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Subject: Summary of Site Conditions and Work Plan, Slick Rock, Colorado

Dear Mr. Layton:

As part of the Department of Energy's effort to keep you informed and updated on the progress at UMTRA Ground Water project sites, planning documents and reports issued during the investigation phases will be forwarded to your office. Enclosed is a copy of the *Summary of Site Conditions and Work Plan, Slick Rock, Colorado* for your records. This work plan specifies the fieldwork that will be conducted at the Slick Rock, Colorado UMTRA sites and is scheduled to commence on August 8, 2000.

Sincerely,

Donald R. Metzler
Technical/Project Manager

Enclosure

cc w/o enclosure:
S. Marutzky, MACTEC-ERS
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NMSS08
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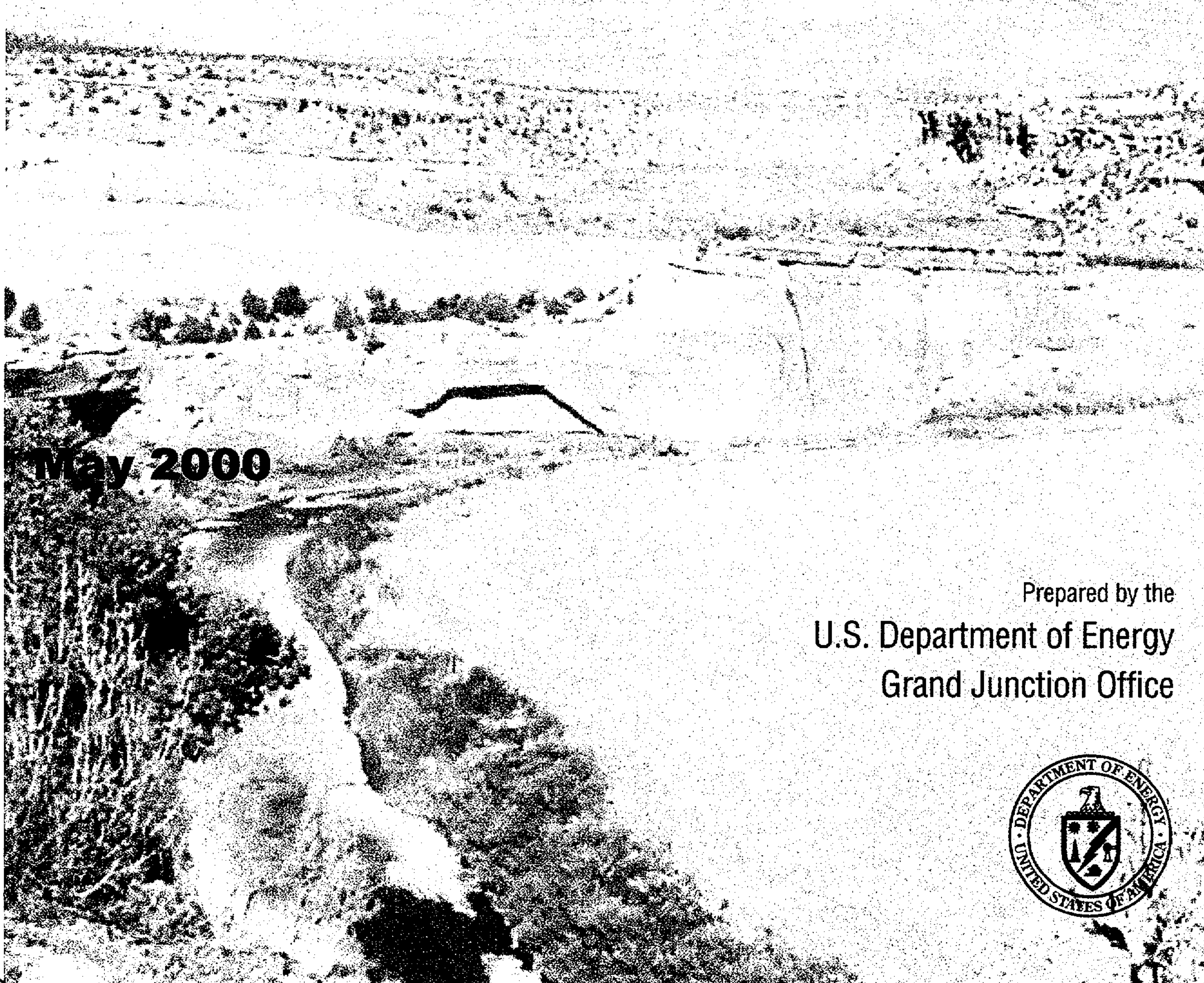
UMTRA Ground Water Project

GJO-2000-143-TAR

Summary of Site Conditions and Work Plan, Slick Rock, Colorado



May 2000

Prepared by the

U.S. Department of Energy
Grand Junction Office

UMTRA Ground Water Project

Summary of Site Conditions and Work Plan Slick Rock, Colorado

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Acronyms and Abbreviations

BLRA	baseline risk assessment
CDPHE	Colorado Department of Public Health and Environment
COPC	contaminants of potential concern
DQOs	data quality objectives
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ft	feet
GANDT	Ground Water Analysis and Network Design Tool
IDW	investigation-derived waste
µm	micrometers
µg/L	micrograms per liter
mg/L	milligrams per liter
mL	milliliters
mm	millimeters
MSL	mean sea level
NC	North Continent (site)
NEPA	National Environmental Policy Act
pCi/g	picocuries per gram
PVC	polyvinyl chloride
rpm	revolutions per minute
SOWP	site observational work plan
UC	Union Carbide (site)
UMTRA	Uranium Mill Tailings Remedial Action (Project)
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

1.0 Introduction

The purpose of this document is to summarize site conditions and identify additional field work necessary to address ground water remediation at the former uranium processing sites located near Slick Rock, Colorado. These Uranium Mill Tailings Remedial Action (UMTRA) Project sites are referred to as the North Continent (NC) site and the Union Carbide (UC) site and are located in San Miguel County, Colorado (Figure 1).

A review of historical documents was conducted to determine the number and scope of previous investigations in order to summarize site conditions and identify potential data deficiencies. Documents reviewed include the following:

- *UMTRA Project Water Sampling and Analysis Plan Slick Rock, Colorado* (DOE 1994)
- *Baseline Risk Assessment of Ground Water Contamination at the Uranium Mill Tailings Sites Near Slick Rock, Colorado* (DOE 1995a)
- *Environmental Assessment of Remedial Action at the Slick Rock Uranium Mill Tailings Sites Slick Rock, Colorado* (DOE 1995b)
- *Remedial Action Plan and Site Design for Stabilization of the Inactive Uranium Mill Tailings Sites at Slick Rock, Colorado* (DOE 1995c)
- *Slick Rock, Colorado, Final Completion Report* (DOE 1997b)

In addition to document reviews, site reconnaissance was conducted to verify current conditions.

On the basis of existing characterization data at the Slick Rock sites, additional investigation is needed to complete the Site Observational Work Plan (SOWP) and determine the final strategy for compliance with the U.S. Environmental Protection Agency (EPA) ground water protection standards (40CFR 192). The target strategy for ground water remediation at the Slick Rock sites is natural flushing, in conjunction with institutional controls and ground water monitoring. In order for the natural flushing to be a valid remediation strategy, constituents of potential concern must decrease to below standards in less than 100 years. To demonstrate that natural flushing will be completed within the 100-year timeframe, ground water flow and transport computer modeling will be performed.

Additional data will be required for input into the ground water flow and transport model. Data requirements include determining hydraulic parameters, background water quality, and extent of contamination in the alluvial aquifer. In addition, data will be collected to determine subpile soil chemistry, impacts to bedrock ground water quality, interaction between ground water and surface water, and interaction between the aquifers and the Dolores River. This will require installation of additional wells, aquifer pumping tests, obtaining Dolores River stream flow data, and additional sampling and analysis.

This abbreviated site summary and work plan format is being used instead of the traditional SOWP Rev. 0 because the magnitude of additional work required is relatively minor. This will expedite the process and directly support the final SOWP, which will be done upon completion of these activities.

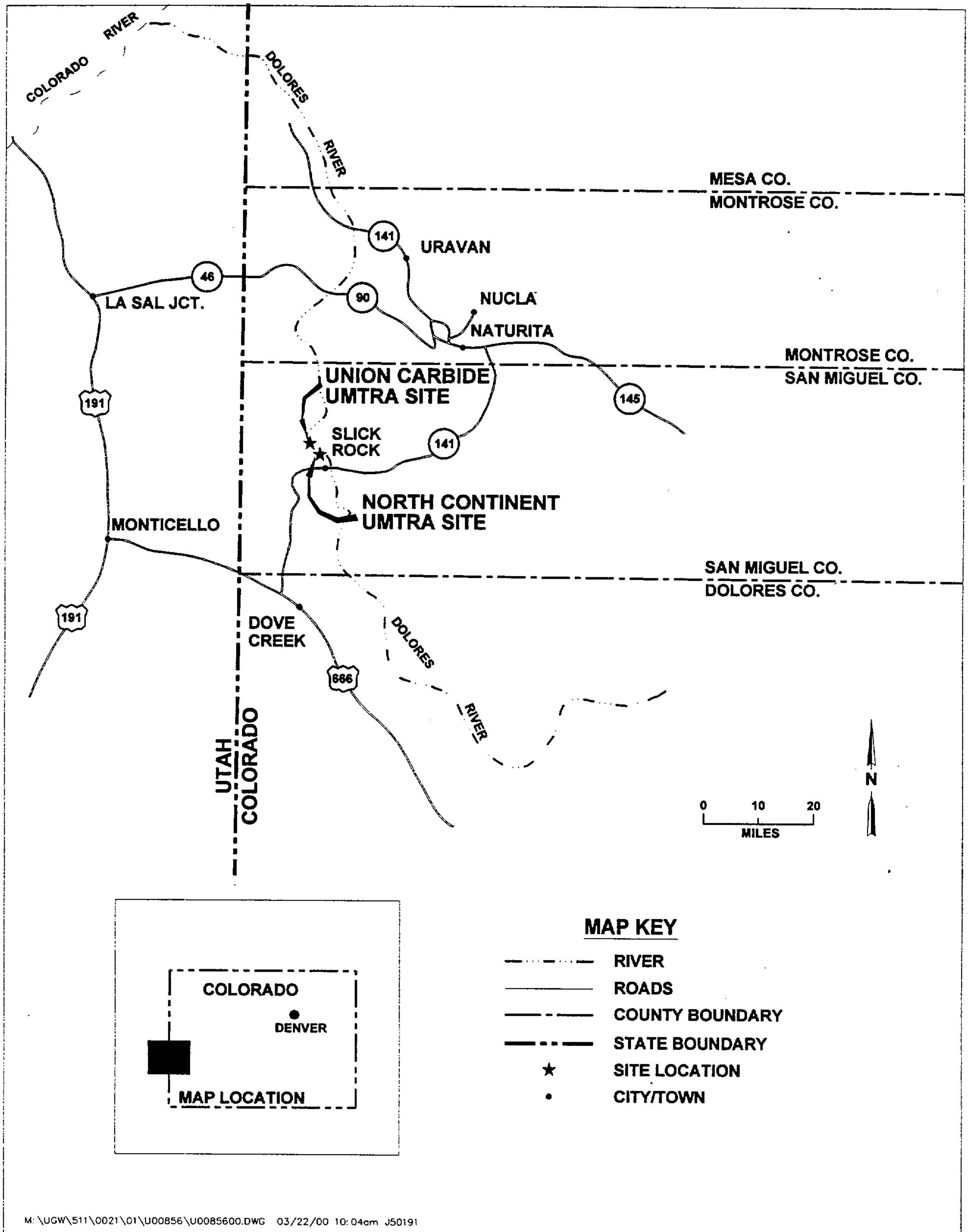

Figure 1. Regional Site Location Map

2.0 Site Conditions

The Slick Rock processing sites are located on the banks of the Dolores River. Steep juniper covered hillsides and cliffs of the Dolores River Canyon surround the sites. Elevations of the former processing sites are approximately 5,450 feet (ft) above mean sea level (MSL), while the surrounding hillsides reach 6,500 ft above MSL. The UC site is approximately 1 mile downstream from the NC site. Surface remediation of tailings and mill related contamination at the Slick Rock sites commenced in February 1995 and was completed in December 1996 (DOE 1997b). Contaminated material from the Slick Rock processing sites was placed in the Burro Canyon disposal cell located 5 miles east of the Slick Rock processing sites. After removal of surface contamination, both sites were re-graded and re-seeded. Supplemental standards were applied to contamination left in place around a natural gas pipeline at the UC site and to contamination left in place at a former vicinity property located across the river from the UC site (DOE 1997b) (Figure 2). The majority of monitor wells at the Slick Rock sites have been decommissioned; two monitor wells remain at the NC site, and 11 monitor wells remain at the UC site.

Two residents currently inhabit the Slick Rock area (Figure 2). A domestic well (672) is shared by these two residents and is currently the only domestic well in used as a source of drinking water in the Slick Rock area. Several other structures and domestic wells exist in the area, but they are not currently utilized.

2.1 Hydrogeologic System

Three hydrostratigraphic units underlie the NC and UC sites. These units are, in descending stratigraphic order, the Quaternary Dolores River alluvium, the Jurassic Entrada Formation (Slick Rock and Dewey Bridge Members), and the Jurassic Navajo Sandstone (Figure 3). The Jurassic Summerville Formation, which lies above the Entrada Formation, crops out in the walls of the terrace surrounding the Dolores River floodplain; however, it is not considered a hydrostratigraphic unit that is directly affected by the NC or UC sites (DOE 1995a).

The Dolores River alluvium ranges in thickness from 18 to 26 ft and consists of unconsolidated clayey sands, sandy gravels, and cobbles. Ground water in the alluvium is unconfined and generally flows to the north and towards the river, with depths to water ranging from 5 to 20 ft below ground surface (DOE 1995a). The Dolores River alluvium is laterally restricted by bedrock that forms the terraces and canyon walls adjacent to the Dolores River (Figure 2). In addition, the Dolores River floodplain is discontinuous and pinches out in areas where the Dolores River meets the canyon wall. Alluvial material also occurs on the terraces adjacent to the Dolores River and is topographically and hydrologically isolated from the Dolores River alluvium. The terrace alluvial deposits are typically unsaturated as indicated by monitor wells at the UC site (which are dry) and the gravel operation located on the terrace between the two sites (no dewatering required for mining).

The Entrada Formation underlies the Dolores River alluvium and crops out in the former tailings areas at both sites. The Slick Rock Member underlies the Summerville Formation and the Dolores River alluvium at the NC site and pinches out under the UC site (Figure 3). The Slick Rock Member is composed of light-brown fine-grained sandstone, and reddish-brown sandy shale. The Dewey Bridge Member underlies the Slick Rock Member at the NC site and underlies the Dolores River Alluvium at the UC site where the Slick Rock Member pinches out. The

Dewey Bridge Member, which is less permeable than the Slick Rock Member, consists of reddish-brown, clayey siltstone, very fine-grained sandstone, and shale (DOE 1995c). Ground water in the Entrada Formation is semiconfined to confined depending on localized variation in lithology. It is confined when fine-grained, low hydraulic conductivity units of the Entrada Formation are encountered (DOE 1995b). The reported flow direction of ground water in the Entrada is to the east; however, this interpretation may be biased by a limited number of monitor wells placed across a relatively small areal extent (DOE 1995c). The top of the Entrada Formation was encountered at depths ranging from 1 to 88 ft beneath the alluvial deposits (DOE 1995c).

