAN

4.1 SAMPLING LOCATIONS

Samples at the Mexican Hat site will be taken from Honaker Trail Formation well 909 and ground water seeps in North Arroyo and Gypsum Creek (Figure 1.3). There are three seeps in North Arroyo:

- 249 — the base of the southeast bank of Gully No. 2, approximately 800 ft (240 m) northeast of the lower tailings pile.
- 251 — approximately 400 to 500 ft (120 to 150 m) north of the lower tailings pile, on the south bank of North Arroyo.
- 255 — approximately 1300 ft (400 m) northeast of the lower tailings pile, in North Arroyo.

Samples will be taken from three locations in Gypsum Creek: an upgradient location (261), a location near the tailings piles (922), and a downgradient location (924). If the near-source location (922) is dry or a sample cannot be obtained, there are three alternate locations (248, 254, and 923) from which a sample can be obtained. The following six seeps are in Gypsum Creek:

- 248 — (alternate near-source) approximately 2200 ft (670 m) east of the lower tailings pile, in the west wall of Gypsum Creek.
- 254 — (alternate near-source) approximately 2200 ft (670 m) east of the lower tailings pile, in an arroyo that drains into Gypsum Creek.
- 261 — (upgradient) approximately 4000 ft (1200 m) east-southeast of the tailings pile, in the east wall of Gypsum Creek.
- 922 — (near-source) approximately 2200 ft (670 m) east of the tailings pile, in the floor of Gypsum Creek.
- 923 — (alternate near-source) approximately 2400 ft (730 m) east-southeast of the tailings pile, in the floor of Gypsum Creek.
- 924 — (downgradient) approximately 3500 ft (1100 m) northeast of the tailings pile and about 500 ft (150 m) upstream from the confluence with the San Juan River, in the floor of Gypsum Creek.

Section D.7.12.1 of the RAP (DOE, 1993a) contains additional details regarding descriptions and locations of the seeps. An attempt will be made to sample the well and every seep; however, sampling will not be possible if the locations are dry. The presence of water depends upon drainage from the tailings, rainfall, and snowmelt.

4.2 CONSTITUENT SELECTION

Filtered water samples will be taken at each location and will be analyzed for the following indicator parameters: field analyses for alkalinity, dissolved oxygen, oxidation/reduction potential, pH, specific conductance, and temperature; and laboratory analyses for ammonium, calcium, chloride, gross alpha, gross beta, iron, magnesium, manganese, molybdenum, nitrate, potassium, radium-226, radium-228, silica, sodium, strontium, sulfate, TDS, uranium, and vanadium.

The recommended analytes will provide an indication of any trends in water quality as a result of cell construction and completion; concentrations of the major anions and cations to evaluate mass-balance and the accuracy of the analytical laboratory; and concentrations of constituents that are useful for the risk evaluation.

4.3 SAMPLING FREQUENCY

Periodic sampling of the ground water seeps and monitor well at the site is performed to evaluate changes to water quality as a result of the construction of the disposal cell. Water quality and seep flow rate information will also be used for the site risk evaluation.

The last sampling event was June 1993. This plan recommends a continuation of the periodic monitoring, with a sampling event in April 1994 and September 1994. The sampling event in April will be representative of high ground water levels; the September sampling event will be representative of low ground water levels.

4.4 DATA INTERPRETATION

Water sampling data collected during 1994 will be evaluated according to prescribed UMTRA Project procedures and compared with the existing data base. Potential trends will be analyzed to determine any variations in ground water flow conditions and ground water quality. Results from the data interpretation may indicate a necessary change to this sampling plan. Any changes will be noted, justified, and implemented as appropriate.

4.5 ANOMALOUS DATA EVALUATION

Water sampling results beyond the range of expected values may result in a reanalysis of the sample or resampling of the well or seep. Immediate resampling would be warranted if there is an urgent need related to potential impacts to human health or the environment. Detailed procedures for anomalous data interpretation are in the WSAP guidance document (DOE, 1993b).

5.0 LIST OF CONTRIBUTORS

The following individuals contributed to the preparation of this report.

Name	Contribution
A. Miller	Overall document responsibility; authorship
C. Yancey, J. McBee, C. Day	Document review
J. Blount	Geochemistry
A. Miller	Geology, hydrogeology
WordCenter Inc.	Text processing
B. Harvey	Graphic design
WordCenter Inc.	Technical editing

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FEDERAL REGISTER

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