The Navajo Sandstone underlies the Entrada Formation at both sites. The Navajo Sandstone is composed of light-brown to reddish-brown, fine-grained sandstone and is encountered at a depth of 53 to 173 ft. Because the Entrada Formation has been partially eroded away, the Navajo Sandstone may be semiconfined under portions of the UC site (DOE 1995c). Confined conditions exist in the Navajo Sandstone beneath the Dolores River floodplain where water levels in Navajo Sandstone wells 669 and 670 are 10 to 15 ft higher than adjacent alluvial water levels (DOE 1995b). Wells 669 and 670 are currently flowing artesian wells. Ground water flow in the Navajo Sandstone is generally to the north (DOE 1995c). The thickness of the Navajo Sandstone beneath the Slick Rock sites was not determined during previous drilling programs.

2.2 Ground Water Quality

Ground water quality at the NC and UC sites will be discussed separately because of the different ground water contaminants, different hydrologic conditions, and the distance between sites.

2.2.1 NC Site

2.2.1.1 Dolores River Alluvium

Background water quality in the Dolores River alluvium (alluvial aquifer) has not been established at the NC site. Alluvial wells 501 and 686 were situated upgradient from the tailings pile, but these wells were within the footprint of surface contamination. Results from these wells exceeded the UMTRA Project standards for molybdenum and uranium, along with elevated sulfate concentrations (up to 500 milligrams per liter [mg/L]).

The alluvial aquifer beneath the NC site has been contaminated from the former uranium milling operation. Concentrations of gross alpha, molybdenum, radium-226 + radium-228, selenium, and uranium have exceeded UMTRA ground water standards in samples collected from alluvial wells at the NC site (Figure 4). Contaminants of potential concern (COPCs) identified in the *Baseline Risk Assessment of Ground Water Contamination at the Uranium Mill Tailings Sites Near Slick Rock, Colorado* (BLRA) include manganese, sodium, sulfate, uranium, lead-210, polonium-210, radium-226, and thorium-230 (DOE 1995a). The historical network of monitor wells has not established the extent of contamination in the alluvial aquifer; uranium concentrations in samples collected from monitor well 504 (furthest downgradient well) have been as high as 3.3 mg/L.

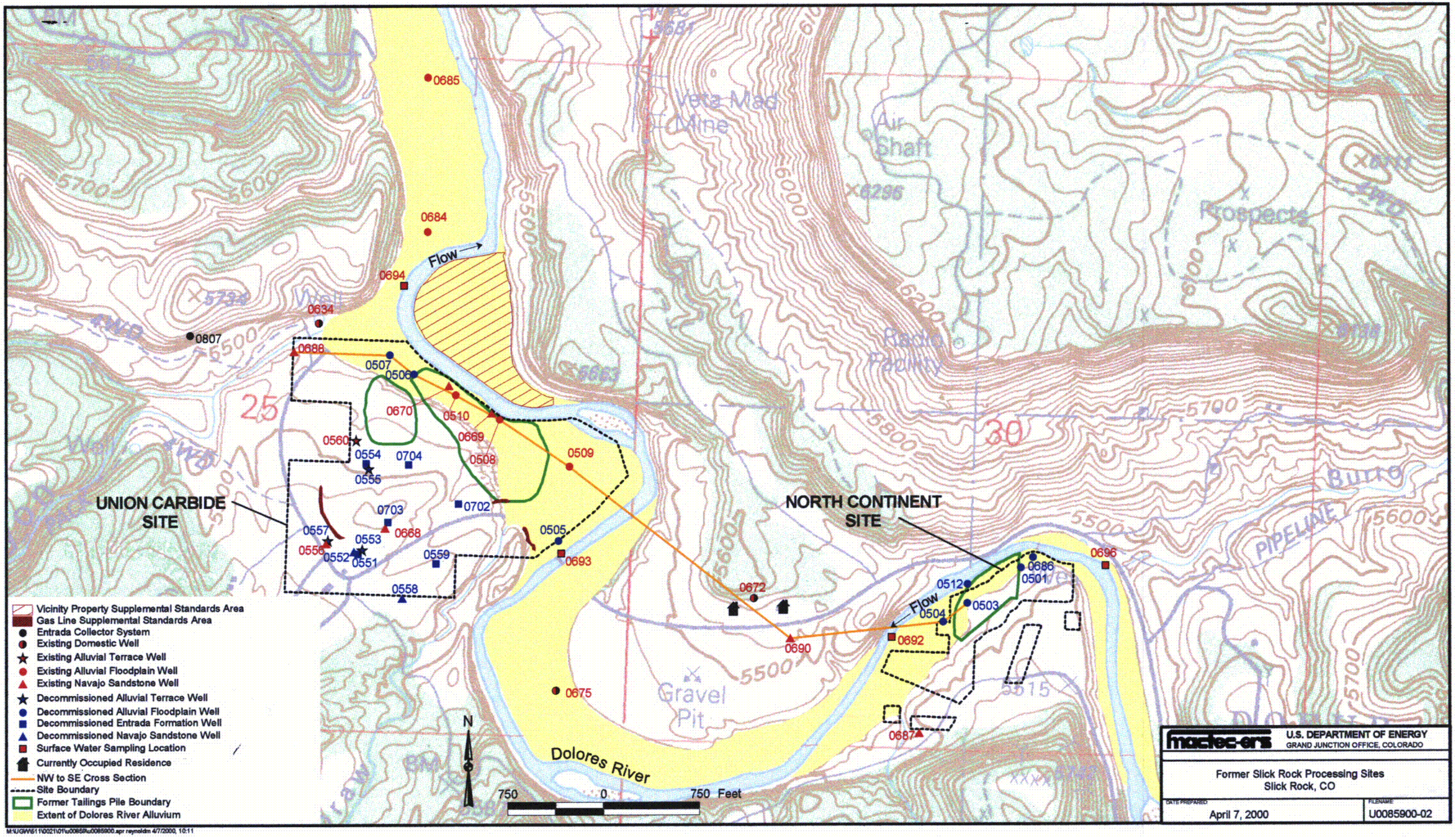

Figure 2. Former Slick Rock Processing Sites

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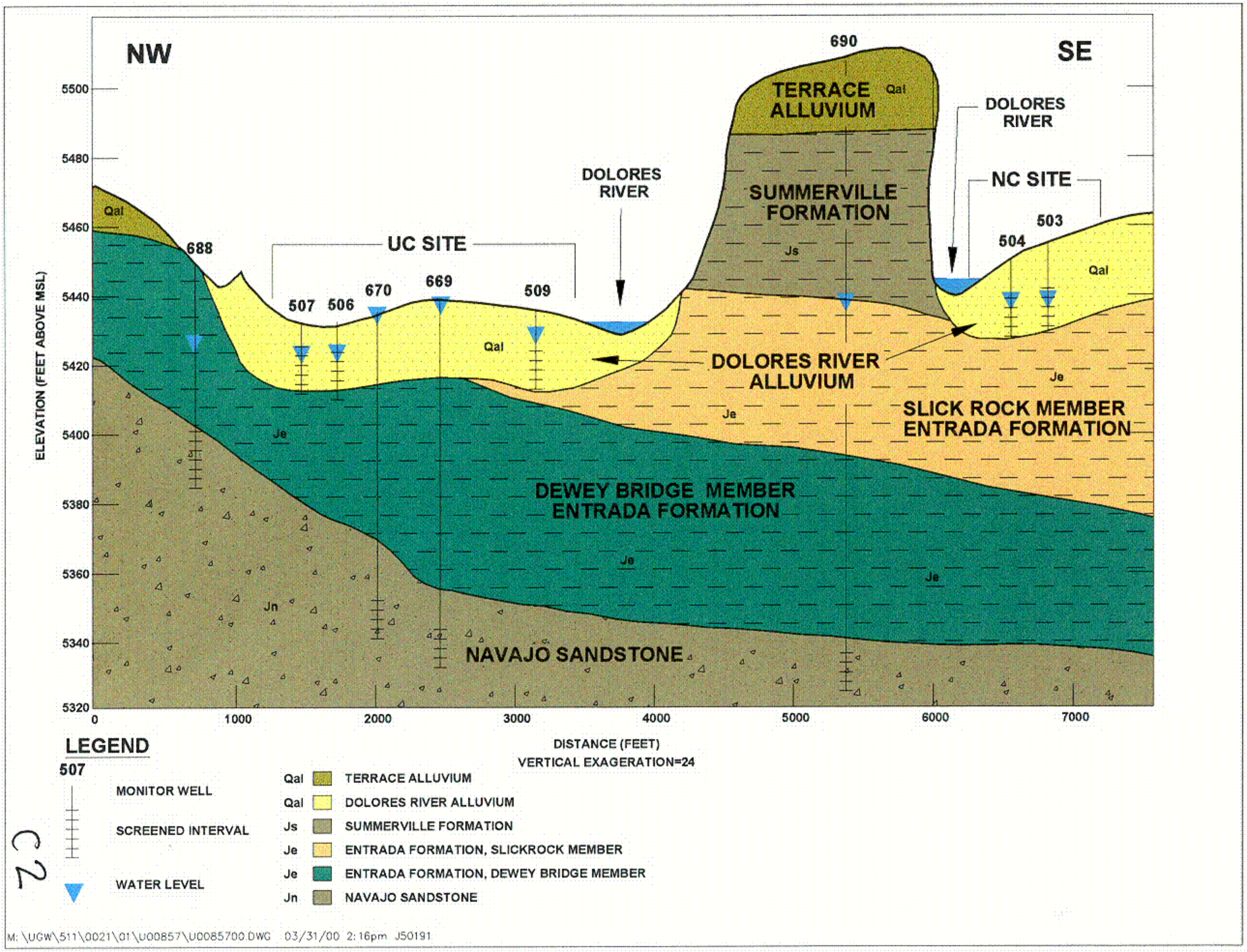

Figure 3. Hydrostratigraphic Units at the Slick Rock Sites

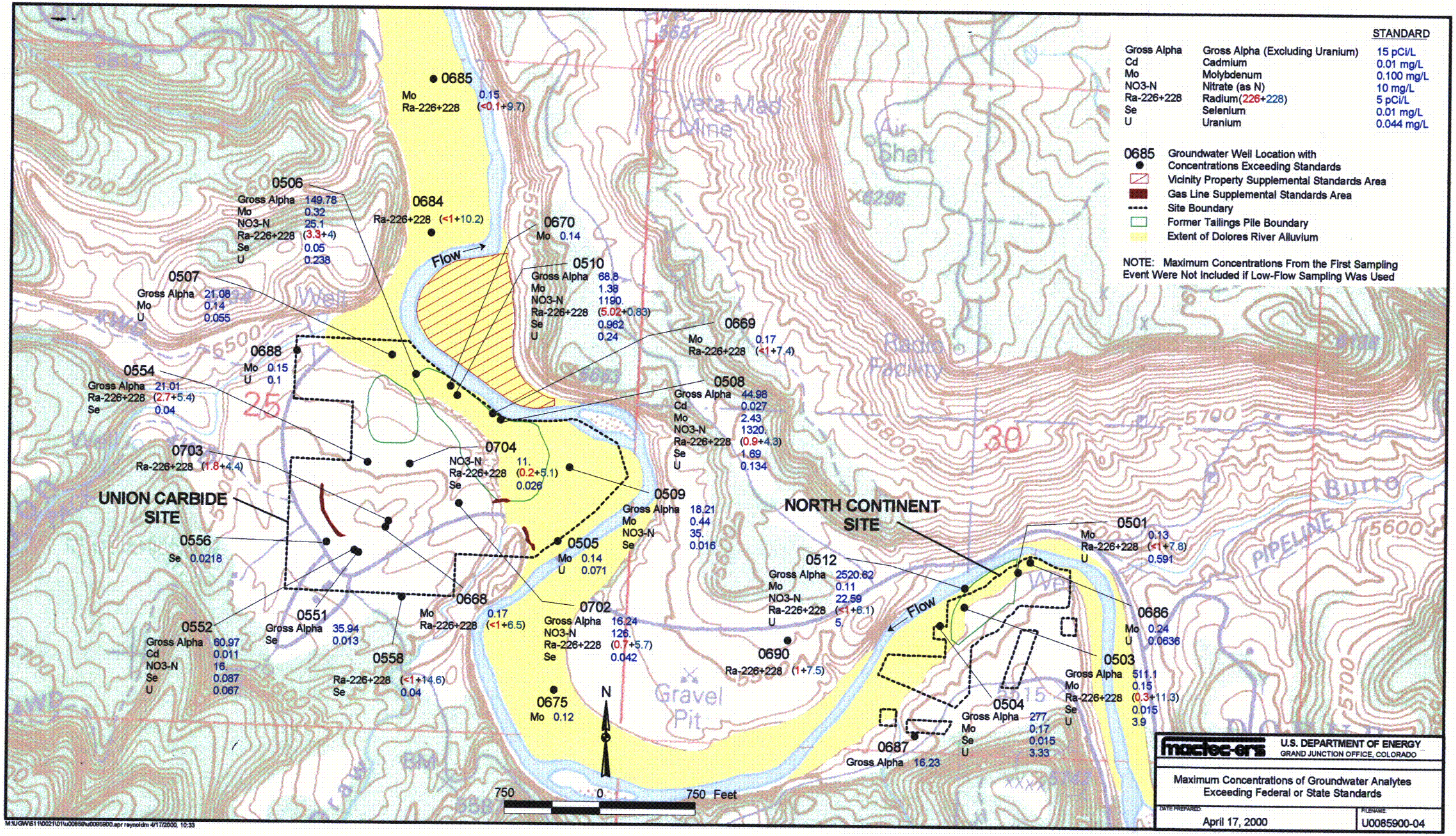

Figure 4. Maximum Concentrations of Groundwater Analytes Exceeding Federal or State Standards

C3

Although the extent of alluvial ground water contamination has not been determined by well placement and sampling, it may be determined by the geology. The Dolores River floodplain alluvium pinches out at the west (downgradient) edge of the NC site where the Dolores River meets the canyon wall (Figure 3). If alluvial ground water discharges into the Dolores River, then the truncation of the floodplain alluvium marks the extent of alluvial ground water contamination from the NC site. If the alluvial ground water flows beneath the river (via potential paleochannel), then the extent of alluvial ground water contamination has not been defined. A hand-dug alluvial well (domestic well 675) is the only alluvial well located north of the river between the sites. Concentrations of molybdenum (0.12 mg/L), sulfate (840 mg/L), uranium (0.0246 mg/L), and vanadium (0.42 mg/L) have been elevated; however, results from this well are suspect because of the type of well construction, which allows surface runoff to flow into the well. Additional investigation of the extent of contamination at the NC site, including potential preferential flow paths and communication between sites, is discussed in detail in Section 5.0.

2.2.1.2 Entrada Formation

Water quality of the Entrada Formation beneath the NC site has not been established because Entrada Formation wells have never been installed at the NC site. Lithologic logs obtained during drilling of onsite alluvial wells show that the alluvium at the NC site rests on a siltstone unit of the Slick Rock Member. This siltstone unit may inhibit downward migration of contaminated alluvial ground water into the Entrada Formation.

2.2.1.3 Navajo Sandstone

Navajo Sandstone well 687 at the NC site is located upgradient of the former tailings piles and ground water quality in this well is indicative of natural background water quality (DOE 1995a). There are no Navajo Sandstone wells onsite or downgradient of the former tailings pile.

2.2.2 UC Site

2.2.2.1 Dolores River Alluvium

Background water quality in the Dolores River alluvium (alluvial aquifer) has not been established at the UC site. Alluvial well 505 was situated upgradient from the tailings pile, but this well was within the footprint of surface contamination. Historical results from this well exceeded the UMTRA project ground water standards for molybdenum and uranium, along with elevated sulfate concentrations (up to 780 mg/L); currently, concentrations of molybdenum and uranium in samples from well 505 are below the standard.

The alluvial aquifer beneath the UC site has been contaminated from the former uranium milling operation. Historically, UMTRA ground water standards for cadmium, gross alpha, molybdenum, nitrate, selenium, radium-226 + radium-228, and uranium were exceeded at least once in samples from alluvial wells at the UC site (Figure 4). COPCs identified in the BLRA include cadmium, chloride, iron, manganese, molybdenum, nitrate, selenium, sodium, strontium, sulfate, uranium, vanadium, lead-210, polonium-210, radium-226, and thorium-230 (DOE 1995a). With one exception, the lateral extent of alluvial aquifer contamination has been adequately defined at the UC site. As with the NC site, the alluvium is laterally restricted by bedrock that forms the terraces and canyon walls adjacent to the Dolores River. The lateral

restriction of the alluvium provides a physical border for the lateral extent of contamination in the alluvial aquifer. Downgradient of the site, wells 684 and 685 are located beyond the contaminant plume and provide delineation of the extent of contamination.

The only portion of the alluvial aquifer where ground water quality has not been investigated is the section of floodplain located across the river from the former UC tailings piles (Figure 2). Supplemental standards were applied to the surface contamination at this former vicinity property, and no monitor wells were installed in this area because of limited access. Soil contamination in this area appears to be wind and/or water transported tailings, which have been thinly dispersed over 17 acres (DOE 1995c). Average radium-226 concentration of surface soils in this area is 7.4 ± 1.4 picocuries per gram (pCi/g) (DOE 1995b). This isolated portion of the floodplain is bounded by the Dolores River and canyon wall; therefore, the area is inaccessible unless a temporary bridge is built across the river.

2.2.2.2 Terrace Alluvium

Alluvial material overlies the Entrada Formation on the terrace at the UC site. The terrace alluvium is hydrologically and topographically isolated from the Dolores River alluvium. Three wells were installed in this material down to the top of the Entrada Formation (553, 555, and 560); water quality data are not available because these wells have never contained water. Water was not detected in wells 553 and 555 from 1990 to 1995; these wells were subsequently abandoned during surface remediation. Water has not been detected in well 560 since 1990, and the latest measurement (February 2000) shows that the well remains dry.

2.2.2.3 Entrada Formation

All Entrada Formation wells installed at the UC site were within the contamination footprint; therefore, samples from these wells did not provide representative background water-quality data. Limited background data (only sampled once) exists from surface location 807, which is a collector system that taps into the cliff face formed by the Entrada Formation approximately 1,500 ft west of the UC site. This collector system is currently in operation and provides water to stock tank.

Historical documentation suggests that ground water in the Entrada Formation may be contaminated at the UC site (DOE 1995a). Specifically, elevated concentrations of mill related contaminants were measured in samples collected from well 702. Review of the water quality data indicates the highest concentrations of contaminants (with the exception of nitrate) occurred during the first sampling event shortly after the well was drilled (March 1989). By the third sampling event (March 1991), contaminant concentrations had dropped significantly and remained low in subsequent sampling events. For example, the uranium concentration in the sample collected during the first sampling event was 0.047 mg/L. By the third sampling event, the uranium concentration was 0.004 mg/L, and the average uranium in the subsequent five sampling events was 0.007 mg/L.

Because the first samples contained the highest contaminant concentrations, initial results may be related to the drilling process rather than indicative of aquifer contamination. The initial sample results may be from surface contamination pushed downward during the drilling process. The low-flow sampling technique used to sample well 702 would not facilitate rapid removal of contaminants remaining from the drilling process; this sampling technique requires removal of a

small volume of water prior to sampling. Only nitrate concentrations were consistently high (46 to 126 mg/L) in samples collected from well 702. High nitrate concentrations could be attributed to former septic systems in the area that served the millsite community.

Elevated concentrations of chloride (up to 1,330 mg/L) and sodium (up to 300 mg/L) in samples collected from well 554 indicate potential site impacts to the aquifer; however, concentrations of nitrate and uranium were near the detection limit (DOE 1995a). Additional investigation required to determine water quality in the Entrada Formation is detailed in Section 5.0.

2.2.2.4 Navajo Sandstone

All Navajo Sandstone wells installed at the UC site were within the footprint of surface contamination; however, results from most of the Navajo Sandstone wells at the UC site display water quality similar to background well 687 (located at the NC site), which has low concentrations of milling-related contaminants (DOE 1995a). Navajo Sandstone wells (669 and 670) near the Dolores River have water levels 10 to 15 ft higher than water levels in the Dolores River alluvium, which indicates an upward vertical gradient. These wells are installed below the most contaminated portion of the alluvial aquifer, but samples collected from these wells display water quality similar to background.

Samples from two former Navajo Sandstone wells (552 and 558) showed elevated concentrations of site related contaminants. However, these wells were located upgradient of the former tailings piles in an area of limited surface soil contamination (6 inch depth of contamination), so voluminous contamination of the Navajo Sandstone aquifer in these areas is unlikely. Historical documents have suggested that the reason for the elevated concentrations of nitrate (up to 30 mg/L), selenium (up to 0.07 mg/L), sulfate (up to 950 mg/L), and uranium (up to 0.03 mg/L) is because these Navajo wells were cross-screened in the Entrada Formation (DOE 1995a). However, when results from Navajo Sandstone well 552 are compared with results from adjacent Entrada Formation well 551, the concentrations of contaminants are an order of magnitude lower. Elevated sample concentrations from wells 552 and 558 (as with Entrada Formation well 702) could be attributed to the drilling process coupled with a low-flow sampling technique.

The UMTRA standard for radium-226 + radium-228 was exceeded in samples collected from Navajo Sandstone, Entrada Formation, and alluvial aquifer wells. Generally, the radium-228 component was significantly larger than the radium-226 component, and the radium-228 component was the reason the standard was exceeded (Figure 4). Because radium-228 is not in the uranium decay chain, it is not considered a site contaminant.

2.3 Surface Water

The Dolores River is the only perennial surface water feature in the vicinity of the Slick Rock sites. Comparison of upstream with downstream water quality data indicates no discernible impact to Dolores River water quality from milling activities (DOE 1995a). Historical sampling locations on the Dolores River are shown in Figure 2; concentrations of selected analytes in samples collected from these sampling locations are displayed in Table 1.

Table 1. Summary of Dolores River Water Quality

Analyte		Location 696 (mg/L)	Location 692 (mg/L)	Location 693 (mg/L)	Location 694 (mg/L)
Cadmium	Minimum	< 0.001	< 0.001	0.001	< 0.001
	Median	< 0.001	0.001	0.001	< 0.001
	Maximum	< 0.001	< 0.01	< 0.2	< 0.1
	U/N[a]	7/7	10/12	9/12	12/13
Molybdenum	Minimum	0.002	0.0018	0.0026	0.0021
	Median	< 0.01	< 0.01	< 0.01	0.01
	Maximum	< 0.01	< 0.1	< 0.1	0.1
	U/N	5/7	8/13	8/13	10/14
Nitrate	Minimum	0.0783	0.0477	0.0901	0.0393
	Median	< 1	< 1	< 1	< 1
	Maximum	12.8	4	3.1	8
	U/N	2/5	5/11	6/11	6/13
Selenium	Minimum	0.0015	0.0017	0.0019	< 0.002
	Median	< 0.005	0.005	0.005	< 0.005
	Maximum	0.0059	< 0.05	< 0.05	< 0.05
	U/N	5/7	10/12	10/12	11/13
Sodium	Minimum	20.9	16	18.2	18
	Median	43.9	42.9	43.7	48.8
	Maximum	87.7	112	115	134
	U/N	0/4	0/11	0/11	0/11
TDS	Minimum	300	199	208	209
	Median	409	341	340	384
	Maximum	683	650	895	618
	U/N	0/3	0/7	0/7	0/7
Uranium	Minimum	0.001	0.0005	< 0.0003	0.0004
	Median	0.001	< 0.003	0.0025	0.0016
	Maximum	0.0023	0.009	0.009	0.014
	U/N	3/7	2/13	3/13	2/14

[a] Number of nondetects/total number of samples

Interaction between the Dolores River and the alluvial aquifer has not been adequately defined. To define the relationship between the river and the alluvial aquifer, river stage (elevation) must be determined. Data from the U.S. Geological Survey (USGS) gaging station adjacent to the UC site (next to the bridge) will be utilized to determine river elevation. The discharge curve will be obtained from the USGS to convert discharge back to river elevation. River elevations will be compared to ground water elevations in the alluvial aquifer to determine interaction between the river and the alluvial aquifer; these data will be used for input into the ground water flow model.

3.0 Human Health and Environmental Risks

There are currently no unacceptable risks to human health or the environment at the Slick Rock sites as a result of previous uranium processing activities. No exposure pathways to contaminated ground water have been identified as complete. However, some potential future adverse health effects could occur if contaminated ground water is used as a source of drinking water for humans and livestock.

3.1 Future Potential Human Health Risks

U.S. Department of Energy (DOE) (1995a) evaluated potential future risks assuming wells were placed in the most contaminated section of aquifers at each site and these wells were used as the sole source of drinking water. This is a conservative approach that results in a worst-case evaluation of risk. Moreover, insufficient background concentration data for the COPCs were not available as a screening tool for COPC selection. Once these data are available, it is likely that several COPCs can be eliminated, thus reducing the risks associated with site-related contamination. Other potentially complete pathways were screened (dermal contact with ground water, the ingestion of garden produce irrigated with ground water, and the ingestion of milk and meat products from cattle watered with ground water); however, these were found to be minor contributors to future risks compared to the direct ingestion of contaminated ground water.

3.1.1 NC Site

Based on potential future use of contaminated ground water as the sole drinking water source, adverse noncarcinogenic health effects could result from the ingestion of manganese, sulfate, and sodium. Lead-210, polonium-210, radium-226, thorium-230, and uranium were evaluated as carcinogens. Total future carcinogenic risks would be unacceptable, with lead-210 and uranium being the major contributors to total risks.

3.1.2 UC Site

Based on potential future use of contaminated ground water as the sole drinking water source, the most significant noncarcinogenic health effects could result from the chronic ingestion of nitrate, sulfate, manganese, chloride, sodium, molybdenum, selenium, and iron. Potential carcinogenic effects were evaluated from lead-210, polonium-210, radium-226, thorium-230, and uranium. Potential future carcinogenic risks were found to be unacceptable, with lead-210 being the major contributor to total risks.

3.2 Environmental Risks

DOE (1995a) presented a screening level evaluation of environmental risks. Based on available data, the potential for adverse health effects to terrestrial and aquatic wildlife is considered low. However, future use of contaminated ground water could result in adverse environmental impacts. Water from contaminated wells from both the NC and UC sites would not be suitable as a long-term source of drinking water for livestock. In addition, water from the most contaminated wells in the alluvial aquifer would be unacceptable as a source of water for stocked fish.

4.0 Compliance Strategy Selection

Based on available information, the proposed strategy for compliance with the EPA ground water protection standards is no remediation in conjunction with natural flushing, along with institutional controls and ground water monitoring. In order to quantify the potential for natural flushing and demonstrate that contaminants will decrease to below standards in less than 100 years, ground water flow and transport modeling will be performed.

5.0 Additional Investigation

5.1 Data Quality Objectives

Based on evaluation of existing information on the Slick Rock processing sites, additional site characterization is needed. Additional data collection is required to: 1) further define the hydraulic parameters, background water quality, extent of contamination, and ground water movement in the alluvial aquifer; 2) to characterize alluvial aquifer sediments; 3) to determine the interaction between ground water and surface water; and 4) to determine interaction between the alluvial and bedrock aquifers. These data will be used in the ground water flow and transport modeling that will support the proposed natural flushing strategy. Additional characterization is also needed to determine impacts to ground water in the Entrada Formation from UC site contaminants. Proposed field investigation objectives and activities are summarized in Table 2.

Table 2. Objectives of the Slick Rock Field Investigation

Data Deficiency	Objective	Action
Background alluvial water quality at both sites	Distinguish between site contributions and background; establish COPCs	Install background wells 300 and 301; sample collection and analysis
Entrada water quality at the NC site	Determine if Entrada has been impacted by site activities	Install monitor well 304; sample collection and analysis
All alluvial wells abandoned at the NC site	Water quality and elevation inputs into the ground water flow and transport model	Install wells 300 to 303, 305, and 309; sample collection and analysis; water level measurements
Hydraulic conductivity at the NC site	Input into the ground water flow and transport model	Install wells 306, 307, and 308; aquifer pumping test
Navajo Sandstone water quality at the NC site	Determine if the Navajo Sandstone has been impacted by site activities	Sample Entrada well 304; if contaminated, install and sample an adjacent Navajo Sandstone well
Extent of alluvial aquifer contamination at the NC site	Determine if contamination is migrating north of the river between the two sites	Install wells 310, 311, and 312; sample collection and analysis; water level measurements
Hydraulic conductivity at the UC site	Input into the ground water flow and transport model	Install wells 314, 315, 316, 317, 321, 322, and 323; aquifer pumping tests
Alluvial wells abandoned at the UC site	Water quality and elevation inputs into the ground water flow and transport model	Install wells 313 to 316 and 318 to 320; sample collection and analysis; water level measurements
Entrada wells abandoned at the UC site	Determine if Entrada has been impacted by site activities; determine flow direction	Install wells 317, 324, 325, and 326; sample collection and analysis; water level measurements
Dolores River elevation	Determine interaction between Dolores River and alluvial aquifer	Obtain USGS discharge data and rating curve; install measuring stakes along river; install data loggers in selected alluvial wells
Vertical gradient between aquifers	Determine potential ground water movement between aquifers	Install Entrada wells 304, 317 and 324; water level measurements
Subpile contamination	Determine if contamination (other than Ra-226) exists in the subpile soils	Subpile soil sampling and analysis
Aquifer transport properties	Input into the ground water flow and transport model	Determine distribution ratios for selected COPCs
Ground water remedial action – natural flushing alternative	Determine if contaminants will flush within the 100-year UMTRA time-frame	Ground water flow and transport modeling
Survey Data	Develop accurate site map, determine ground water surface elevations; ground water flow direction; river elevation	Survey horizontal coordinates and vertical elevation at all sampling locations

Data quality objectives (DQOs) must be established for this investigation to ensure data are of sufficient quality for the intended use. Specifically, the quality of data collected for this investigation must be sufficient to meet the objectives listed in Table 2. In aggregate, data collected during this investigation will be used to determine compliance with federal (100-year UMTRA compliance timeframe, ground water quality, drinking water quality) and state (groundwater quality, surface water quality) regulations. To achieve the data quality required to determine compliance with federal and state regulations, an appropriate level of quality assurance and quality control measures will be implemented during this field investigation, which is detailed in Section 5.9.

Specific tasks associated with additional characterization will include monitor well installation, aquifer pump tests, sampling and analysis of alluvial aquifer material, ground water flow and transport modeling, ground water sampling, surface water, soil and sediment sampling, depth to ground water measurements, and obtaining river stage data.

5.2 Monitor Well Installation

5.2.1 NC Site

Two monitor wells (300 and 301) will be installed in the alluvial aquifer upgradient of the NC site to determine background water quality for both the NC and UC sites (Figure 5).

Monitor wells will be installed at the NC site for aquifer pumping tests (see Appendix A for *Drilling Statement of Work*). This will require drilling and installation of one monitor well as a pumping well (306) and two monitor wells as observation wells (307 and 308) (Figure 5 and Table 3). The pumping well will be drilled to a total depth of approximately 20-ft to the top of bedrock. This well will be screened from approximately 5 to 20 ft with a stainless steel vee wire-wrapped screen to provide full penetration and optimal well performance. Two observation wells will be installed near the pumping well and will be screened from 5 to 20 ft with vee wire-wrapped polyvinyl chloride (PVC) screens.

Table 3. Monitor Wells to be Installed at the NC Site

Well Number	Well Type	Estimated Total Depth (ft)	Formation	Casing Diameter (inches)	Screened Interval (ft)	Location
300	Monitor	20	Alluvium	2	10-20	Upgradient
301	Monitor	20	Alluvium	2	10-20	Upgradient
302	Monitor	20	Alluvium	2	10-20	Onsite
303	Monitor	20	Alluvium	2	10-20	Onsite
304	Monitor	50	Entrada	2	30-50	Onsite
305	Monitor	20	Alluvium	2	10-20	Onsite
306	Pumping	20	Alluvium	6	5-20	Onsite
307	Observation	20	Alluvium	2	5-20	Onsite
308	Observation	20	Alluvium	2	5-20	Onsite
309	Monitor	20	Alluvium	2	10-20	Onsite
310	Monitor	20	Alluvium	2	15-20	Offsite—North of River
311	Monitor	20	Alluvium	2	15-20	Offsite—North of River
312	Monitor	20	Alluvium	2	15-20	Offsite—North of River

All original alluvial monitor wells have been decommissioned at the NC site; therefore, a network of four monitor wells (in addition to background and pumping test wells) (302, 303, 305, and 309) will be installed onsite to determine ground water quality and ground water surface elevation throughout the alluvial aquifer. Data obtained from this network of wells will be used for input into the ground water flow and transport model and used to verify natural flushing.

If contaminated alluvial ground water at the NC site discharges into the Dolores River, then the extent of alluvial ground water contamination is delineated by the extent of the Dolores River alluvium on the south side of the river. However, if a preferential flow path exists (i.e., paleochannel) that allows ground water to flow beneath the river and into the alluvium on the north side of the river, then the extent of contamination has not been defined. A north-south transect of three monitor wells (310, 311, and 312) will be installed north of the river to determine if ground water contaminants have migrated under the river (Figure 5). These wells will be drilled to the top of bedrock and a 5-ft screen will be installed to intercept ground water potentially flowing beneath the river. Ground water samples from these wells will be analyzed for uranium and sulfate in the field using the mobile laboratory. If results from the initial samples provide definitive evidence that contaminants have migrated offsite, then a network of monitor wells will be installed to determine the nature and extent of contamination and ground water flow direction. If results from the initial samples do not provide definitive evidence of contaminant migration, then these wells will be sampled routinely for a full suite of COPCs to make a final determination of contaminant migration.

An Entrada Formation well (304) will be installed to determine if contaminated alluvial ground water has migrated vertically. In addition to obtaining water quality data, this well will be paired with alluvial well 303 to determine the vertical hydraulic gradient between the alluvial and Entrada Formation aquifers. Details of Entrada Formation drilling and well installation are specified in the *Drilling Statement of Work* (Appendix A).

Because fine-grained, low conductivity units in the Entrada Formation should inhibit downward migration of contaminated alluvial ground water, contamination in the Navajo Sandstone aquifer is not expected. However, a sample will be collected from Entrada Formation well 304 and analyzed by the mobile laboratory. If contamination is detected in well 304, then a Navajo Sandstone well will be installed adjacent to wells 303 and 304 and will be included in the sampling network.

5.2.2 UC Site

Two sets of alluvial monitor wells will be installed at the UC site for aquifer pumping tests (see Appendix A for *Drilling Statement of Work*). This will require drilling and installation of two monitor wells as pumping wells (314 and 321) and four monitor wells (315, 316, 322, and 323) as observation wells (two adjacent to each of the pumping wells) (Figure 5 and Table 4). Pumping test wells will be located adjacent to existing monitor wells 509 and 684, so these wells can be utilized during the pumping test. The pumping wells will be drilled to a total depth of approximately 20 ft to the top of bedrock. These wells will be screened from approximately 5 to 20 ft with stainless steel vee wire-wrapped screens to provide full penetration and optimal well performance. Two observation wells will be installed near the pumping well and will be screened from 5 to 20 ft with PVC vee wire-wrapped screens. In addition to alluvial observation wells, an

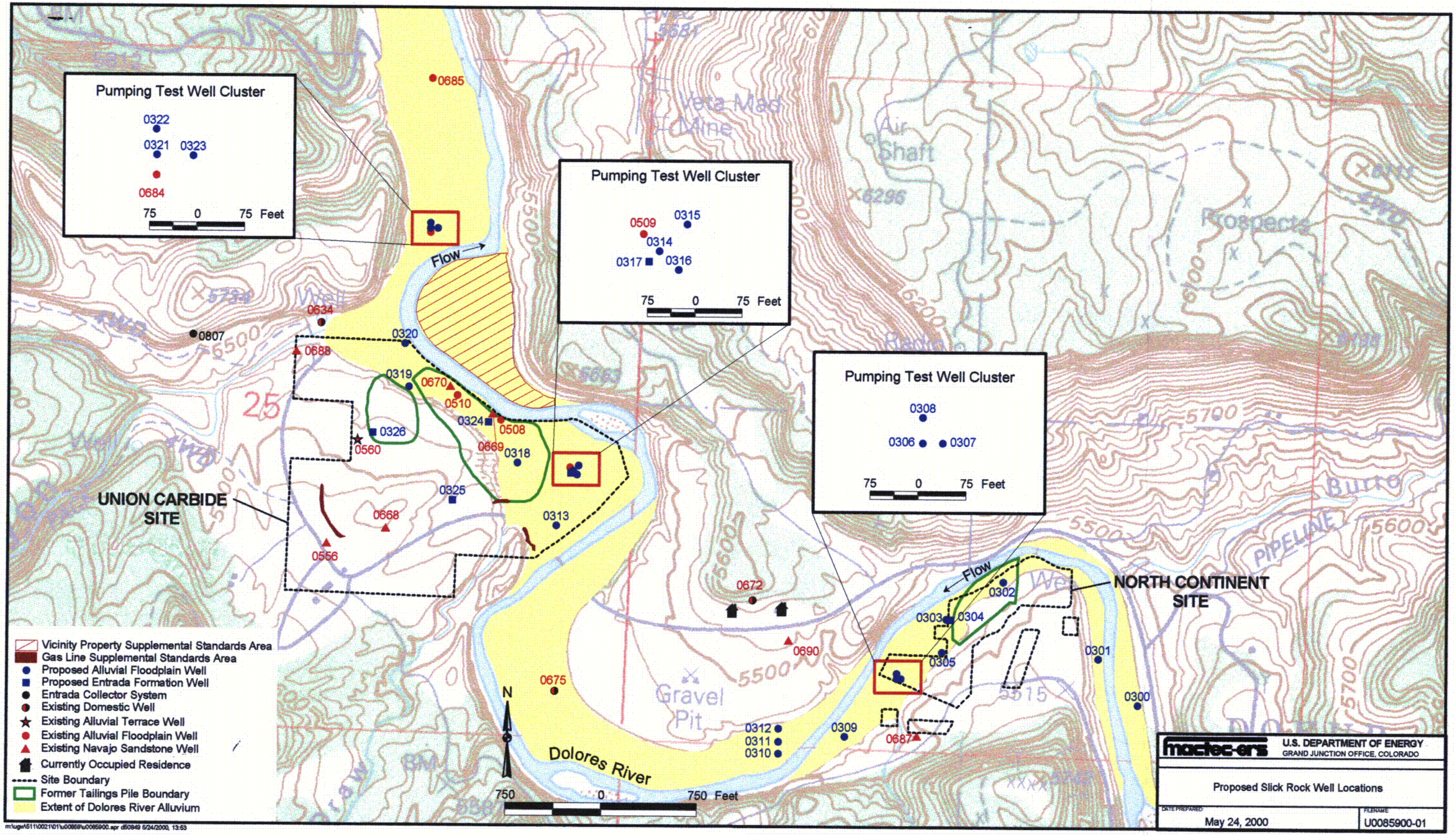

Figure 5. Proposed Slick Rock Well Locations

C4

Entrada Formation observation well (317) will be installed adjacent to pumping well 314. Drawdown in this well will be measured during the pumping test to determine hydraulic connection between the aquifers and to determine if water is being contributed from the Entrada Formation during the pumping test.

Four additional alluvial monitor wells (313, 318, 319, and 320) will be installed in the alluvial aquifer at the UC site to achieve an adequate spatial distribution of wells. Data from these wells will be used for input into the ground water flow and transport model and used to verify natural flushing.

Table 4. Monitor Wells to be Installed at the UC Site

Well Number	Well Type	Estimated Total Depth (ft)	Formation	Casing Diameter (inches)	Screened Interval (ft)	Location
313	Monitor	20	Alluvium	2	10-20	Onsite – Floodplain
314	Pumping	20	Alluvium	6	5-20	Onsite – Floodplain
315	Observation	20	Alluvium	2	5-20	Onsite – Floodplain
316	Observation	20	Alluvium	2	5-20	Onsite – Floodplain
317	Observation	40	Entrada	2	30-50	Onsite – Floodplain
318	Monitor	20	Alluvium	2	10-20	Onsite – Floodplain
319	Monitor	20	Alluvium	2	10-20	Onsite – Floodplain
320	Monitor	20	Alluvium	2	10-20	Onsite – Floodplain
321	Pumping	20	Alluvium	6	5-20	Downgradient – Floodplain
322	Observation	20	Alluvium	2	5-20	Downgradient – Floodplain
323	Observation	20	Alluvium	2	5-20	Downgradient – Floodplain
324	Monitor	40	Entrada	2	30-50	Onsite – Floodplain
325	Monitor	65	Entrada	2	45-65	Onsite – Mill Area
326	Monitor	65	Entrada	2	45-65	Onsite – Mill Area

Former Entrada Formation monitor well 702 was located in the old mill area, and the BLRA (DOE 1995a) indicates the ground water in this portion of the aquifer has been impacted by site activities; however, this interpretation was based on the initial sampling and may be suspect. Therefore, a new Entrada Formation monitor well (325) will be installed at approximately the same location as former monitor well 702. This new well will be screened at approximately the same depth (45 to 65 ft) as well 702. Data obtained from this well will be used to make a definitive determination if ground water in this area of the Entrada Formation has been impacted by site activities. An Entrada Formation well (326) will also be installed in the vicinity of former monitor well 554, which had elevated concentrations of sodium and chloride, and within the footprint of the former tailings pile that was deposited on the terrace. This well will be used to determine if the Entrada Formation has been impacted in this area of the site.

An additional Entrada Formation monitor well (324) will be installed on the Dolores River floodplain to determine if contaminated alluvial ground water has migrated into the Entrada Formation. This well will be installed adjacent to wells 508 (alluvial) and 669 (Navajo Sandstone) to determine the vertical hydraulic gradient between the two aquifers.

Flowing artesian Navajo Sandstone wells near the Dolores River (669 and 670) have water levels 10 to 15 ft higher than water levels in the Dolores River alluvium, which indicates an upward vertical gradient. These wells are installed below the most contaminated portion of the alluvial aquifer, but samples collected from these wells display water quality similar to background. In addition, Navajo Sandstone wells throughout the UC site have water levels that indicate confined conditions (Figure 3); therefore, installation of additional monitor wells in the Navajo Sandstone is not proposed.

Information from the USGS gaging station adjacent to the UC site (next to the bridge) will be utilized to determine river stage. The discharge curve will be obtained from the USGS to convert discharge back to river elevation (stage). Data loggers will be installed in selected alluvial wells adjacent to the river to obtain a continuous record of alluvial water levels. River elevations will be compared to ground water elevations in the alluvial, Entrada, and Navajo aquifers to determine interaction between the river and the aquifers and interaction between aquifers; these data will be used for input into the ground water flow model.

5.3 Aquifer Pumping Tests

Aquifer pumping tests will be performed at three locations at the Slick Rock processing sites (Figure 5). Ground water will be pumped from these wells using a submersible pump and will be discharged to the ground surface. The pumping test wells at the NC site will be located in a wide portion of the floodplain away from the river to minimize the influence of the river on the pumping test. Pumping test wells at the UC site will be located upgradient of the former tailings pile (near well 509) and approximately 1,200 ft downgradient of the former tailings pile (near well 684). Dispersion requirements for pumping test water are discussed in Section 6.4.1.

Step-drawdown tests will be run at each location to determine the optimal discharge rate to adequately stress the aquifer (anticipated to be approximately 20 to 60 gallons per minute). After wells have fully recovered, a constant-rate pumping test will run for a minimum of 72 hours at each of the three locations. An evaluation of data will be conducted during the pumping test to determine the pumping test time required to assess for possible delayed-yield and boundary conditions. During the aquifer pumping tests, pressure-transducers will be placed in the pumping well, adjacent observation wells, and surrounding monitor wells (to measure background fluctuations during the test). Transducers attached to an *In-Situ* eight-channel datalogger will be used to collect data during the pumping test and during the recovery period after the pump is shut off. Water levels will also be manually measured with an electronic sounder to verify datalogger measurements. Ground water levels will be measured using dataloggers in select wells at least one week prior to and during the aquifer pumping tests to determine local variations that may influence interpretation of aquifer test data. River stage data will be obtained for the period before, during, and after the pumping test to determine the affects of river stage on water levels in the observation wells. Precipitation and barometric data will also be obtained for the period prior to and during the period of the tests.

Field data from the dataloggers will be evaluated by one of two software programs available for calculating hydraulic parameters and these results will be input into the computer models mentioned in Section 5.5.

5.4 Subpile Soil Sampling and Analysis

COPCs may have been sorbed in the upper few feet of the alluvial sediments (subpile soil) beneath the areas of the former tailings piles. Remedial action criteria for soil excavation and removal was based on a radiometric standard for radium-226; therefore, there is a potential that other contaminants (e.g., uranium and vanadium) remained in place. Evaluation of remediation strategies requires a reliable estimate of residual amounts of sorbed contaminants in the subpile soil that could provide a continuing source of ground water contamination to the alluvial aquifer. Residual source term could also contribute to human and ecological risk. Subpile soil sampling and analysis is detailed in Appendix B.

5.5 Determination of Distribution Ratios

As contaminated ground water migrates through soils and rocks, some of the contamination transfers between the solid and liquid phases. This phenomenon causes contamination to travel at a slower rate than the average ground water velocity. The chemical processes that cause this retardation can include adsorption, absorption, precipitation, diffusion into immobile porosity, and transfer to vapor phases. It is generally not possible to differentiate among all of these processes. However, for many aquifer systems, a bulk parameter (the distribution coefficient or K_d) has been used with some success to model the retardation of contamination. Most numerical ground water models use the K_d concept in simulations of contaminant transport. Site-specific K_d values are approximated from distribution ratio (Rd) values that are empirically determined. Samples will be collected during the drilling of background wells 300 and 301 at the NC site and analyzed to determine the distribution ratios. This activity is detailed in Appendix C.

5.6 Ground Water Flow and Transport Modeling

To demonstrate that COPCs will decrease to below standards in less than 100 years under the proposed natural flushing compliance strategy, ground water flow and transport modeling will be performed for the alluvial aquifer. Additional data for model input will be collected (as discussed in Sections 5.2 through 5.4) including hydraulic parameters of the alluvial aquifer, and distribution ratios for COPCs.

Modeling of the Slick Rock sites will take into consideration the complexity of the alluvial system. Potential influences on the alluvial system include seasonal irrigation, precipitation and evapotranspiration, and pumping of the domestic well in the area. Seasonal irrigation is conducted on the section of the Dolores River floodplain located north of the river between the two sites. Water used for the irrigation is pumped from the river at the east edge of the field. If needed, an estimate of the volume of water pumped from the river will be obtained from the landowner. Precipitation data will be obtained from a local station, and evapotranspiration estimates will be obtained from current literature. One domestic well is currently in production. This well is completed in the Navajo Sandstone and pumping of the well should not influence the alluvial aquifer. If needed, an estimate of the volume of ground water pumped from the well will be obtained from the land owner. Ground water flow and contaminant transport modeling for the Slick Rock sites will be performed using the Ground Water Analysis and Network Design Tool (GANDT) code, which was developed by Sandia National Laboratory.

The Dolores River and the Entrada Formation bedrock will define boundary conditions for the model. The Dolores River forms a natural boundary to the alluvial system to the north (NC site) and the east (UC site) of the Slick Rock sites and will likely be represented as a constant head boundary in the model. The south (NC site), west (NC site) and bottom of the alluvial aquifer will be defined by the Entrada Formation. The alluvial aquifer is laterally restricted by the Entrada formation that forms the terraces and canyon walls adjacent to the Dolores River. In addition, the alluvial aquifer is discontinuous and pinches out in areas where the Dolores River meets the canyon wall. The Entrada formation will be represented as a no flow boundary in the model.

Stochastic simulations will be performed, varying both flow and transport parameters, to evaluate the uncertainty of the concentrations predicted by the model. These stochastic simulations will be used to calculate mean concentrations and the probability of contamination remaining above acceptable levels across the sites at specific times for each COPC.

5.7 Water Sampling

Routine quarterly water sampling will commence at the Slick Rock sites in May 2000 and will include all existing monitor wells and surface water locations. Upon completion, monitor wells proposed in this work plan will be added to the sampling network. Data loggers will be installed in selected alluvial and bedrock wells to measure water levels over time. Analytical results and water level data will be added to the database and used in evaluation of site conditions for the final SOWP. A minimum of four rounds of data from the proposed wells will be evaluated and incorporated into the SOWP.

In addition to monitor wells, domestic well 672 will be sampled on a quarterly basis. This domestic well is the only well currently used in the Slick Rock area. This well is completed in the Navajo Sandstone and is located on the opposite side of the river and crossgradient from the Slick Rock sites. Concentrations of site-related contaminants from this well have been historically low, and site impacts are not expected.

5.8 Surveying

Surveying will be conducted upon completion of monitor well installation. All new and existing wells will be surveyed to obtain ground elevation, measuring point elevation, and horizontal coordinates. Ground and measuring point elevations will be surveyed to within 0.01 ft, and horizontal coordinates will be surveyed to within 0.1 ft.

To provide for additional river elevation data along the length of the Dolores River, measuring stakes will be installed in the river at each site. Three measuring stakes at the NC site and five measuring stakes at the UC site will be installed along the length of the Dolores River, upgradient, adjacent to, and downgradient of each site. The tops of the stake will be surveyed to within 0.01 ft so that a river elevation can be measured at that point.

5.9 Quality Assurance

The Slick Rock project will be conducted in accordance with the requirements of the UMTRA Ground Water Project Quality Assurance Program Plan. This plan details the project quality

assurance program and includes requirements for personnel training and qualification, quality improvement, control and distribution of documents, control of records, control of work processes, and audits and surveillances.

Quality assurance for sample collection and analysis is accomplished by following detailed procedures in order to maximize data precision, representativeness, and comparability. In addition, quality control samples are collected to assess precision and assess the effectiveness of equipment decontamination. Specific sample collection requirements and quality assurance requirements related to water quality samples are specified in the *Sampling and Analysis Plan for the UMTRA Ground Water Project* (SAP)(DOE 1999c). This document specifies the sample collection protocol, collection of quality control samples, analytical requirements, sample identification and handling, decontamination of sampling equipment, and data validation. Standard operating procedures for water quality sampling are found in the *Environmental Procedures Catalog* (DOE1999a) and are referenced in the SAP. Standard operating procedures and quality assurance measures for drilling, well installation, soil sampling, pumping tests, water level measurements, and surveying are specified in the *Environmental Procedures Catalog.*

The majority of samples collected for this investigation will be analyzed by the GJO Analytical Laboratory. The quality assurance program for the GJO Analytical Laboratory is specified in the *Analytical Chemistry Laboratory Administrative Plan and Quality Control Procedures* (WASTREN 2000); laboratory analytical procedures are detailed in the *Analytical Chemistry Laboratory Handbook of Analytical and Sample Preparation Procedures* (WASTREN 1999). Subpile soil analyses and determination of distribution coefficients will be conducted by the Environmental Sciences Laboratory. Quality assurance measures and analytical procedures are detailed in the *Environmental Sciences Laboratory Procedures Manual* (DOE 1999b).

6.0 Environmental Compliance Plan

The following are recommended actions to comply with Federal, State, and local laws and regulations.

6.1 Environmental Compliance Requirements/Actions

The actions described below are based on a review of the requirements under federal, state, and local laws and regulations to perform the work identified in this work plan. Exemptions from regulatory requirements and/or negotiated requirements have been documented.

6.2 National Environmental Policy Act Assessment

The proposed actions were reviewed to determine the need for assessment under DOE's National Environmental Policy Act (NEPA) regulations. Based on the initial review, it appears that the proposed drilling and monitoring activities fall within the scope of actions included in Categorical Exclusions for routine activities. The proposed work will occur in areas that were disturbed during surface remediation or previous characterization activities and surface disturbance relating to this scope of work will be minimal. However, an environmental checklist will be prepared to confirm this assumption.

6.3 Well Installation

Approximately 27 new wells will be installed at both the NC and UC sites at Slick Rock. Three wells will be used as pumping test wells, seven wells will be used as observation wells, and all wells will be used for ongoing water quality and water level monitoring. The purpose, location, and depths of the wells are described in detail in Tables 3 and 4, and Figure 5 in Section 5.0. Water from the aquifer pumping tests will be dispersed on the ground as described in Section 6.4.1.

Reclamation to all areas disturbed by the proposed activities will be coordinated with the landowner and may include recontouring and reseeding.

6.4 Waste Management

The strategy for managing investigation-derived waste (IDW) generated from well drilling/boring, development, and monitoring is tiered to the *UMTRA Ground Water Project Management Plan for Field-Generated Investigation Derived Waste* (DOE 1997a).

Proper implementation of this strategy will ensure that IDW is managed in a manner that is protective of human health and the environment and is in accordance with federal and state regulatory requirements.

6.4.1 Investigation-Derived Waste

The IDW generated during this investigation and subsequent monitoring activities will consist of both liquid and solid media. Examples of liquid IDW include well development water, well purge water, and aquifer pumping test water. Solid IDW will consist of drill cuttings. At each pumping test location, the estimated total volume of liquid IDW to be placed on the ground is 250,000 gallons. At all other locations, the estimated total volume of liquid IDW is 350 gallons. The estimated total volume of solid IDW from each of the 27 proposed wells is 0.2 to 0.5 cubic yards.

For background wells (i.e., wells outside of the footprint of surface remediation) both solid and liquid IDW will be dispersed in the area around the wells with no restrictions. This is allowable because neither the ground water nor the drill cuttings pose a risk to human health or the environment.

For wells within the former footprint of contamination, ground water IDW (excluding pumping test water from pumping wells 306 and 314) will be dispersed in the area around the well in accordance with the IDW Plan (DOE 1997a). Further restrictions will be placed on the ground water IDW generated from pumping wells 306 and 314 because higher concentrations of contaminants have been measured in these portions of the aquifer. Calculations based on historical ground water data were used to determine the proper dispersion of pumping test water in order to minimize risk to human health and the environment. Based on the calculations, ground water generated from pumping well 306 will be dispersed over an area greater than 22,000 square feet, and ground water from pumping well 314 will be dispersed over an area greater than 3,000 square feet. This will be accomplished by using a low spraying sprinkler system, or a series of drip lines branching from a single source. Ponding shall not be allowed during any pumping test dispersion.

For wells drilled within the footprint of surface remediation, solid IDW (drill cuttings) will be placed a minimum of 6 inches beneath the surface of the ground in the area of the well. Alternatively, the cuttings or borings from all of these wells may be placed in a common trench a minimum of 12 inches deep within the former tailings pile boundary. The clean fill material removed during the excavation will be placed over the IDW upon completion of the characterization activity. This will ensure that potential contaminants in the soil will not pose a risk to human health or the environment.

6.4.2 Management of Spills

Since the only significant equipment used to conduct the proposed activities are trucks, a back hoe, and a drilling rig, any spill will most likely be a petroleum product, such as fuel. Actions that prevent spills and overfills should be used when refueling drill rig generators or trucks in the field.

In the event of a spill, the following actions should be taken:

- Take immediate action to stop and contain the spill,
- Notify the MACTEC–ERS Site Manager, who will notify the MACTEC–ERS Project Compliance Officer,
- The Project Compliance Officer will report petroleum spills exceeding 25 gallons to DOE and other regulatory authorities (e.g., state, tribe, EPA regional administrator) within 24 hours,
- Ensure that the spill poses no immediate hazards by removing all potential fire hazards, and
- Avoid vapor inhalation and skin contact with the spilled material.

Spill clean up of petroleum products should entail:

- Removal of all of the stained soil, over-excavating a few inches,
- Placement of the excavated material on a plastic tarpaulin, and
- Periodic mixing of the soil with a shovel or by lifting the corners of the tarp and alternating ends to roll the material, and remove organic contamination.

When the soil no longer contains a flammable concentration of organic material, the material can be disposed of at a municipal landfill or at the Cheney Repository if it qualifies as residual radioactive material.

For spills of other regulated materials (e.g., nitric acid) the general rules are similar. Workers should stop and contain the spill, ensure that the spill poses no immediate hazards by removing all potential fire hazards, and avoid vapor inhalation and skin contact with the spilled material. For all spills, field personnel must contact the UMTRA Project Environmental Sciences point-of-contact as soon as possible for the regulatory requirements pertinent to specific types of spill clean up and notifications.

6.4.3 Waste Transportation and Disposal

Although it is not anticipated, any regulated wastes will be transported in accordance with U.S. Department of Transportation regulations and disposed of in compliance with Federal and State regulations and the permit and/or licensing requirements of the receiving facility. See Section 7 of the IDW Plan for more detailed information. Any questions regarding the off-site shipment of regulated wastes should be directed to the Transportation Coordinator of Environmental Sciences.

6.5 Cultural Resources Issues

The areas identified for the proposed actions currently have monitor wells and the area was disturbed during surface remediation. Cultural surveys conducted at the time of the original well installation showed no resources were present. However, should evidence of a site be encountered during the proposed activities, all work in the area will be stopped until evaluation and recovery can be completed. Since the proposed wells and sediment sampling are in previously disturbed areas, no additional cultural resource inventories will be conducted.

6.6 Threatened and Endangered Species

Consultation with the U.S. Fish and Wildlife Service (USFWS) on March 7, 2000, uncovered the presence of four potential species of concern; the Bald Eagle, the Southwest Willow Flycatcher, the Mexican Spotted Owl, and the Uncompahgre fritillary butterfly. Although Bald Eagles have been observed roosting in the area, there are no known nesting sites in the vicinity. Because the proposed activities will be occurring in the late fall, it is unlikely that the Southwest Willow Flycatcher will be present at or near the areas under consideration. Neither of the Slick Rock sites contains suitable habitat for the Mexican Spotted Owl. The Uncompahgre fritillary butterfly is only found above 11,000 ft in elevation, so no possible habitat exists.

6.7 Sensitive Ecological Areas/Wetlands

There is no current wetlands delineation, so the possibility exists that proposed locations fall within areas under the jurisdiction of U.S. Corps of Engineers Nationwide Permit Number 199575020, Special Use Resolution 1995-9. A wetland delineation is scheduled for late spring. Once the wetlands are delineated, any proposed locations within the designated wetlands or other sensitive areas will be relocated.

Any areas disturbed by the proposed activities will be reclaimed to their condition prior to the proposed activities.

6.8 Off-Road Activities

Existing roads and trails (including previous routes used to access wells) will be used wherever possible. All off-road activities, routes, and access will be cleared with the landowner and the Environmental Site Compliance Coordinator to minimize impact to soils, vegetation, and other natural resources. If there are periods of inclement weather, the field supervisor will consult with

the landowner to determine under what conditions off-road travel will be permitted. Any adverse impacts created as a result of off-road travel, including rutting and erosion, will be mitigated.

7.0 References

U.S. Department of Energy (DOE), 1994. *UMTRA Project Water Sampling and Analysis Plan, Slick Rock, Colorado*, DOE/AL/62350-146.

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_______, 1995b. *Environmental Assessment of Remedial Action at the Slick Rock Uranium Mill Tailings Sites, Slick Rock, Colorado*, DOE/EA-0339.

_______, 1995c. *Remedial Action Plan and Site Design for Stabilization of the Inactive Uranium Mill Tailings Sites at Slick Rock, Colorado*, DOE/AL/62350-21F Rev 0.

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_______, 1999a. *Environmental Procedures Catalog*, continuously updated, GJO-6.

_______, 1999b. *Environmental Sciences Laboratory Procedures Manual*, MAC-3017, Rev.0.

_______, 1999c. *Sampling and Analysis Plan for the UMTRA Ground Water Project*, MAC-GWADM 19.1-1 Rev.4

WASTREN, Inc., 1999. *Laboratory Handbook of Analytical and Sample Preparation Procedures*, continuously updated.

_______, 2000. *Analytical Chemistry Laboratory Administrative Plan and Quality Control Procedures*, continuously updated.

End of current text

Appendix A

Drilling Statement of Work

EXHIBIT A

U.S. Department of Energy

UMTRA Ground Water Project

Drilling Statement of Work—Slick Rock, Colorado

May 2000

Prepared by
U.S. Department of Energy
Grand Junction Office
Grand Junction, Colorado

Project Number UGW–511–0021–02–000
Document Number U0090200

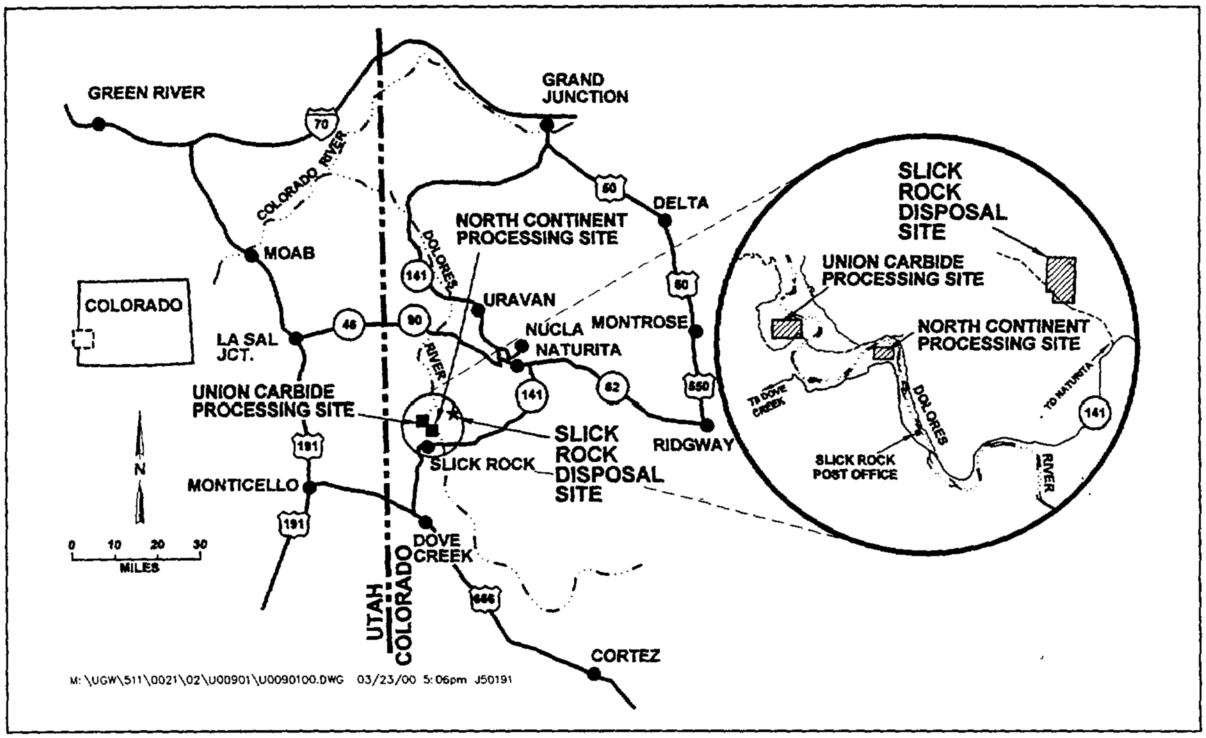

Figure 1–1. Slick Rock Location Map and Routes to Medical Center Cities

Slick Rock to:

Dove Creek	24 miles	(Medical Clinic)
Naturita	40 miles	(Medical Clinic)
Monticello	46 miles	(Hospital)
Cortez	59 miles	(Hospital)
Montrose	82 miles	(Hospital)
Grand Junction	132 miles	(Hospital)

Medical Phone Numbers	
Primary	**Secondary**
Emergency	
Dove Creek Ambulance (970) 677-2500 or 911 Police or Fire (San Miguel County-Telluride) (970) 728-4442 or 911	Naturita Ambulance (970) 864-7601 or 911
Air Ambulance Service	
St. Mary's Air Life, Grand Junction, Colorado 1-800-332-4923	Farmington, New Mexico 1-800-452-9990.

Cellular Phones

Cellular Phones will be available on-site during drilling activities.
Note: Cellular service for 911 calls is available from this area.

Contents

Figures

Tables

1.0 Introduction

This Statement of Work (SOW) describes the activities for installation of monitor wells that are part of the ground water investigation at the Slick Rock, Colorado, Uranium Mill Tailings Remedial Action (UMTRA) sites.

1.1 Site Location and Background

Two former uranium-processing sites are located near the small community of Slick Rock in San Miguel County, Colorado (see Figure 1–1, inside front cover). One site is located a mile downstream (northwest) from the Slick Rock Post Office, beside the Dolores River, and is known as the North Continent (NC) processing site. It is located in Section 30, T44N and R18W. The other site is located further down the Dolores River, approximately 1 mile, and is known as the Union Carbide (UC) processing site. It is located in Section 25, T44 N and R19W (New Mexico Principal Meridian). Both sites are situated on alluvial deposits adjacent to the Dolores River at an elevation of approximately 5,500 feet (ft).

Uranium ore-processing operations took place at the NC site from 1931 to the early 1960s. Ore processing operations at the UC site took place from 1957 to 1961. UMETCO Corporation presently owns both sites. The U.S. government owns the mineral rights and the U.S. Department of Energy (DOE) administers these mineral rights. At the present time, part of the NC site is included in a larger lease to Gold Eagle Mining, Incorporated.

DOE completed the surface remediation of abandoned uranium mill tailings and other residual radioactive materials associated with the former milling operation in 1996. The contaminated materials, 1,140,000 tons, were relocated to a disposal cell approximately 6 miles northeast of Slick Rock at Burro Canyon. The former processing sites are currently covered and regraded with clean fill material and seeded with native grasses.

1.2 Hydrogeology

Three hydrostratigraphic units underlie the NC and UC sites. These units are the Dolores River Quaternary-alluvium, the Jurassic Entrada Formation (Slick Rock and Dewey Bridge Members), and the Navajo Sandstone (Figure 1–2). Ground water conditions in these units are dependent on lithology, structure, stratigraphic, and topographic features.

The Dolores River alluvium ranges in thickness from 18 to 26 ft and consists of unconsolidated clayey sands, sandy gravel, and cobbles. Depths to the unconfined ground water range from 5 to 20 ft. Alluvial terraces that exist above and adjacent to the Dolores River are typically dry.

The Entrada Formation underlies the Dolores River alluvium and crops out in both former tailings areas. The Slick Rock Member underlies the Dolores River alluvium at the NC site. The Slick Rock Member consists of eroded light brown fine-grained sandstone and reddish brown sandy shale. The Dewey Bridge Member underlies the Dolores River alluvium at the UC site. The Dewey Bridge Member is composed of reddish brown clayey siltstone, fine-grained sandstone, and shale. Ground water is expected to be semi-confined when medium- to coarse-grained sediments are interbedded with clayey siltstones and shales.

The Navajo Sandstone underlies the Entrada Formation at both sites. The Navajo consists of light brown to reddish brown, fine-grained sandstone. Depths to the Navajo Sandstone range from 53 to 173 ft. The Navajo Sandstone may be up to 420 ft thick in this area. Two previously drilled wells in the Navajo Sandstone, numbers 669 and 670, have artesian flow.

The alluvial aquifer beneath both sites has been contaminated from the former uranium milling operations. These contaminants have exceeded UMTRA ground water standards. Alluvial ground water contamination consists of gross alpha, molybdenum, radium-226 + radium-228, selenium, and uranium at the NC site. Contamination at the UC site consists of the above contaminants plus cadmium and nitrate.

2.0 Objective and Scope

The objectives of this SOW are to install monitor wells to help define various hydraulic parameters, background water quality, extent of contamination, ground water movement, and determination of ground water interaction between alluvial and bedrock aquifers.

2.1 Drilling Scope

The general scope of work is listed below (see Figures 2–1 and 2–2).

NC Site

- Drill two alluvial monitor wells (300 and 301) to determine background water quality for both the NC and UC sites (Figure 2–1).
- Drill four alluvial monitor wells (302, 303, 305, and 309) to determine water elevation and ground water quality in the alluvial aquifer.
- Drill three alluvial monitor wells (pumping test well cluster) (306, 307, and 308) to be used as a pumping well and two observation wells.
- Drill three alluvial monitor wells (310, 311, and 312) to determine if ground water contaminants have migrated under the river and into the alluvium on the north side of the river.
- Drill four additional alluvial monitor wells if contamination is detected in wells 310, 311, or 312.
- Drill one Entrada monitor well (304) to determine if downward migration of contaminated alluvial ground water has infiltrated into the Entrada Formation.
- Drill one Navajo Sandstone monitor well if contamination is detected in Entrada monitor well 304.
- Drill three boreholes (241, 242, and 243) upgradient of the NC site for subpile soil sampling (Figure 2–2).
- Drill six boreholes (261 to 266) onsite for subpile soil sampling.

UC Site

- Drill three alluvial monitor wells (pumping test well cluster) (314, 315, and 316) to be used as a pumping well and two observation wells.
- Drill three alluvial monitor wells (pumping test well cluster) (321, 322, and 323) to be used as a pumping well and two observation wells.

- Drill one Entrada monitor well (317) installed adjacent to pumping well 314, to determine if there is a hydraulic connection between the alluvial and Entrada Formation aquifers.
- Drill four additional alluvial monitor wells (313, 318, 319, and 320) to achieve an adequate spatial distribution of wells and to be used for flow and transport modeling.
- Drill three Entrada monitor wells (324, 325, and 326) to determine if contaminated alluvial ground water has migrated into the Entrada Formation.
- Drill eight boreholes (267 to274) for subpile soil sampling.

See Table 3–1 Monitor Well Completion List, which lists the well number, well type, estimated total depth, formation, casing diameter, screened interval, and location.

2.2 Sampling Scope

The Subcontractor shall collect continuous samples during drilling of all wells so that lithologic descriptions can be recorded by the Contractor's geologist. At background locations 300 and 301, aquifer material collected from the top of the water table down to bedrock and will be submitted to the laboratory by the Contractor's geologist to determine distribution ratios.

The Subcontractor shall also collect soil samples at three locations upgradient of the NC site (241, 242, and 243), six onsite locations at the NC site (locations 261 to 266), and eight locations at the UC site (locations 267 to 274) shown in Figure 2–2. Two samples shall be collected from each location, one from immediately below the fill material and one from about 3 ft deeper (all samples will be collected above the water table).

3.0 Performance Requirements and Specifications

Requirements and specifications for the drilling tasks are presented in this section. All well locations, the number of boreholes and wells, the quantities of samples, well completion material and dimensions, and the depths of wells are estimates established by MACTEC–ERS (MACTEC) and are subject to change as additional information is obtained during the work. All requirements and specifications of this SOW are considered minimum and therefore, equal to one another in terms of importance. Responses failing to meet all of these requirements and specifications will not be considered further for award. The Subcontractor shall furnish all necessary labor, equipment, material, supervision, and any other items required to complete the work described herein.

The Subcontractor shall drill boreholes that are plumb and straight so that there will be no interference with installation, alignment, operation, or future removal of pumps or other downhole equipment. The Subcontractor shall not use contaminating additives (e.g., diesel fuel, oil, barite), hydrocarbon-based lubricants (e.g., grease or oil), and biocides (e.g., formaldehyde) in the borehole or well. The Subcontractor shall use only nonhydrocarbon-based lubricants, such as silicon, Teflon, or vegetable oil on any downhole equipment or tools.

The Contract award date is anticipated to be July 14, 2000. The Subcontractor shall commence fieldwork 46 calendar days later on August 29, 2000. The Subcontractor shall submit a work schedule with its proposal. The Subcontractor's proposed work schedule shall contain a start date, a completion date, and the total number of calendar days required to complete the work.

3.1 Monitor Well Drilling

The Subcontractor shall drill all wells using the rotosonic method. The Subcontractor shall furnish all necessary labor, equipment, and material required to complete the work in accordance with this SOW.

3.2 Well and Borehole Abandonment

The need for well abandonment is not anticipated at this time. However, if abandonment is necessary, the Subcontractor shall abandon wells in accordance with Rule 15 of the Colorado Water Well Construction Rules (2 CCR 402-2). The Subcontractor shall abandon boreholes by injecting 30 percent solids bentonite grout through a tremie pipe placed within a few feet from the bottom of the borehole. Grout will be placed from the bottom of the borehole to the surface in one continuous operation.

3.3 Well Installation

The Subcontractor shall complete wells as nominal 2-inch I.D. and nominal 6-inch I.D. wells (Table 3–1). The Subcontractor shall install well materials when the desired total depth of the borehole is reached, as determined by the MACTEC Project Drilling Coordinator (PDC). The Subcontractor shall measure the total depth of the borehole to the nearest tenth of a foot and report the measurement to the PDC. The wells shall be installed and completed in accordance

Table 3–1. Monitor Well Completion List

Well Number	Well Type	Estimated Total Depth (ft)	Formation	Casing Diameter (inches)	Screened Interval (ft)	Location
Wells to be Installed at the NC Site						
300	Monitor	20	Alluvium	2	10-20	Upgradient
301	Monitor	20	Alluvium	2	10-20	Upgradient
302	Monitor	20	Alluvium	2	10-20	Onsite
303	Monitor	20	Alluvium	2	10-20	Onsite
304[a]	Monitor	50	Entrada	2	30-50	Onsite
305	Monitor	20	Alluvium	2	10-20	Onsite
306	Pumping	20	Alluvium	6	5-20	Onsite
307	Observation	20	Alluvium	2	5-20	Onsite
308	Observation	20	Alluvium	2	5-20	Onsite
309	Monitor	20	Alluvium	2	10-20	Onsite
310[b]	Monitor	20	Alluvium	2	15-20	Offsite North of River
311[b]	Monitor	20	Alluvium	2	15-20	Offsite North of River
312[b]	Monitor	20	Alluvium	2	15-20	Offsite North of River
Wells to be Installed at the UC Site						
313	Monitor	20	Alluvium	2	10-20	Onsite – Floodplain
314	Pumping	20	Alluvium	6	5-20	Onsite – Floodplain
315	Observation	20	Alluvium	2	5-20	Onsite – Floodplain
316	Observation	20	Alluvium	2	5-20	Onsite – Floodplain
317	Observation	50	Entrada	2	30-50	Onsite – Floodplain
318	Monitor	20	Alluvium	2	10-20	Onsite – Floodplain
319	Monitor	20	Alluvium	2	10-20	Onsite – Floodplain
320	Monitor	20	Alluvium	2	10-20	Onsite – Floodplain
321	Pumping	20	Alluvium	6	5-20	Downgradient – Floodplain
322	Observation	20	Alluvium	2	5-20	Downgradient – Floodplain
323	Observation	20	Alluvium	2	5-20	Downgradient – Floodplain
324	Monitor	50	Entrada	2	30-50	Onsite – Floodplain
325	Monitor	65	Entrada	2	45-65	Onsite – Mill Area
326	Monitor	65	Entrada	2	45-65	Onsite – Mill Area

[a] Drilling of an additional well in the Navajo Sandstone will be required if contamination is detected in this well
[b] Drilling of four additional alluvial wells will be required if contamination is detected in these wells.

with Figure 3–1. The Subcontractor shall complete well installations with a uniform and complete filling of the annular space with filter pack, seal above the filter pack, and grout that are free of voids or "bridges."

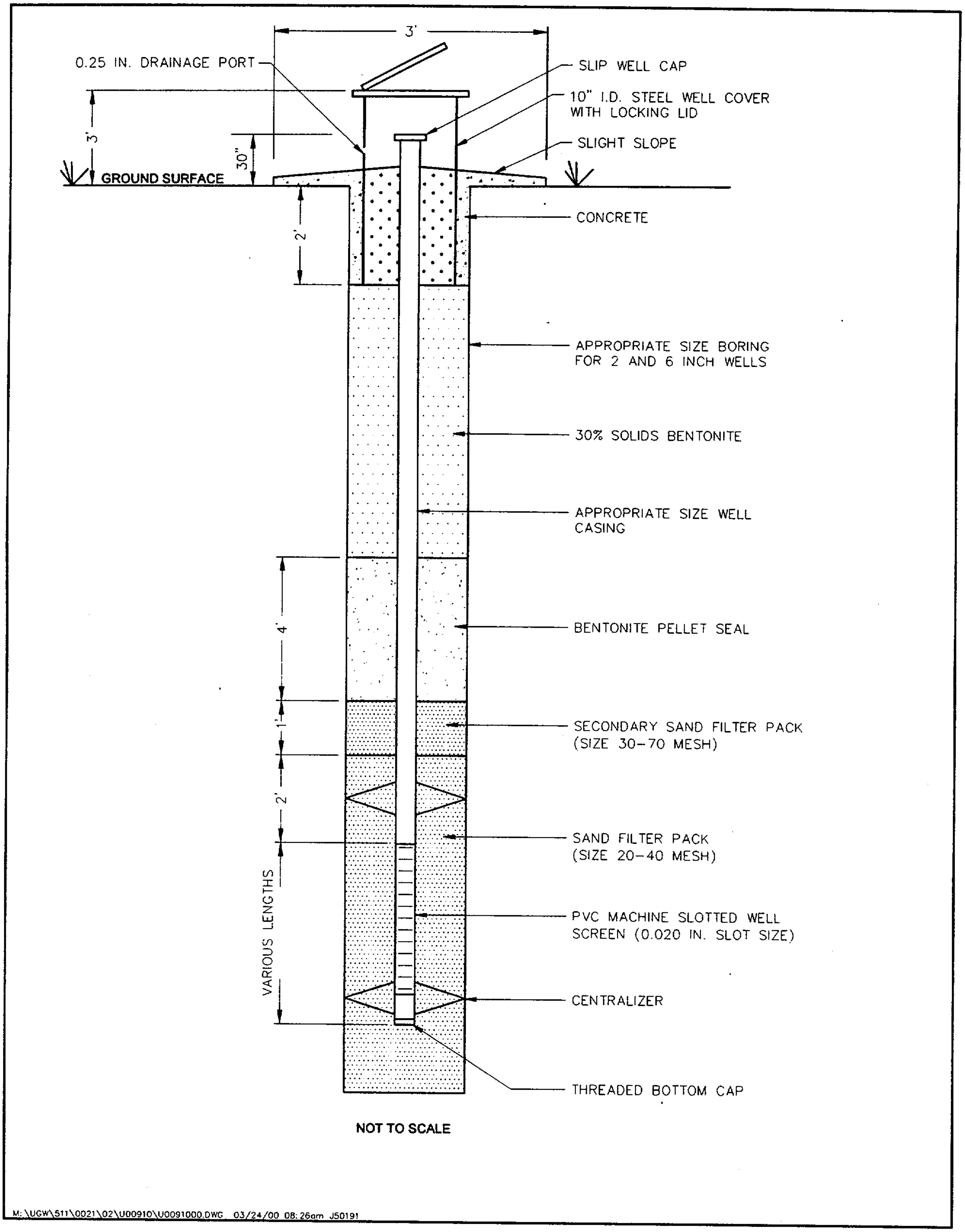

Figure 3–1. Typical Well Completion Detail

The Subcontractor shall redrill any borehole that is too shallow due to "caving." If the boring is determined by the PDC to be too deep, the Subcontractor shall place 10-20 silica sand into the borehole to the desired depth.

All well installation materials (e.g., sumps, screens, casings, primary and secondary filter packs, bentonite pellets, bentonite grout, and cement) shall be delivered to each well site in factory sealed containers until used in the well installation.

Well Completions

Borehole diameter: Sufficient size to provide a nominal 2-inch annular space around the entire circumference of the screened interval of the well.

Sump: 6-inch deep bottom cap, flush threaded, appropriate diameter, Schedule 40 PVC casing.

Centralizer: Stainless steel, nominal 2-inch.

Screen: Flush threaded, nominal 6-inch I.D. diameter, stainless vee wire wrapped (pumping wells 302, 314, and 321) slot size 0.020 inch, 2-inch PVC vee wire wrapped for all others, Schedule 40 PVC, (appropriate well size) slot size of 0.020 inch.

Casing: Flush threaded, nominal 2- or 6-inch I.D. diameter, Schedule 40 PVC, (appropriate well size).

Primary Filter pack: Colorado® silica sand, size 10-20 or equal.

Secondary Filter pack: Colorado® silica sand, size 20-40 or equal.

Bentonite seal: 1/4-inch bentonite pellets.

Grout: 30 percent high solids bentonite grout.

Top Cap: Schedule 40 PVC, (appropriate well size).

Concrete: Compressive strength 3,000 pounds per square inch at 28 days—"Ready mix" or equivalent.

Locking Cap: Royer® locking cap or equivalent, for surface casing type well protectors or appropriate size premanufactured square steel well protectors with lockable lids.

3.4 Well Development

Pre-Completion: The Subcontractor shall vibrate the drill string when withdrawing casing and placing well materials to allow for settling of the filter pack and avoid bridging of materials. The vibration of the drill string during placement of well materials will serve as the pre-completion development of the well. The Subcontractor shall measure the depth well materials to the nearest tenth of a foot and report the measurements to the PDC. Installation of well materials will be conducted in accordance with Figure 3–1.

When the top of the secondary filter pack is at the correct height, as determined by the PDC, the Subcontractor shall then begin placement of a 4-ft bentonite seal (1/4-inch bentonite pellets). The Subcontractor shall then hydrate the bentonite pellets by adding 5 gallons of water, if necessary, and allowing at least a 15 minute period for hydration and expansion of the pellets.

The Subcontractor shall place the 30 percent solids bentonite grout seal in the annular space from the top of the bentonite seal to within 2 ft of the ground surface. The Subcontractor shall place the grout by pumping it through a tremie pipe in one continuous action completely filling the annular space. The Subcontractor shall prepare the grout in accordance with the manufacturer's instructions and supervision of the PDC.

Post-Completion Development: Post-completion development by surging, pumping, and bailing will be conducted by the Contractor. Well development will be considered complete when ground water pumped from the well has a turbidity less than 5 NTUs.

3.5 Monitor Well Head Protection

The Subcontractor shall provide and install a Schedule 40 PVC top cap of appropriate size, for the PVC well casing. A Royer® type lockable metal cap shall be installed for steel surface casing type well covers. If steel casing is not used an appropriate size steel well cover with a lockable cap shall be provided. The well cover shall be centered in a 3-ft by 3-ft by 4-inch thick concrete pad. The top of the concrete pad shall extend 4 inches above ground level with a slight slope to facilitate drainage. The finished height of the lockable metal cap shall be a maximum of 36 inches above ground level. MACTEC will supply the locks.

3.6 Source of Water

The Subcontractor shall obtain approved water for drilling and other tasks associated with the work from an offsite source. Potential offsite sources include the Naturita municipal water supply, the Dove Creek municipal water supply, or the well at the Dry Creek Basin store. The Subcontractor shall have the necessary equipment to obtain, transport, and store water for use at the drill sites.

Tanks, hoses, pumps, and any other equipment used to transport or store the water shall be clean and free from all contamination. Further, the Subcontractor shall protect the water from contamination during storage.

3.7 Equipment Cleaning

The Subcontractor shall prevent the cross-contamination of all wells. High-pressure steam cleaning shall be used to remove debris from equipment at each drilling location before moving to a new location and before leaving the project site. Water from the approved water source shall be used for all cleaning operations. The PDC will direct equipment cleaning and deem it clean when it is visibly free of all soil, oil, grease, and previous fluids.

3.8 Drill Cuttings and Fluid Disposal

The Subcontractor shall place drill cuttings in excavated pits at the NC and UC sites after each onsite well is completed. Fluids at these sites shall be dispersed on the ground. The Subcontractor shall evenly spread drill cuttings and fluids on the ground surface around each well after it is completed on offsite wells.

3.9 Disposal Pits

The Subcontractor shall excavate a disposal pit at each site no larger than 6 ft by 12 ft by 3.5 ft deep. The cover material shall be removed and stockpiled no closer than 2 ft away from the edge of the pit. The bottom of the pit shall not intersect the water surface. The Subcontractor shall place drill cuttings in the pits and when drilling activities have been completed, reclaim the pit with the previously stored excavated soil.

3.10 Trash Disposal

The Subcontractor shall collect and dispose of job-generated, non-hazardous, trash at a minimum of one time per day or as necessary, at the end of each day, and maintain proper site housekeeping at all times. The Subcontractor shall provide an onsite trash receptacle for this task.

3.11 Equipment Maintenance

The Subcontractor may perform equipment maintenance, fueling, and repairs on location with the prior approval of the PDC. If, during this maintenance operation, the Subcontractor spills any hydrocarbon-based fluid, antifreeze, or any other material, the Subcontractor shall immediately clean up and remove the spilled material at their own time and expense. If, at any time, there is fluid leakage from any piece of the Subcontractor's equipment, the Subcontractor shall "diaper" the equipment or use plastic sheeting to prevent fluids from getting on the ground surface until the leak is fixed.

4.0 Contingencies and Site Procedures

This section includes procedures for operations at the site. Included in this section are references to specific Articles in the *Terms and Conditions for Subcontracts and Purchase Orders over $25,000* (Terms and Conditions) (GJO-PROC-114, August 1997) to the subcontract. The Subcontractor is reminded that although reference is made to a few Articles in the Terms and Conditions, all applicable Articles in the Terms and Conditions govern the subcontract.

4.1 Site Access

Most of the drilling and sampling sites are accessible by existing roads or open ground. However, minor road construction or improvement may be necessary. The Subcontractor shall not move equipment off existing roads to the drilling sites without the approval of the PDC. Driving off established roads shall be kept to a minimum.

4.2 Site Conditions

The Subcontractor shall be knowledgeable of general and local site conditions that may affect the cost or quality of the performance of the work, including the suitability of the Subcontractor's equipment to perform the work. Refer to Article 40 of the Terms and Conditions.

4.3 Loss of Drilling Equipment and Hole Abandonment

Refer to Article 38 of the Terms and Conditions.

4.4 Daily Drilling Report

The Subcontractor shall furnish to the MACTEC PDC a complete daily (or shift) drilling log detailing all rig functions, depths, sample intervals, bit records, pipe tallies, casing, screen and other materials used, as well as any other pertinent drilling and safety data (including "tailgate" safety meetings and "rig inspections"). This information shall be recorded on the Daily Drilling Report furnished by MACTEC (Figure 4–1); ***or, subject to prior approval from MACTEC, on a Subcontractor-supplied form that contains the same information.*** **The daily Drilling Report form shall be examined and signed each day or shift by a designated MACTEC PDC and the Subcontractor field supervisor.** The Daily Drilling Report is subject to further audit by MACTEC technical monitor assigned to this project or by MACTEC Drilling Coordinator. Any errors found on this report by the Subcontractor shall be reported to the MACTEC PDC as soon as possible for reconciliation. The Daily Drilling Report is a three-part, carbonless form. **The original (white) copy of this form shall be returned to MACTEC with the Subcontractor's invoices(s).** The yellow copy will be retained in the field by the MACTEC PDC, and the pink copy may be retained by the Subcontractor to use as a rig copy.

4.5 Utilities Clearance

MACTEC will locate all underground and overhead utilities, such as power lines or gas pipelines, on the site prior to commencement of work. The Subcontractor shall repair any damage to utilities during the performance of work. The liability of the cost of repairs shall be in accordance with Article 73 of the Terms and Conditions (GJO-PROC-114).

Grand Junction Office
2597 B ¾ Road
Grand Junction, CO 81503
(970) 248-6000

Drilling Report

State ________ County __________ Project __________________________ Hole Name _________________________ Hole No. __________

Drilling Contractor ______________________________________ Rig Type _______________________________________ Rig No. __________

From A.M. P.M	To A.M. P.M.	Footage			Drilling (check)					Description of Work
		From	To	Hole Size	Drl	Cor	Rem	Agr	Sam	

Materials Used (e.g., casing, cement, water, mud, etc.)	Remarks
	Drill Crew
	Driller ____________________
	Helper ____________________
	Helper ____________________
	Other ____________________

Contract Foreman ______________________ GJO Representative ______________________ Report No. ________________ Date ________

GJPO 1706
Rev. 10/96

White—Return to GJO with Invoices(s) Canary—GJO Field Copy Pink—Rig Copy

Figure 4–1. Daily Drilling Report

4.6 Quality Assurance

MACTEC will oversee all fieldwork. The Subcontractor shall perform in accordance with the requirements, specifications, and procedures set forth herein. Periodic surveillance visits may be scheduled to verify Subcontractor's compliance with the requirements, specifications, and procedures set forth herein.

4.7 Permits and Licenses

MACTEC will provide all necessary access and exploration permits as well as any permits for cuttings/fluid disposal as required by Federal, State, or other controlling agencies. The Subcontractor shall provide any drilling and/or contractor license(s) required by Federal, State, or other controlling agency's authority.

4.8 Material Storage Facility

MACTEC will provide an area (lockable gate and barbed wire fencing) to the Subcontractor for storage of its drilling equipment and material storage.

4.9 Inventory

Prior to starting work, the Subcontractor and the MACTEC PDC shall conduct an inventory to ensure adequate materials and supplies to perform the work are on the site and usable. This inventory, signed by the Subcontractor and MACTEC PDC, will be entered in MACTEC PDC's field notebook and a copy made available to the MACTEC Contract Administrator.

End of current text

5.0 Health and Safety

All work shall be suspended by the PDC when an unsafe practice or condition is observed. Work shall not proceed until the unsafe practice or condition is corrected and the PDC, or designee, approves the resumption of work. The Subcontractor shall not be compensated for efforts required to correct any unsafe practice or condition created by its actions.

All applicable safety regulations and requirements shall be strictly adhered to at all times. These regulations and practices shall include, but are not limited to, the wearing of approved safety hats, safety shoes, and safety glasses, etc. No unauthorized personnel, private vehicles, cameras, firearms, personal pets, illicit drugs, or alcoholic beverages shall be allowed on the designated project area.

The PDC, or designee, in collaboration with MACTEC Site Safety Supervisor, will be responsible for operational health and safety coverage during the drilling activities. This may include the issuance of personal protective equipment such as coveralls, gloves, and boot covers for workers. All Subcontractor personnel shall adhere to MACTEC operational health and safety regulations as outlined in the *Drilling Health and Safety Requirements*, MAC–2012, Revision 2, May 1999. All Subcontractor personnel (and alternates) who will work on this project shall be required to attend a pre-work briefing on the drilling health and safety requirements and the project safety plan, prior to any work being performed on this project. This briefing-orientation will be held on-site as soon as the Subcontractor has mobilized their equipment to the project site.

The "Statement of Understanding" contained in Appendix A of the *Drilling Health and Safety Requirements*, MAC–2012, Revision 2, May 1999, shall be signed by all Subcontractor personnel prior to working on this project.

Vehicular and pedestrian traffic may be present on the access roads. Therefore, the Subcontractor shall use prudent operating practices at all times and confine its activities to those areas within the scope of this SOW. Full cooperation with authorities and property owners is mandatory. Any questions or inquiries from the public shall be referred to the PDC, or designee.

5.1 Site Sanitation Facility

The Subcontractor shall provide potable water and a portable toilet in accordance with 29 CFR 1926.51 (OSHA).

End of current text

6.0 Subcontractor Qualifications, Performance, and Requirements

6.1 Subcontractor Qualification

Due to the technical nature of the work, the successful offer shall be a first-tier subcontractor to MACTEC, shall have a minimum of 5 years business experience in environmental water well drilling, and shall have the ability to provide the necessary and required drilling equipment. The driller shall have a minimum of 3 years drilling experience in environmental drilling and well installations.

6.2 Weather Days

The Subcontractor shall not be compensated nor penalized for any delays caused by weather. If unforeseeable delays occur that are uncontrollable by MACTEC or Subcontractor, the MACTEC Contract Administrator may extend the completion date. Credit of days due to weather shall be added to the period of performance. A "weather day" applies to any normal work day when weather conditions deteriorate to the point that field work is neither safe, nor practical and when 4 hours or less of work have been completed. The Subcontractor, in consultation with the PDC, will decide whether or not to continue work.

6.3 Standby Time

Standby time is lost work time caused by MACTEC activities. The Subcontractor shall be paid in accordance with the stipulated standby time rate. **Standby time will only be paid when authorized by MACTEC PDC.** Standby time will not be paid for Subcontractor equipment breakdown, missing Subcontractor equipment, insufficient supplies, or missing or tardy Subcontractor personnel.

6.4 Work Day and Rotation Schedule

The normal workday will consist of a minimum of eight (8) hours per day or through completion of a given well or boring. The workday shall be limited to the period of time starting no earlier than one-half hour before sunrise and ending no later than one-half hour after sunset. In all cases, MACTEC reserves the right to limit the length of the workday based on safety concerns. The Subcontractor is responsible for obeying all Federal and State labor laws, rules, and regulations. Holidays excepted, the normal work schedule will consist of a "10 day on - 4 day off" rotation and will begin on a Tuesday and end on Thursday of the following week, or as mutually agreed.

After the work is started, the work schedule may only be changed or altered with the written approval of MACTEC PDC. Any desired change shall be submitted in writing to the MACTEC Contract Administrator by the Subcontractor at least five (5) working days prior to the desired change.

6.5 Submittals

The deliverables are listed below in Table 6–1.

Table 6–1. Submittal Schedule

Submittal	Schedule
Technical Proposal Exhibit B (Technical Approach by Task, Proposed Equipment List, Company Personnel and Experience)	Submit with response to the Request For Proposal (RFP)
Business Proposal Exhibit C	Submit with response to the RFP
Proposed Work Schedule	Submit with response to the RFP
Filter pack specifications	Submit with response to the RFP
Bentonite pellet and grout specifications	Submit with response to the RFP
Screen size specifications	Submit with response to the RFP
MSDS sheets for all materials to be brought on site and chemical inventory. Include type and brand of downhole tool lubricants to be used. Submit to the MACTEC PDC.	No later than 5 working days prior to mobilization or delivery to the site
Work Schedule Change Request submitted to the MACTEC Contract Administrator.	No later than 5 working days prior to the effective date of the requested change
Copies of reports, logs, and other required documents submitted to the State	No later than 30 calendar days after completion of work
Subcontractor Invoicing	As determined by Contract Administrator

Appendix B

Subpile Soil Sampling and Analysis

Subpile Soil Sampling and Analysis

Background

Contaminants of potential concern (COPCs) may have been sorbed in the upper few feet of the alluvial sediments (subpile soil) beneath the area of the former tailings piles. Shallow soil contamination was removed during surface remediation completed in 1996. Remedial action criteria for soil excavation and removal was based on a radiometric standard for radium-226; therefore, there is a potential that other contaminants remained in place. Evaluation of remediation strategies requires a reliable estimate of residual amounts of sorbed contaminants in the subpile soil that may behave as a continuing source of ground water contamination. Native soils beneath the former tailings piles will be tested to determine if uranium (and vanadium at the UC site) is present that could provide a continuing source of ground water contamination to the alluvial aquifer and that could contribute to human and ecological risk. Uranium and vanadium were chosen from the COPC list because they are good indicators of subplie contamination, and they represent the high (uranium) and low (vanadium) ends of the spectrum of contaminant mobility in ground water.

Because uranium and vanadium occur naturally in sediment, analytical results from the millsite will be compared to analytical results from background areas. Soil contaminants can leach into ground water by mechanisms such as (1) infiltration of precipitation, (2) a rising water table, or (3) changing chemical conditions due to land use changes (e.g., fertilizer application). Representative leaching tests will be used to examine these types of scenarios. The location of a contaminant source will affect the remediation strategy used at the sites and may influence values assigned to modeling parameters.

Sample Selection and Collection Methods

Samples will be selected from areas of the site that are most likely to have contaminated subpile soils. Soils directly beneath the former tailings piles will be sampled and analyzed. Samples will be collected with a drill rig below the fill material at six onsite locations at the NC site (locations 261 to 266), and eight locations at the UC site (locations 267 to 274) shown in Figure B–1. Two samples will be collected from each location, one from immediately below the fill material and one from about 3 ft deeper (all samples will be collected above the water table). Samples from three additional locations of similar lithology will be analyzed to characterize background (locations 241, 242, and 243).

Sample Analysis

Samples will be air-dried (no oven heat). If the samples contain significant amounts of gravel, they will be sieved using a No. 4 sieve (4.8 millimeters [mm]) to obtain grain sizes suitable for laboratory analysis. Because soil contaminants are likely to be in the fine-grained material, sieving will bias analytical results toward higher solid-phase concentrations than are actually present. Weight fractions of sieved samples will be recorded so correction factors can be calculated if desired.

The mobility of contaminants of interest will be determined by performing contaminant extractions using deionized water and synthetic alluvial ground water. Deionized water will

serve as a surrogate rain water, characterizing contaminant leachability during precipitation infiltration. Extractions using synthetic ground water will characterize the mobility of subpile soil contaminants below the water table. Contaminant extractions will be performed sequentially, first with deionized water, then with synthetic ground water. The same sample will be used in each extraction to preclude problems arising from sample variability. The extraction using synthetic ground water will be harsher than the deionized water extraction, and will therefore be capable of solubilizing additional contamination. Chemical extraction and analysis methods will be capable of detecting small concentrations of contaminants (e.g., 2 micrograms per liter [µg/L] uranium in the leachate). After completing the extractions, the solid phase residue will be completely digested and analyzed for the COPCs.

Specific steps in the extraction procedure are as follows:

- Place 2 grams of soil (accurately weighed) in a 100-milliliter (mL) centrifuge tube.
- Add 100 mL of deionized water and shake the contents on an end-over-end shaker for 4 hours.
- Analyze a split of deionized water for COPCs .
- Centrifuge contents to remove particles less than 2 micrometers (µm). Decant supernatant into a 200-mL volumetric flask.
- Add additional deionized water (about 100 mL) to the sample residue. Shake contents for 15 minutes, centrifuge, and decant into the 200-mL flask. This step will remove most of the residual constituents from the sample.
- Fill the 200-mL flask to volume with deionized water and filter through a 0.2 µm filter. Measure pH, alkalinity, and Eh. Preserve the remaining water and send it to the analytical laboratory for analyses.
- Prepare synthetic ground water using major-ion composition of site ground water.
- Add approximately 100 mL of synthetic ground water to the residue in the 100-mL tube and shake for 4 hours.
- Analyze a split of ground water for the COPCs.
- Centrifuge contents to remove particles less than 2 µm in diameter. Decant supernatant into a second 200-mL volumetric flask.
- Add additional synthetic ground water (about 100 mL). Shake contents for 15 minutes, centrifuge, and decant into the second 200-mL flask.
- Fill the 200-mL flask to volume with synthetic ground water and filter through a 0.2 µm filter. Measure pH, alkalinity, and Eh. Preserve the remaining water and send it to the analytical laboratory for analyses.
- Dry, grind, digest completely, and analyze the residue.

- Analyze all samples for the COPCs.
- Calculate the amount of each constituent removed during each step. Calculate the total amount of each constituent.

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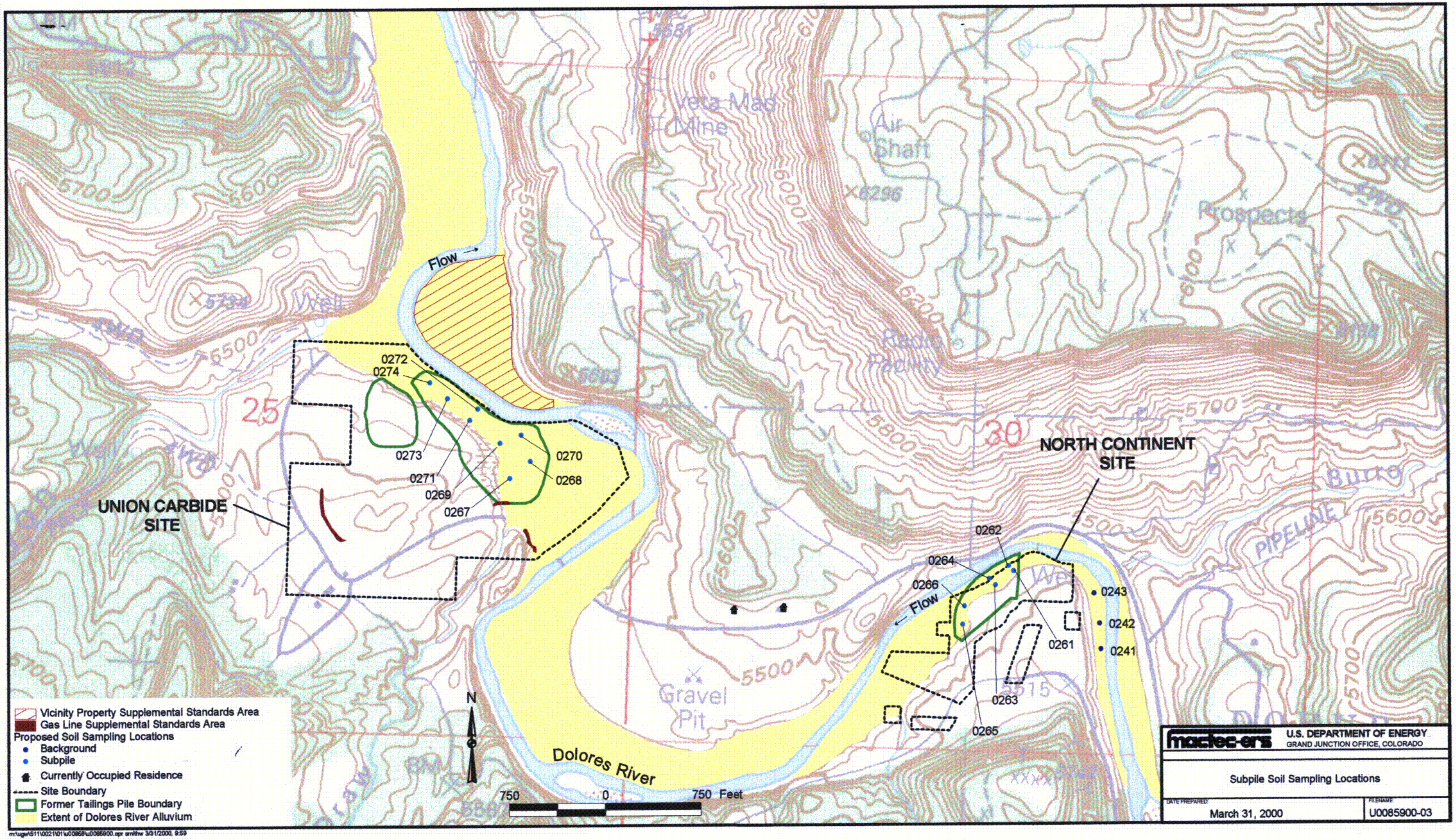

Figure B–1. Subpile Soil Sampling Locations

C5

Appendix C

Determination of Distribution Ratios

Determination of Distribution Ratios

Background

As contaminated ground water migrates through soils and rocks, some of the contamination transfers between the solid and liquid phases. This phenomenon causes contamination to travel at a slower rate than the average ground water velocity. The chemical processes that cause this retardation can include adsorption, absorption, precipitation, diffusion into immobile porosity, transfer to vapor phases, and so on. It is generally not possible to differentiate among all of these processes. However, for many aquifer systems, a bulk parameter (the distribution coefficient or K_d) has been used with some success to model the retardation of contamination. Most numerical ground water models use the K_d concept in simulations of contaminant transport. Site-specific K_d values are approximated from distribution ratio (Rd) values that are empirically determined.

Rd is defined as the concentration of a constituent on the solid fraction divided by the concentration in the aqueous phase:

$$\text{Rd} = \frac{\text{(mass of solute sorbed per unit mass of solids)}}{\text{(mass of solute per volume of solution)}} \qquad \textit{Equation 1}$$

Rd values are calculated from the experimental data as:

$$\text{Rd} = \frac{(A - B)V}{(M_s)B} \qquad \textit{Equation 2}$$

where

A = initial concentration of the constituent (mg/L)
B = final concentration of the constituent (mg/L)
V = volume of solution (100 mL in all cases)
M_s = mass of soil used (g)
K_d = distribution coefficient (mL/g)

K_d is numerically equivalent to the Rd if the system is at equilibrium and the Rds are constant over the range of conditions being modeled. At elevated concentrations of a constituent, the Rd often varies with the concentration. In this case the isotherm is said to be nonlinear and cannot be accurately represented using a K_d.

Sample Selection

Samples will be collected during the drilling of background wells 300 and 301. Samples of the alluvial aquifer material will be collected continuously from the top of the water table to the top of bedrock. Rd values will be determined for uranium and vanadium.

Analysis Methods

Laboratory data will be collected using ESL Procedure CB(BE–3) (DOE 1999) which follows an ASTM procedure for batch-type experiments (ASTM 1993). A representative portion of sample is air dried at room temperature. The samples will be collected in a background area so as to avoid the complication of having contamination present in the solid phases prior to the analysis. If contamination was present in the solids, then it needs to be accounted for by measuring concentrations in both the solid and aqueous phases; whereas, if no contamination is present in the solid phase, only the aqueous solution need be analyzed. Analysis of only the aqueous phase will often result in negative values of Rd if contamination is present in the solid phase.

The samples will be sieved to less than 10 mesh (2 mm). Ground water collected from well 301 will be used to determine Rd values. The ground water will be spiked with appropriate concentrations of contaminants. Six point isotherms will be established for uranium and vanadium.

Five grams of each sample is placed in a 125-mL Nalge bottle with 100 mL of the synthetic ground water. Samples are rotated end-over-end at 8 revolutions per minute (rpm) for 24 hours. They are then centrifuged at 3,000 rpm and filtered through a 0.45 µm filter. Samples are then preserved and analyzed. Controls are run through the same process (but without sediment). Sample masses are varied to determine the 5-point isotherms. Rd values are calculated using Equation 2.

References

ASTM, 1993. "Standard Test Method for 24-h Batch-Type Measurement of Contaminant Sorption by Soils and Sediments," Designation D 4646 – 87, 1993 (Reapproved).

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